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TM2 Tissue Machine him

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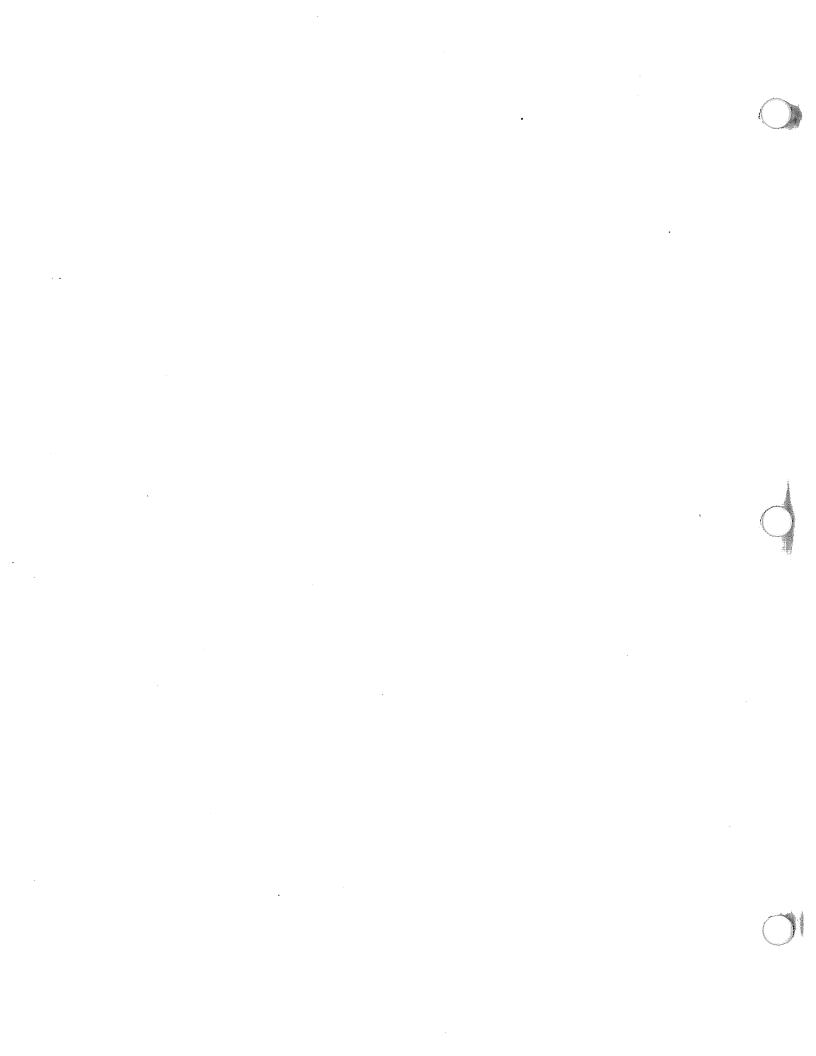
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Overview

Refer to Flow Sheet Stock and Water system. (AN 3401.91)

Stock from Tank 16 is pumped (P 19) to the Machine Chest (Tank 24). The Machine Chest stock is diluted at the suction of the discharge pump (P 36) from 3.5% to 3.0% consistency and pumped to the inlet ports of the double disk refiner, 0 SDM. After passing through the refining tackle, the stock discharges from the outlet branch located at the top of the unit and flows to the "Stuff Box". The level in the Stuff Box is regulated by a control loop (LIC 0224).

The stock is fed from the Stuff Box through a control valve (called the "basis weight valve") into the suction line of the Primary Cleaner Pump (P 37).

The Primary Cleaner Pump blends the thick stock, at 3.0% consistency, with white water from the silo and delivers the slurry at 0.73% to the Primary Cleaner Header.

The stock enters the cleaner tangentially at the top which induces a centrifugal force due to the cylindrical shape of the cleaner. The "heavy" contaminants are flung to the walls of the cleaner. A vortex motion of high rotational speed is maintained inside the cylindrical-conical separating cone. The "heavy" impurities in the suspension concentrate in the range near the wall and exit through a nozzle into the rejects trough (fully enclosed pipe). The rejects from the Primary Cleaners then become the feed to the secondary cleaners.

The good fibers, lightweight impurities, and gas bubbles collect in the center of the separating cone and are forced up the center of the cleaner to the accepts outlet. The lightweight impurities exit the cleaner through a tube in the center of the cleaner head and are directed to the inlet header of the vibrating screen.

The accepted stock is also discharged out the top of each cleaner into a collection header which flows to the inlet of the Fan Pump (P 40).

The "heavy" rejects from the primary cleaning stage flow into the suction of Pump 38 which provides the feed to the Secondary stage cleaners (6 KS 160/6R). To improve the efficiency of cleaning, dilution water is added to the rejects from White Water Silo to decrease the consistency from 0.8% to 0.5%.

Although the principles of cleaning are identical to the Primary Stage, there is no lightweight contaminant separation in the Secondary and Tertiary Cleaning Stages. The

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rejects are forced out the bottom of the cleaner and become the feed to the Tertiary Cleaner Stage. The accepts exit the top of the cleaner and flow to the suction of the Primary Cleaner Pump 37 to be cleaned again (Cascade System).

The heavy contaminants from the Secondary Stage cleaners flow to the suction of pump where they are blended with dilution water from the White Water Silo and pumped to the inlet header of the 2 KS 160/6R cleaners. The principles of cleaning are identical to the previous cleaner stage.

The rejects are forced out of the bottom of the cleaner and are removed from the process. The accepts exit through the top of the cleaner and are recycled back to the rejects line from the Primary Cleaner Stage to be fed back into the Secondary stage.

Accepts from the Primary Cleaners flow to the suction of the Fan Pump (P 40). The fan pump blends the stock with dilution water from the white water silo and delivers the 0.26% slurry to the inlet of the Pressure Screen PS 30.

The Pressure Screen separates contaminants on the basis of size. The Screen Basket is equipped with 2.5mm holes. Contaminants and fiber which are not accepted exit the screen through a reject port located at the bottom of the screen cylinder and flow to the inlet header of the Vibrating Screen 1000K. An air bleed also flows to the vibrating screen. Accepts flow to the Headbox and onto the paper machine.

The vibrating screen separates the contaminants by size. The screen plate is equipped with 2.5 mm holes. The accepted stock passes through the holes and flows back to the White Water Silo. Rejects fall off the screen plate into a collection bin.

Major Equipment

The major equipment used in the Approach Flow are:

- 0 SDM Refiner
- Stuff Box
- Primary Cleaners Type E
- Secondary Cleaners Type R
- Tertiary Cleaners Type R
- Fan Pump DK
- Pressure Screen 30
- Vibrating Screen 1000K.

0 SDM Refiner

Purpose

To modify the fibers by increasing the surface area and flexibility of individual fibers to maximize fiber-to-fiber bonding.

Process Description

Stock from Tank 16 is pumped (P 19) to Tank 24, the Machine Chest. The Machine Chest stock is diluted at the suction of the discharge pump (P 36) from 3.5% to 3.0% consistency. This dilution is done through a consistency regulator and controller (NIC 0223) installed on the discharge side of pump P 36 which activates the valve position 1405, opening and closing it.

The suction of pump (P 36) also receives the recovered stock from the disk filter at 3.5% consistency. Pump (P 36) feeds the stock to the inlet ports of the double disk refiner. The inlet and outlet pressures of the refiner are controlled by means of the valves position 1413, 1414 and 1415 respectively.

The rotor is provided with stock inlet openings near its body (hub), which ensure a uniform stock distribution to the disks, as well as a pressure compensation in the event that the stock supply through both inlets are different.

After passing through the refiner disks, the stock is discharged through the outlet branch, at the centre of the casing to the Stuff Box located on the mezzanine.

Basic Components

The refiner consists of a casing with a hinged cover bolted to the tender side. On this cover is mounted a moveable pressure cover, as well as the disk adjusting device (disk feed mechanism). This device is composed of a 2-stage worm gear unit with a two speed reversible motor, which varies the position to the tender-side stator disk via a threaded spindle.

The shaft rotates on grease lubricated anti-friction bearings. The shaft is provided with a "floating" rotor which may be displaced axially both ways between the stator disks.

The dual set of disks consist of two stator disks; sandwiched between them is a rotor disk fitted with refining plates on both sides. One of the stator disks is rigidly connected to the refiner casing, the second stator disk is axially adjustable in the casing cover. The rotor disk mounted on the shaft is also adjustable. Interengaging spline shaft teeth connect rotor and shaft for torque transmission.

With the disk being adjusted by means of the disk feed mechanism, it is possible to exert more or less pressure on the disks. The result is a more or less refined stock. When passing through the disks, the stock forces the rotor to an intermediate position, so that on both sides of it, the refining conditions remain the same.

The specially designed set of disks forms a self-contained system of forces. Therefore, the shaft bearings are not affected by axial loads.

1) Casing

A one piece refiner casing provides the main body of the refiner.

2) Hinged Casing Cover

A one piece refiner casing cover is bolted to the refiner casing. It is hinged to provide easy plate changes. The disk adjusting device is mounted on this cover.

3) Disk Adjusting Gear

A disk adjusting gear is mounted on the casing cover. It consists of a two-staged helical gear reducer with a poli-changing drive motor. A handwheel is provided as a safety measure in case of motor failure. Each handwheel turn corresponds to a 0.230 mm movement.

4) Inlet Ports

Two Inlet Ports are used to feed the stock into the refiner. One port is located in the casing while the other is located in the casing cover. Their diameters are 80 mm.

5) Outlet Port

The refined stock exits the refiner through the outlet port located in the top of the refiner casing. The diameter of this port is 125 mm.

6) Stator Disks

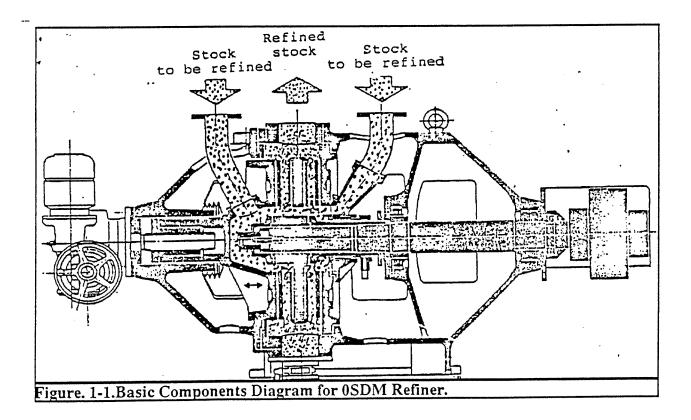
The two stationary disks located at either end of the casing are the Stator Disks. Each disks is cast in 6 segments. Stator Disk 1 has left hand knives. Stator Disk 2 has right hand knives. Since each set of 24 segments is ground and balance individually, it is not possible to replace individual segments of one set by segments of another set.

7) Rotor Disks

The two rotating disks attached to the rotor are the rotor disks. Each faces a stationary stator disk. Each is cast in 6 segments. Rotor disk 1 has left had knives, while disk 2 has right hand knives. Since each set of 24 segments is ground and balanced individually, it is not possible to replace individual segments of one set by segments of one set by segments of another set.

8) Rotor

The Rotor is the drive shaft for the rotor disks. It is mounted inside the refiner casing. The direction of rotation is to the right (clockwise) when looking to the refiner drive journal.



Technical Data

Operating Instructions No. 4265

Size: 0 SDM

Disk Diameter: 500 or 610 mm. Throughput: 20-80 T/D

Throughput: 20-80 T/D Stock Consistency: 3.5-6.0%

Inlet Pressure: 0.7-1.0 bar
Outlet Pressure: 0.55 mPa (max)

Control Air Pressure: 0.4-0.5 mPa

Fresh Water Pressure:

Water Consumption:

Weight:

1.1 mPa

10 l/min.

2965 kg

Refiner Disks -Stator and Rotor

Construction: Cast, supplied in segments.

Segments: 24 segments make up 1 complete set.

12 segments with left hand knives and 12 segments

with right hand knives. 6 segments per disk.

Motor

Three phase, asynchronous, squirrel cage or slip ring motor, or a synchronous motor.

Disk Diameter: 500-610 mm

Power: 500 hp

Refiner Speed: 1180 rpm

Construction Form: B3
Enclosure: IP 54

Start Frequency: 4 times/hour (max)

Direction of Rotation

Rotor: Looking towards the refiner drive journal,

in axial direction, the rotor direction of rotation is to the right (ie. clockwise).

Disk Feed Motor

Looking toward the motor shaft end, the direction of rotation is to the right, (ie. clockwise).

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Dimensions

Height: 1010 mm

Length: 2270 mm

Width: 800 mm

Shaft Diameter: 100 mm

Inlet Port Diameter: 80 mm

Outlet Port Diameter: 125 mm

Operating Parameters

In order to develop strength in the formed sheet, fibers must bond together and form a tight network. As the contact area between fibers increases so does the strength of the sheet.

The surface area of the fiber is increased by "brushing" the primary (outside) wall of the fiber creating "fibrils" or ribbons. The fibrils extend from the fiber and increase the number of potential bonding sites. As the primary wall is brushed, water penetrates the internal layers of the fiber causing it to swell. The flexibility of the fiber is increased by the degree of swelling making it more pliable and bondable.

Some fiber shortening (or cutting) almost always occurs during refining due to the shearing action of the bar crossings. Fiber cutting is considered undesirable in the tissue mill, because it results in slower drainage and loss of strength.

The brushing action occurs in two methods:

1) Shear Stress

The rolling, twisting and tensional actions between the fibers and the refiner's grooves, holes and channels is known as shear stress.

2) Compressional Stress

The bending, rolling, twisting, crushing, pulling, pushing actions between fibers in the area between the refiner plates or "tackle" is compressional stress.

See Smook (p.181 fig.13-16) for illustration of refining method.

Refining Variables

There are several factors which the operator can adjust to affect the refining process. Some of the operating variables which affect refining are:

- Consistency
- Throughput
- Applied Energy
- Temperature
- pH
- Plate Design
- Tackle (construction materials)
- Speed of Disk Rotation

1) Consistency

The higher the stock consistency, the better the refining because there is more fiber-to-fiber contact and less cutting action.

2)-Throughput

The throughput is adjusted with an orifice-type regulating valve mounted in the discharge pipe. The higher the throughput, the shorter the refining time.

3) Applied Energy

The power input is adjusted by variation of the gap width between refiner disks. The gap width is adjusted mechanically. The adjusting gear is mounted inside the casing cover; it consists of a two stage gear unit driven by a pole changing motor which varies the position of the tender side stator disk via a threading spindle. While the stock is entering, the adjustable rotor assumes a central position so that the gap widths on both sides of the dual set of disks are the same. The greater the applied energy, the smaller the gap width, the higher the degree of refining.

4) Temperature

An increase in temperature slows down the rate of refining. Higher stock temperature cause a decrease in fibrillation because of the increased softness of the cellulose. The viscosity of the water decreases, so that its cushioning effect on the fibers in a wad of pulp diminishes.

5) pH

Higher pH levels (above 7) promote a higher degree of refining because of the greater swelling of cellulose in the alkaline solution.

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6) Plate Design

The plate design is chosen to optimize the rate of refining for a specific type of pulped furnish.

7) Material of Tackle

The nature of the material of which refiner plates are made has a desired effect on the rate or degree of refining. The softer metals are more suitable for "wetting" the pulp; whereas, hard stainless steel plates promote "cutting".

8) Speed of Disk Rotation

The speed of the disk rotation affects the rate of refining. The greater the speed the more pump is circulated and forced into the refining zones. However, turbulence becomes a power consuming factor and must be considered when speeding up the disk rotation.

Note:

Fortunately, in practice most of these system variables have been determined before start-up of the refiner. About the only other variables left for the operator to control are the pulp consistency and the applied power (the refiner load).

Start-up and Operating Procedures

1. Check the distance between the refining disks by means of the indicator of the wear measuring device.

- 2. If required, move the pressure cover by means of the handwheel, at least 5 mm, read on the wear measuring device, so that 2.5 mm clearance exists between the refining disks, on both sides.
- 3. Check the valves position. Set the valves at the refiner stock inlet and outlet to the wide open position. Also, set the stock regulating valve between the pump and the double disk refiner to about 25% to 30% open.
- 4. Open the refiner stuffing box seal-water supply valve and the compressed-air supply valve of the no-flow safety device.
- 5. If the casing was drained for the purpose of tackle replacement or maintenance work, open the flushing water valve on the supply side and fill the casing with water. This is necessary to prevent the no-load operation of the refining disks even for a short period.
- 6. Start the refiner drive.
- 7. Start the machine chest pump (P 36). Switch on the machine chest pump as soon as possible (max. 2 minutes difference), because if no stock passes through the machine, there is a risk of a quick temperature increase due to the no-load power consumption.
- 8. Follow the procedure for Fresh Water Supply Adjustment.
- 9. After the stock is passing through the refiner, adjust the pressure cover, until the power consumption is slightly above the no load consumption. This regulation may be effected manually or by means of the gear unit motor. There are three modes of operation for the gear unit; a) Quick Feed, b) Slow Feed and c) Automatic Feed. The Slow Feed mode of operation provides more careful control, however, the cutoff valve between the stock pump and the refiner must be opened completely. In order to feed the refining disks or to increase the applied power, turn the handwheel slowly to the right. When the handwheel is turned to the left the clearance between the refining plates increases.
- 10. Adjust the required flow by means of the regulating valve at the refiner outlet.
- 11. Set the disk feed in the Automatic Feed mode.

Control and Adjustment During Operation

1) The power adjustment must always be carried out with the refining disk feed motor at slow speed.

- 2) Check the stock distribution in the refining disks. The distribution must be uniform. This may be checked by controlling the temperatures on both sides of the stator disks. The side on which passes less stock will have a higher temperature. If required, adjust the inlet stock flow by means of the respective regulating valves until the temperature is uniform on both sides of the stator disks. (ie. If the temperature is higher on the tending side then open the T.S. inlet valve a small bit. This will cause the temperature to drop on the T.S. The operator can also close the drive side inlet valve to raise the temperature on the D.S. untill it is equal to the temperature on the T.S.
- 3) Adjust the refiner throughput with the regulating valve the outlet pipe. In the event that the stock pressure at the refiner inlet is very high, throttle a little the regulating valve at the pump outlet.

Shutdown Procedures

- 1) Withdraw the refining disks.
- 2) Stop the machine chest pump (P 36) to shut-off the stock supply to the refiner inlets.
- 3) Flush the refiner out by opening the clear water valve 1417.
- 4) Stop the refiner drive motor.

Trouble Shooting

- 1. If The Refiner Does Not Accept Load; Power consumption very low.
- i) Check the pressure cover overload protection in the disk feed reducer and readjust the slipping coupling or the friction coupling.
 - ii) Open casing cover for easy motion.
 - iii) Check that the rotor axial motion is free.
 - iv) Check the inlet and outlet pressures; if required reduce the pressure level.
- 2. If There is Unequal Wear on The Disk Plates

When operating with only one stock inlet.

- i) Increase the inlet pressure, if necessary, connect the second stock inlet. It is possible that the stock is exceedingly throttled when passing through the rotor openings. Therefore, the stock distributes unevenly due to the pressure loss across the rotor.
 - ii) Make certain that the rotor can be easily adjusted in the axial direction.

When operating with two stock inlets

- i) Readjust the stock distribution to the inlets by means of the regulating valves.
- ii) Ensure that the rotor can be easily adjusted in the axial direction.
- 3. If There is Premature Wear on the Stuffing Box Packing
 - 1) Reduce the inlet pressure.
- 4. If There Is Reduced Flow and Increased Pressure Loss.
 - i) Replace the rotor assembly-stator disks and rotor disks.

Appendix 0SDM Refiner

The Procedure For Checking Refining Plate Wear.

After each replacement of the refining plate set, a readjustment of the refining plate wear measuring device must be performed. Refer to diagram 7.6.1 p.1052 of the Voith manual.

- 1. Open the side cover (flange) on the refiner casing.
- 2. Rotate the handwheel of the disk feed gear unit until the disks come together.
- 3. Loosen the two hexagon nuts at the free end of the tie rod (3).
- 4. Fix the indicator (4) at the "zero" of scale (2), by means of the hexagon nut already loosened.
- After adjusting the clearance indicator (4), withdraw the pressure cover 5 mm., indicated on the scale (2). This corresponds to a 2.5 mm clearance between the stator and rotor disks.
- 5. Close the side cover (flange) on the refiner casing. The pressure cover (8) is axially displaced towards the drive end, as the refining disk wear increases.
 - The pressure cover may be displaced by means of the handwheel as well as by the disk feed gear unit.

Over a period of time, the wear of the refiner plates can be determined qualitatively. With the refiner stopped, rotate the handwheel to bring the disks together. The wear of the plates on one disk is equal to one quarter of the ear marked on the scale (2) by the indicator (4).

Example

The indicator shows 12 mm from the "zero" of the scale. It means that the plates on each disk have 3 mm wear. If any significant power drop is noticed, then the refiner plates should be checked immediately.

Procedure For Changing Refiner Plates

- 1. Wash out refiner with flushing water to remove any hardened stock.
- 2. Open hinged casing cover by loosening the screws.
- 3. Loosen the plug (27) and cover (80) on the rotor hub, by removing the screws (85) and (82).
- 4. Loosen the screws (92) and (96).
- 5. Now the rotor is freely mounted on the journal. With the rotor mounting and dismounting device, withdraw the rotor from the shaft and swing it out.
- 6. Replace the worn set of refiner plates with a new set.
- 7. In order to mount the new set of plates, the seat surfaces must be cleaned.
- 8. Thoroughly clean the Helical Mid Grip Bushing (9), and then apply grease.
- 9. Mount the new set of plates and fasten them by means of screws (92) and (96).
- 10. To close up the refiner, reverse the sequence of steps outlined above.

Air and Water Connections-Control

The control equipment for the stock pressure regulation is installed in the refiner casing and consists of a pressure transmitter installed in the fixed stock inlet (drive side) and another in the side flange of the refiner casing.

The refiner is supplied with all the required piping for fresh water and compressed air. The fresh water is controlled by means of the manual valve handwheels located on the control box, on the right side of the refiner. (see fig.--)

The procedure for setting up the gland water flow is as follows. Refer to figure 2.6.1 p.998 of Voith manual.

- 1. Open valves 1 and 3.
- 2. Close valve 2 and 4.
- 3. Open slowly valve 2, so that a small amount of water flows constantly from the stuffing box gland into the hose and then into the discharge channel.
- 4. Open valve 4 so that the water pressure reads on the manometer drops to approximately 0.1 mPa above the stock pressure at the refiner inlet. If the fresh water pressure is too high, slowly close valve 1, to reach the desired value. Instrumentation air is also supplied to the refiner as per figure 2.6.2. p.999 of Voith manual.

Stuff Box

The Stuff Box is located on the mezzanine at the backside of the machine. The stock feed to the Stuff Box comes from the discharge of the 0 SDM Refiner.

The function of the Stuff Box is to maintain a constant head of stock on the top of the basis weight control valve. This is achieved by pumping more stock to the stuff box than the machine requires and allowing the excess stock to overflow into the pipe leading to the dry end pulper.

There are essentially three compartments in this box. The compartment in the center receives the stock from the O SDM refiner under pressure from Tank 24 pump (P 36). The stock then enters the constant level compartment from which stock enters the pipe to the basis weight control valve. The third compartment receives the overflow from the other two compartments and where it flows to the dry end pulper to be returned to Tank 24 (Machine Chest).

Primary Cleaners-Deaeration Type E (20 KS 160/6E)

Purpose

To remove particles heavier than the fibers contained in the stock. To deaerate and remove impurities of low specific weight (ie. cork, styro-foam, wax, stickies, etc).

Process Description

The type E cleaner in the Primary Cleaning stage of the Approach Flow system is exactly the same cleaner as those utilized in the primary and Secondary Stage of "Fine Cleaning And Screening" in the Stock Preparation Manual.

The stock flows from the discharge of the Double Disk Refiner (0 SDM) to a constant head tank (ie. "Stuff Box"). The stock is then fed through a control valve ("basis weight" valve) and is introduced into the suction of the Primary Cleaner pump (P 37).

The pump blends the stock with white water from the W.W. Silo and delivers the slurry to the Primary Cleaners Header which feeds two banks (10/10) of KS 160/6E cleaners. The diluted stock enters tangentially at the top of the cleaners and a centrifugal force is created by the cylindrical shape of the cleaner.

Heavy contaminants are discharged into a closed pipe below the cleaner as opposed to a trough. In this manner, the reject stream becomes the feed for the Secondary Cleaners where fibers are recovered and the contaminants are concentrated and entrained air is minimized.

The central vortex flows upwards to the top of the cleaner where the lightweight impurities and gas bubbles exit the cleaner and flow to the inlet box of the vibrating screen (1000K). The accepts exit the cleaner through a separate branch and flow to the suction of the Fan Pump (P 40).



(Please refer to Fine Cleaning. Figure 5-3 for details)

1) Head Section

The Head Section is located at the top of the cleaner. (Type E- inlet, deaeration, and accept branches.) (Type R- inlet and accept branches, immersion tube.)

2) Separating Cone

The Separating Cone is the conical section which extends from the head section to reject nozzle.

3) Rejects Nozzle

The Reject Nozzle is the discharge nozzle for "heavies". It is located at the bottom of the Separating Cone.

4) Hose Section With Straps

The Hose Section connects the reject nozzle to a plexiglass tube. It must be unplugged when the nozzle is removed.

5) Plexiglass Tube

The Tube acts as a splash guard in an open system and connected to collection pipe in a closed system to minimize "entrained" air.

Technical Data

Inlet Stock Consistency:

2.0% (max)

Throughput:

600 l/min/cleaner

Pressure loss:

1.6 bar

Maximum inlet pressure:

3.0 bar

Minimum discharge pressure:

0.6 bar

Stock discharge from deaeration pipe: 15 l/min (approximately)

No flushing or dilution water

Dimensions

Inlet diameter:

60 mm

Accept diameter:

60 mm

Deaeration Diameter Type E:

20 mm

Neck of one reject tip:

70 mm

Height:

Type E:

2296 mm

Type R:

1966 mm

Operating Parameters

1. Pressure Drop

- 1.6 bar per cleaner
- 32.0 bar for bank of 20 cleaners.

A regulating valve (1431) is located on the discharge line from the cleaners accept to the suction of the Fan Pump (P 40). Throughput is varied by opening or closing this valve to achieve the designed pressure drop. A valve (1423) is also located on the inlet header and is normally open during operation.

2. Inlet Consistency

- 0.6% (optimal)
- 2.0% (maximum)

The inlet consistency will be the ratio of thick stock regulated by basis weight valve at the suction of P 37.

Example

Thick Stock Addition:	1970/	59.10/ 3	.0
White Water Silo:	6610/	14.28/ 0	.22
Inlet to Primary Cleaners:	8580/	73.38/ 0	.86

There will be a slight dilution effect at the suction of Pump 37 due to accepts being reintroduced from the Secondary Cleaners into the process at this point.

Inlet to P 37 (from above example):	8580/	73.38/	0.86
Accepts from Secondary Cleaners:	3420/	14.5/	0.41
Discharge from P 37:	12000/	87.88/	0.73

Hence, inlet consistency is slightly above optimal rating but well below the 2.0% maximum.

Start-Up And Operating Procedures

The Cleaners are part of Group Start IX.

No cleaner preparation required other than turning on sealing water valves at Pump 37.

Pump 37

Permanent Interlocks

None

Process Interlocks

- Vibrating Screen 1000K must be on.
- After these interlocks are satisfied the P 37 is ready to start.

Shutdown Procedures

There are no associated motors with cleaners. Stop supply pump P37.

Safety Precautions

There are no moving parts associated with any of the cleaners other than the pump impeller shafts. Ensure that all guards are properly fitted prior to start-up.

Trouble Shooting The KS 160/6E Cleaners

1. If There Is No Reject Discharge From The Reject Nozzle.

i) Unscrew the nozzle, remove the foreign matter. If it is still plugged, the cleaner may be blocked in the cone and should be inspected on the next shutdown.

2. If There Is Excessive Flow From The Reject Nozzle.

- i) The back pressure at the cleaner outlet may be too high. Gradually open the accept valve and monitor the differential pressure.
- ii) The Nozzle diameter may be too large (due to wear). If necessary, install new nozzles on the next shutdown.

3. If There Are Pressure variations In A Whole Cleaning Stage (at intervals of a few seconds).

- i) Air has been trapped in the elevated sections of the pipe system. Air may be removed by the vent system.
- ii) The outlet pressure of the stage may be too low. Increase the outlet pressure by closing the accept valve and monitor the differential pressure.

4. If There Is No Light Contaminant Discharge. No flow in the tubes. (Type E Cleaner Only).

- i) The discharge pressure is too low. Gradually close the accept valve and monitor the differential pressure. Check for flow in the tubes.
- ii) If the no flow condition has not improved, the tube may be plugged. Disconnect the tube and clean.
 - iii) The loop of the tube may be "kinked" or too high. Adjust tube position or change it.

5. If There Is Excessive Flow From Light Contaminant Tube. (Type E Cleaner Only)

- i) The heavy reject nozzle may be plugged or the accept line is plugged. Inspect and clean if necessary.
- ii) The pressure in the accept line may be excessive. Gradually open the Accept Valve and monitor the differential pressure.)

Secondary Cleaners (6 KS160/6R)

Purpose

To recover valuable fibers from the primary cleaner stage rejects. To concentrate contaminants in the reject stream.

Process Description

The "heavy" rejects from the primary stage flow into the suction of Pump 38 which provides the feed to the Secondary Stage Cleaners. To improve the efficiency of cleaning, dilution water is added to the rejects from W.W. Silo to decrease the consistency from 0.8% to 0.5%.

The principles of cleaning are identical to the Primary Stage. The rejects are forced out the bottom of the cleaner and become the feed for the Tertiary Cleaner Stage.

The accepts exit out the top of the cleaner and are directed to the suction of the Primary Cleaner pump (P 37) to be cleaned again.

The type R cleaner in the Secondary and Tertiary cleaning stage of the Approach Flow system are identical to the Type R Cleaner used in the Tertiary stage of "Fine Cleaning and Screening" in the Stock Preparation Manual.

Basic Components

The KS 160/6R Secondary Cleaners are identical to the cleaners described in the primary stage, except there is no light contaminants discharge on the "R" type cleaner as on the "E" type cleaner. Reference for the components can be made in the Primary Cleaners section.

Technical Data (Type R)

Inlet stock consistency:

2.0% (maximum)

Throughput:

600 l/min.

Pressure loss:

1.6 bar

Maximum inlet pressure:

3.0 bar

Minimum discharge pressure:

0.6 bar

No flushing or dilution water.

Operating Parameters

1. Pressure Drop

- 1.6 bar per cleaner.
- 9.6 bar for bank of 6 cleaners.

A regulating valve is located on the accept discharge line to the suction of P 37. Throughput is varied by opening or closing this valve to achieve the desired pressure drop. A valve is also located on the inlet header an is normally open during operation.

2. Inlet Consistency

- 0.6% (optimal)
- 2.0% (maximum)

The inlet consistency is determined by the consistency of the Primary Stage rejects blended with dilution water from the W.W. Silo. There will be a slight thickening of the rejects from the Primary Stage as these is in all cleaning stages. Therefore, the Tertiary Stage inlet consistency will increase as the Primary Stage inlet consistency increases.

 Inlet Primary Cleaners:
 12000/87.88/0.73

 Reject Primary Cleaners:
 1830/14.56/0.78

 W.W. Silo Addition:
 1770/2.30/0.13

 Inlet Secondary Cleaners:
 3600/16.86/0.47

There will be a slight dilution effect at the suction of the Pump (P 38) due to the accepts from the Tertiary Stage being reintroduced into the system at this point.

Inlet to P 38:

3600/ 16.86/ 0.47

Accepts From Tertiary Cleaners: 1230/ 3.14/ 0.25

Discharge from P 38:

4830/ 20.00/ 0.41

Therefore, inlet consistency is less than 0.5% to the Secondary Cleaners.

Start-Up And Operating Procedures

Pump 38

Permanent Interlocks

• None

Process Interlocks

• P 37 must be on.

After these interlocks are satisfied, P 38 is ready to start.

Trouble Shooting

Refer to Primary Cleaner Section

Tertiary Cleaners (2KS 160/6R)

Purpose

To recover fibers from the Secondary Cleaner rejects. To concentrate the contaminants in the Tertiary Cleaner reject stream which are discharge from the process.

Process Description

The heavy contaminants from the secondary stage cleaners flow to the suction of Pump 39 where they are blended with dilution water from W.W. Silo and pumped to the inlet header of two (2) KS 160/6R cleaners. The principles of cleaning are identical to the Secondary Cleaner stage.

The rejects are forced out the bottom of the cleaner to the Reject Regulator area.

The Reject Regulator functions in a manner which resembles a combination of continuous discharge and a reject trap. "Heavies" which settle to the bottom of the cleaner are collected in a smaller cone located below the tip of the main conical section. Fiber saving water can be controlled with a regulating valve and allows water to clean the contaminants and in turn recover valuable fibers. Unlike a reject trap however, this area is continuously discharged through a tip located at the bottom of this collection area. The rejects are collected in a header and flow to sewer.

The accepts exit through the top of the cleaner and are recycled back to the reject line at the Primary Cleaner Stage to be fed back into the Secondary Cleaning Stage.

Basic Components

The KS 160/6R cleaners are similar to the Secondary Stage Cleaners except for the Reject Regulator.

Reject Regulator

The Reject Regulator is a small collection cone where fibers can be washed from the contaminants before discharge.

Technical Data (Type R)

Inlet stock consistency:

2.0% (maximum)

Throughput:

600 l/min.

Pressure loss:

1.6 bar

Maximum inlet pressure:

3.0 bar

Minimum discharge pressure:

0.6 bar

No flushing or dilution water.

Operating Parameters

1. Pressure Drop

- 1.6 bar per cleaner.
- 3.2 bar for bank of 2 cleaners.

A regulating valve (1422) is located on the discharge line from the accept discharge line to the suction of P 38. Throughput is varied by opening or closing this valve to achieve the desired pressure drop. A valve (1418) is also located on the inlet header and is normally open during operation.

2. Inlet Consistency

- 0.6% (optimal)
- 2.0% (maximum)

The inlet consistency is determined by the consistency of the Secondary Stage rejects blended with dilution water from the W.W. Silo. Like the Secondary Cleaners, the inlet consistency is effected by the inlet consistency of the Primary Cleaners. This is due to the cascading design of the cleaning system.

 Rejects From Secondary Cleaners:
 180/
 2.36/
 1.31

 W.W. Silo Addition:
 1020/
 1.33/
 0.13

 Inlet to Tertiary Cleaners:
 1200/
 3.69/
 0.31

There is no dilution or reintroduction at the suction of the Pump (P 39) from any other source but the Secondary Stage rejects. Hence, the 0.31% inlet consistency (at a 0.73% Inlet Consistency Primary Cleaners) is well below the optimal rate and should ensure efficient cleaning at a proper pressure drop.

Start-Up And Operating Procedures

Pump 39

Permanent Interlocks

None.

Process Interlocks

• P 38 must be on (AFM-241).

Shutdown Procedures

Stop Supply Pump (P 39).

Trouble Shooting the KS 160/6E Cleaner

Please refer to Primary Cleaners section-they are virtually the same cleaner.

Fan Pump (Type DK)

Purpose

To blend the accepted stock from the Primary Cleaners with white water and deliver the suspension through the primary screen into the inlet of the headbox. The flow rate must be stable, without pulsations or surges, and yet be capable of being varied over the entire range of machine operation.

Process Description

The heart of the approach flow system is the fan pump, which serves to mix the stock (furnish) with the white water and deliver the blend to the headbox. The flow rate and pressure must be stable for a wide range of machine speeds.

The variable speed centrifugal fan pump is designed with a double flow impeller. The liquid (stock slurry) to be delivered is separated into two flows in the suction nozzle and then is fed to both sides of the impeller by separate channels.

Accepted stock from the Primary Cleaners at 0.70% consistency is added to the suction of Fan Pump (P 40). The pump blends the stock and white water from the silo and delivers the slurry at 0.30% to the inlet of PS 30.

The accepts from the primary screen, under pressure developed by the fan pump, flow to the headbox and onto the paper machine. The demands on this pump are very exacting and impact the whole paper making process.

Basic Components

- 1) Split spiral case with L-wearing rings and removable upper section.
- 2) Closed double entry impeller with offset vanes and exchangeable wearing rings.
- 3) Shaft with two drive journals and ceramic coated stuffing boxes.
- 4) Stuffing boxes with sealing-water connection.
- 5) Variable speed control.

Technical Data

Operating Instructions No. 2112

Notation of centrifugal pumps:

(DK)

Impeller's diameter in mm:

555.

Closed impeller, double flow, compact construction: DK.

i: DK.

40/60:

The pump's size. The numbers are the

diameters for the discharge and suction

nozzles in cm.

Pump Size:

40/60

Delivery (l/s):

400-900

Delivery Head (bar): Power Requirements:

1.5-6.5

75-750 kw

Start-up And Operating Procedures

Permanent Interlocks

• None.

Process Interlocks

- The PS 30 must be running.
- The ninth of 17 events in Group IX.

Note:

Do not start pump before Duoformer and the papermachine are prepared for start-up.

Shutdown Procedure

- 1. Stop pump.
- 2. Close the sealing and cooling water valves. In cold regions where frost may occur, it is advisable to drain the pump completely during prolonged shutdowns to prevent freezing.

Approach Flow 33

Trouble Shooting

1. If Pump Does Not Discharge Or Discharges Poorly.

- i) Deaerate the pump and fill it completely.
- ii) Check the level in the white water silo; it may be too low.
- iii) The Manometric head may be higher than that of the pump.
- iv) The speed of the pump is too low due to a line drop.
- v) The piping may be imperfectly placed, giving rise to trapped "air pockets". Reposition the pipes to avoid trapped air.
- vi) The pump sucks air due to leakage in the feeding pipes or through the stuffing boxes.
- vii) Replace any worn parts, such as impeller, wearing rings, or packing
 - 2. If Pump Discharges Too Much.
- i) The Manometric head is lower than that of the pump; throttle the valve in the discharge line a little more.
 - 3. If Motor Is Overloaded.
- i) Decrease throughput; reduce speed of the fan pump.
- ii) Slacken the stuffing box glands a little, which may be too tight.
- iii) Remove any strings or entangled impurities from the impeller or from the space between the impeller and the wear rings.

Pressure Screen Size 30 (PS 30)

Purpose

To remove contaminants larger in size than the openings in the screen basket (ie. specks, threads, fiber bundles).

Process Description

The PS 30 represents the last barrier for contaminants prior to the Paper Machine.

The diluted stock from the Fan Pump (P 40) is pumped to the inlet of the Pressure Screen 30 and into the Screening Zone where the stationary Screen Basket and Rotor are located. The Screen Basket is equipped with 2.0 mm diameter perforations. Inside the Screen Drum, the rotor with streamlined vanes rotates past the inner surface of the Drum, thus setting up a vacuum which prevents plugging of the Screen Basket. Any flakes contained in the furnish are broken down so that the fibers can pass through the perforations.

The vanes and gravity cause foreign matter to collect in the bottom of the Screen where it is continually removed. The rejects flow to the inlet box of the vibrating screen (1000K). The air bleed also flows to the Vibrating Screen. The reject discharge is controlled by an adjustment of a hand controlled regulating valve.

The accepted stock which passes through the Screen Basket perforations discharged from a tangentially arranged Outlet Branch and flows to the manifold of the Headbox.

The Cleaners are installed ahead of the screens to remove any fine sand particles which might otherwise stick in the fine perforations of the screen.

Basic Components

1) Housing

The Housing is the casing portion of the screening machine. The split-housing can be sectionally dismantled.

2) Cover

The Cover is the cap which seals the machine.

3) Inlet Port

Stock enters the screen tangentially through the Inlet Port under pressure from supply pump (P 40) into the inlet zone located above the Screen Basket.

4) Screen Basket

The Screen Basket is the drum-like structure equipped with either holes or slots. The size of the openings determine the minimum size of debris that will be removed. A retaining ring secures the basket during operation. The area surrounding the Screen Basket is referred to as the Screening Zone.

5) Rotor

The Rotor is the device which is caused to rotate by a belt-pulley drive connected to a motor (8 heavy-duty narrow V-belts). Its principal function is to clean the openings in the Screen Drum to prevent "plugging". The direction of rotation when viewed from the top is clockwise.

6) Motor

The Motor is bracket-mounted to the housing. It is equipped with a belt sheave.

7) Beltguard And Cover Plate

The Beltguard and Cover Plate protects the operator from possible contact with moving external parts of PS 30.

8) Accept Port

The stock must pass through the Screen Basket openings to exit at the Accept Port. It is located below the Inlet Port on the Housing.

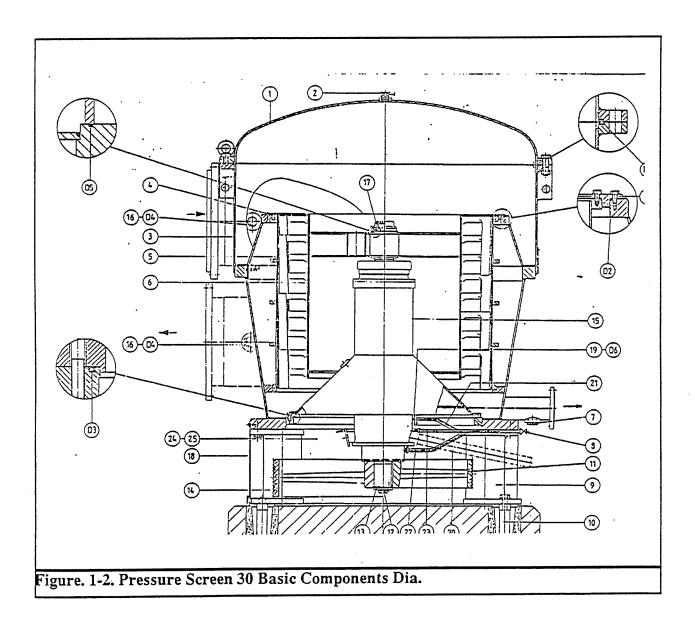
Tissue Machine Manual

9) Reject Port

Contaminants and fibers which are unable to pass through the openings and are heavier than the slurry, flow downwards to the Reject Zone and exit the screen through the Reject Port. It is located at the bottom of the Housing.

10) Lightweight Contaminant Port

Contaminants and fibers which are unable to pass through the openings and are not heavy enough to sink to the Reject Zone are drawn up and out of the screen by the central vortex created by the Rotor through the Lightweight Contaminant Port located in the center of the Cover.



Technical Data

Operating Instructions No.:

2365e

Screen Design:

Centrifugal, Inlet-side Foils

Screen Basket Openings:

2.0 mm holes/pitch 3.43 mm.

Throughput:

400 t/d

@ 0.8 % consistency and 2.2 mm diameter holes.

Throughput depends on grade of stock, consistency and perforations.

Throughput:

38,000 l/min.

Feed Consistency:

2.0% (max)

Pressure Drop:

up to 0.4 bar (slots)

up to 0.3 bar (holes)

Reject Rate:

3 to 15%.

Maximum Inlet Pressure:

7.5 bar

Minimum Outlet Pressure:

0.8 bar

Drive:

Belt and Pulley Arrangement

Motor

Manufactured By:

WEG

Power:

80 hp

Speed:

880 rpm

Pulley Diameter:

184 mm

Rotor

Speed:

159 rpm

Pulley Diameter:

1000 mm

Seal Water Flow Rate: 5 1/min

Operating Parameters

The operating variables which the operators can adjust are:

- Feed Consistency
- Pressure Drop
- Reject Rate

1. Feed Consistency

- 0.8% (Optimal)
- 2.0% (Maximum)

The inlet consistency is dictated by the ratio of thick stock added to white water regulated by the Basis Weight Valve. As with the cleaners, the inlet consistency is a function of this ratio. The accepts from the Primary Cleaners, which are slightly lower in consistency than the cleaner inlet consistency, are blended with white water from the W.W. Silo.

Inlet to Primary Cleaners:	12,000/87.88/ 0.73
Accepts From Primary Cleaners: 1	1,040/74.66/ 0.67
White Water from Silo:	35,709/49.36/ 0.14
Inlet to PS 30:	46,749/124.02/0.26

The designed consistency (flow) to the PS 30 is well below optimal which should lead to efficient screening at proper pressure drop.

2. Pressure Drop

- Up to 0.4 bar (slots)
- Up to 0.3 bar (holes)

Throughput will vary depending on fan pump speed. If fan pump speed is too high, throughput may be too great and plugging could occur. There are no valves at the inlet or accept ports.

3. Reject Rate

• 3-15%

A regulating valve is located on the reject discharge pipe. The reject rate is controlled by opening or closing this valve. Periodically, this valve should be opened fully for 2-5 seconds to remove any, debris which may be "hanging-up" on the valve blade.

Start-up and Operating Procedures

The PS 30 is part of Group Start IX.

Permanent Interlocks

• None.

Process Interlocks

- The second of 17 event in Group Start IX.
- 1. Open valve for Seal Water.
- 2. Open Reject Valve; 60%.
- 3. Open Light Contaminant Valve 100%.

The PS 30 is now ready for operation.

Shutdown Procedures

Group IX sequencing should ensure shutdown. However, if manual shutdown is attempted;

- 1. Stop Screen Feed Pump First (P 40).
- 2. Turn on Dilution/Flush Water.
- 3. Allow Screen to run for brief Flush Period.
- 4. Stop Screen.
- 5. Turn off Flushing Water.
- 6. Drain Screen.

Trouble Shooting

A rise in differential pressure at constant throughput points to a plugging of the screen basket openings. Throttle the inlet valve briefly and the rotor elements should clear the basket surface.

1. If the screen keeps "plugging".

Possible Cause	Solution
• Accept valve open too far. Throughput too great.	Reduce accept valve and watch differential pressure.
 Reject valve closed too far. Not rejecting enough. 	Open reject valve slightly.
• Inlet consistency too high.	Check inlet consistency and reduce if necessary.
Increased rejects in system due to insufficient pre-screening	Are all screening/cleaning units operational ahead of screen? If not, shut down and clean.
 Screen basket is becoming worn. 	Replace basket (if available).

2. Motor Load changes from normal to overload. Amps increase dramatically.

Possible Cause	Solution
Plugged reject line causing rejects to back up into screening zone.	Shut down system and clear line.
• Inlet consistency has decreased	Check consistency and raise if required.
Bearing Problems	Excessive bearing heat or noise should be reported to maintenance.

3. Motor load changes from normal condition to a reduced value. The amps read lower.

Possible Cause	Solution
Accept valve plugged.	Close accept valve. If valve does not close, something is obstructing the valve's movement. Opening valve; and increasing flow may free valve.
Accept line plugged	A "cold" or dense-sounding accept line can indicate a plug. Shut down and open line and clean. Start-up and monitor differential pressure

Safety Precautions

- 1. Ensure that all guards are properly fitted and secured.
- 2. Avoid operating screen with valves closed as this may lead to inadmissible temperatures and steam development.
- 3. During maintenance work, empty the piping system and the working chamber of the unit before opening the machine and lockout motor.

Procedure to Change Screen Basket

Note:

Before opening screen, ensure it is completely locked out from all power sources.

- 1. Completely empty the screen.
- 2. Remove fastening bolts for cover and place cover to one side using the chain block.
- 3. Remove bolts at retaining ring above the screen basket and remove ring.
- 4. Position screen lift-out device. To ensure proper fastening of the screen drum the contact areas must be free from dirt.
- 5. Pull screen drum out.
- 6. Thoroughly clean basket and replace in reverse order.
- 7. When installing the Screen Drum, make absolutely sure that it is in the correct mounting position.

Vibrating Screen 1000K

Purpose

To recover valuable fibers from the Primary Screen rejects. To concentrate the impurities in the reject discharge.

Process Description

The Vibrating Screen 1000K is used as a Secondary Screen in the approach flow system. The vibration keeps the screen plate from plugging, as opposed to the rotor in a pressure screen. The relatively high vibrational frequency of the Screen Basket provides rapid rejects discharge, and as the vibrational amplitude is greater than the maximum fiber length, a high screening efficiency is obtained.

The perforated screen plates have highly polished surfaces with 2.5 mm holes (the same as the Primary Screen).

The Screen Basket is suspended inside the vat from cross beams supported by four compression springs. The Screen Basket is shaken by means of a vibrator motor and an unbalanced shaft weight. Coil springs prevent transmission of the vibration to the screen base.

The Rejects and Lightweight Contaminants from the PS 30 (air bleed) and the Lightweight Contaminants from the Primary Cleaners flow to the Inlet Box and are fed uniformly over the full width of the Vibrating Screen.

The flat Screen Plate of the Screen Basket does not immerse in the stock. It is essential to achieve the buildup of an air cushion underneath the screen plate to ensure the satisfactory operation of the vibration screen. Therefore, the stock level is adjusted in the accepts vat so as to provide a minimum clearance of 30 mm between the Screen Plate and the accepts vat level. The operator can adjust this level by adjusting the Damming Flap. To prevent the air cushion from escaping at the sides, a frame is arranged underneath the Screen Plate. During operation, this frame must immerse in the accepts.

The air trapped underneath the Screen Plate can escape only through the Screen Plate perforations, thus intermittently lifting the layer of impurities which have deposited on the screen plate surface. These impurities are automatically delivered to the discharge end.

The Accepts pass through the screen into an Accepts Vat. An adjustable Damming Flap provides convenient control of the accepts level in the vat. The overflowing accepts leave the screen and flow to the W.W. Silo to a pipe that leads to the suction of P 37.

The rejects discharge from the vibrating screen basket through a chute into a bin. A fiber saving shower is arranged ahead of the rejects discharge zone and prevents the discharge of good fibers.

A Lightweight Hood is used to prevent stock from splashing out of the Screen.

Basic Components

1) Inlet Box

The Inlet Box distributes the inlet flow evenly across the width of the Screen Plate.

2) Steel Vat

The Steel Vat forms the bottom section the unit. It has a collection tray for screen accepts and a clean-out cover. The clean-out cover allows cleaning of vat during shutdowns.

3) Splash guard

The splash guard is a cap which prevents splashing.

4) Screen Basket

The Screen Basket is a basket with a drilled stainless steel bottom plate which screens out contaminants. It is suspended inside the vat from cross-beams supported by four compression springs. Sloped upwards on the rejects discharge end. The hole size determines minimum size of contaminants that can be removed.

5) Cylindrical Compression Springs

Four Compression Springs support the Screen Plate and dampen the Vibration to the foundation.

6) Damming Flap

The Damming Flap is an adjustable weir which regulates the accepts flow in order to maintain designed vat level distance of 30 mm between the bottom of the Screen Plate and the accept level is required for this unit. The flap is adjusted with a handwheel located on the discharge side.

7) Shower

The Shower is used to wash contaminants free of fibers. The shower header is equipped with fan nozzles mounted on supports. The shower pressure is regulated by a valve at the inlet header. The clear water for the showers is supplied by Pump 34 (Tank 30).

8) Coupling

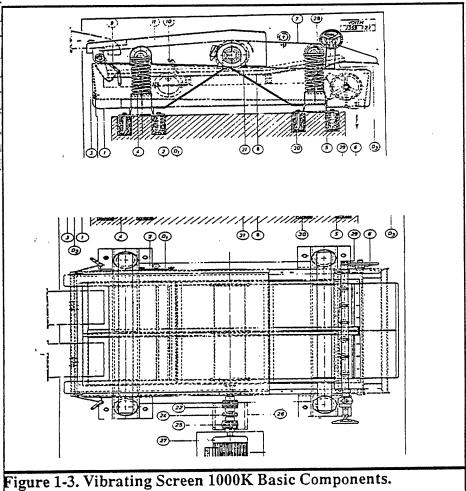
Two flexible Couplings and one flanged Coupling join the motor shaft to the Screen Shaft. They are equipped with a guard to prevent accidental contact with moving parts.

9) Motor

The drive Motor is coupled to the Screen Shaft and provides rotational movement for the unit. Because of the unbalanced weight, a vibrational amplitude is induced.

10) Screen Shaft Assembly

The Screen Shaft Assembly is the driven shaft which rotates in two self aligning bearings. The unbalanced weights positioned on the shaft induce vibrational amplitude. The direction of rotation, when viewed through the motor at the steel vat, is clockwise.



Technical Data

Screen Plate Openings: 2.5 mm holes/pitch 4.5 mm

Throughput: 10-33 t/d (low consistency)

Feed Consistency: 0.3-0.8% Shower Water Consumption: 60 l/min. Shower Water Pressure: 1 bar (min)

Drive: Flexible Coupling

Motor

Manufactured by: WEG
Power: 5 hp
Speed: 820 rpm

Vibration Amplitude: 5-6 @ 820 rpm

Operating Parameters

The operating variables the operator can adjust are:

- Feed Consistency
- Reject Rates
- Differential Head

1. Feed Consistency

0.3-0.8%

The Inlet Consistency is dictated by the ratio of thick stock added to white water regulated by the Basis Weight Valve as with all pieces of Equipment in the Approach Flow System. As Consistency increases, the probability of additional fibers being discharged with the rejects increases. If consistency increases to even higher rates, the vibration may not be adequate to break up the fiber mat and "plugging" may occur on the Screen Plate.

2. Reject Rate

Depending on the amount of contaminants in the inlet slurry, the reject rate may increase. Shower water should be adjusted to wash the contaminants but not to an extent that reject discharge is impeded.

3. Differential Head

The difference in level between the slurry on the Screen Plate and accept slurry in the Vat is the Differential Head.

The designed differential is 30 mm. If the differential head is too high, the stock in the Screen Basket will get entangled, which adversely affects dirt discharge. If its too low, a major part of the stock will dewater on the screen and discharge along with the dirt. The correct adjustment has been found when the discharge end of the Screen Plate is freely visible and covered with impurities only. Adjust the handwheel to control the dam position.

Start-up and Operating Procedures

Permanent Interlocks

None

Process Interlocks

• The 1000K is part of Group Start IX. The first of 17 events in Group Start IX.

Note:

There is no gland or sealing water.

- 1. Start Vibrating Screen.
- 2. Open Shower Water Valve.
- 3. Raise Damming Flap and allow the Vat to fill.
- 4. Open the Inlet Valves from the PS 30 rejects and open the lightweight line from the Primary Cleaners.
- 5. The Screen is now ready for operation.

During operation the operator can adjust the shower water flow so that contaminants remain fiber free and does not impede the contaminant discharge.

Shutdown Procedure

The Group IX Sequencing should shutdown the screen. However, in the case of manual shutdown:

- 1. Stop the stock supply pump (P 37 and 40) for screen.
- 2. Allow the shower to blast dirt and fibers from the screen plate.
- 3. Turn off the Shower Water Valve.
- 4. Stop Screen.

Trouble Shooting

- 1. If Screen Fails to Convey Stock.
- i) The differential head may be too high. This may be the result of the throughput being too great or there may be an increase in impurity concentration.
- ii) The Shower water flow may be inadequate or the motor rotation may be incorrect.
 - 2. If There is Entanglement on the Screen Surface.
- i) The differential pressure may be too high. Stringy impurities are accumulating on the screen.
- ii) The screen perforation or slot width is too small.
 - 3. If There are Stock Deposits Inside The Vat.
- i) The operator should lower the Damming Flap for cleaning and clean the vat through the clean-out hole.
 - 4. If There is "Lumping" in the Screen Basket.
- i) There may be excessive shower water flow or there may be inadequate throughput.

Procedure To Replace The Screen Basket

- 1. Remove the Splash Guard.
- 2. Remove Shower.
- 3. Disconnect the Flange Coupling. Before replacing the Screen Basket or mounting the new Screen Plate, lift the Screen Basket from the four cylindrical compression springs and inspect the area.

Procedure To Clean The Vibration Screen

During Operation

- 1. Inspect the Screen Basket for the presence of impurities at least once during every shift.
- 2. Any dirt particles plugging the surface of the screen can be removed with a scraper and will automatically be discharged.

Scraper Suggestion

A 40mm x 6.5mm x 250mm flat steel scraper welded at right angles to a 2.5 cm diameter pipe. (Approximately 2 meters in Length).

During Shutdown

- 1. Raise the Damming Flap up to its stop so that the screen can be completely emptied.
- 2. If the Vat contains deposits, clean the vat through the Clean-out Hole.
- 3. Thoroughly flush the Screen Basket and Vat with water.

Appendix I

Pumps and Tanks

P 36- Machine Chest Pump

Function

To blend stock in the Machine Chest with thickened stock returned from the Drum Filter and pump the slurry at consistencies of 3% to the inlet of the 0 SDM Refiner.

Operating Data

Designation:

L 275-GIII- 12.5/15

0=

2250 l/min

Pump Head:

26.5 mWG

P 37- Primary Cleaner Pump

Function

To mix the thick stock from the Stuff Box with white water from the white water silo, accepts from the vibrating screen, and accepts from the Secondary Cleaners and deliver it to the inlet of the Primary Cleaners (20 KS 160/6E)

Operating Data

Designation:

L 450-GV-30

0=

13,200 l/min

Pump Head:

34 mWG

P 38- Secondary Cleaner Pump

Function

To blend the Primary Cleaning stage rejects with dilution water from the white water silo and accepts from the Tertiary Cleaning stage and deliver it to the inlet of the Secondary Cleaners (6 KS 160/6R).

Approach Flow 51

Operating Data

Designation: L 309-GIII-12.5/15

Q = 4150 l/min

Pump Head: 34 mWG

P 39- Tertiary Cleaner Pump

Function

To blend the Secondary Cleaning stage rejects with dilution water from the white water silo and deliver it to the inlet of the Tertiary Cleaners (2KS 160/6R)

Operating Data:

Designation: L 295-GIII-12.5/15

Q = 1400 l/min

Pump Head: 35.5 mWG

P 40- Fan Pump

Function

To blend the Primary Cleaning stage accepts with white water from the white water silo and recirculation from the headbox, and deliver the slurry to the inlet of PS 30.

Operating Data

Designation: DK 555-40/60 Q = 46749 l/min

Pump Head: 60 mWG

Tank 24- Machine Chest (60m³)

In:

- Stock from Tank 16.
- Broke from 1E Deflaker (Tank 28).

Out:

- Inlet of 0 SDM Refiner (P 36).
- Sweetener stock for Disk Filter (P 43)

Agitator: MAS 1000

Stuff Box

In:

• Discharge from the 0 SDM Refiner under level control (LIC 224).

Out:

- Inlet of the Primary Cleaner Pump (P 37).
- Overflow to the Broke Pit (Tank 27).

Tank 25-White Water Silo (84m³) Stainless Steel Tank

In

- White water from the wire section of the paper machine.
- Recirculation from Headbox.
- Fresh water for makeup.

Out

- Dilution water for Primary Cleaners.
- Dilution water for Secondary Cleaners.
- Dilution water for Tertiary Cleaners.
- Dilution water for Primary Pressure Screen (PS 30).
- Overflow to wire pit.

No agitator.

Headbox 1

Headbox Type W Size 15500

Purpose

To take the stock delivered by the fan pump and transform the pipeline flow into a uniform, rectangular flow across the width of the Tissue Machine. A constant flow (uniform velocity) must be maintained to keep the same impact point on the Forming Roll.

Process Description

The PS 30 located prior to the Headbox must deliver a constant flow to the Headbox, at a set rejects rate. The screen must be able to handle a high feed flow, and remove debris from the stock without interrupting the Headbox operation.

The Fan Pump must be able to pump a high volume flow with variable speed capability.

The Voith Micro Turbulence headbox is very compact and because of its shape it does not have a perforated roll or any other internal rotating element.

In the Voith Headbox, the stock flows through a circular streamlined Inlet Header, for even distribution. The stock then flows from the Header through a bank of small diameter equalizing tubes to a mixing chamber. This will ensure a homogeneous flow into the Microturbulence Tubes. From the mixing chamber the stock flows through the Microturbulence Tubes into the slice channel. The headbox bottom slice lip is adjustable in the open and close direction. The headbox angle in relation to the Forming Roll can also be adjusted. The CD profile adjustment takes place with slice lip micro adjusters (slice screws) attached to the bottom lip.

Strong micro-turbulence that has been generated through the micro-turbulence tube bank ensures an even stock dispersion. The drainage process reinforces this web as drainage starts in the wire section. Final fine tuning of C.M.D. profile is done with the Headbox slice screws, until the profile is even.

The Voith W Headbox is designed to give even stock flow distribution and also to generate micro-turbulence. This is achieved by using equalizing tubes, mixing chamber and turbulence generator.

The equalizing tubes split and give preturbulence to the stock before it is mixed again in the mixing chamber.

2

After the mixing chamber, the stock is forced through a perforated plate and continues through the micro-turbulence tubes into the slice channel. The round tubes gradually become hexagonal so that the open area of the outlet tubes is very high. This evens out the velocity distribution in the outlet flow of the turbulence generator.

The slice channel is symmetrically tapered to maintain an even jet profile. The slice angle can be adjusted to obtain the desired angle of jet impingement on the Forming Roll. The desired angle should yield at least 20 % of the jet hitting the Forming Roll. The bottom slice lip is adjustable vertically (ie. open/close) in relation to the Top Lip.

There are 20 Slice Screws across the width of the Tissue Machine for CD profiling. They are located across the bottom lip at 140 mm intervals. The two Slice Screws on each end of the Slice Lip are separated by 70 and 125 mm intervals respectively. Each Adjusting Rod is fixed to the slice bar by a screw. The Slice Profile can be adjusted with great accuracy to obtain an even profile.

Headbox 3

Basic Components

1) Distributor

The Distributor is an Inlet Header which receives the accepted stock from PS 30 from the drive side. The distributor is designed to maintain equal pressure across the width of the Headbox.

This creates a fixed speed for the pulp jet and an even basis weight profile across the entire width of the Headbox.

The Distributor is circular and streamlined; that is, the diameter decreases a little by little from the drive side to the tending side of the Headbox. A recirculation line which controls the pressure in the Distributor is located at the Tending Side.

Two manholes located on the Distributor give access to the inside so the operator can clean the header.

2) Recirculation Line

The Recirculation Line is used to correct (ie. control) the difference in the liquid pressure which varies from one end of the Distributor Pipe to the other. A maximum capacity of 10% of the liquid in the distributor can be recirculated back to the Fan Pump. The flow is controlled by a hand valve located in the recirculation line on the tending side.

3) Sight Glass

The Sight Glass is a small diameter header fitted on the back of the Distributor so that the operator can determine which end of the header has higher pressure. By opening or closing the bypass valve on the recirculation line, the operator can control the pressure balance in the distributor.

4) Equalizing Tube Bank

The Distributor and mixing chamber are connected by a group of three rows of tubes placed evenly across them. The tubes are also connected at each end by a perforated plate to hold them together. The tubes have the same diameter at the two ends (that is, from the distributor to the mixing room). Once the Inlet Header is balanced, there will be an even flow of stock through each of the small tubes in the bank. The tubes increase the speed of the stock, which creates microturbulence.

5) Mixing Chamber

The stock flows out the tube bank into the Mixing Chamber. The mixing chamber consists of a single enclosed area across the width of the headbox. This chamber unites the jet issuing from the equalizing tubes into a homogeneous flow. This ensures that the speed of the liquid will be even at the entrance to the Microturbulence Tubes.

6) Microturbulence Tube Bank

From the Mixing Chamber, the stock flows through the Microturbulence Tubes to the slice. The Microturbulence Tubes are arranged in seven asymmetrical rows across the width. At the mixing room end (inlet), the tubes are circular and streamlined. At the other end (outlet), the tubes are hexagonal. Therefore, there is a reduced void space between the tubes.

The shape of the tubes maintain a constant microturbulence in the liquid throughout the slice section. The tubes prevent fiber flocculation and therefore, creates a good sheet formation.

7) Rear Wall

The inside of the rear wall of the Headbox is polished and the bottom part is specially designed. When the wall is raised, it forms part of the mixing room. When the wall is lowered, the tubes can be readily accessed for cleaning and inspection purposes. The wall can be lowered down by removing the screws at the top, side and bottom of the wall and activating the handle attached to the rear wall. Before opening the rear wall, ensure that the Fan Pump (P 40), Primary Cleaner Pump (P 37) and the Machine Chest Pump (P 36) are locked out.

Note:

Do not forget that even if the inside of the rear wall is finished with polished stainless steel, you must pay particular attention and not damage the surface when raising or lowering it. The wall rapidly corrodes if it is scratched or damaged.

8) Bottom Lip Adjustment

To vary the Slice Opening Width, the Bottom Lip is adjustable by motor, through two coupled worm gears. An indicating device on the tender side indicates the respective slice opening width in mm. The Slice Adjustment controls are located in the control box CB1-TM at the Tending Side of the Headbox as well as in control desk CD1-TM in the Paper Machine control room. There are two selector switches on CB1-TM; Top Switch-(CDI/Local); Bottom Switch Spring return-(Open/Close). Also there are two buttons in CDI-TM. The Top button: (push to close). Bottom button: (push to open).

Headbox 5

The slice opening variations influence the stock water amount, the stock consistency and the jet velocity when the other machine conditions remain constant.

9) Fixed Point Adjustment

The Slice Bottom Lip is fitted with 20 manually operated micro-adjusters (slice screws) to regulate the jet profile. The slice screws are used to bend the bottom lip and thereby, modify the jet thickness. The micro-adjusters are numbered form the front side. They are furnished with an indicator dial showing the deviation of the Bottom Lip from the centering position. At erection, the slice is adjusted so as to be parallel to the top lip and the scale of the indicating device is set to "0" (centering position). The scale indication does not express the actual value of the adjusting travel, it just represents a mark. To avoid permanent slice lip deformations, the adjusting difference between 2 consecutive slice screws should not exceed 0.2 mm. When larger adjusting travels are required, the adjacent slice screws must be also adjusted.

Note:

A clockwise screw adjustment causes a local lip opening reduction.

10) Headbox Angle Adjustment

The Headbox can be adjusted to set the stock jet impingement point on the Forming Roll. This makes is possible to effect correction in the Web Formation. The variation of the stock jet impingement point on the Forming Roll is achieved through the Headbox Adjusting device. This device is located below the Headbox. The Headbox is adjusted by means of speed reducers with coupled worm and worm gear, with a useful travel of +/- 10mm. Positive valve movement is forward and negative valve movement is backward.

Technical Data

Design: Type W Micro-turbulence

Size: 15500

Drawing #: AP 2142.30
Design Speed: 1800 m/min
Operating Speed: 524-1677 m/min

Basis Weight: 12-40 g/m²

Products: Creped and Tissue Papers

Production Capacity: 80 t/d
Headbox Consistency: 0.6-0.26%

Dryness at Reel: 94%
Wire Width: 2900 mm
Pond Width: 2770 mm
Bearing Centerline Distance: 3550 mm
Soleplate Centerline Distance: 3690 mm

No. Slice Screws: 20 (No. 1 on T.S., No. 20 on D.S.)

Distance Between Slice Screws

1) No. 1 and No. 20: 70 mm from edge of Headbox 2) No. 2 and No. 19: 125 mm from No. 1 and No. 20 3) No. 3 to No. 18: 140 mm separation between each. Headbox 7

Operating Parameters

The main operating variables for the Headbox are the stock consistency, stock temperature and jet-to-wire speed ratio. Normally, the consistency is set as low as possible to achieve good sheet formation, but consistent with wire drainage capacity and retention requirements. Since higher stock temperature improves stock drainage, temperature and consistency are interrelated variables. Consistency is varied by raising or closing the slice opening. Since the amount of stock is set by the basis weight valve, the main factor that changes with slice opening is the amount of water circulated from the Wire Pit.

The ratio of jet velocity to wire velocity is usually adjusted near unity to achieve the best sheet formation. If the jet velocity lags behind the wire, the sheet is said to be "dragged"; if the jet velocity exceeds the wire speed, the sheet is said to be "rushed". Sometimes, it is necessary to rush or drag the sheet slightly to improve the drainage or change the fiber orientation. The jet velocity is regulated through adjustment of headbox pressure.

Jet velocity is defined by the formula:

Vjet = C 2gh

where, Vjet = jet velocity (m/s)

C = Friction Factor

H = Total head of liquid (m)

g = Acceleration due to gravity (m/s²)

For jet velocity to wire speed ratios, the following % Drag can be derived:

Ratio	%Drag
1.0	0
0.98	2
0.98	4
0.94	6
0.92	8
0.90	10

The normal drag is 2%-6% for paper machine operation. Better formation is obtained with a jet/wire ratio of 1.0 (ie. 0% drag) because of random orientation. CMD tensile strength is maximum with a 1.0 ratio. CMD tear is minimum with a 1.0 ratio. With a lower ratio (ie. higher % drag) the fibers will orientate in the machine direction, increasing CMD tear.

The operator can also adjust the slice opening by using an air motor and speed reducers to open or close the slice. The slice adjust controls are located in control box CB1-TM located on the tending side of the Headbox or in control desk CD1-TM located in the Machine Control Room. The slice opening together with headbox pressure determine the volume of headbox outflow as well as stock consistency out of the slice. Opening the slice will decrease the consistency, while closing the slice will increase it.

The slice top lip is fitted with 20 manually operated micro-adjusters (slice screws) to regulated the jet profile. The slice screws are used to bend the bottom lip and, thereby, modify the jet thickness. The slice screws are numbered from the front side. They are furnished with an indicator dial showing the deviation of the bottom lip from the centered position.

Profile corrections can be made by observing the video CMD basis weight profile (Measurex) and adjusting the appropriate slice screws.

Note:

The adjustment difference between two successive slice screws may not exceed 0.2 mm to prevent deformation of the slice lip.

Headbox Head Control

The Headbox total head is defined as being the air pressure plus the height of the liquid in the Headbox. The head control system consists of a pressure transmitter located inside the slice opening after the micro turbulence tubes, a variable speed fan pump and DCS computer and drive system interface.

The pressure transmitter is a pneumatic device which measures the pressure of the air and liquid in the headbox. It is located near the exit of the micro turbulence tubes on the drive side of the box. The transmitter measures the total head pressure and sends out an electric signal to the measurex computer (DCS) system.

The total head pressure is controlled by the jet-to-wire ratio. This method of controlling head to a inputted % drag allows you to always keep the same point of impact on the wire and it also reduces variations in the sheet as much as possible.

To control by % drag (J/W), the measurex computer checks the speed of the wire and determines the total head pressure by maintaining a speed difference between the wire and the pulp jet at the exit of the headbox.

The measurex computer in turn controls the total head pressure in the headbox by changing the speed of the fan pump. The total head control can be operated in manual or

automatic mode by the computer. To do this the operator has to select either manual or automatic mode on a selector switch located in CD1 in the control room.

The operator inputs the desired jet-to-wire ratio at the computer system keyboard. The computer will then calculate the total head pressure required to achieve the jet-to-wire ratio desired at the existing wire speed. The computer then receives an actual pressure signal from the pressure transmitter in the headbox. If there is a difference between the desired and the actual total head then the following two actions can be performed:

Automatic

In automatic mode, the computer calculates a new fan pump speed setpoint and relays this signal to the Asea Drive Control for the fan pump. The Asea Drive Control will then ramp the fan pump speed to the desired value to achieve the total head pressure required to satisfy the desired jet-to-wire ratio.

Manual

In manual mode, the operator must adjust the fan pump speed manually, by using the fan pump draw (+/-) selector switch on CD1 located in the control room. The operator can adjust the fan pump speed in small increments until he achieves the total head pressure required for the desired jet-to-wire ratio.

When the speed of the fan pump increases, the total head pressure also increases. When the speed of the fan pump decreases, the total head pressure also decreases.

Note:

Only make small incremental adjustments of the fan pump speed to avoid large fluctuations in stock flow out of the headbox and a corresponding loss of production.

The table in Appendix I illustrates the total head pressure required for several % drag values at various slice openings.

System Group Start IX

- 1. Vibrating Screen.
- 2. Pressure Screen 30.
- 3. P 37-Primary Cleaner Feed Pump.
- 4. P 38-Secondary Cleaner Feed Pump.
- 5. P 39-Tertiary Cleaner Feed Pump.
- 6. Refiner Plate.
- 7. Refiner Drive.
- 8. P 36-Machine Chest Pump.
- 9. P 40-Fan Pump.
- 10. Saveall Pulper.
- 11. P 47-Saveall Shower Pump.
- 12. Saveall Drive.
- 13. P 45-Repulper Dilution Pump and Saveall Stock Dilution.
- 14. P 41-Wire Pit Pump on Saveall feed pump.
- 15. P 43-Sweetner pump for Saveall.
- 16. P 19-Tank 16 Discharge Pump.
- 17. P 44-Recovered Stock pump teach to M/C chest.

Headbox 11

Start-up and Operating Procedures

- 1. Routine Check of Area.
 - Personnel clear of area.
 - Tissue machine ready.
 - System filled; all sewer valves closed, headbox manholes closed.
- 2. Start-up Tissue Machine.
 - See Start-up procedure for Duoformer T section.
 - See Start-up procedure for Press Section.
 - See Start-up procedure for Yankee Dryer section.
- 3. Start Vibrating screen.
- 4. Start Pressure Screen 30.
- 5. Start Primary Cleaner Feed Pump (P 37).
- 6. Start Secondary Cleaner Feed Pump (P 38).
- 7. Start Tertiary Cleaner Feed Pump (P 39).
- 8. Start Refiner plate adjustment motor.
- 9. Start the OSDM Refiner Drive Motor.
- 10. Start the Machine Chest Pump (P 36).
- 11. Start the Fan Pump (P 40).
- 12. Start the Saveall repulper drive motor.
- 13. Start the Saveall Shower Pump (P 47).
- 14. Start the Saveall filter drive.
- 15. Start the Saveall Stock and Repulper Dilution Pump (P 45).
- 16. Start the Saveall Stock Feed Pump (P 41).
- 17. Start the Saveall Sweetner Pump (P 43).

- 18. Start the Discharge Pump (P 19) on Tank 16. (Stock To Machine Chest.)
- 19. Start the recovered Saveall Stock Pump (P 44) (Back to Machine Chest.
- 20. Set the total head and recirculation as required.

Shutdown Procedures

- 1. Push Stop button for Group Start IX. (or manually stop P 36 and P 40.)
- 2. Shutdown Tissue Machine as per Duoformer, press section and Yankee Dryer Section Shutdown Procedures.
- 3. Washup Wire Section and Headbox Slice after Wires have been stopped.
- 4. Slacken Press felt if extended shutdown. (ie. more than Four hours.)

Safety

- 1. Lockout Fan Pump when working on the Headbox. (ie. cleaning the distributor or the tube banks.
- 2. When closing manholes on the distributor or the rear wall, after inspection or washout, ensure that the gasket is in good shape and that the hatches are secured properly.

Headbox 13

Troubleshooting

Unbalanced Inlet Header. (Distributor)

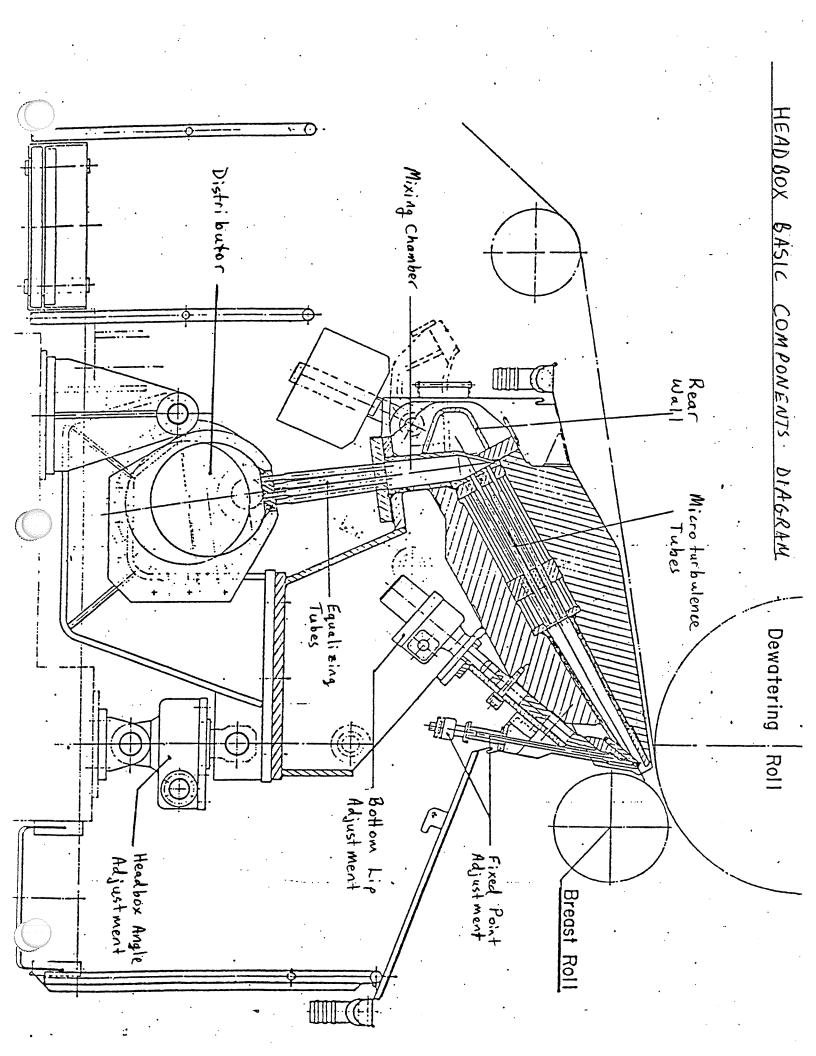
1. Adjust the Headbox recirculation valve by stopping the flow of stock in the sight glass.

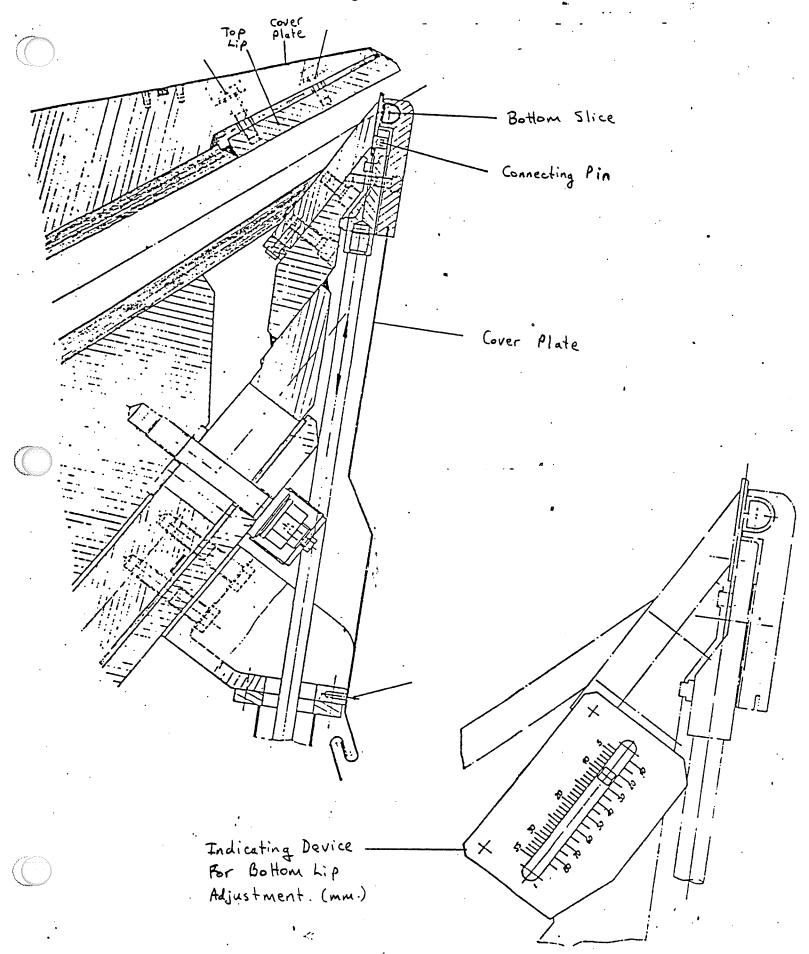
Headbox level not controlling.

1. Check controller operation. Switch to manual if necessary (call instrument technician).

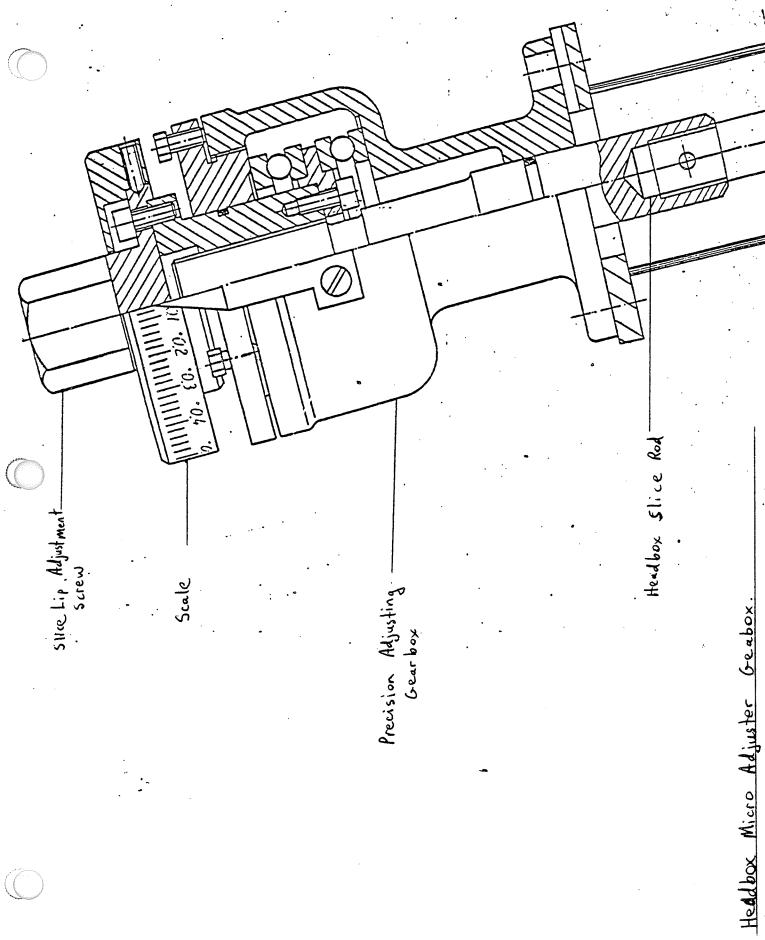
Variations in CMD profile.

1. Adjust respective slice screws across Headbox.





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TM-2 Tissue Machine

(Slice Opening = 7.62 mm.)

Wi	re Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
	500 510	39.6 41.1	38.9 40.3	38.2 39.6	37.5 38.9	36.8
	520	42.6	41.8	41.0	40.3	38.1 39.5
	530	44.1	43.3	42.5	41.7	40.9
	540	45.6	44.8	44.0	43.1	42.3
	550	47.2	46.3	45.5	44.6	43.8
	560	48.8	47.9	47.0	46.1	45.2
	570 580	50.5	49.5	48.6 50.2	47.7 49.2	46.7 48.3
	580 590	52.1 53.8	51.1 52.8	51.8	50.8	49.8
	600	55.5	54.5	53.5	52.4	51.4
	610	57.3	56.2	55.1	54.1	53.0
	620	59.1	57.9	56.8	55.7	54.7
	630	60.9	59.7	58.6	57.4	56.3
	640	62.7	61.5	60.3	59.2	58.0
	650 660	64.6 66.5	63.3 65.2	62.1 63.9	60.9 62. 7	59.7 61.5
	670	68.4	67.1	65.8	64.5	63.2
	680	70.3	69.0	67.7	66.3	65.0
	690	72.3	70.9	69.6	68.2	66.9
and the same	700	74.3	72.9	71.5	70.1	68.7
	710	76.3	74.9	73.4	72.0	70.6
	720 730	78.4	76.9	75.4	73.9 75.0	72.5
	730 740	80.5 82.6	79.0 81.0	77.4 79.5	75.9 77.9	74.4 76.4
	750	84.8	83.1	81.5	79.9	78.3
	760	87.0	85.3	83.6	82.0	80.4
	770	89.2	87.5	85.7	84.1	82.4
	780	91.4	89.6	87.9	86.2	84.5
	790	93.7	91.9	90.1	88.3	86.5
	800 810	96.0 98.3	94.1 96.4	92.3 94.5	90.5	88.7
	820	100.7	98.7	96.8	92.6 94.9	90.8 93.0
	830	103.0	101.0	99.1	97.1	95.2
	840	105.5	103.4	101.4	99.4	97.4
•	850	107.9	105.8	103.7	101.7	99.6
	860	110.4	108.2	106.1	104.0	101.9
	870	112.9	110.7	108.5	106.3	104.2
	880 890	115.4 118.0	113.1 115.7	110.9 113.4	108.7 111.1	106.5 108.9
	900	120.5	118.2	115.9	113.6	111.3
	910	123.2	120.7	118.4	116.0	113.7
	920	125.8	123.3	120.9	118.5	116.1
	930	128.5	126.0	123.5	121.0	118.6
	940	131.2	128.6	126.1	123.5	121.1
gues d'	950 060	133.9	131.3	128.7	126.1	123.6
	960 970	136.7 139.4	134.0 136.7	131.3 134.0	128.7 131.3	126.1 128.7
	980	142.3	139.5	134.0	134.0	131.3
	500	440.J	407.0	200.7	TO 4.0	101.0

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
990	145.1	142.3	139.4	136.7	133.9
1000	148.0	145.1	142.2	139.4	136.5
1010	150.9	147.9	145.0	142.1	139.2
1020	153.8	150.8	147.8	144.8	141.9
1030	156.8	153.7	150.7	147.6	144.6
1040	159.8	156.6	153.5	150.4	147.4
1050	162.8	159.6	156.4	153.3	150.2
1060	165.8	162.6	159.3	156.2	153.0
1070	168.9	165.6	162.3	159.0	155.8
1080	172.0	168.6	165.3	162.0	158.7
1090	175.2	171.7	168.3	164.9	161.6
1100	178.3	174.8	171.3	167.9	164.5
1110	181.5	177.9	174.4	170.9	167.4
1120	184.7	181.1	177.5	173.9	170.4
1130	188.0	184.3	180.6	177.0	173.4
1140	191.3	187.5	183.8	180.1	176.4
1150	194.6	190.7	186.9	183.2	179.4 182.5
1160	197.9	194.0	190.1 193.4	186.3 189.5	185.6
1170	201.3	197.3	196.6	192.7	188.7
1180	204.7	200.6 204.0	199.9	195.9	191.9
1190	208.1 211.5	207.4	203.2	199.1	195.1
1200 1210	215.0	210.8	206.6	202.4	198.3
1220	218.5	214.2	209.9	205.7	201.5
1230	222.1	217.7	213.3	209.0	204.8
1240	225.6	221.2	216.8	212.4	208.1
1250	229.2	224.7	220.2	215.8	211.4
1260	232.9	228.3	223.7	219.2	214.7
1270	236.5	231.8	227.2	222.6	218.1
1280	240.2	235.4	230.7	226.1	221.5
1290	243.9	239.1	234.3	229.6	224.9
1300	247.7	242.8	237.9	233.1	228.3
1310	251.4	246.4	241.5	236.6	231.8
1320	255.2	250.2	245.2	240.2	235.3
1330	259.1	253.9	248.8	243.8	238.8 242.4
1340	262.9	257.7	252.5 256.3	247.4 251.1	246.0
1350	266.8 270.7	261.5 265.3	260.0	254.8	249.6
1360 1370	270.7	269.2	263.8	258.5	253.2
1380	278.6	273.1	267.6	262.2	256.8
1390	282.6	277.0	271.5	266.0	260.5
1400	286.7	281.0	275.3	269.8	264.2
1410	290.7	284.9	279.2	273.6	268.0
1420	294.8	289.0	283.2	277.4	271.7
1430	298.9	293.0	287.1	281.3	275.5
1440	303.1	297.1	291.1	285.2	279.4
1450	307.2	301.1	295.1	289.1	283.2
1460	311.5	305.3	299.1	293.1	287.1
1470	315.7	309.4	303.2	297.1	291.0
1480	319.9	313.6	307.3	301.1	294.9 298.8
1490	324.2	317.8	311.4	305.1 309.2	302.8
1500	328.6	322.0	315.6 319.7	313.2	306.8
1510	332.9 337.3	326.3 330.6	323.9	317.4	310.9
·1520 1530	341.7	334.9	328.2	321.5	314.9
±220					

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Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
1540	346.1	339.2	332.4	325.7	319.0
1550	350.6	343.6	336.7	329.9	323.1
1560	355.1	348.0	341.0	334.1	327.2
1570	359.6	352.4	345.4	338.3	331.4
1580	364.2	356.9	349.7	342.6	335.6
1590	368.7	361.4	354.1	346.9	339.8
1600	373.3	365.9	358.5	351.3	344.1
1610	378.0	370.4	363.0	355.6	348.3
1620	382.6	375.0	367.5	360.0	352.6
1630	387.3	379.6	372.0	364.4	356.9
1640	392.1	384.3	376.5	368.9	361.3
1650	396.8	388.9	381.1	373.3	365.7
1660	401.6	393.6	385.7	377.8	370.1
1670	406.4	398.3	390.3	382.4	374.5
1680	411.2	403.0	394.9	386.9	379.0
1690	416.1	407.8	399.6	391.5	383.4
1700	421.0	412.6	404.3	396.1	388.0

TM-2 Tissue Machine

(Slice Opening = 8.00 mm.)

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
500 510	39.5 41.0	38.8 40.2	38.1 39.5	37.4 38.8	36.7 38.0
520 530	42.5 44.0	41.7 43.2	40.9 42.4	40.2 41.6	39.4 40.8
540	45.5	44.7	43.9	43.0	42.2
550	47.1	46.2	45.4	44.5	43.7
560 570	48.7	47.8	46.9	46.0	45.1
570 580	50.3 52.0	49.4 51.0	48.5 50.1	47.5 49.1	46.6 48.2
590	53.7	52.7	51.7	50.7	49.7
600	55.4	54.3	53.3	52.3	51.3
610	57.1	56.1	55.0	53.9	52.9
620	58.9	57.8	56.7	55.6	54.5
630 640	60.7 62.5	59.6 61.4	58.4 60.2	57.3 59.0	56.2 57.9
650	64.4	63.2	62.0	60.8	59.6
660	66.3	65.0	63.8	62.5	61.3
670	68.2	66.9	65.6	64.3	63.1
680	70.1	68.8	67.5	66.2	64.9
690 700	72.1 74.1	70.7 72.7	69.4 71.3	68.0 69.9	66.7 68.5
710	76.2	74.7	73.2	71.8	70.4
720	78.2	76.7	75.2	73.8	72.3
730	80.3	78.8	77.2	75.7	74.2
740	82.4	80.8	79.3	77.7	76.2
750 760	8 4. 6 86.7	82.9 85.1	81.3 83.4	79.7 81.8	78.2 80.2
770	88.9	87.2	85.5	83.8	82.2
780	91.2	89.4	87.7	85.9	84.2
790	93.4	91.6	89.8	88.1	86.3
800	95.7	93.9	92.0	90.2	88.4
810 820	98.1 100.4	96.2 98 . 5	94.3 96.5	92.4 94.6	90.6 92.7
830	102.8	100.8	98.8	96.9	94.9
840	105.2	103.1	101.1	99.1	97.1
850	107.6	105.5	103.5	101.4	99.4
860	110.1	107.9	105.8	103.7	101.6
870 880	112.6 115.1	110.4 112.9	108.2 110.6	106.1 108.4	103.9 106.3
890	117.6	115.4	113.1	110.8	108.6
900	120.2	117.9	115.6	113.3	111.0
910	122.8	120.4	118.1	115.7	113.4
920	125.5	123.0	120.6	118.2	115.8
930	128.1	125.6	123.2	120.7	118.3
940 950	130.8 133.6	128.3 130.9	125.7 128.4	123.2 125.8	120.8 123.3
960	136.3	133.6	131.0	128.4	125.8
970	139.1	136.4	133.7	131.0	128.4
. 980	141.9	139.1	136.4	133.6	130.9

	%Dmag = 1	%Dwa <i>~ - 2</i>	%Drag = 3	%Drag = 4	%Drag = 5
Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	J/W = .97	J/W = .96	J/W = .95
990	144.7	141.9	139.1	136.3	133.6 136.2
1000	147.6	144.7 147.5	141.8 144.6	139.0 141.7	138.9
1010 1020	150.5 153.4	150.4	147.4	144.5	141.6
1030	156.4	153.3	150.3	147.3	144.3
1040	159.4	156.2	153.1	150.1	147.0
1050	162.4	159.2	156.0	152.9	149.8
1060	165.4	162.2	158.9	155.7	152.6
1070	168.5	165.2	161.9 164.9	158.6 161.5	155.4 158.3
1080	171.6 174.7	168.2 171.3	167.9	164.5	161.1
1090 1100	177.9	174.4	170.9	167.4	164.1
1110	181.0	177.5	173.9	170.4	167.0
1120	184.3	180.6	177.0	173.5	169.9
1130	187.5	183.8	180.1	176.5	172.9
1140	190.8	187.0	183.3	179.6	175.9 179.0
1150	194.1	190.2 193.5	186.4 189.6	182.7 185.8	182.0
1160 1170	197.4 200.7	196.8	192.9	189.0	185.1
1180	204.1	200.1	196.1	192.2	188.3
1190	207.5	203.4	199.4	195.4	191.4
1200	211.0	206.8	202.7	198.6	194.6
1210	214.5	210.2	206.0	201.9	197.8
1220	218.0	213.7 217.1	209.4 212.8	205.2 208.5	201.0 204.2 (
1230 1240	221.5 225.1	220.6	216.2	211.8	207.5
1250	228.6	224.1	219.6	215.2	210.8
1260	232.3	227.7	223.1	218.6	214.1
1270	235.9	231.2	226.6	222.0	217.5
1280	239.6	234.8	230.1	225.5	220.9 224.3
1290 1300	243.3 247.0	238.5 242.1	233.7 237.3	229.0 232.5	227.7
1310	250.8	245.8	240.9	236.0	231.2
1320	254.6	249.5	244.5	239.6	234.7
1330	258.4	253.3	248.2	243.2	238.2
1340	262.2	257.0	251.9	246.8	241.7
1350	266.1	260.8	255.6 259.3	250.4 254.1	245.3 248.9
1360 1370	270.0 273.9	264.6 268.5	263.1	257.8	252.5
1380	277.9	272.4	266.9	261.5	256.2
1390	281.9	276.3	270.8	265.3	259.9
1400	285.9	280.2	274.6	269.1	263.6
1410	290.0	284.2	278.5	272.9	267.3
1420	294.0	288.2 292.2	282.4 286.4	276.7 280.6	271.0 274.8
1430 1440	298.1 302.3	296.3	290.3	284.4	278.6
1450	306.4	300.4	294.3	288.4	282.5
1460	310.6	304.5	298.4	292.3	286.3
1470	314.9	308.6	302.4	296.3	290.2
1480	319.1	312.8	306.5	300.3	294.1
1490	323.4	317.0	310.6	304.3 308.3	298.1 302.0
1500 1510	327.7 332.0	321.2 325.4	314.7 318.9	312.4	302.0
1510	336.4	329.7	323.1	316.5	310.0
1530	340.8	334.0	327.3	320.7	314.1

Wire Speed (M/Min)	%Drag = 1 J/W = .99	Drag = 2 $J/W = .98$	Drag = 3 $J/W = .97$	%Drag = 4 J/W = .96	%Drag = 5 $J/W = .95$
1540	345.2	338.3	331.5	324.8	318.2
1550	349.7	342.7	335.8	329.0	322.3
1560	354.1	347.1	340.1	333.2	326.4
1570	358.7	351.5	344.4	337.5	330.5
1580	363.2	356.0	348.8	341.7	334.7
1590	367.8	360。4	353.2	346.0	338.9
1600	372.4	364.9	357.6	350.3	343.2
1610	377.0	369.5	362.0	354.7	347.4
1620	381.6	374.0	366.5	359.1	351.7
1630	386.3	378.6	371.0	363.5	356.0
1640	391.0	383.2	375.5	367.9	360.3
1650	395.8	387.9	380.1	372.4	364.7
1660	400.5	392.6	384.7	376.8	369.1
1670	405.3	397.3	389.3	381.4	373.5
1680	410.2	402.0	393.9	385.9	378.0
1690	415.0	406.7	398.6	390.5	382.4
1700	419.9	411.5	403.2	395.0	386.9

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TM-2 Tissue Machine

(Slice Opening = 8.50 mm.)

Wir	e Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97		%Drag = 5 J/W = .95
	500	39.4	38.7	38.0	37.3	36.6
	510	40.9	40.1	39.4	38.6	37.9
	520	42.4	41.6	40.8	40.0	39.3
	530	43.9	43.1	42.3	41.5	40.7
	540	45.4	44.6	43.7	42.9	42.1
	550	47.0	46.1	45.2	44.4	43.5
	560	48.6	47.7	46.8	45.9	45.0
	570	50.2	49.2	48.3	47.4	46.5
	580	51.8	50.9	49.9	49.0	48.0
	590	53.5	52.5	51.5	50.5	49.6
	600	55.2	54.2	53.2	52.1	51.1
	610	57.0	55.9	54.8	53.8	52.7
	620	58.7	57.6	56.5	55.4	54.4
	630	60.5	59.4	58.2	57.1	56.0
	640	62.3	61.2	60.0	58.8	57.7
	650	64.2	63.0	61.8	60.6	59.4
	660	66.1	64.8	63.6	62.3	61.1
	670	68.0	66.7	65.4	64.1	62.9
	680	69.9	68.6	67.3	66.0	64.7
	690	71.9	70.5	69.2	67.8	66.5
	700	73.9	72.5	71.1	69.7	68.3
	710	75.9	74.5	73.0	71.6	70.2
	720	78.0	76.5	75.0	73.5	72.1
	730	80.1	78.5	77.0	75.5	74.0
	740	82.2	80.6	79.0	77.5	75.9
	750	84.3	82.7	81.1	79.5	77.9
	760	86.5	84.8	83.2	81.5	79.9
	770	88.7	87.0	85.3	83.6	81.9
	780	90.9	89.1	87.4	85.7	84.0
	790	93.1	91.3	89.6	87.8	86.1
	800	95.4	93.6	91.8	89.9	88.2
	810	97.7	95.9	94.0	92.1	90.3
	820	100.1	98.1	96.2	94.3	92.4
	830	102.5	100.5	98.5	96.5	94.6
	840	104.9	102.8	100.8	98.8	96.8
	850	107.3	105.2	103.1	101.1	99.1
	860	109.7	107.6	105.5	103.4	101.3
	870	112.2	110.0	107.9	105.7	103.6
	880	114.7	112.5	110.3	108.1	105.9
	890	117.3	115.0	112.7	110.5	108.3
	900	119.8	117.5	115.2	112.9	110.6
	910	122.4	120.1	117.7	115.3	113.0
	920	125.1	122.6	120.2	117.8	115.4
	930	127.7	125.2	122.8	120.3	117.9
	940	130.4	127.9	125.3	122.8	120.4
	950	133.1	130.5	127.9	125.4	122.9
	960	135.9	133.2	130.6	128.0	125.4
	970	138.6	135.9	133.2	130.6	127.9
	980	141.4	138.7	135.9	133.2	130.5

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
990	144.3	141.4	138.6	135.9	133.1
	147.1	144.2	141.4	138.6	135.8
1000	150.0	147.1	144.2	141.3	138.4
1010		149.9	147.0	144.0	141.1
1020	152.9	152.8	149.8	146.8	143.8
1030	155.9			149.6	146.5
1040	158.8	155.7	152.6 155.5	152.4	149.3
1050	161.8	158.7	158.4	155.2	152.1
1060	164.9	161.6	161.4	153.2	154.9
1070	167.9	164.6	164.3	161.0	157.8
1080	171.0	167.7 170.7	167.3	164.0	160.6
1090	174.1 177.3	173.8	170.3	166.9	163.5
1100	180.5	176.9	173.4	169.9	166.5
1110	183.7	180.0	176.5	172.9	169.4
1120 1130	186.9	183.2	179.6	175.9	172.4
1130	190.2	186.4	182.7	179.0	175.4
1150	193.4	189.6	185.8	182.1	178.4
1160	196.8	192.9	189.0	185.2	181.5
1170	200.1	196.2	192.2	188.4	184.5
1180	203.5	199.5	195.5	191.5	187.6
1190	206.9	202.8	198.7	194.7	190.8
1200	210.3	206.2	202.0	198.0	193.9
1210	213.8	209.5	205.4	201.2	197.1
1220	217.3	213.0	208.7	204.5	200.3
. 1230	220.8	216.4	212.1	207.8	203.6
1240	224.3	219.9	215.5	211.2	206.8
1250	227.9	223.4	218.9	214.5	210.1
1260	231.5	226.9	222.4	217.9	213.5
1270	235.1	230.5	225.9	221.3	216.8
1280	238.8	234.1	229.4	224.8	220.2
1290	242.5	237.7	232.9	228.2	223.6
1300	246.2	241.3	236.5	231.7	227.0
1310	250.0	245.0	240.1	235.3	230.5
1320	253.7	248.7	243.7	238.8	233.9
1330	257.5	252.4	247.4	242.4	237.4
1340	261.4	256.2	251.1	246.0	241.0
1350	265.2	260.0	254.8	249.6	244.5
1360	269.1	263.8	258.5	253.3	248.1
1370	273.1	267.6	262.3	257.0	251.7
1380	277.0	271.5	266.1	260.7	255.4
1390	281.0	275.4	269.9	264.4	259.0 262.7
1400	285.0	279.3	273.7	268.2	266.4
1410	289.0	283.3	277.6	272.0 275.8	270.2
1420	293.1	287.3	281.5	279.7	273.9
1430	297.2	291.3 295.3	285.4 289.4	283.5	277.7
1440	301.3	299.4	293.4	287.4	281.5
1450	305.5 309.6	303.5	297.4	291.4	285.4
1460 1470	313.8	307.6	301.4	295.3	289.3
1470	313.8	311.8	305.5	299.3	293.2
1490	322.3	315.9	309.6	303.3	297.1
1500	326.6	320.1	313.7	307.3	301.0
1510	331.0	324.4	317.9	311.4	305.0
1520	335.3	328.6	322.0	315.5	309.0
1530	339.7	332.9	326.2	319.6	313.1
100	JJ,				

Wire Speed (M/Min)	%Drag = 1 J/W = .99	Drag = 2 $J/W = .98$	%Drag = 3 J/W = .97	Drag = 4 $J/W = .96$	Drag = 5 $J/W = .95$
1540	344.1	337.2	330.5	323.8	317.1
1550	348.5	341.6	334.7	327.9	321.2
1560	353.0	346.0	339.0	332.1	325.3
1570	357.5	350.4	343.3	336.4	329.5
1580	362.0	354.8	347.7	340.6	333.6
1590	366.6	359.3	352.0	344.9	337.8
1600	371.1	363.8	356.4	349.2	342.0
1610	375.8	368.3	360.9	353.5	346.3
1620	380.4	372.8	365.3	357.9	350.6
1630	385.1	377.4	369.8	362.3	354.9
1640	389.8	382.0	374.3	366.7	359.2
1650	394.5	386.6	378.8	371.1	363.5
1660	399.2	391.3	383.4	375.6	367.9
1670	404.0	396.0	388.0	380.1	372.3
1680	408.8	400.7	392.6	384.6	376.7
1690	413.7	405.4	397.3	389.2	381.2
1700	418.5	410.2	401.9	393.8	385.7

TM-2 Tissue Machine

(Slice Opening = 9.00 mm.)

	Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97		
	500 510	39.3 40.8	38.6 40.0	37.9 39.3	37.2 38.5	36.5 37.8
,	520 530	42.2 43.7	41.5 42.9	40.7 42.1	39.9 41.3	39.2 40.6
	540	45.3	44.4	43.6	42.8	42.0
	550	46.8	46.0	45.1	44.3	43.4
	560 570	48.4 50.0	47.5 49.1	46.6 48.2	45.7 47.3	44.9 46.4
	580	51.7	50.7	49.8	48.8	47.9
	590	53.4	52.4	51.4	50.4	49.4
	600	55.1	54.0	53.0	52.0	51.0
	610 620	56.8 58.6	55.7 57.5	54.7 56.4	53.6 55.3	52.6 54.2
	630	60.4	59.2	58.1	57.0	55.9
	640	62.2	61.0	59.8	58.7	57.5
	650 660	64.0 65.9	62.8 64.6	61.6 63.4	60.4 62.2	59.2 61.0
	670	67.8	66.5	65.2	64.0	62.7
	680	69.7	68.4	67.1	65.8	64.5
(690	71.7	70.3	69.0	67.6	66.3
	700 710	73.7 75.7	72.3 74.2	70.9 72.8	69.5 71.4	68.1 70.0
	720	77.7	76.3	74.8	73.3	71.9
	730	79.8	78.3	76.8	75.3	73.8
	740 ·	81.9	80.3 82.4	78.8	77.2 79.3	75.7 77.7
	750 760	84.1 86.2	84.6	80.8 82.9	81.3	77.7
	770	88.4	86.7	85.0	83.3	81.7
	780	90.6	88.9	87.1	85.4	83.7
	790	92.9	91.1	89.3	87.5	85.8 87.9
	800 810	95.2 97.5	93.3 95.6	91.5 93.7	89.7 91.9	90.0
	820	99.8	97.9	95.9	94.0	92.2
	830	102.2	100.2	98.2	96.3	94.3
	840 850	104.5 107.0	102.5 104.9	100.5 102.8	98.5 100.8	96.5 98.8
	860	107.0	107.3	105.2	103.1	101.0
	870	111.9	109.7	107.6	105.4	103.3
	880	114.4	112.2	110.0	107.8	105.6
	890 900	116.9 119.5	114.7 117.2	112.4 114.9	110.2 112.6	108.0 110.3
	910	122.1	119.7	117.3	115.0	112.7
	920	124.7	122.3	119.9	117.5	115.1
	930	127.4	124.9	122.4	120.0	117.5
	940 950	130.0 132.7	127.5 130.1	125.0 127.6	122.5 125.0	120.0 122.5
	960	135.5	132.8	130.2	127.6	125.0
	970	138.2	135.5	132.8	130.2	127.6
	980	141.0	138.3	135.5	132.8	130.1

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
222	143.8	141.0	138.2	135.5	132.7
990	145.8	143.8	141.0	138.1	135.4
1000	149.6	146.6	143.7	140.9	138.0
1010	152.5	149.5	146.5	143.6	140.7
1020 1030	155.4	152.4	149.3	146.3	143.4
1040	158.4	155.3	152.2	149.1	146.1
1050	161.4	158.2	155.1	151.9	148.9
1060	164.4	161.2	158.0	154.8	151.7
1070	167.4	164.1	160.9	157.7	154.5
1080	170.5	167.2	163.8	160.5	157.3
1090	173.6	170.2	166.8	163.5	160.2
1100	176.8	173.3	169.8	166.4	163.0
1110	179.9	176.4	172.9	169.4	166.0
1120	183.1	179.5	175.9	172.4	168.9
1130	186.3	182.7	179.0	175.4	171.9
1140	189.6	185.8	182.1	178.5	174.9
1150	192.9	189.1	185.3	181.6	177.9 180.9
1160	196.2	192.3	188.5	184.7 187.8	184.0
1170	199.5	195.6	191.7	191.0	187.1
1180	202.9	198.9	194.9 198.2	194.2	190.2
1190	206.3	202.2 205.5	201.4	197.4	193.4
1200	209.7 213.1	208.9	204.8	200.6	196.5
1210 1220	216.6	212.3	208.1	203.9	199.7
1230	220.1	215.8	211.5	207.2	203.0
1240	223.7	219.2	214.9	210.5	206.2
1250	227.2	222.7	218.3	213.9	209.5
1260	230.8	226.2	221.7	217.3	212.8
1270	234.4	229.8	225.2	220.7	216.2
1280	238.1	233.4	228.7	224.1	219.5
1290	241.8	237.0	232.2	227.6	222.9
1300	245.5	240.6	235.8	231.0	226.3
1310	249.2	244.3	239.4	234.6 238.1	229.8 233.2
1320	253.0	248.0	243.0		236.7
1330	256.8	251.7	246.6 250.3	241.7 245.3	240.2
1340	260.6	255.4 259.2	254.0	248.9	243.8
1350	264.4	263.0	257.7	252.5	247.4
1360	268.3 272.2	266.8	261.5	256.2	251.0
1370	276.2	270.7	265.3	259.9	254.6
1380 1390	280.1	274.6	269.1	263.6	258.2
1400	284.1	278.5	272.9	267.4	261.9
1410	288.2	282.4	276.8	271.2	265.6
1420	292.2	286.4	280.7	275.0	269.4
1430	296.3	290.4	284.6	278.8	273.1
1440	300.4	294.4	288.5	282.7	276.9
1450	304.5	298.5	292.5	286.6	280.7
1460	308.7	302.6	296.5	290.5	284.5
1470	312.9	306.7	300.5	294.4	288.4
1480	317.1	310.8	304.6	298.4	292.3 296.2
1490	321.4	315.0	308.7	302.4 306.4	300.1
1500	325.7	319.2	312.8 316.9	310.5	304.1
1510	330.0	323.4 327.6	321.1	314.6	308.1
1520	334.3 338.7	331.9	325.3	318.7	312.1
1530	330./	221.9	J2J.J		

	Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	Drag = 4 $J/W = .96$	Drag = 5 $J/W = .95$
)	1540	343.1	336.2	329.5	322.8	316.2
	1550	347.5	340.6	333.7	327.0	320.3
	1560	351.9	344.9	338.0	331.1	324.4
	1570	356.4	349.3	342.3	335.4	328.5
	1580	360.9	353.7	346.6	339.6	332.6
	1590	365.5	358.2	351.0	343.9	336.8
	1600	370.0	362.7	355.4	348.2	341.0
	1610	374.6	367.2	359.8	352.5	345.2
	1620	379.3	371.7	364.2	356.8	349.5
	1630	383.9	376.3	368.7	361.2	353.8
	1640	388.6	380.8	373.2	365.6	358.1
	1650	393.3	385.5	377.7	370.0	362.4
	1660	398.0	390.1	382.3	374.5	366.8
	1670	402.8	394.8	386.8	379.0	371.2
	1680	407.6	399.5	391.4	383.5	375.6
	1690	412.4	404.2	396.1	388.0	380.0
	1700	417.3	409.0	400.7	392.6	384.5

TM-2 Tissue Machine

(Slice Opening = 9.50 mm.)

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97		
500 510	39.2 40.7	38.5 39.9	37.8 39.2	37.1 38.4	36.4 37.7
520	42.1	41.4	40.6	39.8	39.1
530 540	43.6 45.2	42.8 44.3	42.0 43.5	41.2 42.7	40.5 41.9
550	46.7	45.8	45.0	44.1	43.3
560	48.3	47.4	46.5	45.6	44.8
570 580	49.9 51.6	49.0	48.1	47.1	46.2
580 590	53.2	50.6 52.2	49.6 51.2	48.7 50.3	47.8 49.3
600	54.9	53.9	52.9	51.9	50.9
610	56.7	55.6	54.5	53.5	52.4
620	58.4	57.3	56.2	55.1	54.1
630 640	60.2 62.0	59.1 60.8	57.9 59.7	56.8 58.5	55.7 57.4
650	63.8	62.6	61.4	60.2	59.1
660	65.7	64.5	63.2	62.0	60.8
670	67.6	66.3	65.1	63.8	62.5
680 690	69.5 71.5	68.2 70.1	66.9 68.8	65.6 67.4	64.3 66.1
700	73.5	72.1	70.7	69.3	67.9
710	75.5	74.0	72.6	71.2	69.8
720	77.5	76.0	74.6	73.1	71.7
730 740	79.6 81.7	78.1 80.1	76.6 78.6	75.1 77.0	73.6 75.5
750	83.8	82.2	80.6	79.0	77.5
760	86.0	84.3	82.7	81.1	79.5
770	88.2	86.5	84.8	83.1	81.5
780	90.4	88.6	86.9	85.2	83.5
790 800	92.6 94.9	90.8 93.1	89.1 91.2	87.3 89.4	85.6 87.7
810	97.2	95.3	93.4	91.6	89.8
820	99.5	97.6	95.7	93.8	91.9
830	101.9	99.9	97.9	96.0	94.1
840 850	104.3 106.7	102.2 104.6	100.2 102.5	98.2 100.5	96.3 98.5
860	100.7	107.0	104.9	100.5	100.8
870	111.6	109.4	107.3	105.1	103.0
880	114.1	111.9	109.7	107.5	105.3
890	116.6	114.3	112.1	109.9	107.7
900 910	119.2 121.7	116.8 119.4	114.5 117.0	112.3 114.7	110.0 112.4
920	124.4	121.9	119.5	117.1	114.8
930	127.0	124.5	122.1	119.6	117.2
940	129.7	127.1	124.6	122.1	119.7
950 960	132.4 135.1	129.8 132.5	127.2 129.8	124.7 127.2	122.2 124.7
970	137.9	135.2	132.5	129.8	127.2
. 980	140.6	137.9	135.2	132.5	129.8

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
200	142.4	140.6	137.9	135.1	132.4
990	143.4	143.4	140.6	137.8	135.0
1000	146.3		143.3	140.5	137.6
1010	149.2	146.2		143.2	140.3
1020	152.1	149.1	146.1		143.0
1030	155.0	151.9	148.9	145.9 148.7	145.7
1040	157.9	154.8	151.8		148.5
1050	160.9	157.8	154.6	151.5 154.4	151.2
1060	163.9	160.7	157.5		154.0
1070	167.0	163.7	160.4	157.2 160.1	156.9
1080	170.0	166.7	163.4	163.0	159.7
1090	173.1	169.7	166.4	166.0	162.6
1100	176.3	172.8	169.4	168.9	165.5
1110	179.4	175.9	172.4	171.9	168.4
1120	182.6	179.0	175.4	174.9	171.4
1130	185.8	182.2	178.5 181.6	174.9	174.4
1140	189.1	185.3	184.8	181.1	177.4
1150	192.3	188.5 191.8	187.9	184.2	180.4
1160	195.6	195.0	191.1	187.3	183.5
1170	199.0 202.3	198.3	194.4	190.4	186.6
1180	202.3	201.6	197.6	193.6	189.7
1190	209.1	205.0	200.9	196.8	192.8
1200 1210	212.5	208.3	204.2	200.1	196.0
1220	216.0	211.7	207.5	203.3	199.2
1230	219.5	215.2	210.9	206.6	202.4
1240	223.0	218.6	214.3	209.9	205.7
1250	226.6	222.1	217.7	213.3	208.9
1260	230.2	225.6	221.1	216.6	212.2
1270	233.8	229.2	224.6	220.0	215.6
1280	237.4	232.7	228.1	223.5	218.9
1290	241.1	236.3	231.6	226.9	222.3
1300	244.8	239.9	235.1	230.4	225.7
1310	248.5	243.6	238.7	233.9	229.1
1320	252.3	247.3	242.3	237.4	232.6
1330	256.1	251.0	246.0	241.0	236.1
1340	259.9	254.7	249.6	244.6	239.6
1350	263.7	258.5	253.3	248.2	243.1
1360	267.6	262.3	257.0	251.8	246.7
1370	271.5	266.1	260.8	255.5	250.3 253.9
1380	275.4	269.9	264.5	259.2	257.5
1390	279.4	273.8	268.3	262.9 266.6	261.2
1400	283.3	277.7	272.1	270.4	264.9
1410	287.4	281.6	276.0 279.9	274.2	268.6
1420	291.4	285.6	283.8	274.2	272.3
1430	295.5	289.6 293.6	287.7	281.9	276.1
1440	299.6	297.7	291.7	285.8	279.9
1450	303.7 307.8	301.7	295.7	289.7	283.7
1460	312.0	305.8	299.7	293.6	287.6
1470 1480	316.2	309.9	303.7	297.6	291.5
1480	320.5	314.1	307.8	301.6	295.4
1500	324.7	318.3	311.9	305.6	299.3
1510	329.0	322.5	316.0	309.6	303.3
1520	333.4	326.7	320.2	313.7	307.2
1530	337.7	331.0	324.4	317.8	311.3
2000	- - : -				

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	Drag = 4 $J/W = .96$	Drag = 5 $J/W = .95$
1540	342.1	335.3	328.6	321.9	315.3
1550	346.5	339.6	332.8	326.0	319.4
1560	351.0	344.0	337.1	330.2	323.4
1570	355.4	348.3	341.3	334.4	327.6
1580	359.9	352.8	345.7	338.6	331.7
1590	364.4	357.2	350.0	342.9	335.9
1600	369.0	361.7	354.4	347.2	340.1
1610	373.6	366.1	358.8	351.5	344.3
1620	378.2	370.7	363.2	355.8	348.5
1630	382.8	375.2	367.7	360.2	352.8
1640	387.5	379.8	372.1	364.6	357.1
1650	392.2	384.4	376.7	369.0	361.4
1660	396.9	389.0	381.2	373.4	365.8
1670	401.7	393.7	385.8	377.9	370.2
1680	406.5	398.4	39.0.3	382.4	374.6
1690	411.3	403.1	395.0	386.9	379.0
1700	416.1	407.8	399.6	391.5	383.4

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TM-2 Tissue Machine

(Slice Opening = 10.00 mm.)

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
500	39.1	38.4	37.7	37.0	36.3
510	40.6	39.8	39.1	38.4	37.6
520	42.0	41.3	40.5	39.7	39.0
530	43.5	42.7	41.9	41.1	40.4
540	45.0	44.2	43.4	42.6	41.8
550	46.6	45.7	44.9	44.0	43.2
560	48.2	47.3	46.4	45.5	44.6
570	49.8	48.9	47.9	47.0	46.1
580	51.4	50.5	49.5	48.6	47.6
590	53.1	52.1	51.1	50.1	49.2
600	54.8	53.8	52.7	51.7	50.7
610	56.5	55.4	54.4	53.3	52.3
620	58.3	57.2	56.1	55.0	53.9
630	60.0	58.9	57.8	56.7	55.6
640	61.9	60.7	59.5	58.4	57.2
650	63.7	62.5	61.3	60.1	58.9
660	65.6	64.3	63.1	61.9	60.6
670	67.4	66.2	64.9	63.6	62.4
680	69.4	68.0	66.7	65.4	64.2
690	71.3	70.0	68.6	67.3	66.0
700	73.3	71.9	70.5	69.1	67.8
710	75.3	73.9	72.4	71.0	69.6
720	77.3	75.9	74.4	72.9	71.5
730 740 750 760	79.4 81.5 83.6 85.8 88.0	77.9 79.9 82.0 84.1 86.3	76.4 78.4 80.4 82.5 84.6	74.9 76.8 78.8 80.9 82.9	73.4 75.3 77.3 79.3 81.3
770 780 790 800 810	90.2 92.4 94.7 96.9	88.4 90.6 92.8 95.1	86.7 88.8 91.0 93.2	85.0 87.1 89.2 91.4	83.3 85.4 87.4 89.6
820 830 840 850	99.3 101.6 104.0 106.4	97.3 99.6 102.0 104.3	95.4 97.7 100.0 102.3 104.6	93.6 95.8 98.0 100.3 102.6	91.7 93.9 96.0 98.3 100.5
860 870 880 890 900	108.8 111.3 113.8 116.3 118.9	106.7 109.1 111.6 114.0 116.5	104.8 107.0 109.4 111.8 114.2	102.6 104.9 107.2 109.6 112.0	102.8 105.1 107.4 109.7
910	121.4	119.1	116.7	114.4	112.1
920	124.0	121.6	119.2	116.9	114.5
930	126.7	124.2	121.8	119.3	116.9
940	129.3	126.8	124.3	121.8	119.4
950	132.0	129.5	126.9	124.4	121.9
960	134.8	132.1	129.5	126.9	124.4
970	137.5	134.8	132.1	129.5	126.9
980	140.3	137.5	134.8	132.1	129.5

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95	
990	143.1	140.3	137.5	134.8	132.0	-
1000	145.9	143.1	140.2	137.4	134.6	
1010	148.8	145.9	143.0	140.1	137.3	
1020	151.7	148.7	145.7	142.8	139.9	
1030	154.6	151.6	148.5	145.6	142.6	
1040	157.5	154.4	151.4	148.3	145.3	
1050	160.5	157.4	154.2	151.1	148.1	
1060	163.5	160.3	157.1	154.0	150.8	
1070	166.5	163.3	160.0	156.8	153.6	
1080	169.6	166.3	163.0	159.7	156.5	
1090	172.7	169.3	165.9	162.6	159.3 162.2	
1100	175.8	172.4	168.9	165.5	165.1	
1110	179.0	175.4	171.9	168.5	168.0	
1120	182.1	178.5	175.0	171.5 174.5	170.9	
1130	185.3	181.7	178.1	174.5	173.9	
1140	188.6	184.9	181.2 184.3	180.6	176.9	
1150	191.8	188.1 191.3	187.5	183.7	180.0	
1160	195.1 198.4	194.5	190.6	186.8	183.0	
1170 1180	201.8	197.8	193.9	190.0	186.1	
1190	205.2	201.1	197.1	193.1	189.2	
1200	208.6	204.4	200.4	196.3	192.3	
1210	212.0	207.8	203.7	199.6	195.5	
1220	215.5	211.2	207.0	202.8	198.7	f the
1230	218.9	214.6	210.3	206.1	201.9	
1240	222.5	218.1	213.7	209.4	205.1	And the same
1250	226.0	221.5	217.1	212.7	208.4	
1260	229.6	225.0	220.5	216.1	211.7	
1270	233.2	228.6	224.0	219.5	215.0 218.3	
1280	236.8	232.1	227.5	222.9 226.3	221.7	
1290	240.5	235.7 239.3	231.0 234.5	229.8	225.1	
1300	244.2 247.9	243.0	238.1	233.3	228.5	
1310 1320	251.6	246.6	241.7	236.8	232.0	
1330	255.4	250.3	245.3		235.5	
1340	259.2	254.1	249.0	243.9	239.0	
1350	263.0	257.8	252.6	247.5	242.5	
1360	266.9	261.6	256.4	251.2	246.0	
1370	270.8	265.4	260.1	254.8	249.6	
1380	274.7	269.2	263.8	258.5	253.2	
1390	278.6	273.1	267.6	262.2	256.9	
1400	282.6	277.0	271.4	265.9	260.5	
1410	286.6	280.9	275.3	269.7	264.2	
1420	290.6	284.9	279.2	273.5	267.9	
1430	294.7	288.8	283.0	277.3 281.2	271.6 275.4	
1440	298.8	292.8	287.0 290.9		279.2	
1450	302.9	296.9 300.9	294.9	288.9	283.0	
1460 1470	307.0 311.2	305.0	298.9	292.8	286.9	
1470	311.2	309.1	302.9	296.8	290.7	portion.
1490	319.6	313.3		300.8	294.6	(
1500	323.9	317.5		304.8	298.5	45000
1510	328.2	321.7		308.8	302.5	
1520	332.5	325.9			306.5	
1530	336.8	330.1	323.5	316.9	310.5	
2000						

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	Drag = 5 $J/W = .95$
1540	341.2	334.4	327.7	321.1	314.5
1550	345.6	338.7	331.9	325.2	318.5
1560	350.0	343.1	336.2	329.4	322.6
1570	354.5	347.4	340.5	333.5	326.7
1580	359.0	351.8	344.8	337.8	330.8
1590	363.5	356.3	349.1	342.0	335.0
1600	368.0	360.7	353.5	346.3	339.2
1610	372.6	365.2	357.8	350.6	343.4
1620	377.2	369.7	362.3	354.9	347.6
1630	381.8	374.2	366.7	359.3	351.9
1640	386.5	378.8	371.2	363.6	356.2
1650	391.2	383.4	375.7	368.0	360.5
1660	395.9	388.0	380.2	372.5	364.8
1670	400.6	392.6	384.7	376.9	369.2
1680	405.4	397.3	389.3	381.4	373.6
1690	410.2	402.0	393.9	385.9	378.0
1700	415.0	406.8	398.6	390.5	382.4

TM-2 Tissue Machine

(Slice Opening = 10.50 mm.)

7	Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
	500 510 520 530	39.0 40.5 41.9 43.4	38.3 39.7 41.2 42.6	37.6 39.0 40.4 41.8	36.9 38.3 39.6 41.0	36.2 37.5 38.9 40.3
	540 550	44.9 46.5	44.1 45.6	43.3 44.8	42.5 43.9	41.7 43.1
	560	48.1	47.2	46.3	45.4	44.5
	570 580	49.7 51.3	48.8 50.4	47.8 49.4	46.9 48.5	46.0 47.5
	590	53.0	52.0	51.0 52.6	50.0 51.6	49.1 50.6
	600 610	54.7 56.4	53.6 55.3	54.3	53.2	52.2
	620	58.1	57.0	55.9	54.9	53.8 55.4
	630 640	59.9 61.7	58.8 60.5	57.7 59.4	56.5 58.2	57.1
	650	63.5	62.3	61.1	60.0	58.8
	660 670	65.4 67.3	64.2 66.0	62.9 64.7	61.7 63.5	60.5 62.2
	680	69.2	67.9	66.6	65.3	64.0
J	690 700	71.2 73.1	69.8 71.7	68.4 70.3	67.1 69.0	65.8 67.6
	710	75.1	73.7	72.3	70.9	69.5
	720 730	77.2 79.2	75.7 77.7	74.2 76.2	72.8 74.7	71.3 73.2
	740	81.3	79.7	78.2	76.7	75.2
	750 760	83.4 85.6	81.8 83.9	80.2 82.3	78.7 80.7	77.1 79.1
	770	87.7	86.1	84.4	82.7	81.1
	780 700	89.9 92.2	88.2 90.4	86.5 88.6	84.8 86.9	83.1 85.2
	790 800	94.4	92.6	90.8	89.0	87.2
	810	96.7	94.8	93.0	91.2	89.3
	820 830	99.0 101.4	97.1 99.4	95.2 97.5	93.3 95.5	91.5 93.6
	840	103.8	101.7	99.7	97.8	95.8
	850 860	106.2 108.6	104.1 106.5	102.0 104.4	100.0 102.3	98.0 100.3
	870	111.0	108.9	106.7	104.6	102.5
	880 890	113.5 116.0	111.3 113.8	109.1 111.5	107.0 109.3	104.8 107.1
	900	118.6	116.3	114.0	111.7	109.5
	910 920	121.2 123.8	118.8 121.3	116.4 118.9	114.1 116.6	111.8 114.2
	930	126.4	123.9	121.5	119.0	116.7
	940	129.0	126.5 129.1	124.0 126.6	121.5 124.1	119.1 121.6
	950 960	131.7 134.4	131.8	129.2	126.6	121.6
	970	137.2	134.5	131.8	129.2	126.6
	980	139.9	137.2	134.5	131.8	129.1

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
000	142 7	139.9	137.2	134.4	131.7
990	142.7	142.7	139.9	137.1	134.3
1000	145.6	145.5	142.6	139.8	136.9
1010	148.4 151.3	148.3	145.4	142.5	139.6
1020	154.2	151.2	148.2	145.2	142.3
1030	157.2	154.1	151.0	148.0	145.0
1040	160.1	157.0	153.9	150.8	147.7
1050 1060	163.1	159.9	156.7	153.6	150.5
1070	166.1	162.9	159.6	156.4	153.3
1080	169.2	165.9	162.6	159.3	156.1
1090	172.3	168.9	165.5	162.2	158.9
1100	175.4	171.9	168.5	165.1	161.8
1110	178.5	175.0	171.5	168.1	164.7
1120	181.7	178.1	174.6	171.1	167.6
1130	184.9	181.3	177.6	174.1	170.5
1140	188.1	184.4	180.7	177.1	173.5
1150	191.4	187.6	183.9	180.2	176.5
1160	194.7	190.8	187.0	183.2	179.5
1170	198.0	194.1	190.2	186.4	182.6 185.6
1180	201.3	197.3	193.4	189.5 192.7	188.7
1190	204.7	200.6	196.6	195.9	191.9
1200	208.1	204.0	199.9 203.2	199.1	195.0
1210	211.5	207.3 210.7	206.5	202.3	198.2
1220	214.9 218.4	214.1	209.8	205.6	201.4
1230	221.9	217.5	213.2	208.9	204.6
1240 1250	225.5	221.0	216.6	212.2	207.9
1260	229.0	224.5	220.0	215.6	211.2
1270	232.6	228.0	223.5	218.9	214.5
1280	236.2	231.6	226.9	222.4	217.8
1290	239.9	235.1	230.4	225.8	221.2
1300	243.6	238.7	234.0	229.2	224.6
1310	247.3	242.4	237.5	232.7	228.0
1320	251.0	246.0	241.1	236.2	231.4
1330	254.8	249.7	244.7	239.8	234.9 238.4
1340	258.6	253.4	248.4	243.3	241.9
1350	262.4	257.2	252.0	246.9 250.6	245.4
1360	266.2	261.0	255.7 259.5	254.2	249.0
1370	270.1	264.8 268.6	263.2	257.9	252.6
1380	274.0 278.0	272.4	267.0	261.6	256.2
1390 1400	281.9	276.3	270.8	265.3	259.9
1410	285.9	280.2	274.6	269.1	263.6
1420	289.9	284.2	278.5	272.8	267.3
1430	294.0	288.1	282.4	276.6	271.0
1440	298.1	292.1	286.3	280.5	274.7
1450	302.2	296.2	290.2	284.3	278.5
1460	306.3	300.2	294.2	288.2	282.3
1470	310.5	304.3	298.2	292.1	286.2
1480	314.6	308.4	302.2	296.1	290.0
1490	318.9	312.5	306.3	300.0	293.9
1500	323.1	316.7	310.3	304.0	297.8
1510	327.4	320.9	314.4	308.1	301.7 305.7
. 1520	331.7	325.1	318.6	312.1 316.2	309.7
1530	336.0	329.3	322.7	210.4	309.7

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	Drag = 4 $J/W = .96$	Drag = 5 $J/W = .95$
1540	340.4	333.6	326.9	320.3	313.7
1550	344.8	337.9	331.1	324.4	317.8
1560	349.2	342.2	335.4	328.6	321.8
1570	353.6	346.6	339.6	332.7	325.9
1580	358.1	351.0	343.9	336.9	330.0
1590	362.6	355.4	348.3	341.2	334.2
1600	367.1	359.8	352.6	345.4	338.4
1610	371.7	364.3	357.0	349.7	342.6
1620	376.3	368.8	361.4	354.0	346.8
1630	380.9	373.3	365.8	358.4	351.0
1640	385.6	377.9	370.3	362.7	355.3
1650	390.2	382.5	374.8	367.1	359.6
1660	394.9	387.1	379.3	371.6	363.9
1670	399.7	391.7	383.8	376.0	368.3
1680	404.4	396.4	388.4	380.5	372.7
1690	409.2	401.0	393.0	385.0	377.1
1700	414.0	405.8	397.6	389.5	381.5

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TM-2 Tissue Machine

(Slice Opening = 11.00 mm.)

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97		
500	39.0	38.2	37.5	36.8	36.2
510	40.4	39.6	38.9	38.2	37.5
520	41.9	41.1	40.3	39.6	38.8
530	43.3	42.5	41.7	41.0	40.2
540	44.9	44.0	43.2	42.4	41.6
550	46.4	45.5	44.7	43.8	43.0
560	48.0	47.1	46.2	45.3	44.5
570	49.6	48.6	47.7	46.8	45.9
580	51.2	50.2	49.3	48.4	47.4
590	52.9	51.9	50.9	49.9	49.0
600	54.5	53.5	52.5	51.5	50.5
610	56.3	55.2	54.2	53.1	52.1
620	58.0	56.9	55.8	54.8	53.7
630	59.8	58.6	57.5	56.4	55.3
640	61.6	60.4	59.3	58.1	57.0
650	63.4	62.2	61.0	59.8	58.7
660	65.3	64.0	62.8	61.6	60.4
670	67.1	65.9	64.6	63.3	62.1
680	69.1	67.7	66.4	65.1	63.9
690	71.0	69.6	68.3	67.0	65.7
700	73.0	71.6	70.2	68.8	67.5
710	75.0	73.5	72.1	70.7	69.3
720	77.0	75.5	74.1	72.6	71.2
730	79.0	77.5	76.0	74.5	· 73.1
740	81.1	79.6	78.0	76.5	75.0
750	83.2	81.6	80.1	78.5	76.9
760	85.4	83.7	82.1	80.5	78.9
770	87.6	85.9	84.2	82.5	80.9
780	89.7	88.0	86.3	84.6	82.9
790	92.0	90.2	88.4	86.7	85.0
800	94.2	92.4	90.6	88.8	87.0
. 810	96.5	94.6	92.8	91.0	89.1
820	98.8	96.9	95.0	93.1	91.3
830	101.2	99.2	97.3	95.3	93.4
840	103.5	101.5	99.5	97.6	95.6
850	105.9	103.9	101.8	99.8	97.8
860	108.3	106.2	104.1	102.1	100.0
870	110.8	108.6	106.5	104.4	102.3
880	113.3	111.1	108.9	106.7	104.6
890	115.8	113.5	111.3	109.1	106.9
900	118.3	116.0	113.7	111.5	109.2
910	120.9	118.5	116.2	113.9	111.6
920	123.5	121.1	118.7	116.3	114.0
930	126.1	123.6	121.2	118.8	116.4
940	128.7	126.2	123.7	121.3	118.8
950	131.4	128.9	126.3	123.8	121.3
950 960 970 980	131.4 134.1 136.9 139.6	131.5 134.2 136.9	128.3 128.9 131.5 134.2	123.6 126.3 128.9 131.5	

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95	
990	142.4	139.6	136.9	134.1	131.4	
1000	145.2	142.4	139.6	136.8	134.0	
1010	148.1	145.2	142.3	139.5	136.6	
1020	151.0	148.0	145.1	142.2	139.3	
1030	153.9	150.9	147.9	144.9	142.0	
1040	156.8	153.7	150.7	147.7	144.7	
1050	159.8	156.6	153.5	150.4	147.4 150.2	
1060	162.8	159.6	156.4	153.3 156.1	152.9	
1070	165.8	162.5	159.3 162.2	159.0	155.7	
1080	168.8	165.5 168.5	165.2	161.8	158.6	
1090	171.9 175.0	171.6	168.1	164.8	161.4	
1100 1110	178.1	174.6	171.1	167.7	164.3	
1120	181.3	177.7	174.2	170.7	167.2	
1130	184.5	180.8	177.2	· 173.7	170.2	
1140	187.7	184.0	180.3	176.7	173.1	
1150	190.9	187.2	183.4	179.8	176.1	
1160	194.2	190.4	186.6	182.8	179.1 182.2	
1170	197.5	193.6	189.8	185.9 189.1	185.2	
1180	200.8	196.9	193.0 196.2	192.2	188.3	
1190	204.2	200.2 203.5	190.2	195.4	191.4	
1200	207.6 211.0	206.8	202.7	198.6	194.6	
1210 1220	214.5	210.2	206.0	201.9	197.8	
1230	217.9	213.6	209.4	205.1	201.0	-
1240	221.4	217.0	212.7	208.4	204.2	
1250	225.0	220.5	216.1	211.7	207.4	
1260	228.5	224.0	219.5	215.1	210.7 214.0	
1270	232.1	227.5	223.0	218.5 221.9	217.3	
1280	235.7	231.0	226.4 229.9	225.3	220.7	
1290	239.4 243.0	234.6 238.2	233.4	228.7	224.1	
1300 1310	246.7	241.8	237.0	232.2	227.5	
1320	250.4	245.5	240.6	235.7	230.9	
1330	254.2	249.2	244.2	239.2	234.4	
1340	258.0	252.9	247.8	242.8	237.8	
1350	261.8	256.6	251.5	246.4	241.4 244.9	
1360	265.6	260.4	255.2	250.0 253.6	248.4	
1370	269.5	264.2	258.9 262.6	257.3	252.0	
1380	273.4 277.3	268.0 271.8	266.4	261.0	255.7	
1390 1400	281.3	275.7	270.2	264.7	259.3	
1410	285.3	279.6	274.0	268.4	263.0	
1420	289.3	283.5	277.8	272.2	266.7	
1430	293.3	287.5	281.7	276.0	270.4	
1440	297.4	291.5	285.6	279.8	274.1	
1450	301.5	295.5	289.6	283.7	277.9 281.7	
1460	305.6	299.5	293.5 297.5	287.6 291.5	285.5	
1470	309.8	303.6 307.7	301.5	291.3	289.4	
1480	313.9 318.1	311.8	305.6	299.4	293.2	
1490 1500	322.4	316.0	309.6	303.3	297.1	
1510	326.6	320.2	313.7	307.4	301.1	
1520	330.9	324.4	317.8	311.4	305.0	
1530	335.3	328.6	322.0	315.5	309.0	

Wire Speed (M/Min)	%Drag = 1	%Drag = 2	%Drag = 3	%Drag = 4	%Drag = 5
	J/W = .99	J/W = .98	J/W = .97	J/W = .96	J/W = .95
1540	339.6	332.9	326.2	319.6	313.0
1550	344.0	337.1	330.4	323.7	317.0
1560	348.4	341.5	334.6	327.8	321.1
1570	352.8	345.8	338.9	332.0	325.2
1580	357.3	350.2	343.1	336.2	329.3
1590	361.8	354.6	347.5	340.4	333.4
1600	366.3	359.0	351.8	344.7	337.6
1610	370.9	363.5	356.2	348.9	341.8
1620	375.4	368.0	360.6	353.2	346.0
1630	380.0	372.5	365.0	357.6	350.2
1640	384.7	377.0	369.4	361.9	354.5
1650	389.3	381.6	373.9	366.3	358.8
1660	394.0	386.2	378.4	370.7	363.1
1670	398.7	390.8	382.9	375.2	367.5
1680	403.5	395.5	387.5	379.6	371.8
1690	408.3	400.1	392.1	384.1	376.2
1700	413.1	404.8	396.7	388.6	380.6

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TM-2 Tissue Machine

(Slice Opening = 11.50 mm.)

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98			
500 510	38.9 40.3	38.2 39.6	37.5 38.8	36.8 38.1	36.1 37.4
520	41.8	41.0	40.2	39.5	38.7
530	43.3 44.8	42.5 43.9	41.7 43.1	40.9 42.3	40.1 41.5
540 550	46.3	45.4	44.6	43.8	42.9
560	47.9	47.0	46.1	45.2	44.4
570	49.5	48.6	47.6	46.7	45.8
580 590	51.1 52.8	50.1 51.8	49.2 50.8	48.3 49.8	47.3 48.9
600	54.4	53.4	52.4	51.4	50.4
610	56.1	55.1	54.0	53.0	52.0
620	57.9	56.8	55.7	54.6	53.6
630 640	59.7 61.5	58.5 60.3	57.4 59.1	56.3 58.0	55.2 56.9
650	63.3	62.1	60.9	59 . 7	58.5
660	65.1	63.9	62.7	61.5	60.3
670	67.0	65.7	64.5	63.2	62.0
680 690	68.9 70.9	67.6 69.5	66.3 68.2	65.0 66.8	63.7 65.5
700	72.8	71.4	70.1	68.7	67.3
710	74.8	73.4	72.0	70.6	69.2
720	76.8	75.4	73.9	72.5	71.0
730 740	78.9 81.0	77.4 79.4	75.9 77.9	74.4 76.3	72.9 74.8
750	83.1	81.5	79.9	78.3	76.8
760	85.2	83.6	81.9	80.3	78.7
770	87.4	85.7	84.0	82.4	80.7
780 790	89.6 91.8	87.8 90.0	86.1 88.3	84.4 86.5	82.8 84.8
800	94.0	92.2	90.4	88.6	86.9
810	96.3	94.4	92.6	90.8	89.0
820	98.6	96.7	94.8	92.9	91.1
830 840	100.9 103.3	99.0 101.3	97.1 99.3	95.1 97.4	93.2 95.4
850	105.7	103.6	101.6	99.6	97.6
860	108.1	106.0	103.9	101.9	99.8
870	110.6	108.4	106.3	104.2	102.1
880 890	113.0 115.5	110.8 113.3	108.7 111.1	106.5 108.9	104.4 106.7
900	118.1	115.8	113.5	111.2	109.0
910	120.6	118.3	115.9	113.6	111.4
920	123.2	120.8	118.4	116.1	113.7
930 940	125.8 128.5	123.4 126.0	120.9 123.5	118.5 121.0	116.2 118.6
950	131.2	128.6	126.0	123.5	121.0
960	133.9	131.2	128.6	126.1	123.5
970	136.6	133.9	131.3	128.6	126.0
980	139.3	136.6	133.9	131.2	128.6

Wire Speed	%Drag = 1	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
(M/Min)	J/W = .99	U/W90	U/H97	0/W30	6/N .55
990	142.1	139.3	136.6	133.9	131.2
1000	144.9	142.1	139.3	136.5	133.7
1010	147.8	144.9	142.0	139.2	136.4
1020	150.7	147.7	144.8	141.9	139.0
1030	153.6	150.5	147.6	144.6	141.7
1040	156.5	153.4	150.4	147.3	144.4
1050	159.4	156.3	153.2	150.1	147.1
1060	162.4	159.2	156.1	152.9	149.8
1070	165.4	162.2	159.0	155.8	152.6
1080	168.5	165.2	161.9	158.6	155.4
1090	171.5	168.2	164.8	161.5	158.2
1100	174.6	171.2	167.8	164.4	161.1 164.0
1110	177.8	174.3	170.8	167.4	166.9
1120	180.9	177.3 180.5	173.8 176.9	170.3 173.3	169.8
1130	184.1 187.3	183.6	180.0	176.3	172.8
1140	190.5	186.8	183.1	179.4	175.7
1150 1160	193.8	190.0	186.2	182.5	178.7
1170	197.1	193.2	189.4	185.5	181.8
1180	200.4	196.5	192.6	188.7	184.8
1190	203.8	199.8	195.8	191.8	187.9
1200	207.2	203.1	199.0	195.0	191.0
1210	210.6	206.4	202.3	198.2 -	194.2
1220	214.0	209.8	205.6	201.4	197.3
1230	217.5	213.2	208.9	204.7	200.5
1240	221.0	216.6	212.3	208.0	203.7
1250	224.5	220.0	215.6	211.3	207.0
1260	228.0	223.5	219.0	214.6	210.3
1270	231.6	227.0	222.5	218.0	213.5
1280	235.2	230.6	225.9 229.4	221.4 224.8	216.9 220.2
1290 1300	238.8 242.5	234.1 237.7	233.0	228.2	223.6
1310	246.2	241.3	236.5	231.7	227.0
1320	249.9	245.0	240.1	235.2	230.4
1330	253.7	248.6	243.7	238.7	233.9
1340	257.4	252.3	247.3	242.3	237.3
1350	261.2	256.1	250.9	245.9	240.8
1360	265.1	259.8	254.6	249.5	244.4
1370	268.9	263.6	258.3	253.1	247.9
1380	272.8	267.4	262.1	256.8	251.5
1390	276.7	271.3	265.8	260.4	255.1
1400	280.7	275.1	269.6	264.1	258.7
1410	284.7	279.0	273.4	267.9	262.4 266.1
1420	288.7	282.9	277.3	271.6 275.4	269.8
1430	292.7	286.9 290.9	281.1 285.0	279.3	273.5
1440	296.8 300.8	294.9	288.9	283.1	277.3
1450 1460	305.0	298.9	292.9	287.0	281.1
1470	309.1	303.0	296.9	290.9	284.9
1480	313.3	307.0	300.9	294.8	288.7
1490	317.5	311.2	304.9	298.7	292.6
1500	321.7	315.3	309.0	302.7	296.5
1510	326.0	319.5	313.1	306.7	300.4
1520	330.2	323.7	317.2	310.7	304.4
1530	334.5	327.9	321.3	314.8	308.3

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	Drag = 4 $J/W = .96$	Drag = 5 $J/W = .95$
1540	338.9	332.2	325.5	318.9	312.3
1550	343.3	336.4	329.7	323.0	316.4
1560	347.7	340.7	333.9	327.1	320.4
1570	352.1	345.1	338.1	331.3	324.5
1580	356.5	349.4	342.4	335.5	328.6
1590	361.0	353.8	346.7	339.7	332.7
1600	365.5	358.3	351.1	343.9	336.9
1610	370.1	362.7	355.4	348.2	341.1
1620	374.6	367.2	359.8	352.5	345.3
1630	379.2	371.7	364.2	356.8	349.5
1640	383.9	376.2	368.6	361.2	353.7
1650	388.5	380.8	373.1	365.5	358.0
1660	393.2	385.4	377.6	369.9	362.3
1670	397.9	390.0	382.1	374.4	366.7
1680	402.6	394.6	386.7	378.8	371.0
1690	407.4	399.3	391.2	383.3	375.4
1700	412.2	404.0	395.9	387.8	379.8

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TM-2 Tissue Machine

(Slice Opening = 12.00 mm.)

W	ire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97		%Drag = 5 J/W = .95
	500 510	38.8 40.2	38.1 39.5	37.4 38.8	36.7 38.0	36.0 37.3
	520	41.7	40.9	40.2	39.4	38.7
	530	43.2	42.4	41.6	40.8	40.0
	540	44.7	43.9	43.0	42.2	41.4
	550 560	46.2 47.8	45.4 46.9	44.5 46.0	43.7 45.1	42.8 44.3
	570	49.4	48.5	47.5	46.6	45.8
	580	51.0	50.1	49.1	48.2	47.2
	590	52.7	51.7	50.7	49.7	48.8
	600	54.3	53.3	52.3	51.3	50.3
	610	56.0	55.0	53.9	52.9	51.9
	620 630	57.8 59.5	56.7 58.4	55.6 57.3	54.5 56.2	53.5 55.1
	640	61.3	60.2	59.0	57.9	56.8
	650	63.2	62.0	60.8	59.6	58.4
	660	65.0	63.8	62.5	61.3	60.1
	670	66.9	65.6	64.3	63.1	61.9
	680	68.8	67.5	66.2	64.9	63.6
J	690 700	70.7 72.7	69.4 71.3	68.0 69.9	66.7 68.6	65.4 67.2
	710	74.7	73.2	71.8	70.4	69.0
	720	76.7	75.2	73.8	72.3	70.9
	730	78.7	77.2	75.7	74.2	72.8
	740	80.8	79.3	77.7	76.2	74.7
	750	82.9	81.3	79.7	78.2	76.6
	760 770	85.0	83.4	81.8	80.2	78.6
	770 780	87.2 89.4	85.5 87.7	83.9 86.0	82.2 84.3	80.6 82.6
	790 790	91.6	89.8	88.1	86.4	84.6
	800	93.9	92.0	90.2	88.5	86.7
	810	96.1	94.3	92.4	90.6	88.8
	820	98.4	96.5	94.6	92.8	90.9
	830	100.8	98.8	96.9	94.9	93.1
	840 850	103.1 105.5	101.1 103.4	99.1 101.4	97.2 99.4	95.2 97.4
	860	107.9	105.4	103.7	101.7	99.6
	870	110.3	108.2	106.1	104.0	101.9
	880	112.8	110.6	108.4	106.3	104.2
	890	115.3	113.1	110.8	108.6	106.5
	900	117.8	115.5	113.3	111.0	108.8
	910 920	120.4 123.0	118.0 120.6	115.7 118.2	113.4 115.8	111.1 113.5
	930	125.6	123.1	120.7	118.3	115.9
	940	128.2	125.7	123.2	120.8	118.4
and desired	950	130.9	128.3	125.8	123.3	120.8
	960	133.6	131.0	128.4	125.8	123.3
	970	136.3	133.6	131.0	128.4	125.8
	980	139.1	136.3	133.6	131.0	128.3

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95	(
990	141.8	139.1	136.3	133.6	130.9	
1000	144.7	141.8	139.0	136.2	133.5	
	147.5	144.6	141.7	138.9	136.1	
1010		147.4	144.5	141.6	138.7	
1020	150.4		147.3	144.3	141.4	
1030	153.2	150.2		147.1	144.1	
1040	156.2	153.1	150.1	147.1	146.8	
1050	159.1	156.0	152.9		149.5	
1060	162.1	158.9	155.8	152.6	152.3	
1070	165.1	161.9	158.6		155.1	
1080	168.1	164.8	161.6	158.3	157.9	
1090	171.2	167.8	164.5	161.2	160.8	
1100	174.3	170.9	167.5	164.1		
1110	177.4	173.9	170.5	167.0	163.6	
1120	180.6	177.0	173.5	170.0	166.5	
1130	183.7	180.1	176.5	173.0	169.5	
1140	186.9	183.2	179.6	176.0	172.4	
1150	190.2	186.4	182.7	179.0	175.4	
1160	193.4	189.6	185.8	182.1	178.4	
1170	196.7	192.8	189.0	185.2	181.4	
1180	200.0	196.1	192.2	188.3	184.5	
1190	203.4	199.4	195.4	191.4	187.6	
1200	206.7	202.7	198.6	194.6	190.7	
1210	210.1	206.0	201.9	197.8	193.8	
1220	213.6	209.4	205.2	201.0	196.9	P
1230	217.0	212.7	208.5	204.3	200.1	The second second
1240	220.5	216.2	211.8	207.6	203.3	
1250	224.0	219.6	215.2	210.9	206.6	
1260	227.6	223.1	218.6	214.2	209.8	
1270	231.1	226.6	222.0	217.6	213.1	
1280	234.7	230.1	225.5	220.9	216.4	
1290	238.4	233.7	229.0	224.4	219.8	
1300	242.0	237.2	232.5	227.8	223.1	
1310	245.7	240.8	236.0	231.3	226.5	
1320	249.4	244.5	239.6	234.7	230.0	
1330	253.2	248.1	243.2	238.3	233.4	
1340	256.9	251.8	246.8	241.8	236.9	
1350	260.7	255.6	250.4	245.4	240.4	,
1360	264.6	259.3	254.1	249.0	243.9	
1370	268.4	263.1	257.8	252.6	247.4	
1380	272.3	266.9	261.5	256.2	251.0	
1390	276.2	270.7	265.3	259.9	254.6	
1400	280.1	274.6	269.1	263.6	258.2	
1410	284.1	278.5	272.9	267.4	261.9	
1420	288.1	282.4	276.7	271.1	265.6	
1430	292.1	286.3	280.6	274.9	269.3	
1440	296.2	290.3	284.5	278.7	273.0	
1450	300.2	294.3	288.4	282.5	276.7	
1450	304.3	298.3	292.3	286.4	280.5	
1470	308.5	302.4	296.3	290.3	284.3	
1480	312.6	306.4	300.3	294.2	288.2	1
1490	316.8	310.5	304.3	298.1	292.0	- (
	321.1	314.7	308.4	302.1	295.9	******
1500	325.3	318.8	312.4	306.1	299.8	
1510	329.6	323.0	316.5	310.1	303.8	
1520		327.2	320.7	314.2	307.7	
1530	333.9	341.4	520.7	J= 1 + 4	20, 8,	

Wire Speed (M/Min		%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
1540	338.2	331.5	324.8	318.2	311.7
1550	342.6	335.8	329.0	322.3	315.7
1560	347.0	340.1	333.2	326.5	319.8
1570	351.4	344.4	337.5	330.6	323.8
1580	355.8	348.7	341.7	334.8	327.9
1590	360.3	353.1	346.0	339.0	332.1
1600	364.8	357.5	350.4	343.2	336.2
1610	369.3	362.0	354.7	347.5	340.4
1620	373.9	366.4	359.1	351.8	344.6
1630	378.5	370.9	363.5	356.1	348.8
1640	383.1	375.5	367.9	360.4	353.0
1650	387.7	380.0	372.4	364.8	357.3
1660	392.4	384.6	376.9	369.2	361.6
1670	397.1	389.2	381.4	373.6	365.9
1680	401.8	393.8	385.9	378.1	370.3
1690	406.6	398.5	390.5	382.5	374.7
1700	411.4	403.2	395.1	387.0	379.1

TM-2 Tissue Machine

(Slice Opening = 12.50 mm.)

	Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 $J/W = .97$		%Drag = 5 J/W = .95
	500	38.7	38.0	37.3	36.6	36.0
	510	40.2	39.4	38.7	38.0	37.3
	520 530	41.6 43.1	40.9 42.3	40.1 41.5	39.3 40.7	38.6 40.0
	540	44.6	43.8	43.0	42.2	41.4
	550	46.1	45.3	44.4	43.6	42.8
	560	47.7	46.8	45.9	45.1	44.2
	570	49.3	48.4	47.5	46.6	45.7
	580	50.9	50.0	49.0	48.1	47.2
	590	52.6	51.6	50.6	49.6	48.7
	600	54.2	53.2	52.2	51.2	50.2
	610	55.9	54.9	53.8	52.8	51.8
	620	57.7	56.6	55.5	54.4	53.4
	630	59.4	58.3	57.2	56.1	55.0
	640	61.2	60.1	58.9	57.8	56.7
	650	63.0	61.8	60.7	59.5	58.3
	660	64.9	63.7	62.4	61.2	60.0
-	670 680	66.8 68.7	65.5	64.2	63.0 64.8	61.8
	690	70.6	67.4 69.2	66.1 67.9	66.6	63.5 65.3
أرمست	700	72.6	71.2	69.8	68.4	67.1
•	710	74.5	73.1	71.7	70.3	68.9
	720	76.6	75.1	73.6	72.2	70.8
	730	78.6	77.1	75.6	74.1	72.7
	740	80.7	79.1	77.6	76.1	74.6
	750	82.8	81.2	79.6	78.0	76.5
	760	84.9	83.3	81.6	80.0	78.5
	770	87.0	85.4	83.7	82.1	80.4
	780	89.2	87.5	85.8	84.1	82.4
	790	91.4	89.7	87.9	86.2	84.5
	800	93.7	91.9	90.1	88.3	86.5
	810	95.9	94.1	92.3	90.4	88.6
	820	98.2	96.3 98.6	94.5	92.6	90.7
	830 840	100.6 102.9	100.9	96.7 98.9	94.8 97.0	92.9 95.1
	850	105.3	103.3	101.2	99.2	97.2
	860	107.7	105.6	103.5	101.5	99.5
	870	110.1	108.0	105.9	103.8	101.7
	880	112.6	110.4	108.2	106.1	104.0
	890	115.1	112.9	110.6	108.4	106.3
	900	117.6	115.3	113.1	110.8	108.6
	910	120.2	117.8	115.5	113.2	110.9
	920	122.8	120.4	118.0	115.6	113.3
	930	125.4	122.9	120.5	118.1	115.7
	940	128.0	125.5	123.0	120.6	118.1
Sales in the Sales	950	130.7	128.1	125.6	123.1	120.6
	960 070	133.3	130.7	128.2	125.6	123.1
	970	136.1	133.4	130.8	128.2	125.6
•	980	138.8	136.1	133.4	130.7	128.1

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
990	141.6	138.8	136.1	133.3	130.7
1000	144.4	141.6	138.8	136.0	133.2
1010	147.2	144.3	141.5	138.6	135.8
1020	150.1	147.1	144.2	141.3	138.5
1030	153.0	150.0	147.0	144.0	141.1
1040	155.9	152.8	149.8	146.8	143.8
1050	158.8	155.7	152.6	149.6	146.5
1060	161.8	158.6	155.5	152.4	149.3
1070	164.8	161.6	158.3	155.2	152.0
1080	167.8	164.5	161.3	158.0	154.8
1090	170.9	167.5	164.2	160.9	157.6
1100	174.0	170.5	167.2	163.8	160.5
1110	177.1	173.6	170.1	166.7	163.3
1120	180.2	176.7	173.2	169.7	166.2
1130	183.4	179.8	176.2	172.7	169.2 172.1
1140	186.6	182.9	179.3	175.7 178.7	175.1
1150	189.8	186.1	182.4 185.5	181.8	178.1
1160	193.1 196.4	189.3 192.5	188.6	184.8	181.1
1170 1180	199.7	195.7	191.8	188.0	184.1
1190	203.0	199.0	195.0	191.1	187.2
1200	206.4	202.3	198.3	194.3	190.3
1210	209.8	205.6	201.5	197.5	193.4
1220	213.2	209.0	204.8	200.7	196.6
1230	216.6	212.4	208.1	203.9	199.8
1240	220.1	215.8	211.5	207.2	203.0
1250	223.6	219.2	214.8	210.5	206.2
1260	227.2	222.7	218.2	213.8	209.5
1270	230.7	226.2	221.6	217.2	212.7
1280	234.3	229.7	225.1	220.5	216.0 219.4
1290	237.9	233.2	228.6 232.1	223.9 227.4	222.7
1300	241.6 245.3	236.8 240.4	235.6	230.8	226.1
1310 1320	249.0	244.0	239.1	234.3	229.5
1320	252.7	247.7	242.7	237.8	233.0
1340	256.5	251.4	246.3	241.4	236.4
1350	260.2	255.1	250.0	244.9	239.9
1360	264.1	258.8	253.6	248.5	243.4
1370	267.9	262.6	257.3	252.1	247.0
1380	271.8	266.4	261.1	255.8	250.5
1390	275.7	270.2	264.8	259.4	254.1
1400	279.6	274.1	268.6	263.1	257.8
1410	283.6	277.9	272.4	266.9	261.4
1420	287.6	281.8	276.2	270.6	265.1
1430	291.6	285.8	280.0	274.4 278.2	268.8 272.5
1440	295.6	289.7	283.9	282.0	276.2
1450	299.7 303.8	293.7 297.7	287.8 291.8	285.9	280.0
1460 1470	303.8	301.8	295.7	289.7	283.8
1470	312.1	305.9	299.7	293.6	287.6
1490	316.2	310.0	303.7	297.6	291.5
1500	320.5	314.1	307.8	301.5	295.4
1510	324.7	318.2	311.9	305.5	299.3
1520	329.0	322.4	316.0	309.5	303.2
1530	333.3	326.6	320.1	313.6	307.2

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	Drag = 5 $J/W = .95$
1540	337.6	330.9	324.2	317.6	311.1
1550	341.9	335.1	328.4	321.7	315.1
1560	346.3	339.4	332.6	325.9	319.2
1570	350.7	343.7	336.8	330.0	323.2
1580	355.2	348.1	341.1	334.2	327.3
1590	359.6	352.5	345.4	338.4	331.4
1600	364.1	356.9	349.7	342.6	335.6
1610	368.6	361.3	354.0	346.9	339.7
1620	373.2	365.8	358.4	351.1	343.9
1630	377.8	370.3	362.8	355.4	348.1
1640	382.4	374.8	367.2	359.8	352.4
1650	387.0	379.3	371.7	364.1	356.7
1660	391.7	383.9	376.2	368.5	360.9
1670	396.4	388.5	380.7	372.9	365.3
1680	401.1	393.1	385.2	377.4	369.6
1690	405.8	397.7	389.7	381.8	374.0
1700	410.6	402.4	394.3	386.3	378.4

TM-2 Tissue Machine

(Slice Opening = 13.00 mm.)

Wire Sp (M/M			rag = 2 W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
	500 510	38.7 40.1	38.0 39.4	37.3 38.6	36.6 37.9	35.9 37.2
	520	41.6	40.8	40.0	39.3	38.5
	530	43.0	42.2	41.5	40.7	39.9
	540 550	44.5 46.1	43.7 45.2	42.9 44.4	42.1 43.5	41.3 42.7
	560	47.6	46.7	45.9	45.0	44.1
	570	49.2	48.3	47.4	46.5	45.6
	580	50.8	49.9	48.9	48.0	47.1
	590	52.5	51.5	50.5	49.6	48.6
	600 610	54.2 55.9	53.1 54.8	52.1 53.8	51.1 52.7	50.1 51.7
	620	57.6	56.5	55.4	54.4	53.3
	630	59.3	58.2	57.1	56.0	54.9
	640	61.1	60.0	58.8	57.7	56.6
	650	62.9	61.7	60.6	59.4	58.2
	660 670	64.8 66.7	63.6 65.4	62.3 64.1	61.1 62.9	59.9 61.7
	680	68.6	67.2	65.9	64.7	63.4
	690	70.5	69.1	67.8	66.5	65.2
	700	72.4	71.0	69.7	68.3	67.0
	710	74.4	73.0	71.6	70.2	68.8
	720 730	76.4 78.5	75.0	73.5	72.1	70.7
	740	80.5	77.0 79.0	75.5 77.5	74.0 75.9	72.5 74.4
	750	82.6	81.0	79.5	77.9	76.4
•	760	84.7	83.1	81.5	79.9	78.3
	770	86.9	85.2	83.6	81.9	80.3
	780 700	89.1	87.4	85.7	84.0	82.3
	790 800	91.3 93.5	89.5 91.7	87.8 89.9	86.0 88.2	84.3 86.4
	810	95.8	93.9	92.1	90.3	88.5
	820	98.1	96.2	94.3	92.4	90.6
	830	100.4	98.5	96.5	94.6	92.7
	840	102.7	100.8	98.8	96.8	94.9
	850 860	105.1 107.5	103.1 105.4	101.1 103.4	99.1 101.3	97.1 99.3
	870	110.0	107.8	105.7	103.6	101.5
	880	112.4	110.2	108.1	105.9	103.8
	890	114.9	112.7	110.5	108.3	106.1
	900	117.4	115.1	112.9	110.6	108.4
	910	120.0	117.6	115.3	113.0	110.8
	920 930	122.5 125.1	120.2 122.7	117.8 120.3	115.4 117.9	113.1 115.5
	940	127.8	125.3	122.8	120.4	117.9
و	950	130.4	127.9	125.4	122.9	120.4
	960	133.1	130.5	127.9	125.4	122.9
	970	135.8	133.2	130.5	127.9	125.4
9	980	138.6	135.9	133.2	130.5	127.9

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 $J/W = .97$		%Drag = 5 J/W = .95	dillow.
000	141.3	138.6	135.8	133.1	130.4	1000
990	141.3	141.3	138.5	135.7	133.0	
1000 1010	147.0	144.1	141.2	138.4	135.6	
	149.8	146.9	144.0	141.1	138.2	
1020 1030	152.7	149.7	146.7	143.8	140.9	
1040	155.6	152.6	149.5	146.5	143.6	
1040	158.6	155.4	152.4	149.3	146.3	
1060	161.5	158.3	155.2	152.1	149.0	
1070	164.5	161.3	158.1	154.9	151.8	
1080	167.5	164.2	161.0	157.7	154.6	
1090	170.6	167.2	163.9	160.6	157.4	
1100	173.7	170.2	166.9	163.5	160.2	
1110	176.8	173.3	169.8	166.4	163.1	
1120	179.9	176.4	172.9	169.4	165.9	
1130	183.1	179.5	175.9	172.4	168.9	
1140	186.3	182.6	179.0	175.4	171.8	
1150	189.5	185.7	182.0	178.4	174.8	
1160	192.7	188.9	185.2	181.4	177.8	
1170	196.0	192.1	188.3	184.5	180.8	
1180	199.3	195.4	191.5	187.6	183.8	
1190	202.6	198.6	194.7	190.8	186.9	
1200	206.0	201.9	197.9	193.9	190.0	
1210	209.4	205.3	201.2	197.1	193.1	
1220	212.8	208.6	204.4	200.3 203.6	196.2 199.4	
1230	216.3	212.0	207.7 211.1	206.8	202.6	- 400
1240	219.7	215.4 218.8	211.1	210.1	205.8	
1250 1260	223.2 226.8	222.3	217.8	213.4	209.1	
1270	230.3	225.8	221.2	216.8	212.4	
1280	233.9	229.3	224.7	220.2	215.7	
1290	237.5	232.8	228.2	223.6	219.0	
1300	241.2	236.4	231.7	227.0	222.3	
1310	244.8	240.0	235.2	230.4	225.7	
1320	248.5	243.6	238.7	233.9	229.1	
1330	252.3	247.3	242.3	237.4	232.6	
1340	256.0	250.9	245.9	240.9	236.0	
1350	259.8	254.6	249.5	244.5	239.5	
1360	263.6	258.4	253.2	248.1	243.0	
1370	267.4	262.1	256.9	251.7	246.5	
1380	271.3	265.9	260.6	255.3	250.1	
1390	275.2	269.7	264.3	259.0	253.7	
1400	279.1	273.6	268.1	262.7	257.3 260.9	
1410	283.1	277.5	271.9	266.4 270.1	264.6	
1420	287.1	281.4	275.7 279.6	273.9	268.3	
1430	291.1	285.3 289.2	283.4	273.9	272.0	
1440	295.1	293.2	287.3	281.5	275.8	
1450 1460	299.2 303.2	293.2 297.2	291.3	285.4	279.5	
1470	307.4	301.3	295.2	289.2	283.3	
1480	311.5	305.3	299.2	293.1	287.1	
1490	315.7	309.4	303.2	297.1	291.0	
1500	319.9	313.5	307.2	301.0	294.8	
1510	324.1	317.7	311.3	305.0	298.7	
1520	328.4	321.9	315.4	309.0	302.7	
1530	332.7	326.1	319.5	313.0	306.6	
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Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
1540	337.0	330.3	323.7	317.1	310.6
1550	341.3	334.6	327.8	321.2	314.6
1560	345.7	338.8	332.0	325.3	318.6
1570	350.1	343.1	336.3	329.4	322.7
1580	354.5	347.5	340.5	333.6	326.8
1590	359.0	351.9	344.8	337.8	330.9
1600	363.5	356.3	349.1	342.0	335.0
1610	368.0	360.7	353.4	346.2	339.1
1620	372.5	365.1	357.8	350.5	343.3
1630	377.1	369.6	362.2	354.8	347.5
1640	381.7	374.1	366.6	359.1	351.8
1650	386.3	378.6	371.0	363.5	356.0
1660	391.0	383.2	375.5	367.9	360.3
1670	395.7	387.8	380.0	372.3	364.6
1680	400.4	392.4	384.5	376.7	369.0
1690	405.1	397.0	389.1	381.1	373.3
1700	409.9	401.7	393.6	385.6	377.7

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TM-2 Tissue Machine

(Slice Opening = 13.50 mm.)

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97		%Drag = 5 J/W = .95
500	38.6	37.9	37.2	36.5	35.8
510	40.0	39.3	38.6	37.9	37.2
520	41.5	40.7	40.0 41.4	39.2 40.6	38.5 39.8
530 540	43.0 44.5	42.2 43.6	42.8	42.0	41.2
550	46.0	45.1	44.3	43.5	42.6
560	47.6	46.7	45.8	44.9	44.1
570	49.1	48.2	47.3	46.4	45.5
580	50.8	49.8	48.9	47.9	47.0
590	52.4	51.4	50.4	49.5	48.5
600	54.1	53.1	52.0	51.1	50.1
610	55.8	54.7	53.7	52.6	51.6
620	57.5	56.4	55.3	54.3	53.2
630	59.2	58.1	57.0	55.9	54.8
640	61.0	59.9	58.7	57.6	56.5 58.1
650	62.8	61.6	60.5 62.2	59.3 61.0	59.8
660 670	64.7 66.5	63.5 65.3	64.0	62.8	61.6
680	68.4	67.1	65.8	64.6	63.3
690	70.4	69.0	67.7	66.4	65.1
700	72.3	70.9	69.6	68.2	66.9
710	74.3	72.9	71.5	70.1	68.7
720	76.3	74.8	73.4	72.0	70.5
730	78.3	76.8	75.3	73.9	72.4
740	80.4	78.9	77.3	75.8	74.3
750	82.5	80.9	79.3	77.8	76.2
760	84.6	83.0	81.4	79.8	78.2
770	86.8	85.1	83.4	81.8 83.8	80.2 82.2
780 790	88.9 91.1	87.2 89.4	85.5 87.6	85.9	84.2
800	93.4	91.6	89.8	88.0	86.3
810	95.6	93.8	91.9	90.1	88.3
820	97.9	96.0	94.1	92.3	90.4
830	100.2	98.3	96.4	94.5	92.6
840	102.6	100.6		96.7	94.7
850	105.0	102.9	100.9	98.9	96.9
860	107.4	105.3	103.2	101.2	99.1
870	109.8	107.6	105.5	103.4	101.4
880	112.2	110.1	107.9	105.8	103.6
890	114.7	112.5	110.3	108.1	105.9
900	117.2	115.0	112.7	110.4	108.2 110.6
910	119.8	117.4 120.0	115.1 117.6	112.8 115.3	112.9
920 930	122.3 124.9	122.5	120.1	117.7	115.3
940	124.9	125.1	122.6	120.2	117.7
950	130.2	127.7	125.2	122.7	120.2
960	132.9	130.3	127.7	125.2	122.7
970	135.6	133.0	130.3	127.7	125.2
980	138.3	135.6	133.0	130.3	127.7

Wire Speed	%Drag = 1	%Drag = 2	%Drag = 3	%Drag = 4	%Drag = 5
(M/Min)	J/W = .99	J/W = .98	J/W = .97	J/W = .96	J/W = .95
990	141.1	138.3	135.6	132.9	130.2
1000	143.9	141.1	138.3	135.5	132.8
1010	146.7	143.8	141.0	138.2	135.4
1020	149.6	146.6	143.7	140.9	138.0
1030	152.5	149.5	146.5	143.6	140.7
1040	155.4	152.3	149.3	146.3	143.3
1050	158.3	155.2	152.1	149.1	146.0
1060	161.3	158.1	154.9	151.8	148.8
1070	164.2	161.0	157.8	154.7	151.5
1080	167.3	164.0	160.7	157.5	154.3
1090	170.3	167.0	163.6	160.4	157.1
1100	173.4	170.0	166.6	163.2	159.9
1110	176.5	173.0	169.6	166.2	162.8
1120	179.6	176.1	172.6	169.1	165.7
1130	182.8	179.2	175.6	172.1	168.6
1140	186.0	182.3	178.7	175.1	171.5
1150	189.2	185.4	181.8	178.1	174.5
1160	192.4	188.6	184.9	181.1	177.5
1170	195.7	191.8	188.0	184.2	180.5
1180	199.0	195.1	191.2	187.3	183.5
1190	202.3	198.3	194.4	190.5	186.6
1200	205.7	201.6	197.6	193.6	189.7
1210	209.1	204.9	200.8	196.8	192.8
1220	212.5	208.3	204.1	200.0	195.9
1230	215.9	211.6	207.4	203.2	199.1
1240	219.4	215.0	210.7	206.5	202.3
1250	222.9	218.5	214.1	209.8	205.5
1260	226.4	221.9	217.5	213.1	208.7
1270	229.9	225.4	220.9	216.4	212.0
1280	233.5	228.9	224.3	219.8	215.3 218.6
1290	237.1	232.4	227.8	223.2	222.0
1300	240.8	236.0	231.3 234.8	226.6 230.0	225.4
1310	244.4	239.6 243.2	234.0	233.5	228.8
1320	248.1 251.8	245.2	241.9	237.0	232.2
1330 1340	255.6	250.5	245.5	240.5	235.6
1350	259.4	254.2	249.1	244.1	239.1
1360	263.2	257.9	252.8	247.7	242.6
1370	267.0	261.7	256.5	251.3	246.1
1380	270.9	265.5	260.2	254.9	249.7
1390	274.7	269.3	263.9	258.6	253.3
1400	278.7	273.1	267.7	262.2	256.9
1410	282.6	277.0	271.4	266.0	260.5
1420	286.6	280.9	275.3	269.7	264.2
1430	290.6	284.8	279.1	273.4	267.9
1440	294.6	288.8	283.0	277.2	271.6
1450	298.7	292.7	286.9	281.1	275.3
1460	302.8	296.7	290.8	284.9	279.1
1470	306.9	300.8	294.7	288.8	282.8
1480	311.0	304.8	298.7	292.7	286.7
1490	315.2	308.9	302.7	296.6	290.5
1500	319.4	313.0	306.7	300.5	294.4
1510	323.6	317.2	310.8	304.5	298.3
1520	327.8	321.3	314.9	308.5	302.2
1530	332.1	325.5	319.0	312.5	306.1

	Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
STIPS NO.	1540	336.4	329.7	323.1	316.6	310.1
named of	1550	340.8	334.0	327.3	320.6	314.1
	1560	345.1	338.3	331.5	324.8	318.1
	1570	349.5	342.6	335.7	328.9	322.1
	1580	354.0	346.9	339.9	333.0	326.2
	1590	358.4	351.3	344.2	337.2	330.3
	1600	362.9	355.7	348.5	341.4	334.4
	1610	367.4	360.1	352.8	345.7	338.6
	1620	371.9	364.5	357.2	349.9	342.8
	1630	376.5	369.0	361.6	354.2	347.0
	1640	381.1	373.5	366.0	358.5	351.2
	1650	385.7	378.0	370.4	362.9	355.4
	1660	390.3	382.6	374.9	367.3	359.7
	1670	395.0	387.1	379.4	371.7	364.0
	1680	399.7	391.8	383.9	376.1	368.4
	1690	404.4	396.4	388.4	380.5	372.7
	1700	409.2	401.1	393.0	385.0	377.1

TM-2 Tissue Machine

(Slice Opening = 14.00 mm.)

	Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
	500	38.6	37.9	37.2	36.5	35.8
	510 520	40.0 41.4	39.3 40.7	38.5 39.9	37.8 39.2	37.1 38.4
	530	42.9	42.1	41.3	40.6	39.8
	540	44.4	43.6	42.8	42.0	41.2
	550	45.9	45.1	44.2	43.4	42.6
	560	47.5	46.6	45.7	44.9	44.0
	570	49.1	48.2	47.2	46.4	45.5
	580	50.7	49.7	48.8	47.9	46.9
	590	52.3	51.3	50.4	49.4	48.5
	600	54.0	53.0	52.0	51.0	50.0
	610 620	55.7 57.4	54.6 56.3	53.6 55.3	52.6 54.2	51.6 53.1
	630	59.2	58.0	56.9	55.8	54.8
	640	60.9	59.8	58.6	57 . 5	56.4
	650	62.7	61.6	60.4	59.2	58.1
	660	64.6	63.4	62.1	60.9	59.8
	670	66.4	65.2	63.9	62.7	61.5
700m.	680	68.3	67.0	65.7	64.5	63.2
	690	70.3	68.9	67.6	66.3	65.0
	700	72.2	70.8	69.5	68.1	66.8
	710	74.2	72.8	71.4	70.0	68.6 70.4
	720 730	76.2 78.2	74.7 76.7	73.3 75.2	71.9 73.8	70.4 72.3
	740	80.3	78.7	77.2	75.7	74.2
	750	82.4	80.8	79.2	77.7	76.1
	760	84.5	82.9	81.2	79.7	78.1
	770	86.6	85.0	83.3	81.7	80.1
	780	88.8	87.1	85.4	83.7	82.1
	790	91.0	89.2	87.5	85.8	84.1
	800	93.2	91.4	89.6	87.9	86.1
	810	95.5	93.6	91.8	90.0	88.2
	· 820 830	97.8 100.1	95.9 98.1	94.0 96.2	92.1 94.3	90.3 92.4
	840	102.4	100.4	98.5	96.5	94.6
	850	104.8	102.8	100.7	98.8	96.8
	860	107.2	105.1	103.0	101.0	99.0
	870	109.6	107.5	105.4	103.3	101.2
	880	112.1	109.9	107.7	105.6	103.5
	890	114.5	112.3	110.1	107.9	105.8
	900	117.1	114.8	112.5	110.3	108.1
	910	119.6	117.3	115.0	112.7	110.4
	920	122.2	119.8	117.4	115.1	112.8
and the same	930 940	124.8 127.4	122.3 124.9	119.9 122.4	117.5 120.0	115.2 117.6
Thomas /	950	130.0	127.5	125.0	120.0	120.0
iggipine de de la companya de la com	960	132.7	130.1	127.5	125.0	122.5
	970	135.4	132.8	130.1	127.5	125.0
	980	138.1	135.4	132.8	130.1	127.5

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95	
(11/11211)	5 / 13 2	• ,	- /	,	·	-0.4
990	140.9	138.1	135.4	132.7	130.0	
1000	143.7	140.9	138.1	135.3	132.6	
1010	146.5	143.6	140.8	138.0	135.2	
1020	149.3	146.4	143.5	140.6	137.8	
1030	152.2	149.2	146.3	143.3	140.4	
1040	155.1	152.1	149.1	146.1	143.1	
1050	158.1	154.9	151.9	148.8	145.8	
1060	161.0	157.8	154.7	151.6	148.5	
	164.0	160.8	157.6	154.4	151.3	
1070	167.0	163.7	160.5	157.3	154.1	
1080		166.7	163.4	160.1	156.9	
1090	170.0	169.7	166.3	163.0	159.7	
1100	173.1	172.7	169.3	165.9	162.5	
1110	176.2		172.3	168.8	165.4	
1120	179.3	175.8		171.8	168.3	
1130	182.5	178.9	175.3		171.3	
1140	185.7	182.0	178.4	174.8	174.2	
1150	188.9	185.2	181.5	177.8	177.2	
1160	192.1	188.3	184.6	180.9		
1170	195.4	191.5	187.7	183.9	180.2	
1180	198.7	194.8	190.9	187.0	183.2	
1190	202.0	198.0	194.1	190.2	186.3	
1200	205.4	201.3	197.3	193.3	189.4	
1210	208.7	204.6	200.5	196.5	192.5	
1220	212.1	207.9	203.8	199.7	195.6	
1230	215.6	211.3	. 207.1	202.9	198.8	
1240	219.0	214.7	210.4	206.2	202.0	1
1250	222.5	218.1	213.8	209.5	205.2	
1260	226.0	221.6	217.1	212.8	208.4	
1270	229.6	225.0	220.5	216.1	211.7	
1280	233.2	228.5	224.0	219.5	215.0	
1290	236.8	232.1	227.4	222.8	218.3	
1300	240.4	235.6	230.9	226.3	221.6	
1310	244.0	239.2	234.4	229.7	225.0	
1320	247.7	242.8	238.0	233.2	228.4	
1330	251.4	246.5	241.5	236.7	231.8	
1340	255.2	250.1	245.1	240.2	235.3	
1350	259.0	253.8	248.7	243.7	238.7	
1360	262.8	257.5	252.4	247.3	242.2	
1370	266.6	261.3	256.1	250.9	245.8	
1380	270.4	265.1	259.8	254.5	249.3	
1390	274.3	268.9	263.5	258.2	252.9	
1400	278.2	272.7	267.2	261.8	256.5	
1410	282.2	276.6	271.0	265.5	260.1	
1420	286.1	280.5	274.8	269.3	263.8	
1430	290.1	284.4	278.7	273.0	267.4	
1440	294.2	288.3	282.5	276.8	271.1	
1450	298.2	292.3	286.4	280.6	274.9	
1460	302.3	296.3	290.3	284.4	278.6	
1470	306.4	300.3	294.3	288.3	282.4	
1480	310.5	304.4	298.2	292.2	286.2	
1490	314.7	308.4	302.2	296.1	290.0	
	314.7	312.5	306.3	300.1	293.9	
1500		316.7	310.3	304.0	297.8	
1510	323.1	320.8	314.4	308.0	301.7	
1520	327.3	320.8	318.5	312.0	305.6	
1530	331.6	345.0	210.2	J12.U	303.0	

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	Drag = 5 $J/W = .95$
1540 1550 1560 1570 1580 1590 1600 1610 1620 1630 1640 1650 1660	335.9 340.2 344.6 349.0 353.4 357.9 362.3 366.8 371.3 375.9 380.5 385.1	329.2 333.5 337.8 342.1 346.4 350.7 355.1 359.5 364.0 368.4 372.9 377.4 382.0	322.6 326.8 331.0 335.2 339.4 343.7 348.0 352.3 356.6 361.0 365.4 369.8 374.3	316.1 320.2 324.2 328.4 332.5 336.7 340.9 345.1 349.4 353.7 358.0 362.3	309.6 313.6 317.6 321.6 325.7 329.8 333.9 338.1 342.2 346.4 350.6 354.9 359.2
1670 1680 1690 1700	394.4 399.1 403.8 408.6	386.5 391.1 395.8 400.4	378.8 383.3 387.8 392.4	371.1 375.5 379.9 384.4	363.5 367.8 372.1 376.5

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TM-2 Tissue Machine

(Slice Opening = 14.50 mm.)

Wi	re Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
	500	38.5	37.8 39.2	37.1 38.5	36.4 37.8	35.8 37.1
	510 520	39.9 41.4	40.6	39.9	39.1	38.4
	530	42.8	42.1	41.3	40.5	39.7
	540	44.3	43.5	42.7	41.9	41.1
	550	45.9	45.0	44.2	43.3	42.5
	560	47.4	46.5	45.7	44.8	43.9 45.4
	570 530	49.0	48.1 49.7	47.2 48.7	46.3 47.8	46.9
	580 590	50.6 52.2	51.3	50.3	49.3	48.4
	600	53.9	52.9	51.9	50.9	49.9
	610	55.6	54.6	53.5	52.5	51.5
	620	57.3	56.2	55.2	54.1	53.1
	630	59.1	58.0	56.9	55.8 57.4	54.7 56.3
	640	60.9	59.7 61.5	58.6 60.3	57.4 59.1	58.0
	650 660	62.7 64.5	63.3	62.1	60.9	59.7
	670	66.4	65.1	63.8	62.6	61.4
١	680	68.2	66.9	65.7	64.4	63.1
****	690	70.2	68.8	67.5	66.2	64.9
	700	72.1	70.7	69.4	68.0	66.7
	710	74.1	72.7	71.3	69.9 71.8	68.5 70.3
	720 730	76.1 78.1	74.6 76.6	73.2 75.1	73.7	70.3
	730 740	80.2	78.6	77.1	75.6	74.1
	750	82.3	80.7	79.1	77.6	76.0
	760	84.4	82.7	81.1	79.5	78.0
	770	86.5	84.8	83.2	81.6	79.9
	780	88.7	87.0	85.3	83.6	81.9
	790	90.9	89.1	87.4	85.7 87.8	84.0 86.0
	800 810	93.1 95.4	91.3 93.5	89.5 91.7	89.9	88.1
	820	97.6	95.7	93.9	92.0	90.2
	830	99.9	98.0	96.1	94.2	92.3
	840	102.3	100.3	98.3	96.4	94.5
	850	104.6	102.6	100.6	98.6	96.6
	860	107.0	105.0	102.9	100.9	98.8 101.1
	870	109.5	107.3 109.7	105.2 107.6	103.1 105.4	103.3
	880 890	111.9 114.4	112.2	110.0	107.8	105.6
	900	116.9	114.6	112.4	110.1	107.9
	910	119.4	117.1	114.8	112.5	110.2
	920	122.0	119.6	117.2	114.9	112.6
.)	930	124.6	122.1	119.7	117.3	115.0
er er	940	127.2	124.7	122.2	119.8 122.3	117.4 119.8
	950 060	129.8	127.3 129.9	124.8 127.3	124.8	122.3
	960 970	132.5 135.2	132.6	129.9	127.3	124.8
	970	137.9	135.2	132.6	129.9	127.3
	900			=		

	%Drag = 5 J/W = .95	%Drag = 4 J/W = .96	%Drag = 3 J/W = .97	%Drag = 2 J/W = .98	%Drag = 1 J/W = .99	Wire Speed
** Steamer	,	•	•	0/	U/H55	(M/Min)
	129.8	132.5	135.2	137.9	140.7	990
	132.4	135.1	137.9	140.7	143.5	1000
	135.0	137.8	140.6	143.4	146.3	1010
	137.6	140.4	143.3	146.2	149.1	1020
	140.2	143.1	146.1	149.0	152.0	1030
	142.9	145.9	148.8	151.9	154.9	1040
	145.6	148.6	151.7	154.7	157.8	1050
	148.3	151.4	154.5	157.6	160.8	1060
	151.1	154.2	157.3	160.5	163.8	1070
	153.8	157.0	160.2	163.5	166.8	1080
	156.6	159.9	163.2	166.5	169.8	1090
	159.5	162.8	166.1	169.5	172.9	1100
	162.3	165.7	169.1	172.5	176.0	1110
	165.2	168.6	172.1	175.6	179.1	1120
	168.1	171.6	175.1	178.6	182.2	1130
	171.0	174.6	178.1	181.8	185.4	1140
	174.0	177.6	181.2	184.9	188.6	1150
	176.9	180.6	184.3	188.1	191.8	1160
	179.9	183.7	187.4	191.3	195.1	1170
	183.0	186.8	190.6	194.5	198.4	1180
	186.0	189.9	193.8	197.7	201.7	1190
	189.1	193.0	197.0	201.0	205.1	1200
	192.2	196.2	200.2	204.3	208.4	1210
()	195.3	199.4	203.5	207.6	211.8	1220
- Second	198.5	202.6	206.8	211.0	215.3	1230
	201.7	205.9	210.1	214.4	218.7	1240
	204.9	209.1	213.5	217.8	222.2	1250
	208.1	212.4	216.8	221.2	225.7	1260
	211.4	215.8	220.2	224.7	229.3	1270
	214.7	219.1	223.6	228.2	232.8	1280
	218.0	222.5	227.1	231.7	236.4	1290
	221.3	225.9	230.6	235.3	240.0	1300
	224.7	229.4	234.1	238.9	243.7	1310
	228.1	232.8	237.6	242.5	247.4	1320
	231.5	236.3	241.2	246.1	251.1	1330
	234.9	239.8	244.8	249.8	254.8	1340
	238.4	243.4	248.4	253.5	258.6	1350
	241.9 245.4	246.9	252.0	257.2	262.4	1360
	248.9	250.5	255.7	260.9	266.2	1370
		254.1	259.4	264.7	270.0	1380
	252.5	257.8	263.1	268.5	273.9	1390
	256.1 259.7	261.5	266.9	272.3	277.8	1400
		265.2	270.6	276.2	281.8	1410
	263.4 267.0	268.9	274.4	280.0	285.7	1420
	270.7	272.6	278.3	284.0	289.7	1430
	274.5	276.4	282.1	287.9	293.7	1440
	274.5	280.2	286.0	291.9	297.8	1450
	282.0	284.0	289.9	295.8	301.8	1460
()	285.8	287.9	293.8	299.9	305.9	1470
		291.8	297.8	303.9	310.1	1480
	289.6	295.7	301.8	308.0	314.2	1490
	293.5	299.6	305.8	312.1	318.4	1500
	297.4	303.6	309.9	316.2	322.6	1510
	301.3 305.2	307.6	313.9	320.4	326.9	1520
	303.4	311.6	318.0	324.5	331.1	1530

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	%Drag = 4 J/W = .96	%Drag = 5 J/W = .95
1540	335.4	328.8	322.2	315.6	309.1
1550	339.8	333.0	326.3	319.7	313.1
1560	344.1	337.3	330.5	323.8	317.1
1570	348.5	341.5	334.7	327.9	321.2
1580	352.9	345.9	338.9	332.0	325.2
1590	357.3	350.2	343.2	336.2	329.3
1600	361.8	354.6	347.5	340.4	333.4
1610	366.3	359.0	.351.8	344.6	337.6
1620	370.8	363.4	356.1	348.9	341.7
1630	375.4	367.9	360.5	353.2	345.9
1640	379.9	372.4	364.9	357.5	350.1
1650	384.5	376.9	369.3	361.8	354.4
1660	389.2	381.4	373.7	366.1	358.6
1670	393.8	386.0	378.2	370.5	362.9
1680	398.5	390.6	382.7	374.9	367.2
1690	403.2	395.2	387.2	379.4	371.6
1700	408.0	399.8	391.8	383.8	376.0

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TM-2 Tissue Machine

(Slice Opening = 15.00 mm.)

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98		%Drag = 4 J/W = .96	
500	38.5	37.8	37.1	36.4	35.7
510		39.2	38.4	37.7	37.0
520		40.6	39.8	39.1	38.3
530		42.0	41.2	40.4	39.7
540	44.3	43.5	42.7	41.9	41.1
550		45.0	44.1	43.3	42.5
560		46.5	45.6	44.7	43.9
570		48.0	47.1	46.2	45.3
580		49.6	48.7	47.7	46.8
590		51.2	50.2	49.3	48.3
600		52.8	51.8	50.8	49.9
610		54.5	53.5	52.4	51.4
620		56.2	55.1	54.0	53.0
630	59.0	57.9	56.8	55.7	54.6
640	60.8	59.6	58.5	57.4	56.2
650	62.6	61.4	60.2	59.1	57.9
660	64.4	63.2	62.0	60.8	59.6
670		65.0	63.8	62.5	61.3
680		66.9	65.6	64.3	63.0
690		68.7	67.4	66.1	64.8
<i></i>		70.6	69.3	67.9	66.6
710		72.6	71.2	69.8	68.4
720		74.5	73.1	71.7	70.2
730		76.5	75.0	73.6	72.1
740		78.5	77.0	75.5	74.0
750		80.6	79.0	77.5 79.4	75.9 77.9
760 770		82.6 84.7	81.0 83.1	81.4	79.8
770 780		86.8	85.2	83.5	81.8
780 790		89.0	87.3	85.5	83.8
800		91.2	89.4	87.6	85.9
810		93.4	91.6	89.8	88.0
820		95.6	93.7	91.9	90.1
830		97.9	96.0	94.1	92.2
840		100.2	98.2	96.3	94.3
850		102.5	100.5	98.5	96.5
860		104.8	102.8	100.7	98.7
870		107.2	105.1	103.0	100.9
880	111.8	109.6	107.4	105.3	103.2
890	114.2	112.0	109.8	107.6	105.5
900	116.7	114.5	112.2	110.0	107.8
910	119.3	116.9	114.6	112.4	110.1
920		119.4	117.1	114.8	112.5
930		122.0	119.6	117.2	114.8
940		124.5	122.1	119.6	117.2
950		127.1	124.6	122.1	119.7
960		129.7	127.2	124.6	122.1
970		132.4	129.8	127.2	124.6
980	137.7	135.1	132.4	129.7	127.1

		:		0.7	°Duog – E
Wire Speed (M/Min)	%Drag = 1 J/W = .99	Drag = 2 $J/W = .98$	%Drag = 3 J/W = .97	%Drag = 4 $J/W = .96$	%Drag = 5 J/W = .95
990	140.5	137.7	135.0	132.3	129.7
1000	143.3	140.5	137.7	134.9	132.2
1010	146.1	143.2	140.4	137.6	134.8
1020	148.9	146.0	143.1	140.3	137.4
1030	151.8	148.8	145.9	142.9	140.1
1040	154.7	151.6	148.6	145.7	142.7
1050	157.6	154.5	151.4	148.4	145.4
1060	160.6	157.4	154.3	151.2	148.1
1070	163.5	160.3	157.1	154.0	150.9
1080	166.5	163.3	160.0	156.8	153.6
1090	169.6	166.2	162.9	159.7	156.4
1100	172.6	169.2	165.9	162.5	159.2
1110	175.7	172.3	168.8	165.4	162.1
1120	178.8	175.3	171.8	168.4	165.0
1130	182.0	178.4	174.8	171.3	167.9 170.8
1140	185.2	181.5	177.9	174.3	173.7
1150	188.4	184.6	181.0	177.3 180.4	176.7
1160	191.6	187.8	184.1	183.4	179.7
1170	194.8	191.0	187.2	186.5	182.7
1180	198.1	194.2	190.3 193.5	189.6	185.8
1190	201.4	197.5 200.7	196.7	192.8	188.8
1200	204.8 208.1	204.0	200.0	195.9	191.9
1210 1220	211.5	207.4	203.2	199.1	195.1
1230	215.0	210.7	206.5	202.3	198.2
1240	218.4	214.1	209.8	205.6	201.4
1250	221.9	217.5	213.2	208.9	204.6
1260	225.4	220.9	216.5	212.2	207.8
1270	228.9	224.4	219.9	215.5	211.1
1280	232.5	227.9	223.3	218.8	214.4
1290	236.1	231.4	226.8	222.2	217.7
1300	239.7	235.0	230.3	225.6	221.0 224.4
1310	243.4	238.5	233.8	229.0 232.5	227.8
1320	247.0	242.1	237.3 240.8	236.0	231.2
1330	250.7	245.8	244.4	239.5	234.6
1340	254.5	249.4 253.1	248.0	243.0	238.1
1350	258.2 262.0	256.8	251.7	246.6	241.5
1360 1370	265.8	260.6	255.3	250.2	245.1
1380	269.7	264.3	259.0	253.8	248.6
1390	273.5	268.1	262.7	257.4	252.2
1400	277.4	271.9	266.5	261.1	255.8
1410	281.4	275.8	270.3	264.8	259.4
1420	285.3	279.7	274.1	268.5	263.0
1430	289.3	283.6	277.9	272.3	266.7
1440	293.3	287.5	281.7	276.0	270.4
1450	297.4	291.5	285.6	279.8	274.1
1460	301.4	295.4	289.5	283.6	277.8
1470	305.5	299.4	293.4	287.5	281.6
1480	309.6	303.5	297.4	291.4	285.4
1490	313.8	307.6	301.4	295.3	289.2 293.1
1500	318.0	311.6	305.4	299.2	293.1 296.9
1510	322.2	315.8	309.4	303.2 307.1	300.8
1520	326.4	319.9	313.5 317.6	311.1	304.8
1530	330.7	324.1	317.0	J = 4 + 4	551.5

Wire Speed (M/Min)	%Drag = 1 J/W = .99	%Drag = 2 J/W = .98	%Drag = 3 J/W = .97	Drag = 4 $J/W = .96$	%Drag = 5 J/W = .95
1540	335.0	328.3	321.7	315.2	308.7
1550	339.3	332.5	325.9	319.2	312.7
1560	343.6	336.8	330.0	323.3	316.7
1570	348.0	341.1	334.2	327.4	320.7
1580	352.4	345.4	338.5	331.6	324.8
1590	356.8	349.7	342.7	335.7	328.9
1600	361.3	354.1	347.0	339.9	333.0
1610	365.8	358.5	351.3	344.2	337.1
1620	370.3	362.9	355.6	348.4	341.3
1630	374.8	367.4	360.0	352.7	345.4
1640	379.4	371.8	364.4	357.0	349.6
1650	384.0	376.4	368.8	361.3	353.9
1660	388.6	380.9	373.2	365.6	358.1
1670	393.3	385.4	377.7	370.0	362.4
1680	398.0	390.0	382.2	374.4	366.7
1690	402.7	394.6	386.7	378.8	371.1
1700	407.4	399.3	391.3	383.3	375.4

PRESS

Purpose

To remove the maximum amount of water from the formed sheet by mechanical pressure. It is far more economical to remove water by mechanical means than by evaporation in the dryer section.

To consolidate the sheet in order to achieve higher web strength required for good runnability in the dryer section. This will aid in the development of good fiber-to-fiber bonding during drying.

Process Description

The primary components of the press section for TM-2 consist of a suction pickup roll, a suction first press roll, a blind drilled second press roll and a press felt. Other related equipment located in the press section are: felt rolls, uhle boxes, showers, doctors, savealls, guide and stretch systems.

The formed sheet (approximately 18-22%) from the Duoformer T section is transferred to the press felt by the suction pickup tube. The sheet adheres to the underside of the press felt and is conveyed to the 1st press nip. The 1st press nip is formed by the suction press roll and the Yankee dryer. After the 1st press nip the sheet (approximately 30-35%) sticks to the smooth yankee surface and is transported to the 2nd press nip. The 2nd press nip is formed by the 2nd press pressure roll and the yankee dryer. After the 2nd press nip the sheet (approximately 38-42%) stays in contact with the yankee surface and is further dried by steam in the yankee dryer.

The 1st press loading is designed for a maximum of 70 Kg/cm. The 2nd press loading is designed for a maximum of 90 Kg/cm.

The felt and sheet separate at the 2nd press nip. The felt is then directed around several felt return rolls and is re-conditioned by high and low pressure shower applications, chemical addition and vacuum suction. The water, dirt and chemicals are removed at the uhle boxes and the felt is ready to accept more water from the presses on the next revolution.

A stretch roll is utilized to control the tension of the felt at an optimum value. The guide roll and guide palm mechanisms control the path of the felt to keep the felt running on the machine and not off the machine. Felt return rolls complete the felt run and re-direct the felt back to the press nips.

Basic Components

The main components of the press section are:

- Suction Pickup Tube
- 1st Press Suction Roll (roll #12)
- 2nd Press Pressure Roll (roll #14)
- Felt Return Rolls (roll #'s 10, 11, 13, 15, 16, 17, 18, 19, 20)
- Felt
- Uhle Boxes
- Web Retention Box
- Wire Stretch System
- Wire Guide System
- Showers
- Doctor Blades
- Savealls

Each of these components are essential to the operation of the press section. Each one will be described in detail in the following sections.

1) Suction Pickup Tube

Purpose

To pickup the sheet from the inner wire and transfer it to the felt via a vacuum shoe located at the point of felt-shoe-wire contact.

Description

The suction pickup tube is a stationary element located inside the press felt. The tube consists of a stainless steel shell and a ceramic shoe (foil). The ceramic shoe penetrates the wire at the felt-sheet-wire contact. The sheet is transferred to the underside of the press felt via vacuum applied at the pickup shoe.

The penetration of the shoe into the wire and angle of contact are adjusted via stop screws on both sides of the machine. The penetration depth should be set as low as possible (ie., approxiamtely 15 mm).

Suction width inside the pickup tube can be adjusted using moveable end deckles. The vacuum adjustment is set by means of a suction valve in the exhaust system on the drive side. The operator can throttle the suction valve until the vacuum gauge indicates the desired vacuum level.

A lubrication water shower is used to reduce friction between the ceramic foil and the press felt.

The suction pickup tube is equipped with a pneumatic locking device for felt and roll changes. With the press in the "open" position the pneumatic lock is activated to insert a locking pin in the hydraulic arm at both the tending and drive sides.

Technical Data

Material of BodyStainless SteelMaterial of FoilsCeramicTube Diameter150 mmNumber of Foils2Width of Slot13 mmLength of Slot3080 mm

2) 1st Press Suction Roll (roll #12)

Purpose

To apply mechanical pressure to the paper web and to remove expressed water under applied vacuum.

Description

The suction press was developed in an attempt to maximize water removal in the vertical direction. The holes in the perforated roll provide an easier escape route for the water. The water that is squeezed from the web in the press is forced into the void area of the press felt and then drawn by vacuum from the felt through the holes in the press roll cover and into the suction box. The suction roll consists of a perforated rubber covered shell which rotates around a stationary suction box. Vacuum is applied to the suction box by vacuum pumps P54 and P55. Suction is possible between the suction box and the shell because of sealing strips mounted on the suction box and pneumatically pressed against the internal shell surface.

There are two vacuum zones in the 1st press suction roll:

- 1) Retaining Zone
- 2) Suction Zone

The length of the retaining zone is 600 mm and the length of the suction zone is 100 mm. P54 supplies vacuum to the retaining zone at 4.0 - 4.5 mWG and P55 supplies vacuum to the suction zone at 2.5 - 3.0 mWG. The suction press roll forms a nip with the Yankee dryer cylinder which makes up the 1st press section of TM-2. The press felt wraps the suction roll.

The maximum nip load pressure for the suction roll is 70 kg/cm. The suction roll is driven from the back side of the machine.

The suction roll comes equipped with internal deckles to adjust the suction width. Also, internal showers to lubricate the deckle strips and the sealing strips for the suction zones. This will reduce wear and also provide a better seal for the vacuum compartment.

The deckles on both sides of the suction roll are adjusted by spindles located on the tending side (front side) of the roll. The suction box rotation is adjusted on the tending side of the roll also by a worm gear unit with corresponding scale indication. These adjustments will be set on start up.

Basic Components

1) Shell

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A perforated bronze shell which rotates around the stationary suction box.

2) Roll cover

The roll cover is rubber (type X-300) which covers the external surface of the shell. It is also drilled the same as the shell. The rubber cover is ground at a P & J hardness value of 38.

3) Suction box

The suction box is a stationary element mounted inside the shell which is used to draw the pressed water out of the web. The suction box is sealed to the rotating shell by sealing strips (loaded by air cylinders) and a water layer. The suction box is constructed of mild steel with cast steel supports. There are two suction zones 600 and 100 mm respectively with different vacuum requirements. The suction box is also equipped with deckles, deckle shower, sealing strip showers and adjusting devices to rotate the suction box as well as the suction width. Two vacuum gauges are located on the tending side bearing housing to allow the operator to monitor the suction and retaining zone vacuums during operation.

4) Suction head

The suction head is located on the tending side of the suction box and is used to draw away the water by vacuum to the vacuum pumps.

5) Sealing strips

There is one (1) sealing strip with holding strip and two (2) sealing strips with holding beams. The sealing strips are pressed against the shell by the compressed air hoses. The three (3) sealing strips make up the two (2) vacuum zones.

Press Section 7

6) End deckles

The suction width of the suction box can be adjusted according to the paper width by adjusting the end deckles located at the tending side and the drive side. The width can be adjusted 250 mm on each side. One revolution of the deckle adjusting spindle corresponds to an adjustment of 4 mm of the end deckle. The adjusting spindles for the end deckles are located on the tending side bearing housing.

7) Suction zone adjusting mechanism

This adjusting mechanism is used to change the suction zone length. The sealing strip guide beams can be adjusted to change the suction zone length. The adjusted zone length is indicated by a pointer on a graduated cylinder.

8) Sealing Strip Shower

The sealing strip shower sprays the water tangentially into the interior of the shell ahead of the first sealing strip. The water film prevents a dry contact and improves the sealing effect between the shell and the strips. The water inlet is located on the tending side bearing housing.

9) End deckle shower

This shower provides a water seal for the end deckle at the tending side and drive side. The shower inlet is located on the tending side bearing housing. 8 Machine

Technical Data

External Diameter 955 mm
Face Length 3160 mm
Drilled Length 2900

Shell Material bronze 85/5/5/5

Shell Thickness 45 mm

Roll Covering Material rubber type X-300

Cover Thickness 20 mm

Hardness of Covering 38 P&J + 3 P&J

Hole Diameter in Shell 4 mm

Hole Diameter in Covering 3.6 mm

Open Area of Covering approx. 18 %

Maximum Linear Pressure 70 kg/cm (392 psi)

Number of Suction Zones 2

Suction Zone Lengths 600/100 mm

Suction Box Construction mild steel/rubber cover

Suction Box Supports cast steel

This roll is also equipped with complete roller bearings in cast iron housings, with labyrinth oil seals. Lubrication of the bearings is from the central lubrication system.

3) 2nd Press Roll (roll #14)

Purpose

To apply mechanical pressure to dewater the paper web.

Description

The pressing principles for the 2nd press roll are similar as for the 1st press suction roll. The 2nd press roll cover has a pattern of holes which are drilled to a specific depth to aid in the removal of water. Like the suction press the water squeezed from the web is forced into the holes in the press roll cover and are transported out of the nip. The normal action of centrifugal force causes the water to flow out of the holes into the accompanying saveall.

The 2nd press roll consists of a cast iron shell material with a rubber cover (type X-300) blind drilled to a depth of (?). The hole pattern and depth vary for each application. The rubber cover is ground to a P&J hardness of 38.

The 2nd press roll forms a nip with the Yankee dryer cylinder similar to the suction press. This is called the 2nd press nip. The maximum nip load pressure for the 2nd press is 90 kg/cm. As for the 1st press the 2nd press is also hydraulically loaded with hydraulic cylinders mounted on pivot supports. The 2nd press roll is internally cooled with a constant flow of water.

The 2nd press roll is also equipped with a pneumatic locking system for felt and roll changes. With the press in the "open" position the pneumatic lock is activated to insert a locking pin in the hydraulic arm at both the tending and drive sides.

Technical Data

External Diameter 810 mm
Face Length 3100 mm
Shell Material cast iron

Roll Covering Material rubber type X-300

Cover Thickness 20 mm

Hardness of Covering 38 P&J + 3 P&J

Drill Pattern Blind-drilled

Hole Diameter in Covering 77 mm

Hole Depth in Covering ()

Maximum Linear Pressure 90 kg/cm (504 psi)

Internal Cooling water
Material of Supports cast iron

This roll is equipped with complete roller bearings in cast iron housings, with labyrinth oil seals. Lubrication of the bearings is from the central lubrication system.

Press Section 11

4) Felt Return Rolls (roll #'s 10, 11, 13, 15, 16, 17, 18, 19, 20)

Purpose

To complete the press felt run.

Description

The felt rolls along with the press rolls and the pickup suction tube form the press felt run. Each roll performs a function. There is a guide roll, a stretch roll and felt return rolls. In all there are nine (9) felt rolls within the press section of TM 2.

The stretch roll (17), guide roll (18), and four small felt return rolls (10, 11, 19, 20) are all 364 mm. in diameter. The three large felt return rolls (13, 15, 16) are all 464 mm. in diameter.

Five of the six smaller rolls excepting the guide roll consist of a steel tube covered with ebonite rubber and ground to a P&J hardness +3/-3. The guide roll and the three larger rolls consist of a steel tube covered with black diamond rubber and are ground to a P&J hardness of 0 - 1. All rolls have a maximum felt tension of 3 kN/m.

All the felt rolls are equipped with complete roller bearings in cast iron housings with labyrinth oil seals. Lubrication is provided by the central lube system.

The mechanism associated with the guide and stretch rolls will be covered in later sections.

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Technical Data

Five small felt rolls (roll #'s 10, 11, 17, 19, 20)

External Diameter	364 mm
Face Length	3100 mm
Shell Material	steel tube
Roll Covering Material	ebonite
Cover Thickness	5 mm
Hardness of Covering	+3/-3 P&J
Maximum Felt Tension	3 kN/m

Three large felt rolls (roll #'s 13, 15, 16)

External Diameter	464 mm
Face Length	3100 mm
Shell Material	steel tube

Roll Covering Material Black Diamond

Cover Thickness 7 mm
Hardness of Covering 0 - 1 P&J
Maximum Felt Tension 3 kN/m

Guide Roll (18)

External Diameter 364 mm
Face Length 3100 mm
Shell Material Steel Tube
Roll Covering Material Black Diamond

Cover Thickness 7 mm
Hardness of Covering 0 - 1 P&J
Maximum Felt Tension 3 kN/m

Press Section 13

5) Felt

Purpose

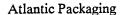
To transport the sheet (web) from the Duoformer section to the dryer section and to absorb the water pressed from the web in the press nip. The following secondary objectives are also desirable in a press felt.

- a) To provide the proper cushioning effect for the sheet to:
 - Reduce crushing
 - Resist shadow marking
 - Resist groove marking
 - Resist yarn marking
- b) To provide the proper surface to the sheet so that the necessary degree of smoothness or finish requirements are imparted to the grade of paper to be manufactured.
- c) To provide desirable durability in terms of strength, resistance to mechanical abrasion, chemical degradation and fill-up.
- d) To act as a drive belt to drive the undriven felt rolls.

Description

The press felt run on TM-2 includes several felt rolls, including a stretch and a guide roll, a pickup tube, a web retention box, a suction press roll, a plain press roll, two (2) uhle boxes and several doctors and showers. All these units combine to keep the felt running on the machine at a set tension and cleaned to enable the press felt to perform its designed purpose.

The sheet is picked up off the inner wire by a suction pickup tube. The sheet is then transported along the underside of the press felt to the 1st press nip between the suction press roll and the Yankee dryer cylinder. The sheet is transferred to the Yankee dryer cylinder at the 1st nip. The press felt then continues on without the sheet to the 2nd press nip. Here the felt comes in contact with the sheet again to remove more water through



the pressing action. After the 2nd press nip the felt completes its run back to the pickup shoe.

The felt undergoes various cleaning and conditioning processes between the 2nd press nip and the pickup shoe. Uhle boxes, high pressure showers and chemical showers are some of the cleaning and conditioning methods used on TM 2.

General Construction

Batt-on-Base

Batt-on-Base needled felts are made of wool and man-made fibers or of man-made fibers alone.

A base fabric is the felt surface which contacts the machine-side ie., felt rolls. It is usually constructed of spun yarns which are woven as an endless belt or woven flat and hand-joined. The base fabric synthetic content varies from 50 % to 100 %.

A web of fibers is then carded and fed onto the base and into the needle loom where thousands of reverse barbed needles punch the web into the base, locking the base and web firmly together. The batt web contacts the sheet, "sheet side" and will vary synthetic content from 20 % to 100 %.

Batt-on-Mesh

Most batt-on-mesh felts are usually made of 100 % synthetics.

The base structure or "mesh" is either incompressible or less compressible than the base of a batt-on-base needled felt. The base may be a single layer or multi layer mesh made of all monofilament synthetic, a combination of monofilament and multifilament, all high twisted multifilament, all high twisted multifilament treated with resin for rigidity, or any combination of these yarns.

The base mesh is woven endless, and the batt applied at the needle loom in a specialized manner to enhance fully the advanced water handling characteristics of the fabric.

Advantages of Batt-on-Mesh compared to Batt-on-Base Felts

Because of the added stability of the base fabric due to the mesh yarns, the following advantages may be experienced:

1. Allows increased press loading without the danger of crushing.

- 2. Improves sheet dryness.
- 3. Reduces hydraulic pressure in the nip.
- 4. Maximizes vertical flow.
- 5. Increases machine speed.
- 6. Resistance to marking.
- 7. Resistance to filling.
- 8. Excellent dimensional stability.
- 9. Resistance to compaction.
- 10. Maintains its permeability throughout life.
- 11. Increases life.
- 12. Lower cost per ton of paper.

Disadvantages.

- 1. Difficulty of installation.
- 2. Higher unit cost (damages more costly).
- 3. Requires more vacuum at suction boxes for proper dewatering of the fabric.

Felt Conditioning

As a felt passes through a nip it is subjected to pressures of up to 1,000 psi and it will have passed through the nip upwards of 70,000 times per day or several million times during its life.

Basically, three things happen to a felt on a paper machine:

- 1) It is compacted. After the initial compaction, any further loss in caliper reduces the felt's permeability. As a felt ages its caliper is reduced between 35% and 45% which is directly related to 75% to 95% air permeability loss, and filling materials occupy 5% to 15% of the felt by weight. This decrease in felt caliper has been found to be the greatest cause in the felt aging process.
- 2) It becomes contaminated. As the felt ages, there is an increase in the density of the felt "filling". Felt deposits are organic and inorganic. Filling results in a further loss of openness.

3) It is subject to wear. Press loadings and surfaces can slowly wear the felt and reduce its life. Fabric cleaning, both mechanical and chemical methods, wear the fabric and reduce its life. Some wear problems contribute to permeability losses in felts eg., fibrillation and flattening of batt fibers causes them to lie flat on the felt surface, so reducing the effective porosity.

Felt Deposits

Deposits can cause poor press section performance and sheet quality problems. To achieve optimum performance from a felt, it must be free of contaminants that hinder water transfer. Press section problems may be blowing (loss of porosity), reduced speed (loss of drainage), crushing (loss of porosity and void volume), loss of vacuum on suction rolls and uhle boxes, and increased number of breaks, and downtime due to poor felt performance, and higher dryer steam demand. Paper quality problems such as wrinkling (uneven moisture profile), picking, and marks on the sheet result from surface deposits can be caused by felt deposits.

Deposits can occur on just the surface of the felt, or they can be trapped internally within the felt. In some cases, one kind of deposit can occur on the surface of the felt, and a different kind of deposit can be trapped within the felt.

Deposits add to felt wear. A mill could compensate for dirty felts by either increasing shower pressures, applying felt cleaning chemicals, increasing vacuums to the uhle boxes and suction rolls, increasing felt tension, or possibly increasing nip pressures. These adjustments all increase felt wear.

Inorganic Deposits

Inorganic deposits can be fillers, such as titanium dioxide, clay, and calcium deposits. Talc used for "stickies" control always ends up in the felt to some extent. In addition to fillers, insoluble salts, hydroxides, and oxides - commonly referred to as scale - may end up in the felt. These organic compounds may come from coatings found in the furnish.

Organic Deposits

Organic deposits can include an even wider range of materials. Materials that most frequently show up during analysis are fatty and rosin acids and esters, hydrocarbon oil, and waxes from either the furnish or the defoamers, triglyceride esters (similar to corn oil) from the furnish, calcium oxylate, and lignosulfonate. Organic deposits often include a variety of components from secondary fiber such as adhesives and hot melts, plastics (polyvinylacetate, polyethylene, and polypropylene), styrene-butadiene copolymer inks, and carbon black. Treatment chemicals such as defoamers, wash aids, pitch control chemicals, fortified rosin size, wet and dry strength aids, retention aids, and ASA size can be found in deposits. Generally, with the exception of defoamers, process aids are a minor component of felt deposits.

6) Uhle Box (2)

Purpose

To clean and dewater the press felt after each rotation to keep the felt "open" and ready to accept more water.

Description

The uhle boxes are part of the press felt conditioning system which also incudes high and low pressure showers. The system utilizes hydraulic energy in the form of high and low pressure showers to loosen and flush the fines and fillers out of the felt structure. The felt is then dewatered and the loosened filling materials is removed by the suction boxes (ie., uhle boxes).

The press section for Tm-2 utilizes two (2) uhle boxes located after the 2nd press nip and just before the stretch roll. The uhle boxes are supplied by vacuum pump P 55. The applied vacuum pressure is 5 mWg with an air flow rate of 113.10 m³/min. The vacuum can be read off two separate gauges and flow can be throttled with valves 1552. See vacuum system section for more details.

The uhle boxes are made of stainless steel tubes with high density polyethylene cover strips. The cover strips are symmetrical in profile.

Each uhle box is equipped with two (2) slots each 15 mm wide. Edge deckles are located at each end of the slots to seal the vacuum with the press felt. The tube can be swivelled by hand to aid in slot cleaning or cover strip removal.

Low pressure showers are applied to the leading edge of the uhle boxes to reduce wear and to improve the vacuum seal between the press felt and the uhle boxes. 18 Machine

Basic Components

The uhle box consists primarily of the following three components.

1) Suction Tube

The suction tube transports the water and debris that is removed by applied vacuum to a seal tank. The tube diameter is 125 mm and is constructed of stainless steel.

2) Cover Strips

The cover strips are constructed of high density polyethylene which provide a smooth wear resistant surface for the press felt to slide over.

3) Deckles

Each slot has two deckles (T.S. and D.S.) which can be adjusted to accommodate different felt widths. The deckles ensure a good vacuum seal between the press felt and the cover strips.

Technical Data (2 uhle boxes)

Tube Diameter 125 mm

Material of Tube stainless steel

Material of Cover Strips high density polyethylene

Number of Slots per Tube 2

Slot Width 15 mm

Slot Length 3080 mm (maximum)

Vacuum

Source P55

Pressure 5 mWG

Air Flow Rate 113.1 m³/min

7) Web Retention Box

Purpose

To hold the sheet against the underside of the press felt prior to the 1st press nip.

Description

The web retention box is located inside the press felt on the downslope between felt return rolls 10 and 11. The web retention box ensures that the sheet (web) remains stuck to the felt (no drop-off) as its prepares to enter the 1st press nip.

The web retention box consists of the exact same design as the uhle boxes except the applied vacuum is lower at approximately 3 mWG. Vacuum is supplied by P55 while the pressure can be read on gauge PI 1004. The air flow rate of 42.63 m³/min can be throttled with valve 1553.

Technical Data

Tube Diameter 125 mm

Material of Tube stainless steel

Material of Cover Strips high density polyethylene

Number of Slots per Tube

Slot Width 15 mm

Slot Length 3080 mm (maximum)

Vacuum

Source P55
Pressure 5 mWG
Air Flow Rate 113.1 m³/min

8) Felt Stretch System

Purpose

The automatic felt stretcher system maintains a constant felt tension by adjusting the roll when the tension varies.

Description

The stretch system for the press felt is similar to that for the Duoformer section. The one notable exception is that the press felt stretch system includes an automatic tension control unlike the fabric stretchers.

The stretch roll bearing housings are clamped into the stretcher carriage at the tending and drive sides of the machine. The stretcher carriages move, back and forth along rails, by threaded spindles. The parallel motion of the two carriages (equal movement) is ensured by a cross shaft connecting the individual gear reducers. The gear reducers translate the rotary motion of the cross shaft to drive the threaded spindles. The cross shaft is driven through the drive shaft by a compressed air motor.

There are two modes of operation for the felt stretchers.- automatic and manual. In manual mode, the felt stretch roll position can be adjusted at the control panel (CD1-TM). By turning the three position spring back switch the operator can activate the compressed air motor to either slacken (release tension) or stretch (increase tension). A tension indicator is located above the 3 position switch in the control room.

The felt tension is measured by the load cells positioned at the end of the stretcher farthest from the cross shaft. The tension of the felt acting on the stretch roll is transmitted from the carriage through the threaded spindle to the load cell.

In automatic mode, the force exerted by the threaded spindle on the load cell is relayed by a transmitter to an instrument controller which compares the actual tension value to the desired tension value (pre-defined setpoint). The controller will then activate the compressed air motor and move the stretcher carriage in the respective direction through the bevel gear units and threaded spindles in order to alter the felt tension to the desired tension value.

The bevel gear units (stretcher carriage drives) on the tender and drive sides are connected to a cross shaft via a disengagable dog clutch. This clutch can be disengaged by

means of a lever located at the tending side stretcher. This permits manual adjustment of the drive side threaded journal to cock the felt (eg., squaring the seam, press felt barring etc.).

The end points for the stretch roll travel are limited by end limit switches (minimum and maximum stretch). When the felt stretch is out of range an alarm is activated at the Measurex Control Room Screen.

Basic Components

1) Compressed Air Motor

A compressed air motor is used to turn the drive cross shaft. It is located on the drive side of the press section.

2) Gear Reducer

A gear reducer converts the drive shaft rotation to drive the threaded spindle through a bevel gear and pinion arrangement. A gear reducer is located at both threading spindles (tending and drive sides).

3) Cross Shaft

The cross shaft connects the two gear reducers. The drive shaft at the air motor is connected to the cross shaft by a die and coupling disk. It allows syncronized movement of both stretcher carriages.

4) Threaded Spindle

A threaded spindle is driven by the bevel gear in the gear reducer and moves the stretcher carriages between the minimum and maximum stretch limits.

5) Stretcher Carriages

The stretcher carriages are used to support the stretch roll bearing housings. It is connected to the tending and drive side threading spindles which allow positioning of the roll.

6) Load Cell

The load cell is located at the end of the threaded spindle (drive side). The felt tension acting on the stretch roll is determined by calibrating the load cell (see next section for further details on the felt tension measuring system).

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7) Clutch Lever

The clutch lever is used to disengage the cross shaft which connects the tending and drive side stretcher carriages. The clutch lever is only used to enable adjustment of the drive side spindle independently of the tending side spindle.

Technical Data

Stretch Roll

External Diameter	364 mm
Face Length	3100 mm
Shell Material	steel tube
Cover Material	ebonite
Cover Thickness	5 mm
Cover Hardness	+3/-3 P&J
Maximum Felt Tension	3 kN/m
Minimum Position of Stretch Roll	36360 mm (felt length)
Maximum Position of Stretch Roll	38586 mm (felt length)
Operating Position of Stretch Roll	36576 mm (felt length)

Operating Parameters

The operating parameters for the felt stretch are the same as for the fabric stretches in the Duoformer section (pages 22-23).

8a) Felt Tension Measuring System

Purpose

To automatically control the press felt tension through a load cell positioned at the end of the threaded spindle in the drive side felt stretcher.

Description

The electric load cell consists of corrosion resistant material. The load cell measures the forces applied to the stretch roll by the press felt and sends an electric signal (ie., 4 to 20 mA) to the tension indicator located in the control desk (CD1-TM). The signal is calibrated to represent the minimum tension (0 KN/M) at 4mA and the maximum tension (4 kN/M) at 20 mA. The maximum felt tension is set at 3kN/m.

The felt tensioning system is equipped with automatic retensioning, an air motor is changed over to "stretch" or "slacken" by means of the boundary signal contacts via a solenoid valve. Monitoring for minimum and maximum values is carried out by an additional boundary value signalling unit.

A tension meter can also be used to manually determine the felt tension on the run. See Duoformer section pages 27-29 for further information.

9) Felt Guiding System

Purpose

To control the felt travel during operation.

Description

The guiding system utilized for the press felt is the same as the system employed for the fabric guiding in the Duoformer.

In the press section the guide roll is located in the felt return run right after the stretch roll. A properly guided felt will run within a straight path, centered on the rolls with a slight oscillation from side to side along the felt run.

The guide roll is fixed on the drive side of the machine and is movable on the tending side of the machine by the guide roll mechanism.

The felt guiding system consists of the guide roll mechanism and the guide palm mechanism. The guide palm mechanism senses movement of the felt and regulates the air pressure in the system. Through this regulation in air pressure, the air cylinders at the guide roll mechanism are activated to adjust the guide roll's position relative to the felt run.

Basically, the guide palm mechanism senses the felt travel and the guide roll mechanism adjusts the guide roll position (tending side only) to correct the felt travel to ensure that the felt runs "true". An alarm device senses felt movement which is beyond the established guiding path and alerts the operator to the condition before the felt runs off the machine.

The air consumption of the system is approximately 40 l/min for an operating pressure of 0.2 to 0.4 MPA (30 - 60 lb/in²).

A detailed description of the guide roll and guide palm mechanisms as well as the alarm device is presented in the next three sections.

9a) Guide Roll Mechanism

Purpose

To change the position of the guide roll.

Description

The guide roll mechanism is located on the tending side of the paper machine. The guide roll bearing housings are supported by the roll mechanism on the tending side and a fixed roll support on the drive side.

The roll support arm pivots on a pin in the roll mechanism carriage casing. This pivot action allows the roll to be positioned according to the piston movement at the air cylinder. A piston rod is connected to the support arm and is actuated by a piston inside the air cylinder. The air cylinder has two chambers which allow a double action movement of the piston. Instrumentation air is supplied to both chambers as well as the guide palm mechanism. As the guide palm exhausts air from one of the two lines, it regulates the air pressure in the cylinder causing the piston to move. When the guide roll system is functioning in the manner outlined above it is said to be in the "automatic mode".

If for some reason the guide system can not be operated automatically (ie., loss of system air), the guide roll can be positioned manually with the handwheel located at the carriage casing. The handwheel turns a screw which in turn moves the carriage casing along a track attached to the staionary base. The end result is not as accurate or as quick to make the necessary changes (as compared to automatic mode).

There are two scales on the roll mechanism. The scale located on the carriage casing indicates the position of the roll support arm relative to the stationary casing. The arm floats between two extremes on the scale (5-0-5). If the arm pointer is fixed at one end of the scale, the guide roll is stationary and not performing its intended job. The guide roll should "float" between these boundaries.

A second scale is fixed to the stationary base and a pointer on the carriage casing indicates the casing position relative to the stationary base. Under ideal conditions, the pointer should be positioned at 0. If the guide roll is operated in the manual mode, the position of the guide roll can be determined from this scale. If the pointer for the arm support is fixed at one of its extremes, the roll carriage should be moved along this scale until the roll begins to "float" again. For example, if the piston rod is fully extended, the

pointer on the support arm will be pointing downward at the low end of the scale. The roll position will remain fixed and if no correction is made, the felt may continue to "runoff" the machine. The carriage should be moved to the left with the handwheel. Make a small adjustment and monitor the pointer on the support arm. By moving the carriage to the left, you are making a coarse adjustment in the direction of the guide roll movement. An adjustment should help the guide roll move the felt towards the front side and return the guide roll to a "float condition".

For more detailed information on guiding principles, see the operating parameters.

Basic Components

1) Support Arm

The support arm supports the tending side guide roll bearings housing. The guide roll is secured with two swing bolts.

2) Carriage Casing

The arm is attached to the carriage casing by means of a pivot pin. The carriage can be positioned horizontally relative to the stationary base through a handwheel.

3) Stationary Base

The stationary base is bolted to the structural component of the Press Section. The carriage casing slides along a track on the base which permits horizontal positioning.

4) Handwheel

The handwheel turns a screw which in turn moves the carriage casing along the track on the stationary base. It is used when the guide roll must be manually controlled.

5) Carriage Pointer

The carriage pointer indicates the carriage position relative to the staionary base on a scale fixed to the base. The scale ranges (6-0-6) where 0 represents the centering position.

6) Air Cylinder

Bolted to the carriage, the air cylinder controls the positioning of the guide roll automatically through air supplied to the cylinder. It moves when air is released from one of the two chambers. The cylinder is composed of two chambers which permit a double action movement. A spring in each chamber automatically centers the piston when the air supply is lost.

7) Piston Pin

A piston pin connects the positioning cylinder to a point on the arm. The piston action is induced by air which controls the positioning of the guide roll.

8) Arm Pointer

The pointer indicates the position of the roll meter automatic control on a scale fixed to the carriage casing. The scale ranges (5-0-5) where 0 represents the centering position.

9b) Guide Palm Mechanism

Purpose

To detect movement of the felt and also control the air pressure in the double action air cylinder.

Description

The guide palm mechanism senses felt movement and in turn exhausts air from one of the two lines leading to the air cylinder. The change in air pressure in the lines result in a movement of the piston inside the air cylinder.

The guide palm always remains in contact with the felt on the tending side edge. As the felt moves (ie., towards the tending side or drive side), the palm will move in the same direction. The palm is connected to the control valve through a vertical shaft.

The control valve is a self contained unit enclosed by a cover. The palm shaft enters the bottom of the unit and is fixed to a central shaft. At one end of the shaft is a rocker cam and at the other end is a positioning spring. The spring positions the palm toward the drive side when no fabric is in contact with the palm. Hence, in a resting position, the palm will extend towards the drive side and in this manner the fabric edge will move it from this rest position. The acting area of the palm will be from this limit to the stopper fixed to the vertical support at the guiding system. The palm moves along this arc restricted by these boundaries.

The rocker cam is equipped with two piston rods which regulate the exhausted air from the air lines. As the palm shaft moves, the rocker cam will pivot on the central shaft and force a piston to contact a ball and spring mechanism. When the mechanism is pushed upwards, it breaks the seal and exhausts air from the air line. The decrease in air pressure in the line results in lower air pressure in one chamber of the air cylinder at the roll mechanism. The opposite chamber is filled with air from the other air line to maintain air pressure equilibrium. It is in this manner, that the piston in the cylinder moves the support arm which changes the guide roll position.

When the felt moves in a straight path, the palm shaft should be relatively vertical and maintain a central position.

The guide palm mechanism is utilized in the automatic mode only. It can be positioned using two locking levers on the square support tube. It should be positioned so that the guiding support is approximately 8 mm below the felt and the palm shaft is vertical when the felt runs "true".

Basic Components

1) Square Suppport Tube

The square support tube is fixed to a vertical support which is fastened to the Press Section structure. It is equipped with two locking levers which enable horizontal and vertical positioning.

2) Guiding Support

The guiding support keeps the felt edge stretched in order to ensure a satisfactory contact between the felt and the palm. It is fastened to a second vertical support fixed to the square tube support. The correct positioning is approximately 8 mm below the felt. The fine adjustment of the guiding support is conducted through nuts on the vertical support. A stopper is fixed to the vertical support to limit the palm's travel towards the tending side of the paper maachine.

Control Valve

The control valve is the mechanism which connects the palm shaft to the rocker cam. Two air lines are connected to this box. A spring mechanism limits the drive side movement of the palm shaft.

4) Palm

The palm is the large area which contacts the felt in a full range of movement. It is usually constructed of stainless steel and has a circular or square shape. It is coated to reduce wear between the felt edge and the metal surface.

9c) Alarm Unit (Voith 1300.44)

Purpose

To detect felt movement which is outside the standard operating boundaries and interlocked with Press Section drive motor to prevent felt loss.

Process Description

The alarm functions to alert the operator to "gross" felt movement to a side of the aper machine. For example, if the guide mechanism fails (ie., loss of air) the felt may move rapidly to a side of the machine and could be destroyed if appropriate action is not initiated immediately. The alarm device helps us by performing two roles:

- 1. Alert operator to felt movement beyond the standard operating path.
- 2. Emergency stop the suction press roll and 2nd press roll drives.
 - The two limit switches are enclosed in a guard box. The pointers are staggered so that I is slightly closer to the wire edge than II. The guard box can be positioned both horizontally and vertically through two handles. It should be positioned so that the first pointer I is slightly beyond the standard operating path.

When the felt contacts the first pointer, the limit switch closes a contact which sends and alarm signal to the Measurex computer. When this condition is indicated, the operator should take immediate steps to correct the felt travel.

If the adjustments are not satisfactory or if the felt moves rapidly toward one side of the machine, the second limit switch (II) will be activated which stops the drive for the 1st press suction roll and the 2nd press roll. The stopping of the press may save the felt which might have otherwise run off the machine.

The press felt has two alarm units (tending and drive) and an emergency stop button.

Basic Components

1) Square Support Tube

The square support tube is fixed to a vertical support which is fastened to the Press Section structure. It is equipped with two locking levers which enable horizontal and vertical positioning.

2) Limit Switches

Two limit switches are associated with the alarm unit. I is the closet and alarms the operator. II is the Emergency Stop which stops the press.

3) Guard

The guard protects the limit switches from moisture or stock.

32 Machine

Operating Parameters

The fundamental principle for guiding any type of paper machine clothing (ie., wire or felt) is based on the principle that "the fabric always travels at right angles to the axis of the first contact".

Therefore, if all rolls in the press section are perpendicular to the machine direction, the felt should run straight and not drift to the tending or drive side of the paper machine. This scenerio is not often the norm on high speed paper machines.

If one roll is slightly misaligned, the felt will make initial contact, the felt will travel at a right angle to the axis.

This travel pattern will move the felt towards the side of the paper machine which is first contacted. Basically, if the felt contacts a point on the tending side part of the roll first, the felt will run to that side of the machine. If the misalignment is too great, the felt will "run-off" the paper machine.

The guide roll mechanism combined with the guide palm mechanism enables the felt run to correct abnormal felt travel by means of the pivoting end of the guide roll. If the felt demonstrates a tendency to move toward one side of the machine, the guide palm will sense this travel and adjust the position of the guide roll with the air cylinder. We can view some examples to help clarify the guiding principles.

Note:

The words "ahead" and "behind" are used as relative points in relation to the perpendicular line to the machine direction.

Example 1

Assume the felt begins to move toward the drive side of the machine. The felt is making contact with a point slightly ahead of the drive side (ie., a contact point on drive side and moving at right angles to the axis at that point). The guide palm will sense this travel as it remains in contact with the tending side edge. The function of the guide mechanism will be to position the guide roll ahead on the tending side. The felt will contact the guide roll on the tending side slightly ahead of the point on the drive side which caused the initial felt travel. In this manner, the guide roll has compensated against the initial tendency and the felt should return to its normal operating position (ie., centered on the rolls).

Example 2

Assume the felt begins to move toward the tending side of the machine. The felt is making contact with a point slightly ahead on the tending side. The guide palm will sense this travel and move towards the tending side with the tending side edge of the felt. The guide roll mechanism will counter this travel by moving the guide roll slightly behind on the tending side. In this manner, the guide roll has compensated against the initial tendency and the felt should return to its normal operating position.

Press Felt

Initial Movement	Guide Roll Positioning	Air Cylinder
To drive side	Ahead-toward dry end	Bottom chamberempties; Top chamber fills.
To tending side	Behind-toward wet end	Bottom chamber fills; Top chamber empties.

There may be instances when the guide roll may not be able to correct the felt travel. It may be positioned at full stroke or fully retracted and the felt still demonstrates a tendency to run toward one side of the machine. The pointer on the support arm can indicate this condition (ie., pointer indicates 5) and does not move from this position. Under normal operating conditions, the pointer should be floating along this scale and steps should be initiated if this condition is altered.

When the pointer is fixed at either end of the scale, it indicates that the roll mechanism is correcting for felt travel but the correction is still not enough to guide the felt back to the operating path. This condition can be altered by making a "gross" adjustment to the guiding with the handwheel. The handwheel moves the carriage along a track in the same plane as the piston rod. Small changes in carriage position can help the guide roll mechanism to place the guide roll at a point where the felt will repond to its position. These adjustmenst should be made in small increments only. The handwheel should be rotated to move the carriage approximately 1 increment on the scale. The guide roll should be monitored to ensure that the pointer on the support arm begins to float about the zero mark. This ensures that the entire control range is available again on both sides of the piston(in the air cylinder).

A general rule can be applied:

If the piston rod is fully extracted, move the carriage towards the right hand side of the scale. (Towards the wet end).

If the piston rod is fully retracted, move the carriage towards the left hand side of the zero (0) on the scale. (Towards the dry end).

Start-up and Operating Parameters

Automatic Regulation

Prior to start-up, it is advantageous to position the guide palm in the mid-position both in the vertical and horizontal planes. Center the edge of the felt at the center of the guide palm and ensure that the palm shaft is vertical.

An adjustment may be necessary following start-up depending on the guiding mechanism.

Manual Control of Guide Roll

If automatic control is interrupted in some way (ie., a failure of the compressed air supply sytem), wire travel can be guided manually. This adjustment is conducted by using the handwheel which positions the guide roll relative to the stationary base.

Press Section 35

Troubleshooting

Situations where guide roll is not able to correct felt travel.

1. Improper Felt Tension

Guiding is directly controlled by surface friction created between the press felt and the guide roll. It is important that felt tension be maintained to create the necessary surfce friction between the guide roll and felt. If guiding problems occur, always check the felt tension indicator and recommended operating tension specified by the felt supplier. If tension is low, raise it to its proper running pressure.

2. Non-uniform Felt Tension

Non-uniform tension across the width of the felt may cause the felt to travel to one side of the machine. Non-uniformity can be caused by a problem in the manufacture of the felt (ie., maybe one side was longer than the other side). If this is the case, the carriage may have to be adjusted to compensate.

3. Improper Guide Palm Sensitivity

Too Sensitive

If the guide palm is too sensitive, it may pick up the normal oscillation of a felt and transfer to the guide roll causing the fabric to shift unnecessarily.

Insufficient Sensitivity

If the guide palm is too sensitive, it may not make the necessary corrections if the felt starts to "runoff" the machine.

If the guide palm mechanism appears to be demonstrating either of the above two conditions, contact instrumentation team to troubleshoot (ie., adjust positioning spring tension or air volume).

Appendix (guide System)

Compressed Air Supply

The compressed air must satisfy the following demands.

It must be water free, oiled, and prefiltered. Its operating air pressure must be 2-4 bar with a maximum pressure of 5 bar.

Oil Volume 0.03 g/m³
Prefiltration 0.050 mm

Reference Data

Register 2019-22
Auto-guide type A
Size Z

Operating and Maintenance

Instruction 1300.14

Shower System

TM-2 has 24 showers located at the wet end of the paper machine. Showers 1-16 are located in the Duoformer "T" while showers 17-24 are located in the press section. Showers 1-16 were covered in the Duoformer section. Showers 17-24 are covered in this section. It is very important to understand all aspects of each shower operation.

- 17. Pickup Tube Lubrication Shower
- 18. High Pressure Roll Cleaning Shower (Ruck-Zuck)
- 19. Suction Roll Lubrication Shower
- 20. Outside Felt Return Roll Showers (3)
- 21. 2nd Press Cooling Water
- 22. Chemical Application shower
- 23. High Pressure Felt Cleaning Shower
- 24. Uhle Box Lubrication Shower (2)

The following sections provide further details for each of the above listed showers.

17) Pickup Tube Lubrication Shower

Purpose

To provide lubrication water between the vaccum pickup tube and the press felt.

Description

A non-oscillating shower located just before the pickup tube. The nozzles deliver a continuous flat jet of fresh water across the leading edge of the pickup tube. This water reduces the wear between the felt and the pickup tube cover as well as aid in vacuum sealing of the suction slots. Hand valve 1343 must be opened to operate this shower.

Supply

The shower is supplied by P48 via a fresh water filter to remove solids. The operating pressure is approximately 2 bar at 20° C.

Water Source

Fresh water from Tank 32.

Location

The pickup tube lubrication shower is located between felt return roll #20 and the pickup suction tube. The shower is directed at the leading edge of the pickup tube.

Shower # 17 Voith Manufacturer Continuous Operation No Oscillation Stroke of Oscillation N/A Type of Water Fresh water 20 °C Water Temperature 53 l/min Consumption P48 Supply Pump Pressure 2 bar Quantity of Nozzles 21 Nozzle Diameter 2 mm 60° Jet Angle Distance Between Nozzle and Felt 150 mm Diameter of Shower Header 57 mm No Cleaning Device 0^{o} Shower Angle

18) High Pressure Suction Roll Cleaning Shower (Ruck-Zuck)

Purpose

To clean the suction press roll holes of stock and debris.

Description

The shower header is constructed of stainless steel tube equipped with a self cleaning device. This shower is referred to as a "Ruck-Zuck" type shower by Voith. The shower header is laterally oscillated by means of double action hydraulic pistons. There are two valves in this shower line. Hand valve 1309 and SV 271 on valve 1322.

Supply

The shower is supplied by P51 (booster pump).

Water Source

Fresh water from Tank 32

Location

The shower header is located facing the 1st press suction roll opposite the 1st press nip.

Shower #

ManufacturerRuck-ZuckOperationDiscontinuousOscillationHydraulic

18

Stroke of Oscillation N/A

Type of Water Fresh water

Water Temperature 20°C
Consumption 82 l/min
Supply Pump P51
Pressure 60 bar

Quantity of Nozzles 6
Nozzle Diameter 2 mm
Jet Angle 30°

Distance Between Nozzle and Felt N/A
Diameter of Shower Header 44 mm

Cleaning Device Yes
Shower Angle N/A

19) Suction Roll Lubrication Shower

Purpose

To reduce wear of the sealing strips and end deckles as well as aid in vacuum seal of the suction box.

Description

The suction press is equipped with a shower inside the shell. This shower is used to spray water on the leading edge of the seal strips to reduce wear and seal the vacuum in the suction box. The edge deckles are also lubricated by this shower.

The shower header is constructed of a stainless steel tube. The orifices deliver a flat jet which impinges the leading edge of the sealing strips and edge deckles. This shower does not oscillate.

Source

The shower is supplied by P48 via a fresh water filter to remove solids. The operating pressure is controlled by a pressure control system PC 201 on valve 1323. The normal operating pressure is regulated at 1 bar. There is also a hand valve 1310 on this line.

Water Source

Fresh water from Tank 32.

Location

The suction roll lubrication shower is located inside the shell directed at the leading edge of the suction box sealing strips and edge deckles.

Shower # 19 Voith Manufacturer Operation Continuous Oscillation No Stroke of Oscillation N/A Type of Water Fresh water 20° C Water Temperature Consumption 70 l/min Supply Pump P48 Pressure 1 bar Quantity of Nozzles 14 Nozzle Diameter 3 mm 60° Jet Angle Distance Between Nozzle and Felt N/A 57 mm Diameter of Shower Header Cleaning Device No Shower Angle N/A

20) Outside Felt Return Roll Shower (3)

Purpose

To lubricate the felt and doctors on the outside felt return rolls in order to reduce wear and to clean the rolls.

Description

The three (3) outside felt return rolls (13, 15, 16) with doctors are equipped with a low pressure shower to lubricate the felt roll and doctor to reduce doctor wear as well as aid in cleaning the roll.

The shower header is constructed of a stainless steel tube with a self cleaning device. The nozzles deliver a continuous flat jet spray of water at a pressure of 2 bar across the felt return roll located on the outside or sheet side of the felt. Each felt roll has a separate hand valve to operate each shower. (Valves 1312, 1349, and 1345 respectively).

Supply

Fresh water from P48 via a fresh water filter to remove any solids.

Water Source

Fresh water from Tank 32.

Location

The three (3) outside felt return rolls are equipped with L.P. Showers to reduce the wear between the doctors and rolls.

Shower# 20 Manufacturer Voith

Operation Continuous

Oscillation No Stroke of Oscillation N/A

Type of Water Fresh water

Water Temperature 20° C

Consumption 3x212 l/min

Supply Pump P48
Pressure 2 bar
Quantity of Nozzles 3x21
Nozzle Diameter 4 mm
Jet Angle 60°
Distance Between Nozzle and Felt 150 mm
Diameter of Shower Header 57 mm

Cleaning Device Yes
Shower Angle N/A

21) 2nd Press Cooling Water

Purpose

To cool the 2nd press roll and cover by water flowing through the internals of the press roll.

Description

The 2nd press roll is equipped with an internal cooling shower to reduce the heat of the press roll cover. When the press is running then SV 261 on valve 1311 will open to supply cooling water.

Supply

Fresh water from P48 via a fresh water filter to remove solids.

Water Source

Fresh water from Tank 32.

Location

The fresh water at 2 bar enters the 2nd press roll from the tending side and is also removed from the same side.

Press Section 47

Technical Data

Shower # 21 Manufacturer Voith Operation Continuous N/A Oscillation Stroke of Oscillation N/A Type of Water Fresh water $20^{\circ}C$ Water Temperature Consumption 60 l/min Supply Pump P48 Pressure 2 bar Quantity of Nozzles N/A Nozzle Diameter N/A Jet Angle N/A Distance Between Nozzle and Felt N/A Diameter of Shoqwer Header N/A Cleaning Device N/A Shower Angle N/A

22) Chemical Application Shower

Purpose

To spray chemicals required for felt conditioning and cleaning.

Description

The chemical application shower is used to supply chemical spray to the felt for cleaning and conditioning. The chemical is applied prior to the uhle boxes and is removed at the uhle boxes.

The header is constructed of stainless steel and is equipped with a self cleaning device. The nozzles deliver a flat jet spray to the felt. The shower does not oscillate.

Source

Chemical additives supplied by one of the chemical companies.

Water Supply

To be designed for this application at a later time.

Location

The chemical application shower is located inside the felt run prior to the uhle boxes.

Shower #

Manufacturer

Operation

Oscillation

Stroke of Oscillation

Type of Water

Water Temperature

Consumption

Supply Pump Pressure

Quantity of Nozzles

Nozzle Diameter

Jet Angle

Distance Between nozzle and Felt

Diameter of Shower Header

Cleaning Device

Shower Angle

22

Voith

Continuous

No

N/A

N/A (chemicals used)

N/A

120 l/min

N/A

2 bar

21

2 mm

60°

150 mm

57 mm

Yes

 0^{o}

23) High Pressure Felt Cleaning Shower

Purpose

To loosen the fines, fillers and debris in the felt to be removed at the uhle boxes so that the felt does not become closed. This shower is an integral part of the felt conditioning system which provides an open felt to improve press efficiency.

Description

The high pressure felt cleaning shower is constructed of stainless steel and is equipped with a self cleaning device. This shower is hydraulically oscillated by double action hydraulic pistons. This shower is only used periodically to clean the felt. Hand valve 1346 is opened. P 50 must be started to deliver 40 bar pressure water through needle jets across the felt.

Supply

Fresh water from P50 (booster pump)

Water Source

Fresh water from Tank 32 is boosted to 40 bar by P50.

Location

The high pressure cleaning shower is located on the outside (sheet side) of the felt just prior to the uhle boxes. These high pressure needle showers loosen the fines and fillers in the felt to be removed by the uhle boxes.

Press Section 51

Technical Data

Shower # 23

Manufacturer Voith
Operation Discontinuous

Oscillation Hydraulic

Stroke of Oscillation N/A

Type of Water Fresh water

Water Temperature 20°C
Consumption 54 1/min

Supply Pump P50 (booster pump)

Pressure 40 bar
Quantity of Nozzles 30
Nozzle Diameter 0.8 mm
Jet Angle N/A

Distance Between Nozzle and Felt: N/A
Diameter of Shower Header 57 mm
Cleaning Device Yes

Cleaning Device Yes Shower Angle 190°

24) Uhle Box Lubrication Shower (2)

Purpose

To lubricate the uhle box cover to reduce wear between the polyethylene cover and the felt. Also, to aid in sealing the vacuum between the felt and the uhle box suction tube.

Description

Each of the two uhle boxes located in the felt return run have a low pressure lubrication shower directed at the leading edge. This provides lubrication to reduce wear and to seal the vacuum.

The uhle box lubricating showers are constructed of a stainless steel tube and are equipped with a self cleaning device. Hand valves 1347 and 1348 respectively are used to operate these two showers. These showers do not oscillate.

Supply

Fresh water from P48.

Water Source

Fresh water from Tank 32 via fresh water filters to remove solids.

Location

The two uhle box showers are located outside the felt run just prior to the leading edge of each of the two uhle boxes.

Shower # 24 (2)
Manufacturer Voith

Operation Continuous
Oscillation No

Oscillation No Stroke of Oscillation N/A

Type of Water Fresh water

Water Temperature 20°C

Consumption 2x120 l/min

Supply Pump P48
Pressure 2 bar
Quantity of Nozzles 2x21
Nozzle Diameter 3 mm
Jet Angle 60°

Distance Between Nozzle and Felt: 150 mm
Diameter of Shower Header 57 mm

Cleaning Device Yes
Shower Angle N/A

11) Doctor Blades

Purpose

To remove water and stock build up on the outside felt return rolls and the suction press roll.

Description

The doctor blades are designed to contact the roll surface along the entire face length and keep the roll clean of stock, water and debris.

The doctor blades for the three outside felt return rolls (#'s 13,15 and 16) are loaded and unloaded manually with a lever located on the tending side of the machine. The blades contact the roll with a loading of approximately 0.8 kN/m.

The 1st press suction roll doctor is a Lodding Accumate Conform 101. This doctor is loaded and unloaded through a valve located on the tending side of the machine. The doctor blade body pivots on bearings secured in the roll support structure. The blade contacts the roll with a loading of approximately 0.12 kN/m.

An oscillating device is attached to each doctor blade on the drive side. The oscillator has a cross machine stroke of 10 mm to each side. The oscillator prevents uneven wear on the roll surface due to "nicks" or sharpe edges on the doctor blade surface. The oscillator should be operated at all times.

Outside Felt Return Rolls (3)

Type Lodding Accumate K35-A

Material of Body Stainless Steel

Material of BladePlasticMaterial of SupportsCast ironBlade Thickness2.8 mmMounting Angle20-25

Loading Mechanism Manual (lever)

Loading Pressure 0.8 kN/m

Oscillation Yes
Strokes of Oscillation 10 mm

1st Press Suction Roll Doctor

Type Lodding Accumate Conform 101

Material of Body Stainless steel

Material of Blade Plastic No. 277 Kleenslip.

Material of Supports

Cast iron
Blade Thickness

Mounting Angle

25°

Loading Mechanism Hand valve
Loading Pressure 0.12 kN/m

Oscillation Yes
Stroke of Oscillation 10 mm

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12) Savealls

The press section contains several savealls positioned throughout the felt run similar to the Duoformer section. Savealls are trays which collect water in the press section. The water that is collected is the water removed during pressing as well as all other excess water from showers. The savealls prevent damage to the felt and prevent slime and dirt from falling down and breaking the sheet in the nips. All savealls drain to the drive side of the paper machine and direct the water to the white water silo or wire pit.

1) Saveall for Upper Felt Section

This saveall is installed below the whole length of the upper felt section recovering shower water from the conditioing section of the felt (ie., uhle box and high pressure showers). It is constructed of stainless steel.

2) Suction Press Roll Saveall

This saveall is shaped to enclose the 1st press suction roll to collect all the water discharge from the perforations as well as any shower water present at this location.

3) Outside Felt Return Roll Savealls

These savealls collect stock and water that is doctored off the outside felt return rolls as well as the water from the roll cleaning showers.

Press Section 57

Technical Data - Press Section

Operating Speed: 524 - 1677 M/Min.

Balanced Speed: 1800 M/Min

Production: 80 T/D

Felt Length: 36360 mm. (minimum)

38586 mm. (maximum)

36576 mm. (operating)

Felt Width: 2900 mm.

Felt Tension: 3 KN/m

Nip Pressures 1st. Press: 70 KN/m (maximum)

2nd. Press: 90 KN/m (maximum)

Lineal Pressures:

Guide Roll Doctors 0.8 KN/m
Suction Roll Doctor 2.5 KN/m
Drawings: Assembly AP.4225.80
Cross Section: AP.4225.81

Operating Theory and Parameters

A) Water Removal

The pressing operation may be considered an extension of the water-removal process that was started in the wire section. It is far more economical to remove water by mechanical means than by evaporation. Water removal should be uniform across the machine, so that the pressed sheet has a level moisture profile.

Sheet wet strength increases with dryness. As shown in fig., fibers are in fluid suspension at consistencies up to 12 %. At consistencies between 12 - 15 %, fibers are bonded by surface tension. Above 25 %, fibers are in mechanical contact with the mucilaginous materials cementing the fibers, one to another, with bonding strength increasing with increased dryness.

Up to 20 % consistency, drainage by water and induced vacuum will remove most of the "free water". The film of water held by surface tension to the sheet fibers must then be removed by pressing. The presses will increase sheet dryness to 35-45 % o.d. (average 36%). At this dryness, the remaining moisture is held by the capillary forces in the pores of the fibers and that absorbed in the crystalline regions of the cellulose. This is considered today to be the practical limit of moisture removed by the pressing. The remaining moisture, principally that contained in the cellulose crystallites, must be removed by heat. The dryer rolls increase the sheet dryness to that desired in the finished sheet.

B) Sheet Consolidation

Sheet consolidation is a crucial phase of the papermaking process. It is here that the fibers are forced into intimate contact so that good fiber-to-fiber bonding develops during drying. Intimate contact develops increased strengths. Consolidation also reduces bulk.

Press Action

All wet pressing of paper webs is carried out in contact between two rolls in the press "nip".

Consider pressing as occuring in four phases (Smook p. 231 16-62)

Phase 1

Compression begins. Air flows out of both sheet and felt until the sheet is saturated; no hydraulic pressure is built up.

Phase 2

Sheet is saturated and the build-up of hydraulic pressure causes movement of water from the paper into the felt. When the felt reaches saturation, water moves out of the felt. Phase 2 continues up to mid-nip, where total pressure reaches maximum. It has been shown that hydraulic pressure reaches a maximum prior to mid-nip.

Phase 3

The nip expands until the fluid pressure in the paper is zero; this corresponds to the point of maximum dryness in the nip.

Phase 4

Both the paper and felt expand and the paper becomes unsaturated. Although a negative hydraulic pressure is created in both structures, the vacuum is greatest in the paper, causing a flow of water to return from the felt to the paper.

Four Main Factors Involved in Removing Water from a Sheet of Paper in the Nips of a Press Section are:

- Time
- Pressure
- Temperature
- Water Drainage

1) Time

- Period that sheet is under pressure
- Nip width divided by velocity (felt section speed)

2) Pressure

- Applied in the nip
- Linear and nip area pressure

3) Temperature

- Temperature of the water within the paper
- Warm water has a lower viscosity than cold water so in theory it can be removed from a felt more readily

4) Place for the water to go

- Space for the expressed water
- Felt or roll cover

Variables of Operation

The major variables affecting press performance are:

a) Design factors

- Roll hardness
- Roll diameter
- Press configuration
- Type of press nip

b) Stock and Sheet Characteristics

- Type of furnish
- Freeness
- Water retention value
- Compressibility
- Basis weight
- Ingoing sheet moisture content
- Sheet temperature

c) Operational

- Applied load
- Felt type and service life
- Felt cleaning and conditioning
- Machine speed

The most significant operational factor is nip pressure, which should be maintained at the highest level consistent with sheet dewatering characteristics. As speed is increased, the press performance will deteriorate because of a lower retention time in the nip. Generally, a higher sheet temperature will improve dewatering because of reduced viscosity (lower resistance to flow) and greater compressibility.

Limitations to Pressing

There are two distinct limitations to pressing:

- 1. The flow-limited situation how rapidly water can be removed from the sheet.
- 2. The pressure-limited situation relating to the degree ofpossible sheet compression.

Pressing is usually carried out in a series of nips (two nips on TM-2 tissue machine), with increasing pressure in each nip. The first nip is almost always flow-limited while the last nip is usually pressure-limited.

Excessive pressure applied in a flow-limited situation gives rise to a conditin known as "sheet crushing". In its most severe manifestation, sheet crushing can cause disintegration of the sheet. Usually the symptoms are localized, "spot crushing", washing out of fines, realignment of fibers, and washing out of fibers into the felt.

Generally, the more readily the sheet loses its water (eg., the more free the stock), the greater the pressure that can be applied to the web.

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Press Generalities

The sheet and felt are pressed between two rotating rolls. The top roll is mechanically loaded (usually with pneumatic cylinders) to create the desired pressure within the nip.

The lineal nip pressure is the sum of the mechanical loading and the weight of the top roll, divided by the length of the contacting face at the press nip. The maximum value depends on several factors, including lineal pressure, roll diameter, roll hardness, and the characteristics of the felt.

In the nip, one side of the sheet is usually in contact with a smooth, hard roll, usually granite or "stonite"; but sometimes, a solid metal roll with or without a hard rubber covering is used. In the case of the Tissue Machine, the top roll with the smooth surface is the Yankee dryer. The roll in contact with the felt is usually covered with a somewhat resilient rubber cover to "soften" the nip.

Because press rolls deflect under loading, it is necessary to camber or "crown" one or both of the rolls to achieve a uniform pressure profile across the contacting face. The amount of the crown required is a function of roll diameter, length, material of construction and applied load. A fixed crown (obtained by grinding the roll) is suitable for only one loading. The effect of correct and incorrect crowning is illustrated in Smook p.232 Fig. 16-64.

In general, uniform pressing across the machine is desired to achieve a reasonably level moisture profile into the dryer section. Occasionally, because of non-uniform drainage of the wire, or other problems, it may be desirable to compensate by uneven pressing action eg., variable crown roll.

Start Up And Operating Procedures

Preliminary Procedures

Before actual start up, check the points of safety. Make sure that the cleaning operation after shut down has been completed or stopped and there is no longer repair or maintenance personnel working on the press section. Furthermore, make sure that all safety devices, like nip guards, removable walkways, handrails etc. are in operating positions.

Actual Start Up Procedure

- 1. Make sure that the central lube oil system is operating.
- 2. Start the press section hydraulic system.
- 3. Make sure that the pneumatic system is operational.
- 4. Check operational readiness of felt guides (watch piston rod movement by manually moving the guide palm). Ensure that the guide palm contacts the felt edge and arm pointer floats about "0" on the scale.
- 5. Apply low tension to the press felt (approx. 1-1.5 kN/m)
- 6. "Unlock" the pneumatic lock for the 2nd press roll.
- 7. Open valve for low pressure showers (uhle box showers).
- 8. "Jog" the felt around two full revolutions, checking for wrinkles and dirt in nips.
- 9. If no wrinkles are present in the felt, load all doctor blades, increase stretch to normal run loading.
- 10. Put press in "crawl".
- 11. Make sure cooling water for 2nd press and seal water for 1st press roll are on and set to desired pressure.
- 12. Start P50 and P51 high pressure shower pumps. Interlock will determine shower operation.
- 13. Adjust water volume of low pressure showers.
- 14. Ensure shower oscillates in "auto" position.

- 15. Check guiding and stretch systems.
- 16. Unlock pickup tube and lower into contact with felt.
- 17. Close 1st and 2nd presses against Yankee (the Yankee must also be in crawl speed).
- 18. Load 1st and 2nd presses against Yankee.
- 19. Speed match the Yankee drive with the two press roll drives.
- 20. Push "run" button to get Yankee and press up to full speed.
- 21. Observe any warning lights and alarm panel, respond to them immediately.
- 22. Start vacuum pumps P54 and P55 for uhle boxes, pickup tube suction roll and web retention box. Adjust vacuum to desired values.
- 23. If the Duoformer is at run speed and ready to receive stock from the headbox, then start the approach system and introduce the jet to the forming roll.
- 24. After the sheet is running down at the end of the inner wire for a short period extend the pickup tube into the wire approxiamtely 15mm and open the vacuum valve to pickup the sheet.
- 25. The sheet will then go through the presses and run down at the Yankee doctor.
- 26. Monitor closely all vacuum pressures, shower pressures, nip load pressures, felt stretch and felt guides for several hours after each start up.

Shut Down Procedures

- 1. Blowdown the sheet at the Yankee doctor.
- 2. Start knock-off showers on inner wire.
- 3. Close vacuum valve to pickup tube and retract out of innerwire. (Sheet will run down at Duoformer inner wire).
- 4. Shut down approach flow system.
- 5. Stop yankee and press section drives. Put Yankee and press sections in crawl to dry out press felt.
- 6. Shut off all showers to the press felt, low and high pressure. (Stop P50 and P51).
- 7. Wash press roll doctors.
- 8. Allow the press to run in crawl for 5 minutes to evenly dry the felt.
- 9. Stop yankee and press drives.
- 10. Stop vacuum pumps P54 and P55.
- 11. Open 1st press.
- 12. Open 2nd press and lock using pneumatic locking device.
- 13. Lift pickup tube and lock using pneumatic locking device.
- 14. Slacken felt to prevent distortions as felt dries.
- 15. Shut down press hydraulics.

Press Felt Change

(A) Preparation for Press Felt Change

Note:

Lock out 1st and 2nd press drives before starting felt change.

- 1. Lift-off doctor blades from outside felt return rolls (13,15 and 16) and the 1st press suction roll (12).
- 2. Remove the electric alarm device, guide palm and protective grating of the stretch roll on the tending side only.
- 3. Make sure the stretch roll is at the minimum stretch position.
- 4. Make sure the pickup tube is locked in the up position (ie., fully retracted).
- 5. Make sure the second press is in the locked position (ie.,fully retracted open).
- 6. Make sure the 1st press roll is in the open position (ie.,fully down).
- 7. Cut off the old press felt.
- 8. Wash-up the press section and inspect roll surfaces, suction box surfaces, doctor blades and plugged showers.
- 9. Check automatic guide for free movement.
- 10. Ensure that stretch roll and guide palm are square to the machine.

Press Section 67

B) Press Felt Change

11. Unpack the new press felt on the operating floor and position felt in proper run and sheet side directions.

Note:

Although press felts are not quite as delicate as fabrics, great care must still be used at all times as this felt is an expensive item.

- 12. Do not use knives or other sharpe objects around a new felt.
- 13. Keep felt as dry as possible during installation.
- 14. Use the crane to disconnect the stretch roll (No.17) and set it into the cradle beside felt roll No.18
- 15. Use the crane to raise the new press felt, by the felt tube, above the press section.
- 16. Unfasten the swing bolts by the intermediate block "A" below felt roll No. 18.
- 17. Lift the frame and remove block "A" by adjusting the jack.
- 18. Insert the felt through the gap (outside to inside M/C) and re-insert block "A" (refasten swing bolts).
- 19. Repeat procedure 16-18 for intermediate block "B" located below felt roll No.19.
- 20. Ensure pickup tube is locked in open position.
- 21. Pull felt around pickup vacuum tube and rolls 10 and 20.
- 22. Unfasten the swing bolts for intermediate block "C" located above the pickup tube and roll 20.
- 23. Open the frame using the hydraulic jack and remove block "C".
- 24. Pass felt through gap (outside m/c to inside m/c) and re-insert block "C" (refasten swing bolts).
- 25. Unfasten the swing bolts for intermediate block "D" located next to roll 10.
- 26. Open the frame using the hydraulic jack and remove block "D".
- 27. Open connecting arm ("E") between supports for rolls 13 and 15 and rolls 10 and 20.

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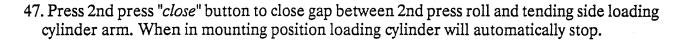
28. Pass felt simultaneously through gaps provided by block "D" and connecting arm "E".

- 29. Refasten swing bolts for block "D" and re-connect arm "E".
- 30. Pass the felt from inside m/c to outside m/c via an opening between supports G and H.
- 31. Unfasten the swing bolts for intermediate block "F" and sustain support G for roll 11 via support H.
- 32. Remove block "F".
- 33. Pass felt through gap (provided by removal of block "F") from the outside of the m/c to the inside of the m/c.
- 34. Re-insert block "F" and re-fasten the swing bolts.

To get the felt around the 2nd press roll follow the procedure outlined below.

- 35. "Unlock" 2nd press pneumatic locking device (located on CB2-TM).
- 36. Position selection switch on CB2-TM to "felt change".
- 37. Press the close button to close 2nd press (the roll will contact Yankee and then withdraw approx. 30 mm from creping cylinder.
- 38. Switch 2nd press felt change to "Lock" position. With this only the tending side loading cylinder will react to "close" or "open" commands.
- 39. Selector switch on CB2-TM should be in position "0" and remove key from panel.
- 40. Mount lifting device on tending side.
- 41. Fix bearing to frame.
- 42. Unfasten fixing screws from tending side bearing base.
- 43. Press "open" (drive side is still locked). Tending side loading cylinder will move to open position without roll.
- 44. "Lock" the 2nd press pneumatic locking device.
- 45. Pass the felt through the gap between the roll and the loading cylinder from the inside to the outside of the paper machine.
- 46. "Unlock" the 2nd press pneumatic locking device.

Press Section 69



- 48. Fasten fixing screws for tending side bearing base.
- 49. Unfasten bearing to frame.
- 50. Remove lifting device for 2nd press roll.
- 51. Unlock drive side hydraulically by switching 2nd press felt change to "unlock".
- 52. Move drive side and tending side press away by pushing "open".
- 53. "Lock" press in open position.

To get the felt around 1st press roll follow the procedure outlined below.

- 54. Lower the 1st press suction roll by pushing "open" on CB2-TM control box.
- 55. Unfasten fixing screws for suction nozzle at the suction head.
- 56. Lift suction nozzle by turning selector switch on CB2-TM to "lift" position.
- 57. Switch 1st press felt change to "close" and press will close to contact Yankee and then automatically retract to approximately 30 mm from creping cylinder.
- 58. Switch to "lock" position. Therefore, only tending side loading cylinder will react to open and close commands. Selector Switch must be in "felt change" position on CB2-TM.
- 59. Selector switch should be in 0 position and key removed from panel on CB2-TM.
- 60. Mount lifting device on tending side for suction roll.
- 61. Unfasten tending side bearing from loading cylinder and secure bearing.
- 62. Press "open" to open tending side loading cylinder. The loading cylinder will move away from the roll bearing.
- 63. Pass the felt through the gap between the roll bearing and loading cylinder, from inside the paper machine to outside the paper machine.
- 64. Switch 1st press felt change to "close" and tending side loading cylinder will contact roll bearing and automatically stop at mounting position.
- 65. Fasten roll bearing to loading cylinder.

- 66. Remove lifting device.
- 67. Switch 1st press to "unlock" position now drive side and tending loading cylinder will move together.
- 68. "Open" 1st press.
- 69. Now pull the felt evenly across the width of the machine and make certain the tradeline "seam" is straight and square.
- 70. Ensure felt is flat and free of wrinkles and machine debris.
- 71. Lower suction nozzle by pressing "close" on suction tube movement selector switch and fasten screws.
- 72. "Unlock" pneumatic locking device for 2nd press.
- 73. Felt change selector switch should be in "operation" position.
- 74. Use crane to replace stretch roll in stretcher carriage and fasten up.

Start Up And Operating Procedures

- 1. Wet felt with low pressure water shower.
- 2. Adjust stretch to about half the normal run stretch and jog the felt 2 full revolutions. Stop it and watch for wrinkles.
- 3. If there are no wrinkles, load roll doctors, and increase stretch to normal run loading. Maintain tension during start up and check frequently. Increases or decreases will be necessary depending on the felt type, synthetic level, and rigidity of felt rolls.
- 4. Jog felt section watching the guiding.
- 5. When felt is uniformly wet, load press to normal weight and turn on vacuum equipment.

Press Section 71

Shutdown Procedures

At shut downs, reduce felt tension to prevent distortion as felt dries out. When restarting a machine after a prolonged shut down, repeat the above procedure. This is very critical to prevent wrinkling problems at re-starts.

Trimming

If trimming is necessary, it is recommended that a guideline be placed on the edge to be trimmed with a marking pen. A razor or sharpe knife is then held firmly against the guideline near a roll where the felt is firmly supported. Jog the felt a full revolution, then cut the trimmed loop and pull it free. If ravelling occurs after the trim, edge sealing materials are usually effective. Edge fringes from high synthetic felts should never be pulled free by hand due to the high strength of the yarns. The safest method is to hold a razor near a roll so that when centrifugal force throws the fringe out, it hits the sharpe edge of the razor and is cut off.

Note:

Never trim a felt on the edge which activates the guide palm.

If the felt should appear too wide at installation, trimming should be delayed, if possible, in the event that the width comes in during run-in.

11.2 ROLLS 10.20 ABD PICK-UP ROLL

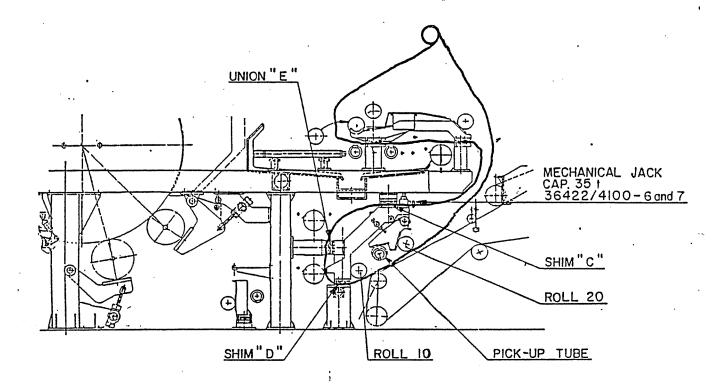


FIG.11.2.1

- Pick-up lever to be locked
- Pull felt to accomodate on pick-up tubular shaft
- Unfasten fixing screws of shim "C"
- Open frame and remove shim "C"
- Felt bottom part to be passed through the provided opening (outside the Paper machine).
- Mount shim "C" with screws
- Un fasten fixing screws of shim "D"
- Open frame and remove shim
- Open articulatable connecting arm "E"
- Felting should be made (inside the PM) simultaneously by openings provided by shim "D" and articulatable connecting arm "E". - Shim "D" to be mounted with screws
- Mount connecting arm E.

11.3 ROLL NO.11

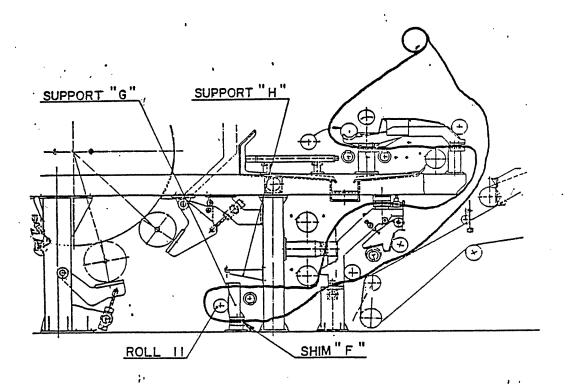
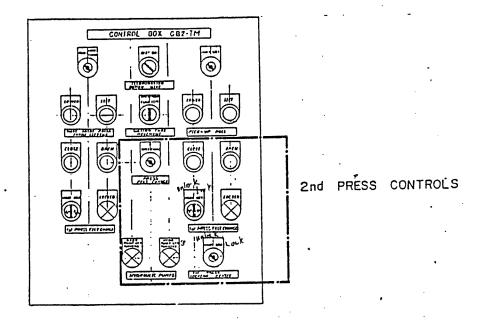


FIG. 11.3.1

- Pass the felt from inside to outside PM via a opening between supports "G" and "H".
- Unsfasten screws for fixing of shim "F"
- Sustain support "G" of NO.11 roll via support "H"
- Remove shim "F"
- Felting should be made via the provided opening (to the inside of PM).
- Mount shim "F" with screws.



- Lever lock pin should be actuated outside (pneumatic actuation). Press locking device *unlock.
- When "OPEN" is pressed press will be hydraulically withdrawn.
- Position selector to " FELT CHANGE ".
- Press "Close" and with this press will contact and will automatically withdrawn approx. 30 mm of creping cylinder.
- Switch 2nd Press Felt Change to "Lock". With this only lever "LC" will react to "Close" or "OPEN" commands.
- For works on site selector should be in position "O" and remove key from panel.
- Mount lifting device on T.S.

11.4 - NO.14 ROLL (2ND PRESS)

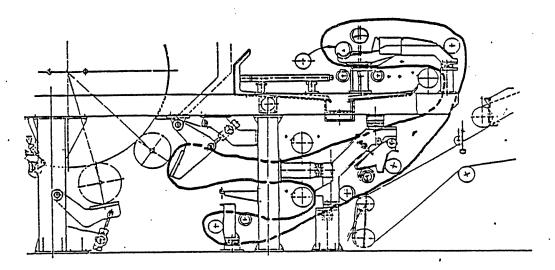


FIG. 11.4.1

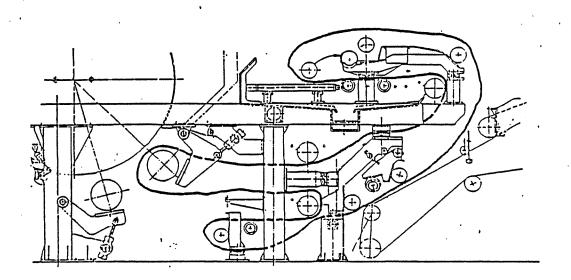
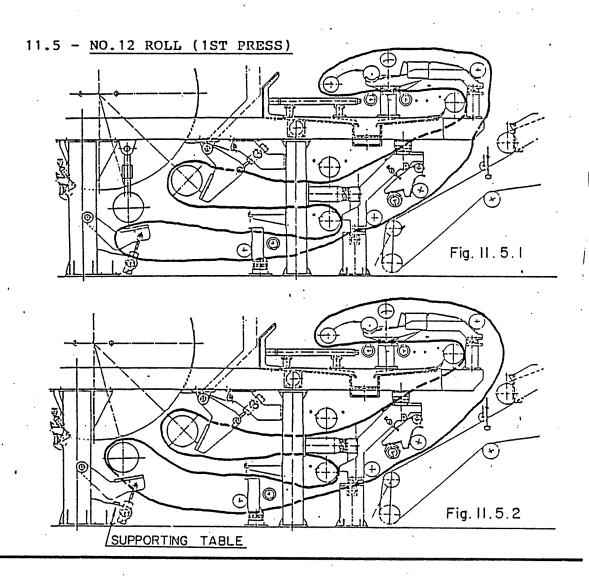
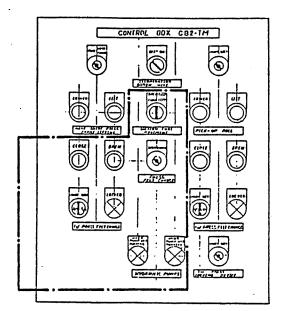


FIG. 11.4.2





1st PRESS CONTROLS

Duoformer Type T

Purpose

To dewater the formed web from a jet consistency of 0.3% to a pre-press consistency of 18%. To convey the web from the forming section to the press section of the Tissue Machine.

Process Description

The Duoformer Type T is the formation section of the paper machine. This type of former is referred to as a "twin-wire C-wrap". Two wires converge at a large diameter forming roll, wrap the roll, and then, separate from the roll. The area where the two wires are in contact is in the shape of a "C". The tissue sheet is formed between two wires as they pass around the forming roll. The top (outer; drainage) wire is closest to the wet-end while the bottom (inner carrying) wire is closest to the dry end. The top wire is the forming fabric and the bottom wire is the conveying fabric.

The stock jet from the headbox slice is discharged into the nip formed by the two wires as they wrap the forming roll. The wires sandwich the fiber suspension which passes around the solid forming roll. The centrifugal force around the large diameter forming roll (largest diameter roll in Duoformer) combined with the tension of the top wire creates the drainage pressure required for dewatering. Drainage takes place through the top wire and is normally complete along only one-quarter (1/4) of the circumference of the forming roll. The drainage area or forming length is very short relative to other paper machines (approximately 1000 mm). The sheet is formed rapidly with approximately 95% of the water removed through the top wire.

The water is collected in a large saveall tray which directs it back to the white water silo to be reintroduced to the Duoformer (closed loop).

The formed web remains sandwiched until the forming roll rotates to a point where the two wires separate. At this point, vacuum is applied through a suction box which ensures that the web is transferred to the bottom wire. The top wire wraps a wire roll and completes a path which leads it back to the slice lip. Along the path are showers which clean the wire (to keep it open) and the rolls. Doctor blades keep the roll surfaces clean.

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The bottom wire conveys the web to the shoe where it is transferred to the press section. The bottom wire also completes a path which leads it back to the slice lip. The bottom wire path is also equipped with wire and roll showers. Doctor blades keep the roll surfaces clean.

Basic Components

Each of these components play an important role in the operation of the Duoformer and will be outlined in detail in the following sections. The main components of the Duoformer are:

- Forming Roll
- Wire Rolls
- Wires
- Wire Guide Mechanism
- Wire Stretch Mechanism
- Shower System
- Doctor Blades
- Inner Wire Suction Box
- Support Foil
- Savealls And Mist Removal
- Structure



Purpose

To provide the surface for web formation.

Description

The forming roll is the largest diameter roll in the Duoformer section. It is a solid rubber covered roll which is driven by an electric motor. It is the only drive for the section and therefore both wires are driven by this roll.

Both wires converge at the forming roll and the stock jet is discharged into the nip between the two wires. The forming roll surface is the "table" on which formation occurs. The circumference of the roll is 3927 mm while the diameter is 1250 mm.

Drainage and formation occur in the 1000 mm of roll surface from the point of jet contact. This is a very short formation length relative to other paper machines.

The forming roll bearings are lubricated through the central lubrication system.

Technical Data

Bearing length: 3550 mm.
Face length: 3100 mm.
External diameter (incl. cover): 1250 mm.
Circumference (over cover): 3927 mm.
Shell Material: Carbon Steel
Diameter (without cover): 1230 mm.

Cover

Material: Black Diamond

Thickness of Cover: 10mm Hardness of cover: 0 P&J

Wire Rolls

Purpose

To complete the top and bottom wire runs.

Description

The wire rolls form the wire path. The Forming Roll is at the center of both runs. It is referred to as roll 1. Rolls 2,3 and 4 complete the bottom wire path. Rolls 5,6,7,8, and 9 form the top wire path. Each roll performs a function. There are guide rolls, stretch rolls, and wire return rolls. The mechanisms associated with the guide and stretch rolls will be covered in later sections.

The characteristics of the rolls are shown in Table ().

All the rolls have a bearing length of 3550 mm and the bearings are lubricated through the central lubrication system. The Duoformer is dynamically balanced for a machine speed of 1800 m/min with an operating speed range of 524-1677 m/min.

The top wire wire length (ie. path length) is 16820 mm with a maximum stretch of 345 mm. The bottom wire length is 13570 with a maximum stretch of 265 mm. The Duoformer is designed for a maximum wire tension of 8 kN/m.

Technical Data

Roll	Function	Face Length	Diameter	Covering	Thickness
1	Forming Roll	3100	1250	Black Diamond	10
2	Return Roll	3100	364	Black Diamond	7
3	Stretch Roll	3100	464	Black Diamond	7
4	Guide Roll	3100	364	Black Diamond	7
5	Return Roll	3100	464	Black Diamond	7
6	Guide Roll	3100	364	Black Diamond	7
7	Stretch Roll	3100	364	Black Diamond	7
8	Return Roll	3100	364	Black Diamond	7
9	Breast Roll	3100	464	Black Diamond	7

Note:

All measurements are in Millimeters.

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Wire

Purpose

To support the wet fiber mat and retain fibers during formation and drainage.

Description

A paper machine wire is a fabric, woven from polyester strands and made endless to form a continuous belt.

The support a forming fabric imparts to the fiber mat is of primary importance to paper quality. In the early stages of drainage, the wire acts as a filter, regulating the collection of the first few fibers which in turn affect the accumulation of the fiber mat. The collection of fibers by the fabric provides further bridging points for those that follow, and therefore the collection efficiency of the fabric surface increases as the fiber mat gradually builds up.

The weave pattern in the wire is constructed using machine directional strands (warp) and cross machine directional strands (shute). The polyester monofilament yarns are generally 0.08-0.27 mm in diameter.

The term "shed" refers to the number of shutes (CD yarns) in which the weave pattern repeats. For example, the traditional bronze wire was usually woven in a three-shed design, with the warp strand (M/D) going over one shute strand (C/D) and then under two shute strands. The trend today, with the synthetic wires, is toward four or five shed (ie. over one shute and under three or four). By varying the number and size of yarns within a specific weave, the wire manufacturer tailors the fabric to the type of paper machine.

The mesh count is the number of MD yarns/inch multiplied by the CD yarns/inch. A mesh count of 145 would therefore indicate a less open fabric than a 78 mesh. A higher mesh count fabric has more yarns per square inch of area. More yarns per inch also provide additional support by reducing the distance a paper fiber needs to bridge. In the first stages of formation, the fibers are highly oriented in the machine direction, and consequently, the average span between CD supports points has a strong influence on retention.

During initial formation, only the wire strands are present to catch the fibers and each fiber must be supported by at least two wire strands. If no such stable support is established for the fiber, then it will penetrate deeper into the wire structure, eventually passing right

Duoformer 7

through it. The shorter the fiber, the denser (higher mesh count) the supporting strands have to be positioned to catch it.

The weave pattern will determine the "openness" of the wire. This refers to the open areas in the wire structure that is unoccupied by strands. A wire must maximize water removal but must also balance the necessity to retain fibers which may pass through open areas. Contaminants in the stock, such as stickies, attempt to fill these open areas and reduce the available area for drainage. Small fibers or "fines" often get trapped in the weave and must be blasted out by cleaning showers on the wire return.

There are two sides to every wire; the top side which receives the stock from the headbox and transports the wet web (sheet side) and the bottom side which runs along the wire section rolls (machine side). The sheet side is the forming surface while the machine side is the wearing surface.

Double layered wires can be constructed with a shed design that optimizes formation and retention on the sheet side and wear on the machine side. The major advantage in converting to multilayer weaves is the requirements for the sheet side of the fabric can be designed independently from the wear side. Multilayer weaves allow finer meshes (ie. more smaller yarns per inch) particularly in the cross machine direction. The finer meshes have different weave patterns. The bottom side of the monoflex 2000 has a fiber shed weave. The thicker MD yarns occupy more surface area and will wear better than the CD yarns. The top side has a three shed design which reduces the open area, indicated by the shaded areas, increasing the retention characteristics of the wire. As fiber support goes up, fines retention is increased because of less penetration of the fibers into the body of the fabric. The drainage path through a double layered fabric is on a diagonal and is not straight through as in single layer weaves. This allows for better sheet support and drainage than with single layer weaves with the same mesh count. The sheet forming advantages such as controlled drainage, reduced loss of solids, better sheet formation and support are inherent in a double layer fabric because of its structure.

Wire Guiding System

Purpose

To correct variations in the fabric's path during operation.

Description

A guiding system is a main component of each fabric run on the paper machine. A properly guided fabric will run within a straight path, centered on the rolls with a slight oscillation from side to side along the wire run. There is a guiding system for both wire runs and the design of the system is identical in both applications. A complete understanding of the guiding system is required to properly operate the Duoformer.

A guiding system is comprised of two basic components; the roll mechanism and the guide palm mechanism. Both mechanisms will be studied in greater detail in the following sections.

The guide palm mechanism senses movement of the fabric and regulates the air pressure in the system. Through this regulation in air pressure, the air cylinder at the guide roll mechanism is activated to adjust the guide roll's position relative to the fabric run. Basically, the guide palm senses fabric travel and the guide roll mechanism adjust the guide roll position to correct the fabric travel to ensure that the fabric runs "true". An alarm device senses wire movement which is beyond the established "guiding path" and alerts the operator to the condition before the fabric "runs-off" the machine.

Air consumption of the system is approximately 40 l/min.

The rolls utilized as guide rolls for the top and bottom wire runs have identical characteristics outlined in the following chart.

Roll	Diameter	Face Length	Covering	Thickness
4	364 mm	3100 mm	Black Diamond	7.0 mm
6	364 mm	3100 mm	Black Diamond	7.0 mm

The guide roll mechanism, palm mechanism, and alarm device is identical on both wire runs of the Duoformer. A detailed description of each component is presented in the next sections.



(A) Guide Roll Mechanism

Purpose

To change the position of the guide roll.

Description

The guide roll mechanism is located on the tending side of the paper machine. The guide roll bearing housings are supported by the roll mechanism on the tending side and a fixed roll support on the drive side.

The roll support arm pivots on a pin in the roll mechanism carriage casing. This pivot action allows the roll to be positioned according to the piston movement at the air cylinder. A piston rod is connected to the support arm and is actuated by a piston inside the air cylinder. The air cylinder has two chambers which allow a double action movement of the piston. Instrumentation air is supplied to both chambers as well as the guide palm mechanism. As the guide palm exhausts air from one of the two lines, it regulates the air pressure in the cylinder causing the piston to move. When the guide roll system is functioning in the manner outlined above it is said to be in the "automatic mode".

If for some reason the guide system can not be operated automatically (ie. loss of system air), the guide roll can be positioned manually with the handwheel located at the carriage casing. The handwheel turns a screw which in turn moves the carriage casing along a track attached to the stationary base. The end result is not as accurate or as quick to make the necessary changes.(as compared to automatic mode)

There are two scales on the roll mechanism. The scale located on the carriage casing indicates the position of the roll support arm relative to the stationary casing. The arm floats between the two extremes on the scale (5-0-5). If the arm pointer is fixed at one end of the scale, the guide roll is stationary and not performing its intended job. The guide roll should "float" between these boundaries.

A second scale is fixed to the stationary base and a pointer on the carriage casing indicates the casing position relative to the stationary base. Under ideal conditions, the pointer should be positioned at 0. If the guide roll is operated in the manual mode, the position of the guide roll can be determined from this scale. If the pointer for the arm support is fixed at one of its extremes, the roll carriage should be moved along this scale until the roll begins to "float" again. For example, if the piston rod is fully extended, the pointer on the support arm will

be pointing downward at the low end of the scale. The roll position will remain fixed and if no correction is made, the fabric may continue to "run-off" the machine. The carriage should be moved to the left with the handwheel. Make a small adjustment and monitor the pointer on the support arm. By moving the carriage to the left, you are making a coarse adjustment in the direction of the guide roll movement. An adjustment should help the guide roll move the fabric towards the front side and return the guide roll to a "float condition".

For more detailed information on guiding principles, see the operating parameters.

Basic Components

1) Support Arm

The support arm supports the tending side guide roll bearings housing. The guide roll is secured with two swing bolts.

2) Carriage Casing

The arm is attached to the carriage casing by means of a pivot pin. The Carriage can be positioned horizontally relative to the stationary base through a handwheel.

3) Stationary Base

The stationary base is bolted to the structural component of the Duoformer. The carriage casing slides along a track on the base which permits horizontal positioning.

4) Handwheel

The handwheel turns a screw which in turn moves the carriage casing along the track on the stationary base. It is used when the guide roll must be manually controlled.

5) Carriage Pointer

The carriage pointer indicates the carriage position relative to the stationary base on a scale fixed to the base. The scale ranges (6-0-6) where 0 represents the centering position.

6) Air Cylinder

Bolted to the carriage, the air cylinder controls the positioning of guide roll automatically through air supplied to the cylinder. It moves when air is released from one of the two chambers. The cylinder is composed of two chambers which permit it a double action movement. A spring in each chamber automatically centers the piston when the air supply is lost.

7) Piston Pin

A piston pin connects the positioning cylinder to a point on the arm. The piston action is induced by air controls the positioning of the guide roll.

8) Arm Pointer

The pointer indicates the position of the roll meter automatic control on a scale fixed to the carriage casing. The scale ranges (5-0-5) where 0 represents the centering position.

(B) Guide Palm Mechanism

Purpose

To detect movement of the fabric and also controls the air pressure in the double action air cylinder.

Description

The guide palm mechanism senses fabric movement and in turn exhausts air from one of the two lines leading to the air cylinder. The change in air pressure in the lines result in a movement of the piston inside the air cylinder.

The guide palm always remains in contact with the fabric on the tending side edge. As the fabric moves (ie. towards the tending side or drive side), the palm will move in the same direction. The palm is connected to the control valve through a vertical shaft.

The control valve is a self contained unit enclosed by a cover. The palm shaft enters the bottom of the unit and is fixed to a central shaft. At one end of the shaft is a rocker cam and at the other end is a positioning spring. The spring positions the palm toward the drive side when no fabric is in contact with the palm. Hence, in a resting position, the palm will extend towards the drive side and in this manner the fabric edge will move it from this rest position. The acting area of the palm will be from this limit to the stopper fixed to the vertical support at the guiding support. The palm moves along this arc restricted by these boundaries.

The rocker cam is equipped with two piston rods which regulate the exhausted air from the air lines. As the palm shaft moves, the rocker cam will pivot on the central shaft and force a piston to contact a ball and spring mechanism. When the mechanism is pushed upwards, it breaks the seal and exhausts air from the air line. The decrease in air pressure in the line results in lower air pressure in one chamber in the air cylinder at the roll mechanism. The opposite chamber is filled with air from the other air line to maintain air pressure equilibrium. It is in this manner, that the piston in the cylinder moves the support arm which changes the guide roll position.

When the wire moves in a straight path, the palm shaft should be relatively vertical and maintain a central position.

The guide palm mechanism is utilized in the automatic mode only. It can be positioned using two locking levers on the square support tube. It should be positioned so that the

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guiding support is approximately 8 mm below the fabric and the palm shaft is vertical when the fabric runs "true".

Basic Components

1) Square Support Tube

The square support tube is fixed to a vertical support which is fastened to the Duoformer structure. It is equipped with two locking levers which enable horizontal and vertical positioning.

2) Guiding Support

The guiding support keeps the fabric edge stretched in order to ensure a satisfactory contact between the fabric and the palm. It is fastened to a second vertical support fixed to the square tube support. The correct positioning is approximately 8 mm below the fabric. The fine adjustment of the guiding support is conducted through nuts on the vertical support. A stopper is fixed to the vertical support to limit the palm's travel towards the tending side of the paper machine.

3) Control Valve

The control valve is the mechanism which connects the palm shaft to the rocker cam. Two air lines are connected to this box. A spring mechanism limits the drive side movement of the palm shaft.

4) Palm

The palm is the large area which contacts the fabric in a full range of movement. It is usually constructed of stainless steel and has a circular or square shape. It is coated to reduce wear between the fabric edge and the metal surface.

Alarm Unit (Voith 1300.44)

Purpose

To detect fabric movement which is outside the standard operating boundaries and interlocked with Duoformer drive motor to prevent fabric loss.

Process Description

The alarm unit functions to alert the team member to "gross" fabric movement to a side of the paper machine. For example, if the guide mechanism fails (ie. loss of air) the fabric may move rapidly to a side of the machine and could be destroyed if appropriate action is not initiated immediately. The alarm device helps us by performing two roles:

- 1. Alert operator to wire movement beyond the standard operating path.
- 2. Emergency stop the Forming Roll Drive.

The two limit switches are enclosed in a guard box. The pointers are staggered so that I is slightly closer to the wire edge than II. The guard box can be positioned both horizontally and vertically through two handles. It should be positioned so that the first pointer I is slightly beyond the standard operating path.

When the wire contacts the first pointer, the limit switch closes a contact which sends an alarm signal to (). When this condition is indicated, the team member should take immediate steps to correct the fabric travel.

If the adjustments are not satisfactory or if the wire moves rapidly toward one side of the machine, the second limit switch (II) will be activated which stops the drive for the Forming Roll. The stopping of the Duoformer may save the fabric which might have otherwise run off the machine.

Each fabric has two alarm units (tending and drive side) and an emergency stop button.

Basic Components

1) Square Support Tube

The square support tube is fixed to a vertical support which is fastened to the Duoformer structure. It is equipped with two locking levers which enable horizontal and vertical positioning.

2) Limit Switches

Two limit switches are associated with the alarm unit.

I is the closest and alarms the operator. II is the Emergency Stop which stops the Duoformer Drive.

3) Guard

The guard protects the limit switches from moisture or stock.

Operating Parameters

The fundamental principle for guiding any type of paper machine clothing (ie. wire or felt) is based on the principle that "the fabric always travels at right angles to the axis of the first contact."

Therefore, if all rolls in the wire section are perpendicular to the machine direction, the fabric should run straight and not drift to the tending or drive side of the paper machine. This scenario is not often the norm on high speed paper machines.

If one roll is slightly misaligned, the fabric will make initial contact, the fabric will travel at a right angle to the axis.

This travel pattern will move the fabric towards the side of the paper machine which is first contacted. Basically, if the fabric contacts a point on the tending side part of the roll first, the fabric will run to that side of the machine. If the misalignment is too great, the fabric will "run off" the paper machine.

The guide roll mechanism combined with the guide palm mechanism enables the wire run to correct abnormal wire travel by means of the pivoting end of the guide roll. If the fabric demonstrates a tendency to move toward one side of the machine, the guide palm will sense this travel and adjust the position of the guide roll with the air cylinder. We can view some examples to help clarify the guiding principles. Machine

Note:

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The words "ahead" and "behind" are used as relative points in relation to the perpendicular line to the machine direction.

Example 1

Assume the top wire begins to move toward the drive side of the machine. The fabric is making contact with a point slightly ahead on the drive side. (ie. a contact point on drive side and moving at right angles to the axis at that point) The guide palm will sense this travel as it remains in contact with the tending side edge. The function of the guide mechanism will be to position the guide roll ahead on the tending side. The fabric wire contact the guide roll on the tending side slightly ahead of the point on the drive side which caused the initial fabric travel. In this manner, the guide roll has compensated against the initial tendency and the fabric should return to its normal operating position (ie. centered on the rolls).

Example 2

ž.

Assume the top wire begins to move toward the tending side of the machine. The fabric is making contact with a point slightly ahead on the tending side. The guide palm will sense this travel and move towards the tending side with the tending side edge of the fabric. The guide roll mechanism will counter this travel by moving the guide roll slightly behind on the tending side. In this manner, the guide roll has compensated against the initial tendency and the fabric should return to its normal operating position.

Wire	Initial Fabric Movement	Guide Roll Positioning	Air Cylinder
Тор	To drive side	Ahead-toward dry end	Bottom chamber empties; Top chamber fills
	To tending side	Behind-toward wet end	Bottom chamber fills; Top chamber empties
Bottom	To drive side	Ahead-toward dry end	Bottom chamber empties; Top chamber fills
	To tending side	Behind-toward wet end	Bottom chamber fills; Top chamber empties.

There may be instances when the guide roll may not be able to correct the fabric travel. It may be positioned at full stroke or fully retracted and the fabric still demonstrates a tendency to run toward one side of the machine. The pointer on the support arm can indicate this condition (ie. pointer indicates 5) and does not move from this position. Under normal operating conditions, the pointer should be floating along this scale and steps should be initiated if this condition is altered.

When the pointer is fixed at either end of the scale, it indicates that the roll mechanism is correcting for fabric travel but the correction is still not enough to guide the fabric back to the operating path. This condition can be altered by making a "gross" adjustment to the guiding with the handwheel. The handwheel moves the carriage along a track in the same plane as the piston rod. Small changes in carriage position can help the guide roll mechanism to place the guide roll at a point where the fabric will respond to its position. These adjustments should be made in small increments only. The handwheel should be rotated to move the carriage approximately 1 increment on the scale. The guide roll should be monitored to ensure that the pointer on the support arm begins to float about the zero mark. This ensures that the entire control range is available again on both sides of the piston (in the air cylinder).

On the Duoformer T, a general rule can be applied:

If the piston rod is fully extracted, move the carriage towards the right hand side of the scale. (Towards the wet end).

If the piston rod is fully retracted, move the carriage towards the left had side of the zero (0) on the scale (towards the dry end).

Start-Up and Operating Procedures

Automatic Regulation

Prior to start-up, it is advantageous to position the guide palm in the mid-position both in the vertical and horizontal planes. Center the edge of the fabric at the center of the guide palm and ensure that the palm shaft is vertical.

An adjustment may be necessary following start-up depending on the guiding mechanism.

Manual Control of Guide Roll

If automatic control is interrupted in some way (ie. a failure of the compressed air supply system), wire travel can be guided manually. This adjustment is conducted by using the handwheel which positions the guide roll relative to the stationary base.

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Trouble Shooting

Situations where guide roll is not able to correct fabric travel.

1. Improper Wire Tension

Guiding is directly controlled by surface friction created between the forming fabric and the guide roll. It is important that fabric tension be maintained to create the necessary surface friction between the guide roll and fabric. If guiding problems occur, always check fabric tension indicator and recommended operating tension specified by the fabric supplier. If tension is low, raise it to its proper running pressure.

2. Non-Uniform Fabric Tension

Non-uniform tension across the width of the fabric may cause the fabric to travel to one side of the machine. Non-uniformity can be caused by a problem in the manufacture of the fabric (ie. making one side was longer than the other side. If this is the case, the carriage may have to be adjusted to compensate.

If the piston rod is at full stroke, move the carriage in the direction of the piston stroke. If the piston rod is fully retracted, move the carriage in the direction of retraction. (For more information see operating parameters).

3. Improper Guide Palm Sensitivity

Too sensitive

If the guide palm is too sensitive, it may pick up the normal oscillation of a fabric and transfer to the guide roll causing the fabric to shift unnecessarily.

Insufficient sensitivity

If the guide palm is too insensitive, it may not make the necessary corrections if the fabric starts to "runoff" the machine.

If the guide palm mechanism appears to be demonstrating either of the above two conditions, contact instrumentation team to troubleshoot (ie. adjust positioning spring tension or air volume).

Appendix (guide system)

Compressed Air Supply

The compressed air must satisfy the following demands.

It must be water free, oiled, and prefiltered. Its operating air pressure must be 2-4 bar with a maximum pressure of 5 bar.

Oil Volume:

 0.03 g/m^3

Prefiltration:

0.050 mm

Reference Data

Work Order Number:

Duoformer 36421

Register:

2019-22

Auto-guide type:

 \mathbf{A}

Size:

Z

Operating and Maintenance Instruction:

1300.14

Wire Stretch System

Purpose

To adjust the tension of the fabric (ie. wire).

Description

The stretch roll bearing housings are supported in locking clamps on swinging levers which pivot on the Duoformer structure. The parallel motion of the two levers (in unison) is ensured by a cross shaft connecting the gear reducers. The gear reducers translate the rotary motion of the cross shaft to drive the threaded spindles. The cross shaft is driven through the drive shaft by an Ingersoll-Rand compressed air motor.

The wire stretch roll position can be adjusted at the control panel (CD1-TM) through two switches:

Bottom Wire (B-0175 SS1)

Top Wire (B-0176 SS1)

It can be either be slackened (release tension) or stretched (increase tension) by positioning this switch. A tension indicator is located at the switches. The fabric tension is measured by the load cells positioned under the drive side bearings of the guide roll. (See next section).

The end positions for the stretching mechanism are limited by end limit switches. (ie. maximum stretch and slack).

When the Duoformer drive is on and the wire stretch is out-of-range (for both wires), a warning signal is sent to the Measurex screen.

The rolls utilized as stretch rolls for the top and bottom wire runs are outlined below.

Roll	Diameter	Face Length	Covering	Cover Thickness
3	464 mm	3100 mm	Black Diamond	7.0 mm
7	364 mm	3100 mm	Black Diamond	7.0 mm

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Basic Components

1) Compressed Air Motor

A compressed air motor is used to turn the drive shaft. It is located on the drive side of the Duoformer.

2) Gear Reducer

A gear reducer converts the drive shaft rotation to drive the spindle through a bevel gear and pinion arrangement. A gear reducer is located at both spindles (tending and drive side).

3) Cross Shaft

The cross shaft connects the two gear reducers. The drive shaft at the air motor is connected to cross shaft by a die and coupling disk. It allows sychronized movement of both support arms.

4) Spindle

A threaded spindle is driven by the bevel gear in the gear reducer and moves the support arms around the pivot axis on the machine frame.

5) Support Arms

The Support Arms are used to support to the stretch roll. It is connected to pivots at the Duoformer which allows positioning of the roll.

6) Handwheel

The Handwheel is located on the tending side of the stretch roll. It is used to move the tending side spindle independently of the drive side. It is used primarily for correcting the seam.

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Operating Parameters

Maintaining proper fabric tension is important in optimizing fabric life and web quality. The stretch roll mechanism is a main component of each fabric run on the paper machine. A properly tensioned fabric is critical to efficient operation of the Duoformer. There is a stretch roll mechanism for both wire runs and the design of the system is similar in both applications. A complete understanding of the stretch roll mechanism is required to properly operate the Duoformer.

If the fabric is too loose, premature wear can result from slippage at the driving roll (ie. forming roll). Excessively high tension can cause stretching of the wire in the machine direction and narrowing in the cross direction and could also lead to premature wear and wire failure. Improper tensioning can effect guiding by impacting the frictional forces between the fabric and the rolls. Excessive tension will lead to "sluggish" guiding while inadequate tension can result in "over-guiding". It is important to operate the fabric tension at the range specified by the manufacturer. During operation, the tension can be measured with a tensionmeter. (See page 28)

The most important principle to follow in order to obtain a constant, uniform tension across (ie. cross-machine direction) and lengthwise (ie. machine direction) is to ensure that the fabric seam is square. By maintaining a sufficient and even tension on the fabrics coupled with proper guiding, the fabric should maintain a "square" seam.

Squaring The Seam

It is important for the fabric to run with a square seam as this maximizes the designed open area and in turn drainage efficiency. An uneven seam causes distortion in the pattern of the fabric. The pores, (ie. open area) close and reduce the drainage capabilities of the fabric. Too much distortion causes the fabric to be disorientated and can lead to creases or destruction of the fabric.

When the seam is square, the seam is perpendicular (at right angles) to the fabric direction across the entire width of the fabric.

Diagram

Points A and B are running at the same point and will contact the stretch roll at the same moment.

When the seam is uneven, point A will either contact the stretch roll ahead or behind B.

Diagram

When the seam is ahead (A1), the path of fabric travel on the tending side is shorter than the path on the drive side. In this case, the stretch roll must be positioned ahead to lengthen the run on the tending side in order to resquare the seam.

When the seam is behind (A2), the path of fabric travel on the tending side is longer than the path on the drive side. In this case, the stretch roll must be positioned behind to shorten the run on the tending side in order to resquare the seam.

Note:

If the seam is leading on the tending side, lengthen the run and if the seam is behind, shorten the run.

In order to accomplish the resquaring of the seam the stretch roll is movable on the tending side independently of the drive side. This is conducted through a handwheel on the tending side. Before squaring the seam, make sure that you know which direction to turn the handwheel in order to make the correction.

When squaring the seam proceed slowly and watch each change closely. An over correction can result in an opposite movement of the fabric which could lead to fabric destruction.

Operation

Assuming that the operator has to tighten the bottom fabric in order to obtain a tension of 7 KN/m, the operator uses the selector (B-0175 SS1) on console CD1-TM. By placing it in the stretch position, an electric signal is sent out to the electromagnetic valve which controls the air supply to the motor.

The motor turns the drive shaft which turns the cross shaft, the gear reducers translate this motion to drive the threaded spindles which move the stretch roll. By moving the position of the roll around the pivot, you are varying the length of the wire run.

Top wire length: 16820 mm

Maximum Stretch: 345 mm

Bottom Wire length: 13570 mm

Maximum Stretch: 265 mm

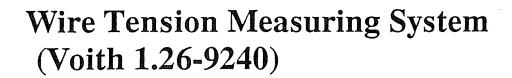
The maximum stretch value is approximately 2% increase of the wire lengths. This increase in length for a given fabric length results in an increase in tensional forces in the fabric. This force exerts pressure on the guide roll where the load cell senses the pressure. A signal from the load cell is sent to the tension indicators at CD1-TM.

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The operator keeps the selector at the "stretch" position until the desired tension is obtained at the tension indicator. When desired tension is obtained, place the selector switch in the vertical position which closes the electromagnetic valve.

Note:

When Changing a wire, it becomes necessary to adjust the stretch roll to the minimum stretch position. The top wire stretch mechanism can be moved to the wire change position without removing any shower brackets, savealls, or other machine components. The shower header for shower 8 must be removed from the bottom wire stretch roll support arms. If this header is not removed, the stretch roll cannot be fully retracted.



Purpose

To measure the tension of the fabric through a load cell positioned under the bearing plate of guide roll on the drive side of paper machine.

Description

The load cell which measures fabric tension is located on the drive side support bracket for the guide rolls of the Duoformer. The support bracket is actually a hinge on a pivot pin with the load cell located between the two surfaces. A stop bolt is also located in this area and acts as the maximum tension limit. The load cell area is enclosed by a guard box and equipped with a drain if water accumulates in the unit.

The load cell measures the forces applied to the guide roll due to the tension of the fabric. The cell sends an electric signal (ie. 4 to 20 mA) to the tension indicators on the control desk (CD1-TM). The signal is calibrated to represent the minimum (4 mA) and maximum (20 mA) tension. The maximum tension for the forming fabrics is 8 KN/m.

Note:

1 KN/m is equivalent to 5.6 psi.

Tension Indicators

- Bottom Wire (A-0175 W1)
- Top Wire (A-0176 W1)

Basic Components

1) Pivot

The Pivot is the pin on which the bases hinge. (ie.Support and bearing bases).

2) Load Cell

The Load Cell is the electric load cell which senses the applied force on the guide roll due to the fabric tension.

3) Stop

The Stop is the bolt which limits the tension applied to the guide roll. It is positioned at the maximum force point on the Load Cell.

4) Guard Box

The Guard Box protects the load cell from water and stock. It is equipped with a drain.

Tensiometer

Purpose

To measure fabric tension.

Description

A tensiometer (see figure?) is an instrument designed to measure tension in forming fabrics. It is important that the fabric be run at the tension for which it was designed and manufactured.

When the instrument is placed on the fabric, the contact shaft exerts a pressure on the internal spring of the cylinder. This action is converted to an indication which shows the fabric's tension on the scale. After the reading, the operator repositions the needle to zero by pressing the push button.

Note:

Depending on the manufacturer of the instrument (exp. HUYCH), the scale may have to be converted to obtain units which correspond to the indicators at the CD1-TM Console.

Basic Components

1) Frame

The Frame is the bottom rectangular part of the instrument which comes into contact with the fabric.

2) Contact Shaft

The Contact Shaft is located at the center of the frame and is attached to the cylinder.

3) Cylinder

The Cylinder contains a spring and is used as the handle.

4) Dial

The Dial displays a scale in force Newtons or pounds per inch.

5) Push Button

The push button resets the indicator to zero on the scale on the dial.



The instrument is designed so that the reading is not affected by the amount of pressure applied by the operator. It is preferable to apply only a light amount of pressure when taking a tension reading. Avoid creasing the fabric by applying too much pressure.

Warning:

To prevent serious injury and damage to the machine and fabric. Do not use the instrument near an entry nip.

The safe and adequate method for taking the tension of a fabric is the following sequence.

- 1. Reset the indicator to zero using the push button.
- 2. Hold the instrument by the cylinder and do not allow your fingers to contact the frame.
- 3. Ensure that indicator dial facing the operator.
- 4. Place the frame on the fabric approximately 300 mm from the guide roll and inside the fabric run. A tension reading too far from the roll results in an inaccurate reading.
- 5. Remove the instrument from the fabric surface and check the indicator on the scale.
- 6. Reset the indicator and perform the operation again.
- 7. Check second indication.
- 8. Check tension indicators with tensiometer readings to correlate the results.
- 9. Adjust fabric tension if required.

The fabric tensions should be checked at least once per shift. The tension of the fabrics is affected by temperature changes. When a machine is started up after a long shutdown, the fabric tension must be checked several times so that the necessary corrections can be made as the machine heats up. Under the influence of heat, the fibers in the fabric become more flexible and this lowers the tension at a set stretch roll position.

The instrument must be placed in the appropriate box when not in use and must always be kept clean and dry.

Duoformer Shower System

There are 16 shower locations on the Duoformer "T". It is important to understand all aspects of each shower operation.

- 1. Inner Wire Suction Box Lube Shower.
- 2. Tail Cutter.
- 3. Trim Squirts.
- 4. Roll No.2 Cleaning Shower.
- 5. Inner Wire Cleaning Shower.
- 6. Inner Wire Edge Cleaning Shower.
- 7. Inner Wire Knock-off Shower.
- 8. Inner Wire Cleaning.
- 9. Inner Wire Guide Roll Cleaning.
- 10. Outer Wire Guide Roll Cleaning.
- 11. Outer Wire Stretch Roll Cleaning.
- 12. Outer Wire Cleaning Shower.
- 13. Outer Wire Edge Cleaning Shower.
- 14. Outer Wire Cleaning.
- 15. Outer Wire Knock-off Shower.
- 16. Headbox Lip Cleaning Shower.

(1) Inner Wire Suction Box Lube Shower

Purpose

Lubrication of inner wire suction box foils when wires are running but there is no stock on wire.

Description

The shower header is constructed of stainless steel tube equipped with a self cleaning device. The orifices deliver a flat jet which impinges on the leading edge of the foil. This shower is non-oscillating.

Supply

The shower is supplied by Pump 34.

Water Source

Clear water from the Disk Filter is collected in Tank 30.

Location

The inner wire suction box shower is located between the forming roll and the leading edge of the suction box.

Technical Data

Shower:

inner wire suction box lube shower.

Shower #:

1.

Manufacturer:

Voith.

Operation:

Discontinuous.

Oscillation:
Stroke of Oscillation:

No.

Type of Water:

N/A.

Water Temperature:

Clarified. 30°C

Consumption:

50.5 1/min.

Supply Pump:

P 34.

Pressure:

2 bar.

Quantity of Nozzles:

21.

Nozzle Diameter:

2 mm.

Nozzie Diameter Jet Angle:

60°.

Height from Nozzle to Wire:

150 mm

Diameter of Shower Header:

57 mm.

Cleaning Device:

Yes.

Shower Angle:

155°.

Inner Wire Suction Box Lube Shower -Logic

Tag #:

MAA0158

Segment:

S 158

In order for the shower to be activated automatically:

Process Interlocks

- Valve 1359 must be open -valve controls clear water to Duoformer.
- Duoformer Drive must be activated.

When no stock is on the wire (a signal from 236.1), the valve 1330 will open and water will flow to the shower header. If stock to the wire is resumed, then the valve 1330 closes and the shower is off.

(2) Tail Cutter

Purpose

To cut the paper web to the desired width for "threading" and at "full width" during operation.

Description

The tail cutter can be operated in three ways:

- Manually
- Automatically.
- Motor controlled by push-button stations.

Note:

For detailed information see operating mechanisms.

Supply

The tail cutter is supplied by P 49. The fresh water is filtered prior to delivery to remove solids. (See filter information in trim squirt section.)

Water Source

Fresh water from Tank 32.

Location

The tail cutter is located directly under the bottom wire between Cantilever beams III and IV.

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Basic Components

1) Support Brackets

The Support Brackets fasten the tail cutter device between the two longitudinal beams.

2) Dual Chain/Sprocket Arrangement

The Dual Chain/Sprocket Arrangement moves the squirt across the machine by means of two sprockets and a chain. The squirt holder is fixed to the top chain. The chains are protected from water and deposits by stainless steel tubes. A second chain and sprocket arrangement connects the motor to the main chain to drive the nozzle in the automatic mode.

3) Actuator

The Actuator is the drive mechanism for automatic control of the tail cutter. It disengages the clutching mechanism coupling lever.

4) Motor

The motor drives the sprocket in conjunction with the actuator when in automatic mode. It is mounted to the support on the IV Cantilever on the drive side.

5) Handwheel

The Handwheel is located on the tending side and is designed to move the tail cutter in manual mode. (Clutch Disengaged).

6) Squirt

The Spray nozzle is manufactured by Maxey L. Gatewood. The Nozzle diameter is 0.5 mm. It is fastened to the hose by threads in the squirt holder.

7) Hose

The hose is connected to supply pipe on drive side. The hose will lose its elasticity and may become entangled if stretched for extended length of time. When the machine is down, the squirt should be positioned on the drive side.

Shower:

Tail Cutter.

Shower #:

Manufacturer:

Voith.

2

Operation:

Discontinuous.

Oscillation:

electromechanical.

Stroke of Oscillation:

Full Width.

Type of Water:

Fresh Water.

Water Temperature: Consumption:

20° C.

Supply Pump:

0.6 l/min.

P 49

Pressure:

12 bar.

Quantity of Nozzles:

1

Nozzle Diameter:

0.5 mm.

Jet Angle:

N/A.

Height from Nozzle to Wire:

40mm.

Diameter of Shower Header:

N/A.

Height from Nozzle to Wire:

40 mm

Diameter of Shower Header:

N/A.

Cleaning Device:

Without.

Shower Angle:

N/A

Other:

Gatewood Glass Nozzle

0.02" diameter

MAD Actuator

Type of actuator:

MA 1-16D132 Class IP 65.

Fabrication #:

2250 104-11.

Speed of the output shaft:

32 rpm.

rpm/stroke:

72.

Adjustable torque in opening direction: 100 Nm.

Adjustable torque in closing direction: 100 Nm.

Motor

Manufactured By:

HEW

Type:

RF80K/4-B08.

Power:

()hp.

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Operating Mechanisms

The tail cutter is operated either manually with the handwheel on the tending side, automatically operated in conjunction with photocells, or motor controlled by push-buttons at two control stations. One control station is fixed on a beam at the Yankee (CB4) and the other is located on the reel/calendar control panel at the dry end.

Coupling Lever at Actuator

The coupling lever activates the clutching mechanism in the actuator housing. In order to operate the tail cutter in the methods listed above, this lever must be adjusted to move from the automatic or motor-controlled method to the manual mode. If the clutching mechanism is not disengaged you will not be able to operate the tail cutter in the manual mode. The coupling lever acts as the selector switch for the mode of operation.

The actuator is reversed to motor operation by starting the motor only. The manual operation is automatically decoupled inside the actuator when the motor is started. It is not possible to reverse the actuator from manual to motor operation with the coupling lever, it is only possible by starting the motor.

Operation

1) Manual

For manual operation, turn the coupling lever at the actuator which disengages the clutching mechanism. This action permits manual operation of the squirt by means of the handwheel on the tending side.

The actuator is reversed to motor operation by starting the motor. The manual mode is automatically decoupled inside the actuator. It is not possible to reverse actuator from manual to motor operation with the coupling lever, it is only possible by starting the motor.

2) Automatic

In the auto mode, the tail cutter will be activated by a signal relayed to the motor. A photocell will signal a break on the machine which activates the tail cutter to move to the tending side to cut a tail. The tail cutter would leave its parked position on the drive side and move toward the tending side cutting the web. It stops at approximately 200 to 250 mm from the tending side forming a "tail" in the paper. When the tail is successfully threaded, the squirt starts to return to the drive side where it parks in its initial position.

3) Motor controlled by push-button stations.

This method differs from the auto mode in the sense that the tail cutter is activated by pushing the appropriate button at the control panel and not "automatically" based on a photocell signal.

Therefore, if a break occurs on the machine the tail cutter will move toward the tending side only if the tail button is pressed. The "narrowing" button can also be used if a portion of the sheet greater than the tail width is to be threaded. When the tail has been threaded through the machine, the "full-width" or "widening" button is pressed to move the tail cutter back to the parked position.

Control Buttons

Control Button Tail Button

This button activates the tail cutter from its parked position on the drive side towards the tending side. It cuts a tail approximately 200 to 250 mm wide on the front side. This button can be found on CB4 (D-0180-1PB4) and reel/calendar console (D-0180-1PB2).

Narrowing Button

This button is pushed to decrease the width of the paper during operation. It is located on CB-4 (B-0180-PB3) and reel/calendar console (B-0180-PB1).

Widen Button

This button controls the gradual shifting of the travelling squirt. It is located on CB4 (C-0180-PB2) and reel/calendar console (C-0180-PB2).

Full-Width Button

This button controls the automatic positioning of the travelling squirt to the back at a speed of 250mm/s. It is located on CB4 (A-0180-1PB3) and reel/calendar console (A-0180-1PB1).

(3) Trim Squirts

Purpose

To "trim" the sheet of paper to the required width at the reel.

Description

Two trim squirts are positioned on each side of the machine. The trim squirt is bracket mounted and can be adjusted to achieve the required width on a slide bar.

Each trim squirt is constructed with a strainer at the top to prevent the hole (nozzle) from becoming obstructed. Trim squirts are manufactured with various nozzle diameters.

Supply

The trim squirts are supplied by pump P 49 with water from Tank 32. A system of two in-line filters are located on the pressure side of the pump on the branch to the trim squirts and tail cutter. During operation only one filter operates and the other is used as a backup.

Note:

You must always ensure that the backup filter is clean and in good operating condition at all times so production will not be interrupted during a filter switch.

Water Source

Fresh water from Tank 32 is used for the Trim Squirts.

Location

The Trip Squirts are located on the Inner Wire between the Forming Roll and Roll No.2.

Shower:

Shower #:

Manufacturer:

Operation:

Oscillation:

Stroke of Oscillation:

Type of Water:

Water Temperature:

Consumption:

Supply Pump:

Pressure:

Quantity of Nozzles:

Nozzle Diameter:

Jet Angle:

Height from Nozzle to Wire:

Diameter of Shower Header:

Cleaning Device:

Shower Angle:

Other:

Trim Squirts

3.

Voith.

Continuous

none.

N/A

Fresh

 $20^{\circ}C$

0.6 l/min/nozzle (4)

P49

12 bar.

1

0.5 mm.

N/A.

50 mm.

N/A.

Without.

N/A.

Gatewood Glass Nozzle:

0.02" Diameter.

(4) Roll No. 2 Cleaning Shower

Purpose

To continuously clean roll No. 2 at the doctor blade to prevent buildup of fibers.

To lubricate roll surface to reduce doctor blade's wear.

Description

The shower type is a "STAMM". The tube is constructed of stainless steel with special flat-jet nozzles. The tube is equipped with a cleaning device.

Supply

The shower is supplied by pump (P 34).

Water Source

Clear water from Tank 30.

Location

The shower is located between the support foil and the No.2 roll.

Shower:

Shower #:

Manufacturer:

Operation:

Oscillation:

Stroke of Oscillation:

Type of Water:

Water Temperature:

Consumption:

Supply Pump: Pressure:

Quantity of Nozzles:

Nozzle Diameter:

Jet Angle:

Height from Nozzle to Wire:

Diameter of Shower Header:

Cleaning Device:

Shower Angle:

Roll 2 Cleaning Shower

4

Voith.

Continuous

none.

N/A

Clarified.

30°C

164 l/min.

P 34

3 bar.

21

3 mm.

60°.

150 mm.

57 mm.

Yes.

(5) Inner Wire Cleaning Shower

Purpose

To provide high pressure cleaning for the bottom wire on a intermittent basis.

Description

The tube is constructed of stainless steel with no self cleaning device. The header is laterally oscillated by means of double action hydraulic pistons. The orifices are the needle-jet type.

Supply

The shower is supplied by P 51 (booster pump).

Water Source

Fresh water from Tank 32.

Location

The shower is located on the inside wire between roll 2 and 3.

Shower:

Shower #:

Manufacturer:

Operation: Oscillation:

Stroke of Oscillation:

Type of Water:

Water Temperature:

Consumption:

Supply Pump: Pressure:

Quantity of Nozzles:

Nozzle Diameter:

Jet Angle:

Height from Nozzle to Wire:

Diameter of Shower Header:

Cleaning Device:

Shower Angle:

Bottom Wire Cleaning.

5.

Voith.

Discontinuous

Hydraulic. --

.

Fresh Water.

20°C

110 l/min.

P 51.

60 bar.

29

1 mm.

N/A (needle)

120 mm.

57 mm.

Without.

Inner Wire Cleaning Shower- Logic

Tag #:

MAA 0161

S 161.

Segment:

This shower blasts high pressure water (max 60 bar) at the bottom wire Process interlocks must be satisfied to supply water to the shower header.

Hydraulic pumps 4 or 5 must be running. When one of the hydraulic pumps are started, the shower oscillating mechanism can be started.

Once oscillation action is initiated, two limit switches monitor the stroke. If for some reason, the stroke is interrupted. The valve will close discontinuing the water supply.

For the water supply to be initiated the following condition must be met:

- Duoformer Drive must be on.
- Supply pumps (P 51) must be on.

When these conditions are met, and the oscillator has moved the preset times established in the counter (exp. 002), then the valve (1324) will open.

The valve (1324) will close if:

- Oscillation fault.
- Duoformer drive stops.
- Hydraulic pump stops.
- Shower is shutdown.

(6) Inner Wire Edge Cleaning

Purpose

To keep edges of bottom wire clean.

Description

The header is constructed of stainless steel tube equipped with a self cleaning device. The orifices are fitted with flat jet nozzles. This header is non-oscillating.

Supply

The shower is supplied by P 49 (booster pump).

Water Source

Fresh water is from Tank 32.

Location

The shower is located on the inner wire between roll 2 and 3.

Machine

Technical Data

Shower:

Bottom Wire Edge Cleaning.

Shower #:

Manufacturer:

Operation:

Oscillation:

Stroke of Oscillation:

Type of Water:

Water Temperature:

Consumption:

Supply Pump:

Pressure:

Quantity of Nozzles:

Nozzle Diameter:

Jet Angle:

Height from Nozzle to Wire:

Diameter of Shower Header:

Cleaning Device:

Shower Angle:

6.

Voith.

Continuous

None.

N/A.

Fresh Water.

20°C

82 l/min.

P 49.

12 bar.

4

3 mm.

60°.

150 mm.

57 mm.

Without.

(7) Inner Wire Knock-off Shower

Purpose

To knock-off fibers and operated on an intermittent basis.

Description

The header is constructed of stainless steel tube equipped with a self-cleaning device. The header oscillates laterally by means of double action hydraulic pistons. The orifices are equipped with flat jet nozzles.

Supply

The shower is supplied by P 52 (booster pump).

Water Source

Clear water from Tank 30.

Location

The shower is located at the ingoing nip of roll no.3.

Shower:

Bottom Wire Knock-off.

Shower #:

Manufacturer:

Operation:

Oscillation:

Stroke of Oscillation:

Type of Water:

Water Temperature:

Consumption:

Supply Pump:

Pressure:

Quantity of Nozzles:

Nozzle Diameter:

Jet Angle:

Height from Nozzle to Wire:

Diameter of Shower Header:

Cleaning Device:

Shower Angle:

7.

Voith.

Discontinuous

Hydraulic.

N/A

Clarified.

30°C

282 l/min.

P 52.

12 bar.

20

3 mm.

60°.

150 mm.

57 mm.

Yes.

Inner Wire Knock-off Shower -Logic

Tag #:

MAA 0163

Segment:

S 163

The process interlocks associated with this shower are:

- Hydraulic pumps 4 or 5 must be running. When hydraulic pump started, the shower oscillating mechanism can be started.
- Limit switches monitor the stroke of oscillation.

For the water supply to be initiated the following conditions must be met:

- Duoformer drive must be on.
- Supply pump (P 52) must be on.

When these conditions are met, and the oscillator has moved the preset times established in the counter (exp.002), the valve (1325) will open.

The valve (1325) will close if:

- Oscillation fault.
- Duoformer drive stops.
- Hydraulic pump stops.
- The stop button for the shower is activated.

(8) Inner Wire Cleaning

Purpose

Inner wire cleaning of the machine side of the fabric. The shower header is equipped with a connection for the application of cleaning chemicals.

Description

Stamm shower.

Supply

The shower is supplied by P 34.

Water Source

Clear water from Tank 30.

Location

The shower is located on the inside of the bottom wire between the rolls 2 and 3.

Duoformer

Technical Data

Shower:

Inner Wire Cleaning Shower

Shower #:

Manufacturer:

Operation:

Oscillation:

Stroke of Oscillation:

Type of Water:

Water Temperature:

Consumption:

Supply Pump:

Pressure:

Quantity of Nozzles:

Nozzle Diameter:

Jet Angle:

Height from Nozzle to Wire:

Diameter of Shower Header:

Cleaning Device:

Shower Angle:

8.

Voith.

Discontinuous

None.

N/A.

Clarified.

30°C

149 l/min.

P 34.

3 bar.

20

3 mm.

60°.

150 mm.

57 mm.

Yes.

(9) Inner Wire Guide Roll Shower

Purpose

To continuously clean roll No. 4 at the ingoing nip to prevent buildup of fibers which may effect guiding. To lubricate roll surface and reduce doctor blade wear.

Description

The shower header sprays the water at the ingoing nip (ie. between the wire and the roll surface).

Supply

The shower is supplied by pump P34.

Water Source

Clear water from Tank 30.

Location

The shower is located between roll 3 and 4.

Shower:

Shower #:

Manufacturer:

Operation:

Oscillation:

Stroke of Oscillation:

Type of Water:

Water Temperature:

Consumption:

Supply Pump:

Pressure:

Quantity of Nozzles:

Nozzle Diameter:

Jet Angle:

Height from Nozzle to Wire:

Diameter of Shower Header:

Cleaning Device:

Shower Angle:

Inner Wire Guide Roll

9.

Voith.

Continuous

None.

N/A.

Clarified.

30°C

203 l/min.

P 34.

3 bar.

26

3 mm.

60°.

120 mm.

57 mm.

Yes.

(10) Outer Wire Guide Roll Shower

Purpose

To continuously clean roll No. 6 at the ingoing nip to prevent buildup of fibers which may effect guiding. To lubricate roll surface to reduce doctor blade wear.

Description

The shower header sprays the water at the ingoing nip (ie. between the wire and the roll surface).

Supply

The shower is supplied by pump P 34.

Water Source

Clear water from Tank 30.

Location

The shower is located between roll No. 5 and 6.

Shower: Outer Wire Guide Roll.

Shower #: 10.
Manufacturer: Voith.

Operation: Continuous.

Oscillation:

Stroke of Oscillation:

None.

N/A.

Type of Water:

Clarified.

Water Temperature:

30°C

Water Temperature: 30°C
Consumption: 203 l/min.

Supply Pump: P 34.
Pressure: 3 bar.
Quantity of Nozzles: 26

Quantity of Nozzles: 26
Nozzle Diameter: 3 mm.
Jet Angle: 60°.

Height from Nozzle to Wire: 120 mm.

Diameter of Shower Header: 57 mm.

Cleaning Device: Yes. Shower Angle: 80°.

(11) Outer Wire Stretch Roll Shower

Purpose

To continuously clear Roll no. 7 at doctor blade to prevent buildup of fibers. To lubricate roll surface to reduce doctor blade wear.

Description

Stamm shower operates at doctor blade.

Supply

The shower is supplied by P 34.

Water Source

Clear water from Tank 30.

Location

The shower is located at the outgoing nip at roll No. 7.

Shower:

Outer Wire Stretch Roll

Shower #: 11. Manufacturer: Voith.

Operation: Continuous.

Oscillation: None.

Stroke of Oscillation: N/A.

Type of Water: Clarified.

Water Temperature: 30°C

Water Temperature: 30°C Consumption: 195 l/min.

Supply Pump: P 34.

Pressure: 3 bar.

Quantity of Nozzles: 25

Nozzle Diameter: 3 mm.

Jet Angle: 60°.

Height from Nozzle to Wire: 125 mm.

Diameter of Shower Header: 57 mm.

Cleaning Device: Yes.
Shower Angle: 145°.

(12) Outer Wire Cleaning Shower

Purpose

To clean the sheet side of the top wire. The shower nozzle is equipped for the application of cleaning chemicals.

Description

The header is constructed of stainless steel tubing.

Supply

The shower is supplied by P 34.

Water Source

Clear water from Tank 30.

Location

The shower is located on the outside of the top wire between rolls No. 7 and 8.

Shower:

Shower #:

Manufacturer:

Operation:

Oscillation:

Stroke of Oscillation:

Type of Water:

Water Temperature:

Consumption:

Supply Pump:

Pressure:

Quantity of Nozzles:

Nozzle Diameter:

Jet Angle:

Height from Nozzle to Wire:

Diameter of Shower Header:

Cleaning Device:

Shower Angle:

Outer Wire Cleaning

12.

Voith.

Continuous.

None.

N/A.

Clarified.

30°C

149 l/min.

P 34.

3 bar.

19

3 mm.

60°.

150 mm.

57 mm.

Yes.

(13) Outer Wire Edge Cleaning

Purpose

To keep edges of outer wire free of stock deposits.

Description

The header is constructed of stainless steel tube equipped with a self cleaning device. The orifices are fitted with flat jet nozzles. This header is non-oscillating.

Supply

The shower is supplied by P 49 (booster pump).

Water Source:

Fresh water is from Tank 32.

Location

The shower is located on inside wire between roll No. 7 and 8.

Duoformer 61

> 13. Voith.

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Technical Data

Shower:

Outer wire Edge Cleaning

Shower #: Manufacturer:

Continuous. Operation:

Oscillation: None. Stroke of Oscillation:

N/A.

Type of Water: Fresh Water.

20°C Water Temperature: Consumption: 82 l/min. Supply Pump: P 49. Pressure: 12 bar.

Quantity of Nozzles:

Nozzle Diameter: 3 mm. 60°. Jet Angle:

Height from Nozzle to Wire: 130 mm.

Diameter of Shower Header: 57 mm.

Cleaning Device: Without. 297°. Shower Angle:

(14) Outer Wire Cleaning Shower

Purpose

High pressure cleaning of outer wire on an intermittent basis.

Description

The tube is constructed of stainless steel with no self cleaning device. The header is laterally oscillated by means of double action hydraulic pistons. The orifices are needle-jet type.

Supply

The shower is supplied by P 51 (Booster Pump).

Water Source

Fresh water from Tank 32.

Location

The shower is located between roll no. 7 and 8 inside wire.

Shower:

Shower #:

Manufacturer:

Operation:

Oscillation:

Stroke of Oscillation:

Type of Water:

Water Temperature:

Consumption:

Supply Pump:

Pressure:

Quantity of Nozzles:

Nozzle Diameter:

Jet Angle:

Height from Nozzle to Wire:

Diameter of Shower Header:

Cleaning Device:

Shower Angle:

Top Wire Cleaning

14.

Voith.

Discontinuous.

Hydraulic.

?.

Fresh Water.

20°C

110 l/min.

P 51.

60 bar.

29

1 mm.

N/A (needle)

180 mm.

57 mm.

Without.

Top Wire Cleaning Shower -Logic

Tag #:

MAA 0162

Segment:

S162.

This shower blasts high pressure water (max. 60 bar) at the top wire. Process interlocks must be satisfied to supply water to the shower header.

Hydraulic pumps 4 or 5 must be running when hydraulic pump started, the shower oscillating mechanism can be started.

Once oscillation action is initiated, two limit switches monitor the stroke. If for some reason the stroke is interrupted, the valve will close discontinuing the water supply.

For the water supply to be initiated, the following conditions must be met.

- Duoformer drive on.
- Supply pump (P 51) on.

When these conditions are met, and the oscillator has moved the preset times established in the counter (exp. 002), then the valve (1357) will open.

The valve (1357) will close if:

- Oscillation fault.
- Duoformer Drive stops.
- Hydraulic pump stops.
- Shutdown shower initiated by stop button.

(15) Outer Wire Knock-off Shower

Purpose

To knock-off fibers and operated on an intermittent basis.

Description

The header is constructed of stainless steel tube equipped with a self-cleaning device. The header oscillates laterally by means of double action hydraulic pistons. The orifice are equipped with flat jet nozzles.

Supply

The shower is supplied by P 52 (Booster Pump).

Water Source

Clear water from Tank 30.

Location

The shower is located at the ingoing nip of roll No.8.

Shower:

Shower #:

Manufacturer:

Operation: Oscillation:

Stroke of Oscillation:

Type of Water:

Water Temperature:

Consumption:

Supply Pump:

Pressure:

Quantity of Nozzles:

Nozzle Diameter:

Jet Angle:

Height from Nozzle to Wire:

Diameter of Shower Header:

Cleaning Device:

Shower Angle:

=

Top Wire Knock-off

15.

Voith.

Discontinuous.

Hydraulic.

?.

Clarified.

30°C

282 l/min.

P 52.

12 bar.

20

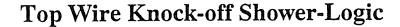
3 mm.

60°

150 mm.

57 mm.

Yes.



Tag #:

AA 0164

Segment:

S164

Process Interlocks

Hydraulic pumps 4 or 5 must be running when hydraulic pump is started, the shower oscillating mechanism can be started.

Limit switches monitor the stroke of oscillation.

For the water supply to be initiated the following conditions must be met.

- Duoformer must be on.
- Supply pump (P 52) must be on.

When these conditions are met, and the oscillator has moved the preset times established in the counter (exp.002), the valve (1358) will open.

The valve (1358) will close if:

- Oscillation fault.
- Duoformer drive stops.
- Hydraulic pump stops.
- Shutdown of shower is initiated-stop button.

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(16) Headbox Lip Cleaning Shower

Purpose

To continuously clean the lip of the headbox to prevent accumulation of fibers.

Description

The shower header sprays water at the adjustable lip of the headbox to prevent fibers from depositing in this location.

Supply

The shower is supplied by P 34.

Water Source

Clear water from Tank 30.

Location

The shower is located directly below the headbox lip in the area between the headbox and roll no.9.

Technical Data

Shower:

Shower #:

16. Manufacturer: Voith.

Operation: Continuous.

Headbox Lip Cleaning

Oscillation: None. Stroke of Oscillation: N/A

Type of Water: Clarified.

30°C Water Temperature:

28 l/min. Consumption:

Supply Pump: P 34.

2 bar. Pressure:

Quantity of Nozzles: 11 Nozzle Diameter: 2 mm.

60° Jet Angle:

Height from Nozzle to Wire: 250 mm.

57 mm. Diameter of Shower Header:

Cleaning Device: Yes.

180°. Shower Angle:

Doctor Blades

Purpose

To contact the roll surface along the entire face length and keep the roll surface free from deposits.

Process Description

The doctor blades are designed to be loaded and unloaded through a switch on the tending side of the machine. The doctor blade body pivots on bearings secured in the roll support structure. The blades contact the roll with a loading of approximately 9 kg/m.

An oscillating device is attached to each doctor blade on the drive side. The oscillator has a cross machine stroke of 10mm to each side. The oscillator prevents uneven wear on the roll surface due to "nicks" or sharp edges on the doctor blade surface. The oscillator should be operated at all times.

Technical Data

Type:

Lodding Accumate K35-A

Material of body:

Stainless Steel

Material of blade:

Stainless Steel

Material of Supports:

Cast Iron

Blade

Material:

Plastic

Thickness:

1.5 mm

Loading

Contact pressure of blade to roll:

9 kg/m

Oscillation

Stroke of Oscillation:

10 mm

Bearing designed with two-way moving piston rod and fittings of bronze.

Doctor Oscillation-Logic

Bottom Wire Tag #:

MAA 155

Segment:

S 155

Top Wire Tag #:

MAA 156

Segment:

S 156

Process Interlocks

- Hydraulic pumps 4 or 5 must be running.
- Duoformer drive must be on crawl or run.
- Press Start button for doctor oscillation.

After completion of the above interlocks, the doctor blades should begin to oscillate.

Inner Wire Suction Box

Purpose

To retain the web on the bottom wire through the application of vacuum.

Description

The Suction Box is located prior to the point where the two wires separate. The formed web (at approximately 18% consistency) must follow the bottom wire and must not follow the top wire.

The suction box is equipped with deckle strips on the tending and drive side. By moving these strips either inwards or outwards you can adjust the size of the suction area to match the width of the sheet (pond width at headbox 2770 mm).

The suction box can be angularly adjusted. The box is supported and fixed to III Cantilever Beam. It is designed to permit a $\pm 1/4$ swing (ie. 0 to 1 mm between the leading edge of the cover and the wire).

The vacuum levels are monitored with a gauge on the tending side. The vacuum is adjusted by means of a valve in the exhaust piping on the drive side. A water separator is also located on the exhaust piping which "separates" the water and air prior to the vacuum pump (P 55).

Basic Components

1) Box

The Box forms the housing of the suction box. It extends from the drive side to the tending side and is fastened to Cantilever III.

2) Cover Strip

The Cover Strip is the leading edge strip positioned to support the two wires and place the suction zone in the optimal location to ensure that the web follows the bottom wire.

3) Back Cover Strip

The Back Cover Strip is position on the backing side. It acts as a mate to the cover strip on the leading edge.

4) Deckle

The Deckle is an adjustable edge deckle. The open area bounded by the edges of the cover strips and deckles forms the "suction zone".

5) Deckle Adjusting Nut

The adjusting nut functions to permit the positioning of the deckles.

6) Angular Adjusting Nut

The Angular Adjusting Nut functions to permit the adjustment of the angle of contact between the leading edge of the suction box and the wires.

7) Swivel Pin

The Suction Box swivels on the this pin when adjusted angularly.

8) Clean-out Cover

The Clean-out cover is located on the tending side and is used to clean the internals of the suction box.

Technical Data

Face Length:

3100mm

Width of suction box:

125 mm

Suction Box

Material:

Stainless Steel 316

Support Material:

Cast Stainless Steel

Water Separator Material:

Stainless Steel

Foils

Number of Foils:

2

Deckles:

2

Material:

Chromium Oxide

Slot Width:

13 mm

Suction Area:

 $0.4 \, \text{m}^2$

Operating Pressure:

2.5 mWG

Specific Air Volume:

 $530 \text{ m}^3/\text{min/m}^2$

Total Air Volume:

 $19.98 \text{ m}^3/\text{min}$

Vacuum Source:

P 55

Operating Parameters

A. Adjusting the vacuum level of the suction box.

The vacuum level can be adjusted with a valve on the exhaust side of the suction box. Observe the vacuum indicator and ensure that the maximum admissible vacuum is not exceeded.

B. Deckle Adjustment

- 1. Loosen nuts (5) and adjust them to the desired position. The web should lie flat on the wire with no blowing at either edge.
- 2. Tighten nuts (5)

C. Angular Adjustment

- 1. Loosen Nut (6).
 - 2. Adjust the angular position.
 - 3. Tighten nut (6) when position is selected.

D. Cleaning

Always try to maintain a clean suction box in order to preserve the equipment and to keep the efficiency of each component at optimal levels.

To wash the internals of the suction box, remove the screw, cover, and gasket on the Tending side.

E. Lubrication

A shower is mounted on the box which sprays a water jet at the leading edge foil when there is no stock on the wire. The water acts as a lubricant to reduce any wear between the foil strip and bottom wire. For detailed information of the shower see "Shower" section.

Support Foil -Deflector

Purpose

To "support" the Bottom Wire between the Forming Roll and Roll 2.

Description

The foil supports the Inner Wire as it runs from the Forming Roll towards Roll 2. This improves the stability of the wire with the added weight of the formed web. In this manner, the sheet lies flat on the wire and is more effectively transferred to the press section at the inner wire shoe.

The foil does not act as a dewatering foil as do other foils in twin wire blade formers. You should observe very little water removal at the leading edge of this foil. Its role is solely to support the wire.

Regular inspection of the strip edge should be conducted since any irregularities may cause or provoke wire damage.

Basic Components

1) Foil Body

The Foil Body is the main structure that supports foil. It extends from the tending side to the drive side.

2) Foil Strip

The Foil Strip is constructed of ceramic to reduce wear. It is formed in segments in order to avoid any break caused by bending. This also permits easy replacement of parts in case of surface damage.

3) Clamping Strip

The Clamping Strip secures the foil to the foil body and permits the removal of the foil by removing the fastening screws.

4) Support Brackets

The Support Brackets fasten the foil body to the drive and tending sides of the lateral beams between Cantilever beams III and IV.

5) Vertical Adjustment Screw

The vertical height of the foil body can be adjusted by the vertical adjustment screw. The nuts at the side and above the support bracket must be loosened before the adjuster can be moved. Adjustments must be made on both side of the Foil Body.

6) Angular Adjustment Screw

The angle of contact between the leading edge of the foil and the wire can be adjusted by the angular adjustment screw. The angle is adjusted by loosening the screw and rotating the bracket around the pin.

Technical Data

Face Length:

3100 mm

Width of Foil:

60 mm

Foil Material:

Ceramic

Foil Body Material:

Stainless Steel 316.

Support Material:

Cast Stainless Steel

Operating Parameters

Under normal operating conditions, the foil's position is relative to the bottom wire and is rarely adjusted. It is usually set at start-up and remains in this position until the foil strip is replaced. It is important to remember that adjustment is possible if operating conditions dictate.

Foil Strip Replacement

Special care must be taken in order to avoid any damage of fragile elements (ie. new foil strip segments). To remove segments, loosen the fastening screws at the clamping strip until the segment is "freed" from clamping pressure.

Cleaning

Try to maintain a clean foil strip in order to reduce possible wear between the strip and the bottom wire. During all bottom wire changes, ensure that the entire assembly is cleaned and free of deposits.

Lubrication

This foil does not require any lubrication and therefore no shower is located in this area.

Savealls

Savealls are trays which collect water in the Duoformer. The water collected is the water removed during formation of the sheet and all other excess water from showers. The Savealls prevent damage to the wire from the weight of the excess water and prevent disruption of the sheet during formation. All Savealls drain to the drive side of the paper machine and direct the water to the white water silo or wire pit.

A) Saveall At Forming Roll

The largest saveall on the machine and it is shaped to enclose the forming portion of the forming roll surface. It collects the large volume of water removed during formation and directs it to the white water silo. Plates are fixed inside this saveall in the direction of water flow to aid in mist and water separation.

B) Saveall between Forming Roll and Tail Cutter.

This saveall extends from the Forming Roll to the area directly below the Tail Cutter. It collects the water from showers (ie. suction box shower to protect inner wire on its return to the forming zone. Very little water is collected on this saveall due to the web drainage through the wire.

C) Savealls at Rolls 2,3,5,7,8 and 9.

These Saveall trays remove water from the area under the roll due to showering. Deposits scraped from the roll surfaces due to the doctor blade are also collected in these Savealls.

D) Saveall above walkway on Wet End side of Headbox.

This saveall collects water from the top wire prior to its re-entry in to the Formation area. Its main role is to provide adequate protection for the operator when repositioning the micro-slice actuators.

Mist Removal

The speed of the wire and the spray from the showers produces a great deal of mist which impairs visibility in the Duoformer area. To improve the operating conditions, mist extraction ducts have been installed at 6 points where mist formation is more intense on the Duoformer.

- 1) Saveall at Forming Roll.
- 2) At base of Splash Guard-Outer Wire.
- 3) By the Inner Wire Suction Box.
- 4) At Base near Roll No. 3.
- 5) At Base on outgoing side of Roll No.8.
- 6) At Forming Roll above Suction Box.

A fan is supplied to help evacuate the mist and exhaust it to atmosphere. Inspection of the Duoformer is also aided with directional lighting.

Duoformer "T"-Construction

Overview

The main structural components of the Duoformer center around vertical supports which support four cantilever beams. Each cantilever beam extends from the tending side to a point beyond the drive side (ie. 2030 mm between center lines of drive side vertical support and cantilever support). The vertical support on the tending side is equipped with an aluminum spacer block. This block is removed using the cantilever design to replace a wire (see wire replacement). Cantilever beams I and II are part of the top wire construction while III and IV are part of the bottom wire construction. The rolls, showers, and saveall trays are attached to this main structure.

The Duoformer is equipped with walkways on both sides of the machine (with stairs). Two walkways are positioned in the cross-machine direction on both sides of the headbox.

Cantilever Operation

During normal operating conditions, the load of the Duoformer is supported on the vertical supports at the drive and tending sides of the machine. When a wire is replaced, the Duoformer must be partially disassembled to allow the replacement wire to be "draped" on the machine. The Cantilever operation is designed to facilitate a wire change by allowing the removal of spacer blocks in the support columns on the tending side.

When a spacer block is removed, the structure is no longer supported on the tending side but rather the load is solely on the drive side. Tie rods, attached to vertical columns fixed to the ends of the cantilever beams, are adjusted to provide a maximum "sag" of 10 mm at the tending side. In other words, when the block is removed the load is supported by the drive side vertical supports and held down by the vertical columns at the end of each Cantilever.

The Cantilever operation must be sequenced in a manner so that the top wire is cantilevered first (I and II) followed by the bottom wire (III and IV). The bottom wire structure cannot be Cantilevered without first Cantilevering the top wire structure.

Top Wire Change

(A) Preparation For Top Wire Change

- 1. Lift-off doctor blades from all wire Rolls (Forming Roll, Roll 5, 6, 7, 8, and 9).
- 2. Remove the electric alarm device, guide paddle, and protective grating of the Stretch Roll.
- 3. Withdraw the stretch roll to wire change position (ie. minimum stretch). Ensure that the Wire Stretch Roll has been fully retracted.
- 4. Remove pins at each side of deflecting wall and lower it so that it rests on the mist extraction piping.
- 5. Cut off old wire, wash-up and inspect wire run (ie. rolls, Savealls, etc.).
- 6. Loosen wing nuts at lateral plate under roll no, 8 and remove plate. Place the plate away from the machine.
- 7. Loosen swing bolts above Cantilever II (connection between top and bottom wire structures) tending and drive side. Swing bolts out and allow them to rest on bottom wire structure.
- 8. Loosen swing bolts beneath Forming Roll bearing housing (second connection between top and bottom wire structures). Swing bolts out and toward the top structure side.

(B) Wire Structure- Top Frame Lifting/Lowering

Tag #:

MAA 0150

Segment:

S150

Conducted through Control Box 2 (CB2)

To Lift

- Wire Change switch actuated (KS1-CB2)
- Lift Button Pressed (PB2-CB2)
- Hydraulic Pump #1 Started (140 MCC-1-CB2)

There will be a short delay before the frame lifts while the hydraulic system becomes pressurized. The pump will stop when the frame is lifted (timer actuated).

To Lower

- Wire Change switch actuated (KS1-CB2)
- Lower Button pressed (PB2-CB2)
- Hydraulic Pump #1 started (140 MCC-1-CB2)

There will be a short delay before the frame lowers and the pump will stop when lowering is complete (timer actuated).

Note:

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Two bolts fixed to Roll No.9 support on the Tending and Drive sides. The position of these bolts denote the operating position of the top wire frame. Their function is that of a "stopper" when the top frame is lowered.

Control Box 2 (CB2) contains the control buttons required for retraction of the top frame. A keyswitch (C-0150 KS1) must be turned to switch CB2 to wire change mode. By pressing the lift button (B-0150-PB1) the hydraulic cylinders located on each side of the frame, will retract, which in turn lifts the frame. The frame pivots on a hinge point located below Roll No. 9.

- 9. Remove portion of platform walkway above Roll No. 9.
- 10. Remove top platform handrails.
- 11. Loosen swing bolt at stairway and place stairway (on wheels) at end of platform.

12. Loosen swing bolts at Cantilever I and II and let them rest against the lower portion of the vertical support.

- 13. Insert hydraulic jacks at I and II spacer blocks. The jacks must be inserted from the backside so that the jack will contact the vertical support in the groove provided at the top of the spacer block.
- 14. Lift the structure approximately 3 mm utilizing the jacks.
- 15. Slide the spacer blocks towards the tending side and remove them.
- 16. Lower the jacks noting the slight "sag" to the front side (max 10 mm).
- 17. Inspect all wire-contacting components of the top wire run. Check for sharp edges or imbedded objects.
- 18. Top wire structure ready for installation.

(C) Top Wire Change

Attention

Cover the sharp corners and edges on the machine or support structure with used felt pieces.

Drape a piece of felt over the scraper strip which is fixed to the mist extraction deflecting wall at Roll No. 8.

Cover tending side edges of Saveall pan under Roll No.9 and by Roll No.7.

Clean area on machine room floor.

Ensure all objects are placed away from wire changing area.

Attention

A paper making wire is an expensive item and is easily destroyed if not handled properly. Great care must be used at all times during installation. Follow these instructions for handling and installing the wire.

- 1. When unpacking a new wire, be extremely cautious.
- 2. Do not use knives or other sharp objects around wire.
- 3. Avoid wetting a new wire as this adds extra weight and makes handling slightly more difficult. An old felt can be placed on the floor to protect the wire (if available).
- 4. Unpack wire bundle and place it on floor in front of the machine (tending side).
- 5. Position wire in proper run and sheet side directions.
- 6. Position team members to install wire and watch for "hang-ups" at:
 - Wire pit by Roll No. 8.
 - Outside wire run at deflecting wall.
 - Stretch mechanism Roll No. 7.
 - Roll No. 5.
 - Rover (in many places offering assistance).

- 7. When positioning wire on machine:
 - Do not excessively tug at wire. This may indicate a "hang-up" which could damage the wire if tugging persists. The wire should slide on to the machine with minimal amount of exertion.
 - Work as a team. The wire should be draped evenly across the machine when moving from tending toward the drive side.
 - Position wire on machine as close to running position as possible.

(D) Reestablishment of the Duoformer to Operating Conditions.

- 1. Insert hydraulic jacks at the Cantilever spaces. Ensure that jack is positioned to permit replacement of the spacer blocks.
- 2. Lift the structure to accommodate the spacer blocks.
- 3. Clean spacer block surfaces.
- 4. Slide the blocks in place. The guide bars should help reposition the blocks.
- 5. Lower the jacks when blocks are positioned.
- 6. Position the swing bolts and firmly tighten the nuts.
- 7. Remove the jacks.
- 8. Ensure that the wire is flat across the width of the machine.
- 9. Reposition the stairway and tighten the swing bolt.
- 10. Reposition handrails at top platform and portion of walkway.
- 11. Using Control Box 2 (CB2), press lower button (A-0150-PB2) to move the pistons for the top frame. This action will lower the top frame to the operating position.
- 12. The top frame should lie flush on the pad at Roll No.5 and rest on stopper at Roll No. 9.
- 13. Position and tighten swing bolts at Rolls No. 5 and No. 9 (tending and drive side).
- 14. Switch keyswitch (C-0150-KS1) at CB2 to "run" mode.

- 15. Check wire and ensure that it is flat.
 - 16. Replace lateral plate under Roll No. 8.
 - 17. Replace shower 12.
 - 18. Lift deflecting wall and insert pins.
 - 19. Replace the electric alarm device, guide paddle, and protective grating of the Stretch Roll.
 - 20. Sprinkle wire with water, inside and out, Guard against throwing dirt and debris onto the wire.

(E) Top Wire Startup

- 1. Check operation of the autoguide controller using the guide paddle. Watch piston rod movement by manually moving guide palm. Ensure guide palm contacts edge and arm pointer floats about "0" on scale.
- 2. Apply low tension to wire (2 kN/m).
- 3. Jog wire for two revolutions at lowest possible speed.
- 4. Check wire for wrinkles.
- 5. If no wrinkles, load all doctor blades.
- 6. Bring wire tension up to normal operating tension (max. 8 kN/m).
- 7. Turn on the showers. A moving plastic wire should be lubricated with water at all times, to reduce chance of fibrillation.
- 8. Increase wire section to normal running speed. Accelerate slowly to avoid slippage. Watch the guiding of the wire for inconsistencies.
- 9. Following start-up, adjust the tension as required. The slight stretching of polyester monofilament (about 0.1 to 0.2 % linearly) is most noticeable during the first 24 to 48 hours. After that, a properly designed wire should remain stable.
- 10. Monitor ammeter for the Forming Roll.

Bottom Wire Change

In order to change the bottom wire, the top wire structure must be Cantilevered.

(A) Top Wire Cantilevered

- 1. Lift-off doctor blades from all wire rolls (F.R. 5, 6, 7, 8, 9).
- 2. Remove the electric alarm device and guide paddle mechanism.
- 3. Withdraw the stretch roll to wire change position (ie. minimum stretch). Ensure wire stretch roll has been fully retracted.
- 4. Remove pins at each side of deflecting wall and lower it so that it rests on the mist extraction piping.
- 5. Loosen swing bolts above Cantilever III (connection between top and bottom wire structures) tending and drive side. Swing bolts out and allow them to rest on bottom wire structure.
- 6. Loosen swing bolts beneath Forming Roll bearing housing (second connection between top and bottom wire structures). Swing bolts out and toward top wire structure side.
- 7. Using the keyswitch (C-0150-KS1) at Control Box 2 (CB2), activate the wire change mode.

Note:

As the top frame is extracted, position team members around the top wire (tending and drive side) to monitor the wire. Ensure that the wire is not pinched or damage during the top frame extraction. Also, check that air or hydraulic lines are not disconnected during lift.

- 8. Press lift button (B-0150-PB1)
- 9. Top Wire should be draped over the wire run.
- 10. Remove portion of platform walkway above Roll No. 9.
- 11. Loosen swing bolts at Cantilever I and II and let them rest against the lower portion of the vertical structure.
- 12. Insert a hydraulic jack at I and II spacer blocks.



- 13. Lift the structure approximately 3 mm utilizing the jacks.
- 14. Slide the spacer blocks toward tending side and remove them.
- 15. Lower jacks.

Top wire structure now Cantilevered.

(B) Preparation For Bottom Wire Change

- . 1. Ensure Pick-up Shoe is retracted.
 - 2. Lift-off doctor blades from all wire rolls (2,3,4).
 - 3. Remove the electric alarm device and guide paddle.
 - 4. Remove protective grating at Rolls 2 and 3.
 - 5. Swing protective grating at Pick-up Shoe toward the dry-end.
 - 6. Remove brackets for shower 8 and place shower header on floor.
 - 7. Withdraw the stretch roll (3) to wire change position. Ensure wire stretch roll has been fully retracted.
 - 8. Remove top and bottom platform handrails and stairs to press section.
 - 9. Remove old wire and place it on catwalk on dry end side of headbox. Wash up wire run (ie. rolls, Savealls, etc.)
 - 10. Loosen swing bolts at Cantilever III, IV, and vertical spacer located below Forming Roll bearing housing. Let the bolts rest against the lower portion of the vertical supports.
 - 11. Insert hydraulic jacks at III and IV spacer blocks.
 - 12. Lift the structure approximately 3 mm utilizing the jacks.
 - 13. Slide the spacer blocks and the vertical spacer towards the tending side and remove them.

Note:

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Before lowering the jacks, position a team member at Roll 9 to watch the lowering of the Forming Roll. It should not contact the headbox lip or Roll No. 9. If this occurs immediately jack up the structure and replace the spacer blocks. Notify the team leader.

- Inspect all wire-contacting components of the bottom wire run.
- Check for sharp edges or imbedded objects.

The bottom wire has now been Cantilevered.

(C) Bottom Wire Change

Note:

Cover the sharp corners and edges on the machine or support structure with used felt pieces. Clean area on machine room floor. Ensure all objects are placed away from wire changing area.

Note:

A papermaking wire is an expensive item and is easily destroyed if not handled properly. Great care must be used at all times during installation.

When unpacking a new wire, be extremely cautious. Do not use knives or other sharp objects around wire. Avoid wetting a new wire as this add extra weight and makes handling more difficult. An old felt can be placed on the floor to protect the wire (if available). Unpack the wire bundle and place it on floor in front of the machine (tending side). Position a team member to install wire and watch for "hang-ups" at:

- Catwalk (wet end side of headbox)
- Catwalk (dry end side of headbox)
- Cantilever beam III (top).
- Roll No. 3.
- Rover (in many places offering assistance).

When positioning the wire on machine:

- Do not excessively tug at wire.
- Work as a team.
- Position wire on machine as close to running position as possible.

(D) Reestablishment of the Duoformer to Operating Conditions.

- 1. Insert hydraulic jacks at the Cantilever III and IV spaces.
- 2. Ensure jack is positioned to allow replacement of the spacer blocks.
- 3. Lift the structure to accommodate the spacer blocks.
- 4. Clean the spacer block surfaces.
- 5. Slide the blocks plus the vertical support into place. The guide bars should help reposition the blocks.
- 6. Lower the jacks when blocks are positioned.
- 7. Position swing bolts and firmly tighten the nuts.
- 8. Remove jacks.
- 9. Reposition shower 8 and secure it to the Stretch Roll Frame.
- 10. Ensure that the Inner Wire is flat across the width of the machine.
- 11. Reposition the stairway at the press section and the handrails (top and bottom platforms).
- 12. Insert hydraulic jacks at Cantilever I and II spaces.
- 13. Clean spacer block surfaces.
- 14. Lift structure to accommodate the spacer blocks.
- 15. Slide the blocks in place.
- 16. Lower jacks when blocks are positioned.
- 17. Position the swing bolts and firmly tighten the nuts.
- 18. Remove the jacks.
- 19. Ensure that the top wire is flat across the width of the machine.



20. Press lower button (A-0150-PB2). This action will lower the top frame to the operating position. The top frame should lie flush on the pad at Roll No. 5. and rest on stopper at Roll No. 9.

- 21. Position and tighten swing bolts at Rolls 5 and 9 (tending and drive side).
- 22. Switch keyswitch (C-0150-KS1) at Control Box 2 (CB2) to "run" mode.
- 23. Check wires and ensure they are flat with no wrinkles.
- 24. Lift deflecting wall and insert pins.
- 25. Replace the electric alarm device and guide paddle for both wires.
- 26. Sprinkle both wires with water, inside and out. Guard against throwing dirt and debris onto the wire.

(E) Bottom Wire Startup

- 1. Check operation of the autoguide controller using the Guide Paddle.
- 2. Watch the movement of the piston. Center the Guide Roll. Apply low tension, 2 kN/m, to both wires.
- 3. Jog wires for two revolutions at lowest possible speed. Check wires for wrinkles.
- 4. If no wrinkles develop, load all doctor blades.
- 5. Bring wire tensions up to normal operating tension. (max. 8 kN/m).
- 6. Turn on showers. A moving plastic wire should be lubricated with water at all times to reduce the chance of fibrillation.
- 7. Increase wire section to normal running speed. Accelerate slowly to avoid slippage. Watch the guiding of the wire.
- 8. Following start-up, adjust the tension as required. The slight stretching of polyester monofilament (about 0.1 to 0.2% linearly) is most noticeable during the first 24 to 48 hours. After that a properly designed wire should remain stable.
- 9. Monitor ammeter for the Forming Roll.

Technical Data-Duoformer Type T

Operating Speed:

524-1677 m/min.

Balanced Speed:

1800 m/min.

Production:

80 TPD with 12.5 g/m² sheet trimmed to 2650mm

at the reel, 20% creping, (based on 100%

waste paper).

Outer Wire Length:

16820 mm.

Maximum Stretch:

345 mm.(2.05%)

Inner Wire Length:

13570 mm.

Maximum Stretch:

265 mm.(1.95%)

Wire Width:

2900 mm.

Maximum Wire Tension:

8 kN/m

Drawings: Assembly:

AP 3253.50

Cross Section:

AP 3253.51

Operating Parameters

The stock jet is discharged into the nip formed by the two wires as they converge and wrap the Forming Roll. The fabrics sandwich the fiber suspension which pass around the solid forming roll. The centrifugal force around the large diameter forming roll combined with the tension of the top wire creates the drainage pressure required for rapid dewatering.

All initial drainage takes place through the Outer Wire and is normally complete along one quarter of the forming roll circumference.

The length of this drainage zone (ie. forming length) changes as wire tension, basis weight, and machine speed varies. It also changes with variations in freeness, jet/wire speed ratio, and angle of jet impingement.

Before we look at these affects on the forming length we must first define:

- Forming Length
- Drainage Pressure
- Phases of Formation on Duoformer.

1. Forming Length

The length of the forming zone is defined as the circumferential distance from the point of minimum pressure (ie. point of jet impingement) to the point where the pressure has returned to essentially atmospheric (ie. region where fluid pressure drops to atmospheric as the free water is depleted).

A general theory defines this zone to be approximately 85° of Roll Rotation from the point of jet impingement. This would make the forming length on the Duoformer approximately 930 mm.

Many variables can impact this forming length (ie. extend or shorten it) and the fabric tension of the top wire is our method of compensating for changes in forming length.

2. Drainage Pressure

The Drainage pressure in the forming zone is defined as the tension of the top wire divided by the radius of the Forming Roll or simply

$$P = T/R$$

Where:

P is drainage Pressure (kN/m²)

T is Tension of Top Wire (kN/m)

R is Radius of Forming Roll (m)

On the Duoformer, the value for R is a constant at 0.625 m.

The value for **T** can range between 2 kN/m to 8 kN/m. Since the size of the forming roll is constant, the top wire tension is the only variable which can be used to vary the drainage pressure and in turn the length of the forming zone.

The drainage pressure is directly proportional to the top wire tension and the radius of the forming roll. As the top wire tension is increased, drainage pressure increases linearly.

Top Wire Tension (KN/m)	Forming Roll Radius (m)	Drainage Pressure (KN/m²)
2	0.625	3.2
3	0.625	4.8
. 4	0.625	6.4
5 .	0.625	8.0
6	0.625	9.6
7	0.625	11.2
8	0.625	12.8

3. Phases of Formation

The forming process is a function of the forming length and drainage pressure. The sheet must be dewatered and formed efficiently in this process so as to maximize the efficiencies of the downstream processes (ie.,Pressing). A typical pressure profile is shown in Figure () where pressure is illustrated as increasing on the vertical axis and distance from the point of jet impingement is on the horizontal axis.

(A) Stock Jet impinges on the Forming Roll.

If this peak is not present (in a pressure profile) there is no jet impingement (ie. the jet hits the top wire first) and the headbox angle should be readjusted.

(B) Top Wire contacts the Forming Roll and constrains the Jet.

This is the start of the forming zone.

Note that as the jet rebounds from the surface of the roll the pressure falls briefly and then begins to rise as the jet is constrained by the top wire.

(C) Highest Forming Pressure.

From B to C, the pressure rises to approximately the value defined by the wire tension and forming roll radius.

(D) End of Forming Length (ie. atmospheric pressure).

All formation and dewatering has occurred. The force exerted by the outer wire is now supported by the structure of the fibre mat and the inner wire.

This may correspond to Dry Line on the Fourdrinier.

(E) Wires leave the Forming Roll.

The decrease in pressure after E is the vacuum induced by the separation of the Forming Roll and the fabrics. Hence, two zones are apparent around the circumference of the forming roll. The distance between points B and D represents the necessary drainage time (and forming length). The distance between points B and E represent the available drainage time (ie., total circumferential distance on Forming Roll).

Point C can be driven toward B or D by varying the Outer Wire Tension.

Increasing Outer Wire Tension

As the Outer Wire Tension is increased, the value for drainage pressure also increases. Therefore, point C would move upwards along the vertical axis. An increase in wire tension will also move C along the horizontal distance towards B. The result is a shorter forming length at higher drainage pressures.

Decreasing Outer Wire Tension

As the Outer Wire Tension is decreased, the value for drainage pressure will also decrease. Therefore, point C would move downwards along the vertical axis. Point C will also move along the horizontal axis towards E. The result is a longer forming length at lower drainage pressure.

Hence, as wire tension increases, drainage pressure increases while the forming length decreases.

A balance must be established through experimentation between rapid formation at high drainage pressure and slow formation at low drainage pressure. Generally, decreasing drainage pressure leads to gentler formation over a longer period with higher retention. However, care must be taken not to extend D too close to point E as this would result in not all of the water removed in the forming zone. This situation would produce a wet sheet at the Inner Wire Suction Box and increase the water removal loading at the press and dryer sections.

We have studied the impact of varying top wire tensions on the length of the forming zone and drainage pressure, we are now prepared to study the effects on the forming length due to process variations.

Process Variations

- Machine Speed
- Basis Weight
- Freeness.
- Jet/Wire Speed ratio.
- Angle of Impingement.

1. Machine Speed

A change in machine speed is directly proportional to a change in forming length. Figure () illustrates the effect of machine speed on forming length with two different basis weights. The curves are approximately linear with speed-doubling the machine speed results in a doubling of the forming length (all other variables remaining unchanged).

An increase of forming length with an increase in machine speed. Curves are approximately linear with speed equivalent drainage times are required for sheets of the same weight.

Example:

Basis Weight	Machine Speed 915 m/min	Forming Length 480 mm
16 g/m ²	1830 m/min	968 mm (x2)

Note:

If you double the speed you must double the forming length.

2. Basis Weight

As Basis Weight increases, the Forming Length increases if all other factors remain constant (ie., machine at constant speed).

3. Freeness

As freeness values vary (ie. stock drains water slower or faster), the length of the forming zone also changes. If the freeness decreases, the stock is less willing to release its water (slower) and therefore the forming length increases. This is similar to the reaction of the

"dry line" on a fourdrinier machine as it moves toward the dry end as freeness decreases. As freeness values increase, the forming length decreases (ie.,point D is moved towards B) because the stock drains more readily.

4. Jet to Wire Speed Ratio

Figure () shows forming length plotted against headbox pressure and tensile ratio [machine direction (MD) to Cross Direction (CD) tensile strengths]. The forming length is quite drastically changed by changing the jet-to-wire ratio or headbox pressure varying up to 30% with only a 10% change in headbox pressure. The rapid change of forming length with jet-to wire ratio is probably due to the change in fiber alignment, as both curves have approximately the same shape.

When tensile ratio is the lowest, the fibers should be fairly randomly orientated in the sheet and thus the flow passages available for drainage are either relatively large or great in number. As fibers become more aligned (ie. increase in tensile ration), a reduction of the number or size of the flow passages must occur.

It is helpful to think of a screen to visualize this situation. In a screen mesh where the wires are perpendicular to each other there is open area in the "squares" whereas if the same number of wires are aligned in one direction, the open area would be considerably less. This same effect takes place in a sheet during the forming process.

As the fibers become more aligned in the machine direction (MD) which is indicated by a higher tensile ratio and occurs as the headbox pressure increases, the forming length increases. This is due to the reduced open are between the MD aligned fibers. Forming length reaches a minimum value near the point where jet speed and wire speed are matched (1:1 ratio).

Example:

In a Screen if the wires are perpendicular to each other they create a square mesh. This is opposed to an array consisting of the same number of wires aligned in one direction. The open area would be considerably less in the parallel array. This same effect takes place on a sheet during the forming process.

5. Angle of Jet Impingement

As the angle of Jet Impingement on the Forming Roll is changed, the initial peak can be greatly effected. At large impingement angles, the pressure peak is increased and Formation deteriorates. A balance must be found which delivers the jet at an angle between the jet barely touching the Forming Roll and the jet hitting it too hard.

The Forming Length is not varied as the angle varies but rather, formation is either improved or disrupted by proper impingement. It is important to understand that the stock jet must touch the forming roll first and then be enveloped by the top wire at the point where the forming length begins. If no initial contact is made between the jet and the forming roll, the jet contacts the top wire first and Sheet Formation is disrupted by the breast roll "pumping". See figure ().

Top curve. The jet is impinging at a large angle onto the roll and as a result, the pressure peak is quite high.

As the angle is reduced the pressure peak is reduced. The pressure peak and its accompanying negative response can be completely eliminated by introducing the jet at zero impingement angle onto the roll.

If impact pressure becomes too high, Formation deteriorates.

Summary

In summary, the forming length will increase as

- Machine speed increases.
- Basis Weight increases.
- Freeness decreases.
- Headbox pressure and tensile ratio increase.

An increase in wire tension can decrease the forming length to compensate for the above variations.

Start-up Procedure

The Forming Roll is the single drive roll for the Duoformer and therefore, both wire runs must be prepped before it is ready to run.

The following list of items must be accomplished before the sheet can be introduced to the wires.

- 1. If machine is down for an extended period, sprinkle wires with water both inside and out. Guard against throwing dirt and debris onto the wire.
- 2. Check operation of guiding system. Watch piston rod movement by manually moving the guide palm. Ensure that the guide palm contacts the wire edge and arm pointer floats about "0" on the scale.
- 3. Apply low tension approx. 2 kN/m on both wires.
- 4. Jog wires for two complete fabric revolutions at lowest possible speed. Check wire for wrinkles.
- 5. If no wrinkles are present in the wires, load all the doctor blades.
- 6. Increase wire tension to the standard operating tension (to a maximum of 8 kN/m).
- 7. Start P 34 Roll Showers (Shower No. 4,9,10,11), Inner Wire Suction Box Lube Shower, and headbox lip cleaning (P 34). A moving plastic wire should be lubricated with water at all times to reduce the chance of fibrillation.
- 8. Increase wire section to normal running speed. Accelerate slowly to avoid wire slippage. Watch guiding of wire. Check wire tension.
- 9. Start P 49 -Edge cleaning, tail cutter, and trim squirt showers.
- 10. Start P 51 and P 52-high pressure shower pumps for wire cleaning and knock-off. Interlocks will determine shower operation. Start hydraulic pump either 4 or 5 (for oscillating mechanism).
- 11. Ensure shower oscillators in "auto" position. (Showers No.5, 7, 14, 15).
- 12. Start mist extraction fan.
- 13. Start vacuum pump for inner wire suction box (P 55). If vacuum pump is already started, ensure control valve on drive side is opened.

14. Position valve at inner wire suction box exhaust to achieve vacuum desired. Indication on pressure gauge.

- 15. The Duoformer should now be ready to run. All doctor oscillators should be operating.
- 16. Assuming Paper Machine components (ie. Press Section) have been started, with wires at operating speed, start approach flow system and introduce the jet to the Forming Roll.

During Operation

Once the Duoformer is running and the sheet has been established, the following items should be checked.

- 1. Check guiding system to be sure it is operating within the scale limits.
- 2. Check that fabric is centered on the rolls.
- 3. Check that tension is at operating level and does not exceed the maximum limit 8 kN/m.
- 4. Adjust valve at Inner Wire Suction Box to maintain a vacuum level of 2 mWG.
- 5. Monitor ammeter for the Forming Roll.
- 6. Check shower oscillation to ensure proper operation.

Shutdown Procedures

The shutdown procedure must be done routinely as outlined below.

- 1. Shut off stock supply from approach flow system. This usually entails cutting off the thick stock supply (P 36) or closing thick stock valve and allow the Headbox to flush with white water only prior to shutdown.
- 2. Shut off vacuum pump (P 55).
- 3. Shut off vacuum pump (P 54).
- 4. Shut off the high pressure shower pumps (P 51 and P 52).
- 5. Shut off P 49 shower pump.
- 6. Slow the Duoformer to a stop.
- 7. Shut off low pressure shower pumps (P 34).
- 8. Shut off mist extraction fan.
- 9. Check to see if doctors have stopped oscillating.
- 10. Wash up the Duoformer with hose. Ensure washing of the following items:
 - Roll Doctor Blades
 - All Savealls
 - The Inner Wire Suction Box Cover
 - All Rolls

If the shutdown is to last for an extended period of time, the following tasks must also be done.

- 1. Unload the doctors from the rolls.
- 2. Reduce tension of the wires.
- 3. Clean the ceramic cover areas thoroughly.

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Emergency Stop Procedure

An emergency stop of the Duoformer will result in stock being left between the wires on the Forming Roll. It is important that this fabric "wedge" be cleared of stock before the fabrics are restarted. Starting the fabrics before the "wedge" is cleared may damage the wires.

As both fabrics must be washed and the fabric tension reduced. The inner wire suction box cover should also be cleaned thoroughly. This cover cleaning must be emphasized to prevent stock from hardening in the cover slots.

After the stock is cleaned from the wires and covers, the procedures for the "normal" start or shutdown can be followed.

Steam and Condensate System

Purpose

To evaporate water from the paper web through the conduction of heat through the metal shell in the Yankee Dryer.

Process Description

Reference Drawing No. AN5002.05 Steam and Condensate System.

Basically, the Steam and Condensate System is a loop that begins and ends at the Boiler. The boiler produces steam by heating process water (ie. returned condensate) and makeup fresh water. The steam flows to the mill and is directed by the main Steam header to the Yankee Dryer. A Secondary Header directs steam to the lube system and the heating screw in stock preparation.

As the steam flows into the Yankee Dryer, it condenses and releases a great quantity of heat. The heat flows through the Yankee shell to the paper web and evaporates water. The condensation phase produces water as steam changes phase (from steam to water). The condensate must be removed from the Yankee as it acts as a barrier to heat transfer. A syphon is used to remove the condensate under differential control where it flows to a separator. The condensate separates into two components; Flash Steam and water as it did in the Yankee dryer. The Flash Steam is reused in the Yankee through a Thermocompressor. Excessive Flash Steam can also be directed to a heat exchanger which warms process water for the paper machine shower system. Condensate flows from S1 to a second separator S2 under level control.

In S2, the condensate separates into Flash Steam and water again. This Flash Steam is used exclusively in the heat exchanger. Condensate collected in S2 is pumped to three points; back to the boiler, the aquitherm rolls (calender), and temperature control for the Secondary Steam Header.

There are nine control loops which regulate process variables to setpoints established at the controllers. The loops are listed below and will be discussed in greater detail during the study of the overall system.

Control Loops

DIC 200
PIC 300
PIC 303
dPIC 304
FIC 304
LIC 306
LIC 307
TIC 309
PIC 310
PIC 312
PIC 311

Major Equipment

The major equipment used in the Steam and Condensate System will be the:

- Boiler
- Yankee Dryer
- Separators
- Thermo Compressor
- Heat Exchanger

Boiler and Steam Supply

Purpose

To raise the temperature of the water to produce Steam and supply the steam to the process points as required.

Process Description

The steam system uses a Boiler to heat water to produce steam and directs it through pipes to the process points. The Steam Header from the Boiler to the Tissue Mill branches into two headers; a Main Header to the Yankee Dryer and a Secondary Header to the Lube System and Heating Screw Conveyor.

The boiler provides the means for converting fuel energy into steam. The fuel can be any substance which can be burned to give off heat (ie. natural gas, oil, bark) and the required air for the combustion of the fuel. Combustion is the combining of fuel and air in a burning process to produce heat energy. The resulting hot combustion gas contacts heat transfer surfaces and heats the feed water and converts it to steam.

In order for the water to reach the required steam temperature (ie. saturated steam temperature) it must absorb a tremendous amount of heat. The cost of fuel used to produce the steam makes drying a costly operation in the papermaking process.

As operators, we have no direct control of the steam supplied as this is the responsibility of the Boiler Team. We are concerned with the use of the steam in the mill and the return of the condensate to the Boiler.

Yankee Dryer

Purpose

To conduct heat through the metal shell to evaporate moisture from the paper web.

Process Description

The term "Yankee" denotes a steam heated paper dryer consisting of a large revolving drum with a highly polished surface in order to enhance sheet adherence. It is constructed from cast iron (single mould) with a center shaft consisting of journals and an internal spacer.

The Yankee shell thickness is much greater than the conventional dryer shell thickness (59 mm) due to the high operating steam pressures (0.8 MPa) and the loads from the suction pressure roll (70 kN/m) and the pressure roll (90 kN/m).

In the press section, the sheet is pressed against the surface of the Yankee with a moisture content of approximately 60% (ie. sheet consistency 40%). The sheet is literally plastered to the shell during the drying cycle and then doctored off to the calender and reel section.

The saturated steam produced in the boiler flows through the piping into the inlet of the Yankee, located at the center of the dryer on the tending side. The steam condenses in the Yankee and the heat is released. This heat is conducted through the dryer shell to the paper. The condensate (water) is removed from the Yankee through syphons to the condensate outlet located in the center of the dryer journal on the drive side.

Basic Components

1) Steam Inlet

The steam is injected into the Yankee through the Steam Inlet. There is a rotary joint located on the tending side of the Paper Machine which allows the steam to pass from a stationary pipe to a rotating pipe. (see appendix).

2) Hollow Shaft

The Hollow Shaft is a zone where steam is released to the Yankee "internally" through two openings.

3) Condensate Syphon

The Condensate Syphon removes condensate from the internal surface of the Yankee.

4) Condensate Outlet

The condensate is removed from the Yankee through the Condensate Outlet. This is also equipped with a rotary joint.

5) Shell

The Shell is the metal surface which conveys heat to the paper web.

6) Head

The side pieces of the Yankee Shell combine to form the Head.

7) Man Hole Cover

The Man Hole Cover is located on the drive side header. It permits easy access to the internal section of Yankee for inspection and maintenance.

8) Insulating Plates

The Side Plates which minimize heat loss through the headers in the machine room are the Insulating Plates.

Technical Data

4500 mm Diameter: 3230 mm Shell Width: 59 mm

Shell Total Thickness:

70 kN/m at Suction Roll Maximum pressure of press: 90 kN/m at Pressure Roll

3050 mm

Felt Width: 2770 mm Maximum Web Width:

Shell Surface

Smooth Inside: Ground Outside: VZ4 Shell Material:

55 Material Class:

225 HB Minimum average surface hardness: RA 2 less than 2 micron

Surface Finishing: **ASME**

Cylinder Construction: 40 HB max. Total surface hardness amplitude: Rotary Syphons

Condensate Removal System: Steam Tending Side Rotary Joints for: Condensate Drive Side

From Central Lube System

Lubrication: 0.8 MPaA (8 bar) Working Overpressure: 1.6 MPaA (16 bar)

Hydraulic Test Overpressure: Lineal pressure of doctors:

250 kg/m Creping and Knock-off: 80 kg/m Cleaning:

Note: The shell thickness is dimensioned to permit a 3 mm reduction in thickness during grinding without any reduction of maximum steam pressure. It can be reduced 10 mm without any pressure reduction in the Presses.

Steam and Condensate

Condensate Removal Syphon

A syphon with a hopper is used for smooth internal dryer surfaces. A hopper would be located on the tending and drive side of the Yankee. The arrangement in the Yankee consists of four condensate headers. Each is equipped with two hoppers. The hoppers are positioned 2.0 mm from the dryer surface.

Spoiler bars are used with smooth internal shell surfaces to break up the condensate layer to promote better heat transfer. A recent development in drying technology is the addition of spoiler bars to the inside surface of the dryer shell. These bars are installed parallel to the dryer axis and are spaced to create turbulence in the condensate layer. The bars "break-up" the insulating layer of water inside the Yankee and permit more efficient heat transfer.

Separator (S1 and S2)

Purpose

To separate condensate and blow-through steam through a reduction of pressure in the separator vessel.

Process Description

A separator is basically a vessel which has three main connections; condensate inlet, Flash Steam outlet, and a residue condensate outlet. It is also equipped with a pressure guage.

Condensate is generated at the saturation temperature of the steam. As the condensate is discharged from the Yankee into a lower pressure area (ie., separator), its temperature drops to the saturation temperature at the lower pressure. The heat released by the drop in temperature evaporates a percentage of the condensate producing Flash Steam. The condensate and Flash Steam are separated before the condensate is removed from the separator. The Flash Steam is recovered for use in low pressure steam applications.

Significant economic savings can be realized through effective reuse of condensate, blow-through, and Flash Steam.

Treated water is required for use in the steam generating system; therefore, reuse of condensate and steam will result not only in fuel savings but in savings in the chemical treatment process.

The heat exchanger plays an important role in that large quantities of water vapours may be lost if the system design is incapable of handling all blow-through and Flash Steam under peak load conditions.

S1

Refer to Drawing AN. 5002.05

Condensate and blow through steam removed from the Yankee through the syphons flows to S1. A sight glass allows operator to view condensate (water) and blow-through steam flow. Inside S1, the blow-through steam and condensate separate because of the reduction in line pressure. The "flash" steam is directed through the top outlet of the vessel to the suction port of the Thermocompressor. The Flash Steam can also flow to the heat exchanger (see differential control section). The condensate flows from an outlet located at the bottom of the vessel and flows to S2.

The level in S1 is controlled through the LIC 306 control loop. The designed setpoint for the level is 50%. A control valve is regulated to achieve the selected setpoint. Control of condensate levels within the tanks ensures that the system will at all times remain sealed and that sufficient volume is maintained above the liquid level to ensure separation of condensate and steam.

Technical Data

Maximum Pressure:

Inside Diameter:

Volume

1.0 MPaG

1000 mm

 $1.1 \, \mathrm{m}^3$

Condensate collected in S1 flows to S2 under S1 level control (LIC 306). The S2 vessel smaller than S1 and results in another condensation phase. The "flash" steam is directed rough the top outlet of the vessel to the heat exchanger.

The condensate flows from two outlets which flow to four branches. Four condensate umps supply condensate to:

- 1. Boiler House (CP1 and CP2).
- 2. Aquitherm Rolls (CP3).
- 3. Temperature Control for Steam in Secondary Header (CP4)

Technical Data

Maximum Pressure:

1.0 MPaG

Inside Diameter:

800 mm

Volume:

 0.6 m^3

Condensate-Return To Boiler

Low pressure condensate is returned to the boiler from S2 flash tank by two pumps (CP01 and CP-02) arranged in parallel. At a given time, only one pump is required while the other is used in case of a malfunction to the first pump. The pump delivers approximately 3600 kg/h condensate at 111°C back to the Boiler.

A valve located on the pressure side of the pumps regulates the level in S2. The valve throttles the condensate flow to allow recirculation back to S2 to maintain the tank level at setpoint.

A flow transmitter (FT308) monitors flow back to the boiler.

Two strainers are located on the suction side of the two pumps. These strainers should be inspected and cleaned regularly. The strainers remove dirt and scale which may have been picked up by the steam as it flowed through the system.

Condensate Pump 1-CP1 (S301)

Technical Data

Pump

Manufactured by:

Gould

Coupling:

Flex TDE8

Quantity Supplied:

3590 kg/h

Motor

Manufactured By:

WEG

Power:

7 hp

Speed:

3500 rpm

Permanent Interlocks

Level in S2 is greater than or equal to 50%.

Process Interlocks

- None.
- 1. Turn on Sealing Water valve for pump packing.

Pump will stop if an MCC fault is defected or a stop is initiated at the console (or E/stop).

Condensate Pump 2-CP2 (S302)

Technical Data

Pump

Manufactured by:

Gould

Coupling:

Flex TDE8

Quantity Supplied:

3590 kg/h

Motor

Manufactured By:

WEG

Power:

7 hp

Speed:

3500 rpm

Permanent Interlocks

• None.

Process Interlocks

- None.
- 1. Turn on Sealing water valve for pump packing.

Pump will stop if an MCC fault is detected or a stop is initiated at the console (or E/stop).

Condensate-To Aquitherm Rolls (calender)

Low pressure condensate is delivered to the aquitherm rolls from S2 flash tank by a pump (CP-03). The pump delivers approximately 3700 kg/h at 90°C to the tending side inlet of the aquitherm rolls. Condensate exits the aquitherm rolls on the tending side (separate ports) and flows back to S2 flash tank. Basically, this loop provides warm water for the aquitherm rolls which heats the rolls which heats the sheet and assists in the calendering operation.

A control loop (TIC 309) maintains the condensate temperature at setpoint which is designed to be 90°C. A sensor is located on the return line from the aquitherm rolls which measures the return water temperature. The controller regulates two valves which either directs the water back to S2 or to the suction of the pump (CP-03). The water added at the suction of the pump will be slightly cooler than the condensate in S2 due to heat transfer at the rolls and losses in the loop. This water addition would regulate the inlet water to the pump (which in S2 is approximately 111°C). In this manner, the temperature to the rolls is controlled to setpoint.

A strainer is located on the suction side of the pump which should be inspected and changed regularly.

Condensate Pump 3-CP3 (S303)

Permanent Interlocks

Level in S2 must be greater than or equal to 50%.

Process Interlocks

- Calender Bottom roll drive run or crawl.
- Calender Top roll drive run or crawl.
- Calender close signal activated.
- 1. Turn on sealing water valve for pump packing.

Pump will stop if an MCC fault is detected or a stop is initiated at the console (or E/stop).

CP3 Technical Data

Pump

Manufactured By:

Gould

Coupling:

Flex

Quantity Supplied:

37080 kg/h

Motor

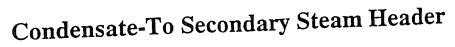
Manufactured By:

WEG

Power: Speed: 15 hp

1750

Steam and Condensate



Low pressure condensate is metered into the steam flow off the machine Steam header. The addition of condensate lowers the temperature of the steam used to heat the lube oil and the stock before the 10 ZSE. A pump (CP-04) supplies the condensate from S2 Flash Tank at a flow rate of approximately 50 kg/h at 111°C.

The control loop (TV 313) maintains a steam setpoint which is designed at 150°C for the process applications. A sensor located in the steam header measures steam temperature and is located downstream from the control valve. The controller regulates the condensate addition by opening or closing the control valve. For example, if the temperature in the header is higher than the setpoint, more condensate is added to "cool" it.

A spring safety angle valve ensures that excess volume is removed if it is not required (ie., bleed-off valve).

A strainer is located as the suction side of the pump which should be inspected and cleaned regularly.

Condensate Pump 4-CP4 (S304)

Permanent Interlocks

• Level in S2 must be greater than or equal to 50%.

Process Interlocks

- None.
- 1. Turn on sealing water valve for pump packing. The pump will stop if the following conditions are met:
 - Low level is detected in S2 (LT 307)
 - The E/Stop or stop at console is activated.
 - An MCC fault.

CP4 Technical DataPump

Manufactured By:	Gould
Coupling:	()
Quantity Supplied:	100 kg/h

Motor

Manufactured By:	()
Power:	()hp
Speed:	()rpm

Thermocompressor

Purpose

To reuse "blow-through" steam (ie., Flash Steam) from the separator (S1) and direct it back to the Yankee. To function as part of the differential control system for the Yankee.

Process Description

The principle of operation is known as the "venturi effect". This states that the speed of a fluid increases when it flows through a constriction. The increase in velocity produces a decrease in pressure in the line at the constriction. If another line is connected at this point, the low pressure will "draw" fluid into the system at the constriction.

To return the "blow-through" steam to the section inlet header, the thermocompressormust raise its pressure an amount equal to the sum of the differential pressure and the pressure loss in the piping and separator. Although recompression work is large at high pressure, the Thermocompressor is able to use large amounts of motive steam to do the job because the high density steam permits large flows.

High pressure steam (ie. 1.35 MPa) from the main steam header flows into the Pressure Port of the Thermocompressor. This steam is sometimes referred to as "motive steam" because it produces the motion of the suction fluid. The actuator is usually controlled from a remote point and varies the position of the spindle which in turn controls the degree of the constriction.

Low pressure steam (ie. 0.7 MPa) from S1 is drawn into the Thermocompressor. The steam obtains an intermediate velocity as it enters the convergent-divergent throat diffuser. As the throat expands at the discharge, the velocity energy (velocity of the steam) is converted to pressure energy (ie. wider opening, slower speed, and therefore higher pressure). The discharge is at an intermediate pressure as it flows to the inlet of the Yankee. The pressure of 0.8 MPa combines with the direct steam flow from the Boiler and in this manner steam is effectively recovered and reused in the Yankee dryer.

If the spindle is creating a tight constriction, then the resulting velocity of the motive steam will be greater and more Flash Steam will be pulled into the thermocompressor.

Basic Components

1) Actuator

The Actuator is the mechanism which moves the spindle to adjust the nozzle size. It is controlled by the differential control loop for the Yankee.

2) Pressure Port

The high pressure steam from the Boiler flows into the Pressure Port.

3) Suction Port

The "blow-through" steam from S1 flows into this port.

4) Spindle

The Spindle adjusts towards nozzle as the actuator is moved.

5) Nozzle

The Nozzle is the constricting point which develops the "venturi" effect.

6) Diffuser

The Diffuser converts velocity energy to pressure energy by increasing discharge diameter.

7) Discharge Port

The steam exits the Thermocompressor at the Discharge Port and flows to the Yankee at intermediate pressure.

8) Body

The Body is the housing which contains the unit.

Steam and Condensate

Heat Exchanger

Purpose

To extract heat from the Flash Steam leaving the separators and transfer it to the feed water for shower system.

Process Description

Flash Steam is directed from both separators to the heat exchanger. Flash steam from S1 is directed to the heat exchanger only when PV 304B or FV 304B begins to open. This occurs on the top end of the differential control around the Yankee. All Flash Steam from S2 is directed to the heat exchanger. The steam condenses in the exchanger as heat is transferred to the feed water. The condensate flows back to S2.

The feedwater is fresh water at 20°C in the shower system. The water is warmed to approximately 50°C and returned to the shower system.

Temperature and pressure are proportional and in the loop around the heat exchanger it is Flash Steam pressure which is controlled resulting in a warm water discharge. Flash Steam pressure is sensed by PT310 and a signal is transmitted to a controller (PIC 310). The designed setpoint is 0.15 MPaA. As pressure increases above the setpoint, the control valve (PV 310) opens to allow more water to circulate through the exchanger. The maximum flow rate to the exchanger is 38500 kg/hr.

Machine 20

Theory of Operation

As we described in an earlier section, the task of the boiler is to raise the temperature of the water to produce steam (change of phase) which will provide the mill with saturated steam (ie., no moisture drops present in the steam). It is the change of phase from steam to water in the Yankee (latent heat of condensation) which releases the large amount of heat required in the drying section of the Paper Machine.

A general rule states that steam will always condense at the saturation temperature as defined by the pressure in the system. Therefore, the steam system is designed to induce a change of phase in the Yankee at a defined stable pressure. The maximum working pressure at which this occurs in the Yankee is 0.8 MPaA (specified by Voith).

During operation, the steam is actually transported from the boiler house to the mill at a temperature slightly above the saturation point (ie., super heated) to prevent condensation within the pipe lines leading to the Yankee. Therefore, we have steam at the saturation point marginally superheated to avoid losses, at a defined pressure, flowing into the Yankee where it condenses and releases heat.

The drying time is a function of the rate at which the heat can be transferred from the inside Note: of the Yankee to the paper web.

The condensing rate is defined as the rate of kilograms per hour of steam condensed by the Yankee cylinder. "Blow-through" steam is expressed as a percentage of the condensing rate. In the case of the flows described in the steam and condensate system, "blow-through" percentage is equal to 66% of the condensed flow 2760 kg/hr.

4590 kg/hr Total Steam In: 2760 kg/hr Condensate Flow Out: 1830 kg/hr Blow-Through Steam Out:

In this case the condensing rate is 60% of the total ingoing steam to the Yankee.

The method of heat transfer is conduction as the heat must be conducted through the Yankee shell to the sheet. While the Yankee is constructed of cast iron, a very good conductor of heat, there are other substances which hinder the efficient transfer of heat. The largest resistance is "condensate" (ie. water in liquid form is a poor conductor) which was created during the change of phase.

Barriers To Efficient Heat Transfer

The continuous evacuation of condensate, air, and other noncondensable gases from the Yankee assures even drying of the sheet (within the limits of dryer drainage control). Heat transfer to the sheet will improve and lower steam pressure will be required to evaporate the water from the paper. In this may the total steam consumption will be reduced.

The condensate layer is the greatest resistor to the transfer of heat. Water is a good insulator and has a very low thermal conductivity factor. The design of the dryer must allow for the efficient uniform removal of condensate. The following factors determine the resistance that condensate can provide:

- Condensate Thickness
- Movement of Condensate Layer
- Presence of Air and Non-condensible Gases
- Deposit Influence
- Dryer Shell Thickness

Condensate Thickness

The thicker the layer of condensate, the greater the insulating effect. Because of the low thermal conductivity factor coupled with increased thickness, the condensate layer sets up a tremendous barrier for heat transfer.

Movement of Condensate Layer

There are three different conditions of condensate movement in the Yankee cylinder which act as barriers to heat transfer; puddling, cascading and rimming. Due to the high speeds involved, the condition usually developed in the Yankee is "rimming". Rimming is the condition where the thickness and uniformity of condensate is equal around the internal surface of the Yankee. This condensate acts as an insulator and retards efficient heat transfer.

Presence of Air and Non-condensible Gases

Air and non-condensible gases are also good insulators and have a low thermal conductivity factor. Therefore, these gases must also be removed as efficiently as possible to increase heat transfer. The gases usually can be vacated under the proper differential pressure in the form of "blow-through" steam. This will be discussed in greater detail in the differential control section.

Machine 2

Deposit Influence

Rust, Deposits, and the finish of the inside surface of the dryer cylinder will reduce the drying efficiencies. Each of these components can offer additional resistance to the transfer of heat. Specialty chemicals are often used to minimize the deposit and scale build-up on the Yankee's internal surface.

Holding condensate to a minimum is the key to improving the evaporative process; as the insulating effect of the condensate is reduced, more heat can be transferred to the sheet.

Sheet-Dryer Contact Resistance

On a conventional dryer, this component creates a significant resistance and methods (ie. dryer felts) are used to minimize its impact. The adherence of the sheet directly to the Yankee surface minimizes heat losses and maximum heat transfer benefits are more fully realized. Dryer-sheet adhesion chemicals are designed to maximize heat transfer from the dryer shell to the sheet.

Factors which also impact the degree of resistance are as follows:

- 1. Type of fiber presented to the surface of the dryer (ie. grade of paper, degree of refining, etc.) In our mill, the nature of the recycled fiber may vary due to a variety of sources and the degree of fiber development will vary according to the grade being produced.
- 2. Amount and types of chemical additives in the stock slurry delivered to the machine will also change the adherence to the Dryer.
- 3. Stock pH will also affect adherence of the sheet to the Yankee.
- 4. Outer surface dirt or corrosion will affect the resistance to heat transfer (similar to deposit influence inside the dryer).

Dryer Shell Thickness

The thickness for a dryer is determined by the operating steam pressure, dryer size, press loading, and type of metal used for construction of dryer. The cast iron used in Yankee dryer applications is a good conductor of heat, however, the shell thickness of 59 mm offers greater resistance to heat transfer than a conventional dryer with a much smaller thickness.

Steam Supply To Mill

Steam supplied to the mill from the Boiler flows through a main header (6" diameter). It splits into two lines; the steam feed to Yankee and a secondary steam header to the lube system and heating Screw Conveyor in Stock Preparation. Two pressure control loops regulate the steam pressure in the two headers.

Steam Pressure To Yankee Dryer (PIC 300)

The steam pressure to the Yankee Dryer is regulated through control loop PIC 300. A pressure sensor (PT 300) measures steam pressure in the header to the Yankee and transmits a signal to a controller. The controller regulates a control valve (PV300) to obtain the setpoint pressure. The designed setpoint pressure at this process point is 1.35 MPaA which provides the proper working pressure (0.8 MPaA) at the Yankee after losses.

Temperature and flow are also measured in this header. At a steam pressure of 1.35 MPaA (under the designed parameters), the steam temperature is approximately 193°C at a flow rate of 2760 kg/hr.

Steam Pressure To Secondary Header (PIC 312)

The steam pressure to the Secondary Header which supplies steam to the Lube System and Heating Screw Conveyor (stock prep) is regulated by the PIC 312 control loop. A pressure sensor (PT312) measures header pressure and transmits a signal to the controller. The controller regulates the control valve (PV312) to obtain the setpoint pressure. The designed setpoint pressure at this process point is 0.45 MPaA. But the temperature of this steam is reduced by the addition of condensate following the control valve (PV312).

Steam Pressure To Heating Screw Conveyor (PIC 311)

The Steam Pressure to the Heating Screw Conveyor is controlled through control loop PIC 311. This loop reduces the steam pressure from 0.45 MPaA to 0.10 MPaA required at the locating screw. A pressure sensor (PT311) measures steam pressure and transmits a signal to the controller. The controller regulated a control valve (PV 311) to obtain the setpoint pressure. The designed set point pressure at this process point is 0.10 MPaA which provides the proper working Pressure at a steam temperature of 100°C at a flow rate of 2500kg/hr.

Machine 24

Steam And Condensate Control Systems

The control systems at the Yankee are designed to regulate steam pressure at the inlet and efficiently evacuate condensate at the syphon and through the Condensate Outlet. Inlet pressure is controlled through PIC 303 loop while differential control is achieved by either dPIC 304 or FIC 304.

Total steam pressure at the inlet is a combination of "live" steam from the boiler and recirculated blow-through (or flash steam) from S1 through the Thermocompressor. Differential control ensures that the condensate, blow-through steam, and non-condensible gases are removed from the Yankee at an efficient rate in order to maximize heat transfer.

The supply steam line splits into three lines following the PIC 300 control valve. Two lines flow direct to the Yankee and steam flow is regulated by the pressure control loop PIC 303. The third line provides the "motive" steam required at the Thermocompressor.

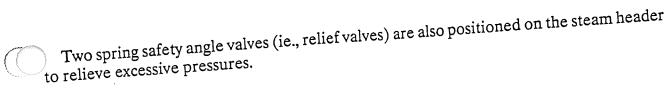
Steam Pressure At Yankee Inlet (PIC 303)

A pressure sensor (PT303) measures steam pressure in the steam pipe at the inlet to the Yankee and transmits a signal to the controller. The total steam pressure is a combination of "live" steam from the boiler and the recirculated steam from the Thermocompressor which is regulated by the differential control loop.

The controller setpoint should be set to achieve the desired Yankee surface temperature based on moisture setpoint. Depending on the volume of steam being recirculated from the Thermocompressor to achieve proper differential, the controller will regulate two valves (PV 303A and PV303B). The PV303B valve is a full range control valve (ie., 3-15 psi) and will regulate steam flow in the low-end range. The PV303A valve operates at the top end (ie. 9-15 psi) and will only begin to open when PV303B has opened by 75% (9 psi). The PV303 A valve helps supply "live" steam at the top end of the control range.

As illustrated in the flow diagram, 75% of total steam pressure is supplied through the Thermocompressor, with 25% (the remainder) made-up by "live" steam. Although this ratio may change due to run conditions, the total steam pressure at the Yankee inlet should be controlled to the steam pressure required to efficiently dry the sheet.

This control loop (PIC 303) is interlocked with the break detectors on the paper machine. When a break is sensed, the setpoint pressure is dropped to a predetermined setpoint. This prevents the Yankee surface from overheating which could lead to operational problems (ie., sheet sticking). The pressure setpoint can be raised back to normal conditions when the sheet is rethreaded and on the reel.



Differential Control To Yankee

Differential between the steam inlet and condensate outlet must be controlled to maximize the removal of condensate from the Yankee. The primary requirement of the control system must be to ensure that the condensate is removed as fast as the steam condenses.

If the condensate is not removed faster than the condensation rate, then the condensate heat transfer barrier increases in thickness and can substantially reduce the drying rate. In extreme cases, the excessive volume of condensate can increase the drive load and possibly "trip-out" the dryer drive.

If the condensate is removed faster than the condensation rate, a certain amount of uncondensed steam (ie., "blow-through") will pass through the dryer. "Blow-through" is steam that passes through the Dryer without condensing. Excessive "blow-through" results in a less efficient use of generated steam but if "blow-through" is controlled it can be recirculated to the Yankee through the Thermocompressor.

Controlled blow-through serves several key purposes:

- 1. It reduces the density of the two phase mixture (steam and water) and allows removal with a reasonable differential.
- 2. It entrains and evacuates non-condensible gases.
- 3. It helps to stabilize the evacuation of condensate.

In our system design, it appears that the blow-through rate is 40% of the total inlet steam flow. At higher differentials more condensate will be drawn out of the Yankee while at lower differentials less condensate and more blow-through steam will be evacuated.

There may also be occasions when the condensate (in the liquid phase) is not being removed efficiently. This will result in "flooding" and can be viewed in the sight glass. If the Yankee begins to flood, the differential should be increased high enough to remove the condensate. The differential should be returned to normal operating levels as the condensate removal rate returns to normal.

There are two methods of controlling the Yankee differential:

- Differential Pressure (dPIC 304).
- Blow-Through steam flow rate (FIC304).

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Note:

The method of control is selected through a switch.

1. Differential Pressure (dPIC 304)

A pressure sensor is located at both the inlet and outlet lines at the Yankee Dryer. The sensors measure pressure in MPaA. The outlet pressure is subtracted from the inlet pressure to result in a differential pressure value. The value is transmitted to a controller which evaluates the actual based on the setpoint valve (designed at 0.1 MPaA). The controller adjusts two valves to regulate the differential pressure to the setpoint valve.

The first valve (dPV 304A) is at the Thermocompressor while the second valve (dPV 304B) is on the flash steam line to the heat exchanger. The valves operate on a split control range with the first valve controlling the differential on the low end of the scale (3-9 psi signal) and the second valve opens only when the first valve is fully open (9-15 psi signal).

With a machine speed increase, condensate removal is in jeopardy unless the differential is increased. With decreased speed, blow-through becomes grossly excessive if no differential adjustment is made.

On a web break, with differential pressure control, "blow-through" steam roughly doubles. Consequently, the Thermocompressor is called upon to compress twice as much steam against a much increased compression ratio. At the same time the condensing load becomes so light and the PC is forced to close the makeup valve (PV 303A and B) and throttles the Thermocompressor in order to avoid a climb in dryer pressure. The DPC is forced to open the dump valve (dPV 304B) widely in trying to maintain differential and a lot of steam is dumped into the heat exchanger.

Increase Differential Pressure (Example)

If the actual differential is less than the setpoint value, the controller will open dPV 304A until the actual differential pressure matches the setpoint value. If the dPV 304A valve is fully open and the differential pressure is still not at the setpoint valve, the second valve (dPV304B) will begin to open and direct "blow-through" steam flow to the heat exchanger.

2. Flow Rate-"Blow Through" Steam (FIC304).

A flow sensor (FT 305) is positioned in the line above S1. It measures the "blow-through" steam flow rate and transmits the signal to the controller. The controller regulates the same two control valves as used in the differential pressure control loop only now they are regulating flow. The designed setpoint valve for flow is 1830 kg/h which represents a 40% regulating flow. The designed setpoint valve for flow is increased the setpoint "blow-through" rate of ingoing steam. If the ingoing steam flow is increased the setpoint should also be increased to maintain this 40:60 ratio between "blow-through" steam and condensate.

The valve in the differential pressure control loop at the Thermocompressor (dPV 304A) now becomes the flow rate control value (FV 304A). Likewise, with the second control valve (dPV 304B) now becomes (FV 304B).

Increase "blow-through" steam flow to maintain 40:60 ratio (example).

If the actual "blow-through" steam flow is less than the setpoint valve, the controller will open FV304A until the actual flow matches the setpoint valve. If FV 304A is fully open and the flow is still not sufficient then FV 304B will begin to open and direct steam flow to the heat exchanger until setpoint is obtained.

This system differs from the conventional differential pressure control in that the rate of flow of separated "blow-through" steam is controlled instead of differential pressure across the Yankee. The syphon "blow-through" rate is established to evacuate condensate from the Yankee. The controller maintains a preset "blow-through" flow over the entire operating range of the machine. A flow rate of "blow-through" steam is the fixed percentage of the condensing rate at any given normal drying conditions.

During a paper break, flow control reduces the loss of steam to the heat exchanger. With the loss of paper on the Yankee, the condensing load drops, and the flow of "blow-through" steam increases if differential pressure is maintained constant. But with flow control, the flow of blow-through steam is maintained at the preset rate and the differential pressure drops. Thus, the Thermocompressor has less work to do on a break and both the motive steam and amount of steam discharged to the heat exchanger are reduced. Following a break, the "blow-through" rate continues to be maintained at the preset rate, and differential pressures automatically return to normal levels.

Flow control systems normally operate with lower differential pressures and respond more rapidly to load changes. When pressure is suddenly increased, causing a sudden increase in condensing, differential pressure automatically jumps upward to maintain drainage. Flow control tends to be more stable and reliable, along with substantially less steam consumption. In addition, good dryer drainage can be maintained at much lower steam pressures, and the range of dryer working pressures is extended.

A rise in steam pressure causes an increase in density, an increase in the condensing rate and an increase in "blow-through" steam flow proportional to condensing rates; the percentage of "blow-through" steam remains constant. The percentage of "blow-through" steam can be increased or decreased by varying the controlled pressure drop (differential) through the syphon.

The desired operating point is always lower with "blow-through" control than with differential control because sudden surges or upsets are sensed and corrected much more quickly.

Control line B at constant percentage "blow-through" in each graph characterizes "blow-through" control. In Figure 1 it is obvious that line B intersects each curve at the same relative

position, indicating that the same most desired operating point is automatically set at each operating pressure. Much the same is true at other machine speeds as indicated in Figure 2.

During web break conditions, "blow-through" flow rates, well in excess of the minimum, but at far less differentials shown in Figure 3. The only signs of changed status is a large drop in "makeup" steam flow and a large dip in the indicated differential pressure on Control line B which automatically drops drastically and reduces compression work. The Thermocompressor thus remains in control with reduced effort and no steam is dumped to the heat exchanger; the usual event with differential pressure control.

Control line B therefore secures the optimum in control for all major dryer drainage variants (ie. steam pressure, machine speed, and web break conditions. Consequently, under all operating conditions, the least practical amount of high pressure motive steam is used.

Operating Parameters

There are three variable which affect drying efficiencies on the Yankee.

- Steam Pressure
- Machine Speed
- Web Break Conditions

1) Steam Pressure

Higher steam pressures result in higher temperatures on the Yankee Surface. Sudden increases in steam pressure often cause condensate drainage upsets. Condensing rates may immediately increase by several times after a sudden increase in pressure before settling down to new steady rates. The extra transient condensing provides the heat energy necessary to raise the equilibrium temperature of the Yankee to new levels.

If a sudden increase in pressure is too large, drainage from the Yankee may be interrupted and must be resumed quickly by altering differential pressure.

2) Machine Speed

Higher machine speeds at constant steam pressure (with no change in hood conditions) will result in higher moisture levels in the finished sheet. As speeds increase, differential pressure increases as does blow through percentage at nearly identical condensing rates. Greater differentials are required to act against the increased centrifugal forces acting on

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the condensate layer. As differential pressure is increased for a given condensing rate, the percentage of blow-through steam increases.

3) Web Break Conditions

On a Web Break, the steam pressure is automatically dropped by a fixed value to reduce the condensing rate with no sheet on the Yankee. The web heat transfer drops to roughly 12% of the normal load.

Start-Up And Operating Procedure

The heating of the Yankee Dryer from a cold start is a long, controlled process which brings the shell temperature to operating level with minimal deformation to the shell surface.

Heating should occur only with the dryer in rotation. The heating must be done slowly so that the cast material may gradually adapt itself to the thermal expansion and not cause permanent deformation to the cylinder shell.

General Guidelines

Dryer must be increased to working pressure (0.8 MPaA) in 6 to 8 hours. In the first hour, pressures should not exceed 0.02 MPa.

Dryer shell temperature corresponds to an inlet steam pressure. Shell temperature should be increased by approximately 15°C/hr until the working pressure has been reached.

Time	Pressure (MPaA)	Shell Temperature (°C)
Less Than 1 hr	0.02	less than 35°C
1 hour	0.25	35°C
2 hour	0.03	50°C
3 hour	0.04	65°C
4 hour	0.05	80°C
5 hour	0.085	95°C
6 hour	0.15	110°C
7 hour	0.24	125°C
8 hour	0.37	140°C
9 hour	0.55	155°C
10 hour	0.80	170°C

Paper Machine Heat-up Procedure

- 1. Close main steam valve (PV 300) and bypass valve.
- 2. Position the photocell selector on "Manual Operation" by means of selector switches at the panel to enable all contacts and controls.
- 3. Run the Yankee at approx. 250 fpm.
- 4. Open all drains of the steam main line manually at the corresponding line points to drain all condensate.
- 5. Position the steam main line controller PIC 300 on "automatic" and adjust the set point 0.02 MPaA by means of controller at the panel. This permits steam passage.
- 6. Position the controllers PIC 303 and dPIC 304 on "manual" and keep them closed.
- 7. Open the steam main valve bypass to slowly heat the main line.
- 8. Close all drains of steam main line.
- 9. Adjust the set point of Steam main controller PIC 300 to 1.25 MPaG. (12.5 bar) to fully pressurize the steam main line.
- 10. Fully open the main steam valve.

Note:

Open the valve slowly to avoid condensate shocks. This action releases steam to the main steam line.

- 11. Open the drain of the flash tanks S1 and S2.
- 12. Start the Yankee heat-up according to the instructions and tables attached. This must be done slowly and carefully to heat the Yankee properly (PV 303 A and B).
- 13. Close the drain of the flash tank S1.
- 14. Position the controller LIC-306 on "Automatic" and adjust the set point to 50% of level, to control the Flash Tank (S1) level.
- 15. Close the drain of the Flash Tank S2.
- 16. Position the controller LIC-307 on "Automatic" and adjust the set point to 50% of level, to control the Flash Tank (S2) Level.

- 7. Open the sealing water valves of the condensate pump (CP01 or CP02).
- 18. Switch on the condensate pump (CP 01 or CP 02) of Flash Tank S2 to remove condensate from S2.
- 19. Position the controller TIC 309 (calender) on "Automatic" and adjust the set point to 90°C.
- 20. Open the sealing and water valve of the condensate pump (CP-03).
- 21. Switch on the condensate pump of the calender heating system (CP-03) to slowly heat the calender thermic rolls.
- 22. Open manual valve at the inlet of the heat exchanger.
- 23. Position the controller PIC 310 on "Automatic" and adjust the set point to 0.05 MPaA.
- 24. The controllers dPIC 304 and PIC 303 must be adjusted to control the pressure difference (or flow control) according to the increase of cylinder pressure.
- 25. When Yankee surface temperature is achieved, (based on steam pressure) Yankee is ready.

Shutdown Procedures

- Lift all doctors when shutting down.
- Rapid cooling should be avoided.

Do not use cold water or compressed air to cool the surface of the Dryer. This may lead to "stress cracks" which could cause shell failure.

Keep the cylinder rotating a minimum of 30 minutes at jog speed until it is completely emptied of condensate and cooled to approximately 60°C (less than 0.04 MPaA).

During Shutdown

Rotate Yankee half a rotation every 15 minutes if drive cannot be run at minimum machine speed.

If required, drain the Yankee through a plug located on the tending side.

In Case of Power Failure

- Immediately shut-off steam supply to Yankee.
- Apply a lever to the dryer head bolts to give the dryer half a rotation every 15 minutes.

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Trouble Shooting

Sheet Moisture Content Profile

Profile problems can be caused in the Yankee by uneven condensate removal. Moisture profile problems can result in operational and quality problems including; "soft" rolls, "corrugated rolls", converting difficulties and rejected paper. Overdrying the sheet to compensate for moisture profile problems result in higher steam consumption and reduced production.

Poor Drying

Possible Causes and Suggested Remedies.

1. Low Dryer Steam Pressure.

• Raise dryer steam pressure to the amount required to dry sheet.

2. Hood system out of Adjustment.

- Check dryer hood temperatures and adjust if required.
- Adjust fresh air and exhaust dampers to ensure maximum drying.
- Check cleanliness of air intake screens; clean if necessary.

3. Hood exhaust screens plugged.

- Check and remove all broke from the exhaust screen (wet and dry end).
- Plugged up holes in air ducts will cause uneven drying; remove broke from any plugged holes.

4. Dirty dryer surface.

- Put the cleaning blade against the dryer to even coating and slightly reduce coating thickness.
- Cut back on dryer coating.
- Change creping doctors frequently.

5. Heavy Basis Weight.

• If roll weight is above standard, reduce stock to bring basis weight back to standard.

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6. Not enough vacuum on suction pressure roll.

• Check that vacuum valve, from suction box to vacuum pump, is fully open.

7. Suction box not in right position in suction roll.

 Rotate box to get maximum drying. Maximum drying is usually obtained by having suction box as far out of nip as possible without crushing.

8. Dryer filled up with water.

- Check sight glass on dryer condensate line.
- If sight glass is full of water, increase differential pressure in the dryer (decreased the steam pressure) and open bypass until water is drained.

9. Uneven condensate removal across dryer surface.

 Very hard to determine without doing a special heat analysis or climbing inside the Yankee. The condition is characterized by "wet streaks" in the moisture profile.

10. Pressure Roll leading incorrect.

Put maximum allowable pressure on the pressure roll.

11. Suction press loading incorrect.

Increase press loading; front and back indicator should be equal.

12. Felt carrying too much water.

- Cut down on felt shower water slightly.
- Felt may be filled up. (See corrective measures for crush).
- Straighten felt seam.

13. Too much water on wire.

Close slice slightly.

14. Machine speed too high.

• If all other measures to improve fail, reduce machine speed.

15. Improper crown on rolls.

• Crown suction press and pressure roll should be such that carbon paper prints under full operating pressure show a uniform nip.

Blisters

Blisters are localized raised portions of the paper. The result of poor adhesion between portions of the web and the Yankee surface.

1. Yankee cylinder too hot.

Reduce dryer temperature.

2. Sheet moisture content too high.

 Check stock freeness, pressure roll press loading. Check hood temperature to be sure the supply and exhaust fans are running.

3. Improper adhesion to Yankee Surface.

• Check sheet moisture, freeness, white water pH, and dosage rate of adhesive chemical and release agent.

4. Dirty or Plugged Felt.

- Dry Blister: Spots on felt where only a thin layer of sheet picks off the wire (pitch, gum, paint, etc.)
- Shutdown and clean felt.
- Wet Blister: Spots on felt where thickness of sheet is picked up but where spot will not dry in presses (grease).
- Shutdown and clean felt.

5. Dirty Yankee Cylinder Surface.

• Clean or polish Yankee cylinder.

6. Low or high spot in pressure roll.

- Try slight changes in pressure loading.
- Pressure Roll may need grinding.
- Check Pressure Roll for loose rubber.
- If rubber loose, report to team leader.

Flaring

Flaring is a continuous area of raised paper which does not contact the dryer surface. This condition is different to "blistering" which is localized to a spot. Poor adhesion between the web and Yankee cylinder will result in flaring.

Possible Causes and Suggested Remedies.

1. Overdrying.

Speed up machine if possible.

2. Uneven drying.

See corrective measures under "poor drying".

3. Not enough dryer coating. Poor coating development.

• Increase dryer coating addition slightly to improve sheet adhesion. Check release agent addition rate and reduce slightly if high.

4. pH Fluctuations.

Check wire pit pH and adjust to standard operating pH.

5. Uneven pressing.

• Check press loads and equalize front and back side pressure.

6. Dirty Felt.

More shower water and more vacuum on uhle box will help clean felt.

7. Oil in system.

Look around all bearings for oil leaks. Notify maintenance if a leak is located.

8. Pressing Roll Crown.

• If sheet continues to flare, it may be an indication of uneven or improper crown on a pressing roll. Nip impression will show any irregularities in crown.

Appendix I

Steam Trap

The Steam Trap is a device that allows the drainage of condensate but, ideally, not steam from a pipe line.

The trap opens a few degrees below saturation temperature and discharges large amounts of condensate without any further cooling (ie., there is not backing up of condensate) at any pressure within its operating range. It closes just before saturation temperature is reached, so no steam loss occurs. Opening and closing are controlled by the temperature feeler (with Duo steel plates) assisted by Thermodynamic effects the closing unit (style nozzle).

The trap vents automatically during start-up and in continuous operation.

Maximum Service Pressure:

6 bar

Maximum Temperature:

300°C

Maximum Differential Pressure:

4 bar.

Relief Valve

The relief valve, when operating correctly on gas or vapor, will open with a sharp clear pop at the pressure for which it is set. When pressure accumulates above the set pressure, the lift will increase until maximum lift and valve capacity are obtained at the accumulated pressure at which the valve was rated. When the pressure drops, the lift will decrease until the valve closes.

Rotary Steam Joints

Two Rotary Steam Joints allow the passage of steam from a stationary pipe to a rotary pipe (or vice versa).

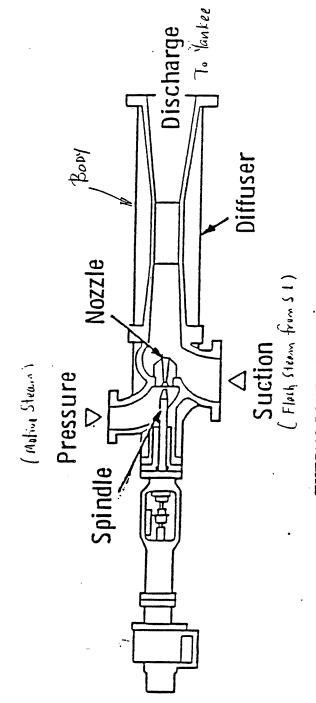
- 1. Steam flow from a stationary part (steam inlet bend) to a rotary part (inlet pipe on dryer journal).
- 2. Condensate flow from a rotary part (outlet pipe on dryer journal) to a stationary part (outlet bend).

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AppendixII

Conversions

	1 MPaA	=10 Bar	=145 psi
Inlet Steam Pressure:	0.8 MPa	=8Bar	= 116psi
Outlet Condensate Pressure:	0.7MPa	=7Bar	= 101.5psi
Differential Pressure:	0.1 MPa	=1Bar	= 14.5psi
A Pressure of:	0.3 MPa	=3 Bar	= 138-141° C
	surface termperature on the Yankee.		

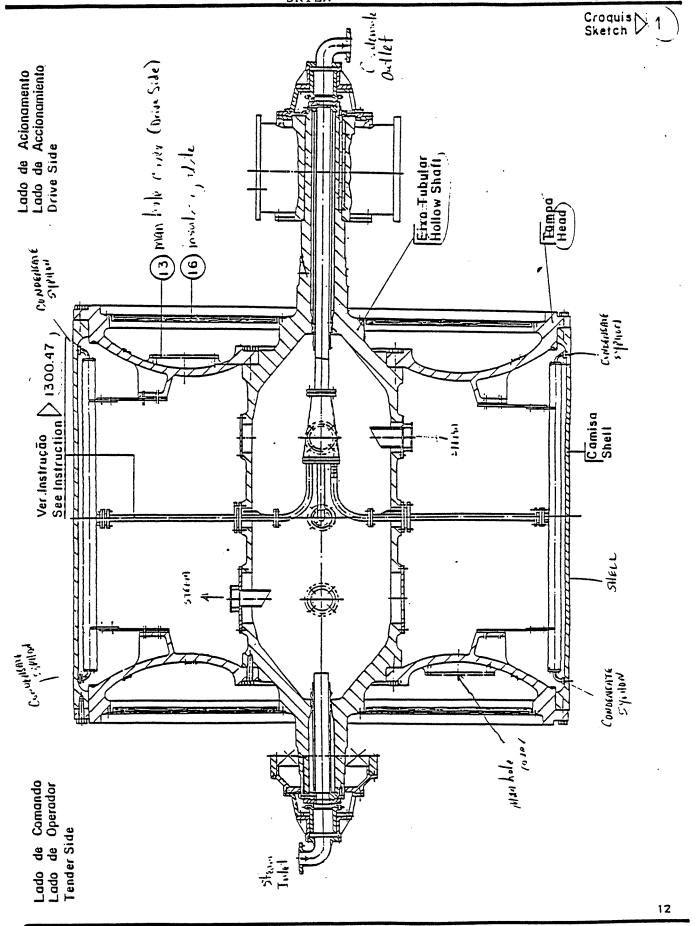


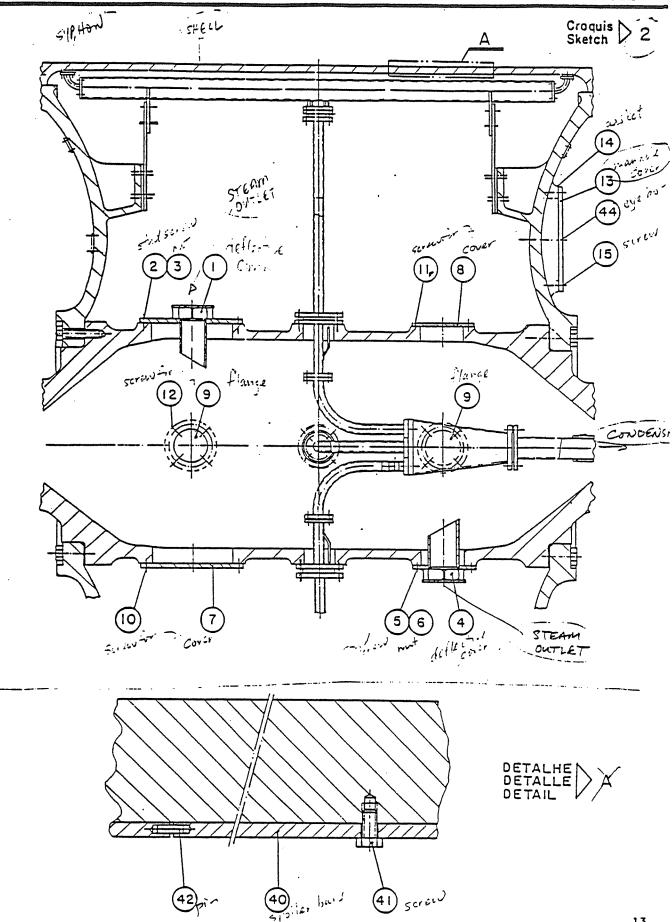
THERMOCOMPRESSOR

possible to take advantage of final moisture, affords the machines. Incoming web moisture, after press part, is also able to be measure today The advent of the computer and final moisture pickup ahead of the reel to measure and Most modern drying control systems utilize micro-processor hardware has made it lags inherent in all which, in conjunction with measure ultimate in steam system control. input to the dryer part. dryer mass time

Dryer Section Performance

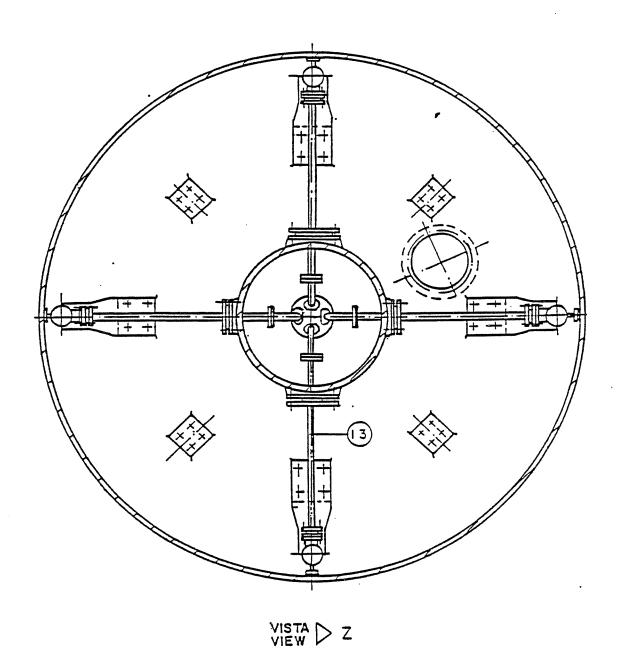
one machine with another it becomes important to steam supply press The most there exist can be measured. increased or if more drying cylinders are added. items, As with most operating, productive by which dryer section performance frequently becomes important to compare be expected In other cases, able to predict what migh grade. making the same





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Croquis Sketch ≥ 3



5

Tempo---de--aquecimento X temperatura supercial

Heat-up time X surface temperature

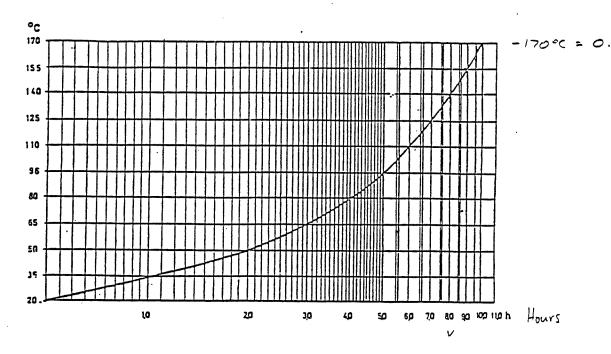
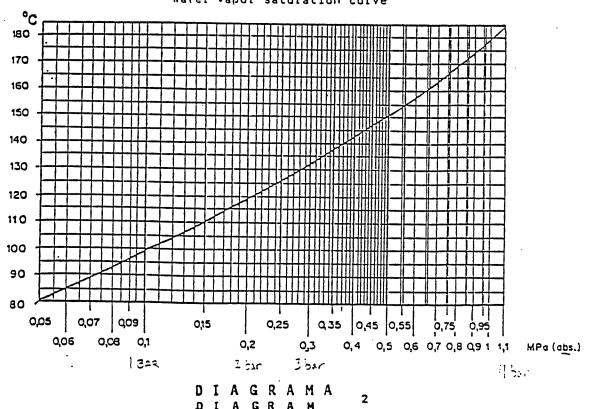


DIAGRAMA DIAGRAM

Gurva-de-saturação-do-vapor-d'agua Water vapor saturation curve



ANKEE STEAM INLET PRESSURE CONTROL (PIC303) TANKEE STEAM INLET PRESSURE control (PIC303) The control steam pressure in order to efficiently clry the sheet to achieve targetted moisture values

PANKEE DRUER DRAINAGE CONTROL (JPIC304 or FIC304)

- (A) DP control = setpoint difference between inlet and outlet pressure at Yankee
 - -if actual is greater than setpoint -T.C. closes to build pressure on outlet side of Yankee
 - if actual is less than set point - T.C. opens to relieve pressure on outlet side of Yankee.
- B) Blow-through flow control

 -> set point is a flow value of flash

 steam from S1 (kg/h)
 - -if actual flow is greater than setpoint -T.C. closes to reduce flow
 - -if actual flow is less than setpoint -T.C. opens to increase flow.

Termocompressor

-position of spindle controls motive steam flow

1 motive steam flow (as T.C. opens) 1 flash steam flow drawn from 51 1 discharge pressure at T.C. discharge to Yankee.

-if T.C. open 100% and inlet pressure at Yankel greater than setpoint (PIC 303), the pressure control will now control the T.C. in conjunction with PV 303 A and B.

-it will begin to throttle 303 A and B until
they are closed
-if the steam pressure is still too great
the pressure control system will begin
to throttle (close) the T.C.
-at this point, if differential control
(either DP or flow control) is jeopardited
the dump value FU304B will open and
direct flash steam to the heat
exchanger.

tence.

1) As steam pressure is increased -more condensate is produced and therefore greater drawage forces are required to remove the liquid. 1 DP or 1 flow

2) As machine speed increases
- greater forces (dvainage) are required
to overcome increased centrifugal
forces acting on condensate layer 1 DP or 1 Flow

- break conditions

 - more blow through is produced because of the reduction in the condensing load therefore less differential torce is required to remove the liquid/gas mixture from the Yankee
 - -inlet steam pressure should be decreased (no sheet on Yankee) and DP or Flow control should also be decreased.

Hood System

Purpose

To remove water from the paper web by blowing hot air onto the web surface and exhausting the evaporated water.

Process Description

Hood drying is a convective heat-transfer process as opposed to conductive heat-transfer in the steam and condensate system. Convection is the heat-transfer process by which heat is transferred by the actual mass motion of a fluid (ie., air) while conduction was heat transfer without the motion of a medium. (ie., heat passing through metal).

In the hood system, the heat is transferred from the heated air (fluid) to the sheet (solid). In the steam and condensate system, the heat had to pass through the material medium, the Yankee Shell plus the heat transfer barriers (ie., condensate layer) to the sheet.

The Yankee steam and condensate system and the Hood system act as one total drying system. Any change in one part of the system will result in variations in the other. For example, decreasing the steam pressure in the Yankee dryer (reducing surface temperature) will require more drying to be done by the hood system in order to meet the moisture set point (if unchanged).

Machine

Wet-End Hood Process Flow

Refer to Hood Ventilation Flow Sheet (AN.7527.01)

Combustion air for the Maxon Burner is supplied by a centrifugal fan (HBM-0322). The air flows through a heat exchanger and is warmed prior to introduction in the burner. The Maxon Burner unit regulates the mixture of combustion air and natural gas to produce a flame which will heat recirculated air to the operational set point temperature. Hood operating air temperature is selected through controller TIC 320 on the Measurex system.

A recirculation fan (HBM-0323) draws exhausted air from W.E. Burner and directs it through the Maxon Burner unit. The air is heated and supplied to the hood cap where it passes through nozzles at high velocities and impinges on the web. The exhaust air, containing the evaporated moisture, exits the hood through exhaust ports and is recirculated through the W.E. Burner with a portion of the flow directed to atmosphere by a manual louver register. The majority of the air is recirculated (greater than 50%) in order to converse heat.

A portion of the W.E. Hood exhaust is vented to atmosphere because it contains considerably more moisture than the D.E. Exhaust (0.413 vs. 0.147 kg. H₂O/kg. dry air). At higher moisture levels the air is less ready to accept evaporated moisture and therefore water removal efficiencies are diminished.

Hence, the vented air is replaced with D.E. Hood exhaust and recirculated to the W.E. Burner.

The vented air flows through the heat exchanger where heat is transferred to the combustion air and D.E. makeup air before being lost to the atmosphere. In this manner, some of the heat is recovered. The air is exhausted to atmosphere through the exhaust fan (HMB-0321).

Dry End Hood Loop Process Flow

Refer to Hood Ventilation Flow Sheet (AN. 7527.01)

Combustion air is supplied by the centrifugal fan (HBM-0324) through a heat exchanger where it is warmed.

Maxon Burner unit controls the regulation of combustion air and natural gas through TIC 321 to achieve the desired hood supply air temperature.

Exhaust air from the Dry End hood and makeup air from the heat exchanger flow to the Burner through the recirculation fan (HBM-0325). The makeup air replaces the Dry End hood exhaust which flows to the wet-end burner. Therefore, as the louver register is adjusted to increase or decrease the amount of Dry End exhaust used at the Wet End burner, the Dry-End makeup air louver register be adjusted.

The heated supply air flows to the hood, impinges on the sheet and is exhausted to either the Dry-End burner or the Wet-End burner. The relatively low moisture content of the Dry-End exhaust makes it a valuable component of the Wet-End recirculation air. (ie. it can accept more water when reintroduced to the hood). No exhaust air from the D.E. Hood is exhausted to the atmosphere. Air for the burner is a combination of makeup air and D.E. Hood Exhaust.

Basic Components

- 1) Centrifugal Fans
- 2) Burner Units
- 3) Hood Caps
- 4) Heat Exchanger
- 5) Connecting Ductwork and Dampers

Centrifugal Fans

A centrifugal fan induces air movement in much the same manner as a centrifugal pump causes liquid movement. A drive motor is connected to the fan shaft through a direct coupling. The fan is caused to rotate by the drive motor. There are five centrifugal fans associated with the Hood system.

- Wet End combustion Air Fan.
- Dry End combustion Air Fan.
- Wet End recirculation Air Fan.
- Dry End recirculation Air Fan.
- Exhaust Fan.

1. Combustion Air Fans

The combustion air fans draw air from the atmosphere and direct it to the two burner units. The fans are manufactured by MAXON as part of the burner unit. The air supplied by the combustion fans is regulated by a damper as part of the temperature control loop.

2. Recirculation fans

The recirculation fans draw air from the exhaust ports of the hood caps and direct the air flow into the burner chamber. The recirculated air is then reheated and directed back to the hood cap. An inlet vane with a pneumatic positioner controls the flow rate into the fan. As the inlet vane is closed, the resultant in-line pressure increases. The inlet vane is controlled through the pressure control loop.

3. Exhaust Fan

The exhaust fan draws air from the Wet End hood cap exhaust ductwork. The amount of air which is exhausted through this fan to atmosphere is controlled by a louver register which is manually positioned. This fan is equipped with an inlet vane and pneumatic positioner. The inlet vane is controlled through the pressure control loops associated with the system.

4. MAXON Burner Units

The Burner units are designed to regulate the combustion air-natural gas mixture to heat the recirculated air to achieve an operating air temperature set point for the hood supply air.

The Burner unit (one for W.E. and one for D.E.) is equipped with the Burner Housing, the natural gas pipe train, combustion air fan, and a control panel. The control panel monitors process conditions to efficiently operate the Burner unit. It safeguards against any potential dangers which may be present due to the natural gas fuel source (ie. gas leaks). A more detailed description of the control system can be found in the Start-up and Operating Procedures.

Burner Pipe Train Components (For Both Burners)

- 1. Main Gas Cock.
- 2. Cock For Manometer.
- 3. Manometer.
- 4. Gas Pressure Regulator.
- 5. Pressure Switch-Minimum.
- 6. Main Gas Shut-off valve.
- 7. Valve closed switch.
- 8. Pressure Switch-Maximum.
- 9. Manometer.
- 10. Cock.
- 11. Pilot Gas Cock.
- 12. Pilot Gas Pressure Regulator.
- 13. Pilot Valve.
- 14. Pilot Cock.

Hood Caps

6

The Hood Caps are the two segments situated directly above the Yankee. The Hood Caps enclose almost two-thirds of the Yankee dryer (a 230° wrap). The Hood Caps can be retracted from the operating position which allows cleaning of the area between the Yankee surface and the Hood Caps.

The Hood Cap frames are constructed of high temperature resistant steel (15 M03) which helps minimize heat deformation during operation. The outside skin of the Hood body is constructed of stainless steel 304, with 316 L SS at the Wet End portion. Hood insulation is a mineral wood filling approximately 200 mm thick. The pressure chambers are made of steel (15 M03).

The pressure chamber surface directed at the Yankee is equipped with small diameter nozzles which are spaced to guarantee uniform drying. The exhaust air is removed through larger diameter tubes constructed of stainless steel and exits the Hood Cap through the exhaust port.

The nominal distance between pressure chamber surface and the Yankee dryer is 20 mm.

Heat Exchanger

The air-air Heat Exchanger preheats combustion air and dry-end hood makeup air with Wet-End exhaust air. By preheating this air, less energy is required to raise it to operating temperatures. It also recovers heat which would be lost if no heat exchanging unit is present.

The heat exchanger has condenser tubes which are 0.3 mm thick through which the heat from the exhaust air must pass to warm the fresh air.

Connecting Ductwork And Dampers

The ductwork for the Hood system requires large diameter (ie. 1000 mm) ducting to handle large volumes of air.

The Inlet Ports of the Hood Caps allows heated air from the burner to enter the hood. The ductwork system at the inlet is equipped with an articulated joint which allows the hood to be opened without disconnecting the ductwork. An expansion joint of stainless steel is also situated on the ductwork to eliminate stresses resulting from thermal expansion of the materials.

The exhaust Port allows hood exhaust to vacate the hood cap. The ductwork is also equipped with an articulated joint and an expansion joint.

Dampers are platelike devices used to control the air flow through the ductwork. The dampers are listed below.

- a) Three (3) inlet vanes with pneumatic positioners located at the inlet of the two recirculation fans and the exhaust fan. The two inlet vanes at the recirculation fans regulate the air flow to the fans and in turn affect line pressure. The inlet vane at the exhaust fan also regulates air flow to the fan. The inlet vanes are controlled through the Measurex System to achieve system pressure set point
- b) Four louver registers with pneumatic cylinders are located at the inlet to both hoods and at the bypass line to the exhaust from both hoods. These louver registers are either open or closed. When the Hood is in its operating position, the louver register to the hood is opened and the recirculation register is closed. The opposite occurs when the hood is in a recirculation mode (ie., no sheet on the Yankee).
 - c) Three (3) louver registers with manual positioners.

These louver registers must be adjusted by hand and function to regulate:

- Wet end exhaustion
- Dry end to Wet End recirculation
- Dry end makeup air.

Technical Data

Production Rate: 80 t/d
Basis Weight: $12.5 g/m^2$ Sheet Width: 2770 mm
Dryness after the Press: 40%

Dryness after the Yankee: 94%

Maximum Operating Temperature: 400°C

Impingement Air Flow Rate: 20 m³/s

Specific Dryer and Hood evaporation: 155 kg/hr x m²

Specific Hood Evaporation: 103 kg/hr x m² (66.5 %)
Specific Dryer Evaporation: 52 kg/hr x m² (33.5 %)

Combustion Fans

Manufactured by: Maxon

Type: RVK 08/45

Maximum Inlet Temperature: 20°C
Maximum Volume: 0.75 m³/s

Maximum Air Flow Rate: 1.2 kg/m³
Fan Shaft Speed: 3600 rpm

Total Pressure: 900 Pa

Fan Motor

Manufactured By: ASEA
Power: 20 hp

Speed: 3600 rpm

Recirculation Fans

Manufactured by: Pollrich

Type: Wet End: VR35S15C6UK2000/LG 270

Dry End: VR35S15C6UK2000/RG 270

Fabrication Number: Wet End: 100448

Dry End: 100447

Maximum Inlet Temperature: 350°C
Maximum Volume: 16.5m³/s

Maximum Volume: 16.5m³/s
Maximum Air Flow Rate: 0.54 kg/m³

Fan Shaft Speed: 1160 rpm Total Pressure: 5000 Pa

Fan Motor

WEG Manufactured By: 250 hp Power: 1160 rpm Speed:

Exhaust Fan

Pollrich Manufactured By:

VR63S1DC5UR0900/RG 360MGG4 Type:

100441 Fabrication Number: 350°C Maximum Inlet Temperature: $9.44 \,\mathrm{m}^3/\mathrm{s}$ Maximum Air Flow Rate: 1760 rpm Fan Shaft Speed: 1600 Pa

Fan Motor

Total Pressure:

WEG Manufactured By: 50 hp Power:

1760 rpm Speed:

Burner Unit

Maxon Manufactured By:

Ovenpak Model:

EB7-MRV-MA Type: Wet End: 88097363 Fabrication Number:

88097364 Dry End:

13m³/sec (Related To Inlet Temperature) Wet End: Air Quantity: 18m³/sec Dry End:

400°C Maximum Outlet Temperature:

Natural Gas Fuel:

Wet End-265m³/h Fuel Consumption:

Dry End-197m³/h

Electric Ignition:

Ultra-Violet Combustion Control:

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Hood Caps

Manufactured By: Voith Approx. Hood Wrap Angle: 230°

Theory of Operation

The heat that is transferred from the impingement air and the Yankee cylinder to the paper is used to:

- Increase the temperature of the paper to its equilibrium drying temperature
- Evaporate the water from the paper
- Increase the temperature of the paper above the equilibrium temperature after the surface water has evaporated.

The amount of energy required to heat the paper (sensible heat) is generally less than the amount of energy required to evaporate the water (latent heat).

The drying process can be represented on a psychrometric chart. Figure? is a thermodynamic chart for humid air showing the weight of water in the air (absolute humidity) as a function of the dry bulb temperature.

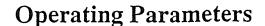
On this chart, the air is initially at a high temperature and low humidity (state 1). As the air transfers heat to the paper and picks up evaporating water, it moves along to state 2. The path between states 1 and 2 can be idealized by a series of four separate phases, represented here by four segment A, B, C, and D.

A-The paper is heated by the air to the equilibrium temperature before any evaporation begins. The air loses heat during this time so its temperature decreases along path A with no gain in air humidity.

B-The air transfers heat to the paper causing a moisture removal (evaporation) which is proportional to the amount of heat transferred. This process follows the adiabatic saturation (wet bulb) line on the psychrometric chart where constant decreasing air temperature and increasing humidity is illustrated.

C-Additional heat added to the paper by an external heat source causing an additional amount of water to be evaporated. On this chart, this action increases air humidity but does not decrease the air temperature along line C.

D-The paper is now nearly dry and the heat that is transferred from the air to the paper causes an increase in the paper temperature above equilibrium temperature without corresponding evaporation along line D.



With the Hood System, drying rates can be controlled by:

- Air Flow Rates
- Air Temperature
- Amount of Exhausted Air From System.

1. Air Flow Rate

Heat transfer increases with increasing flow rates. The flow rates are adjusted by the position of the inlet vanes at the recirculation fans. A pressure sensor measures the air pressure in the ductwork prior to the recirculation fan. A pressure signal is sent to a controller which regulates the inlet vane.

For example, if the sensor measures an air pressure lower than set point this would indicate that pressure has decreased in the ductwork. In order to increase the air pressure, the inlet vanes are closed which restricts air flow and increases the air pressure upstream from the inlet vane.

2. Air Temperature

Heat transfer increases as air temperature increases. The hood system is equipped with temperature sensors on the discharge side of the burners. The sensor transmits a signal to the controller which then regulates the natural gas-combustion air mixture to heat or cool the discharged out. The maximum discharge temperature is 400°C.

The Hood system can respond to sheet moisture variations more quickly than the steam and condensate system. However, the cost of natural gas is more than the cost of steam and a balance must be maintained on the evaporative load to maximize drying and minimize cost.

For example when the sheet moisture begins to rise, the Measurex scanner senses this increase and begins to increase the air temperature to the hood caps. It also begins to vamp up the steam pressure in the Yankee to increase the Yankee surface temperature. As the Yankee surface temperature increases, the Measurex system will begin to reduce the temperature in the hood system thus reducing the consumption of natural gas. The two systems act in unison to control moisture at the least cost.

3. Amount of Exhausted Air From System

Controlling the amount of exhausted air can impact on the overall hood system. Once the air is drawn into the system there is only one way it can be exhausted without being recirculated (besides spilling from the sides of the Yankee or losses due to ductwork) which is through the exhaust fan to atmosphere. Wet end exhaust air contains a higher moisture content relative to the dry end exhaust (0.413 kg H₂O/kg air vs 0.147 kg H₂O/kg air). As the moisture content of the air increases, it is less able to absorb more evaporated water. In an effort to maximize recirculation of exhaust air and drying rates, some of the W.E. exhaust is vented to the atmosphere and replaced with drier air (ie. Dry End exhaust). The Dry End exhaust combines with partial flow from the Wet End hood to result in a drier air flow for the Wet End burner.

In order to maintain balance in the system, the Dry End exhaust which is used in the Wet End burner must be replaced. This is controlled with the Dry End makeup air damper located near the heat exchanger. Adjusting this damper allows air to draw from the atmosphere to replace exhaust air used in the Wet End burner. This makeup air combines with the Dry End exhaust and is supplied to the Dry End burner.

For example, if the Wet End exhaustion damper is closed slightly, more Wet End exhaust from the hood would be directed to the exhaust fan. To maintain a flow balance, additional air would have to replace the increased exhaust. This air would be supplied by slightly opening the Dry End-Wet End recirculation damper which would supply Dry End exhaust to replace the Wet End exhaust. Hence, in order to maintain a flow balance, air must replace this D.E. exhaust. This is supplied from the atmosphere (ie., room) by slightly opening the Dry End makeup air damper.

Process Controls

1) Hood Movement

Hood movement (ie., open and close) is activated through control box 4 (CB4) on the calender column. Limit switches are used to signal hood position.

Limit Switches

W.	E.	Ca	p
----	----	----	---

Open	LS1
Intermediate	LS2
Close	LS3
C103C	

D.E. Cap

Open:	LS4
Intermediate:	LS5
Close:	LS6

The hood is provided with a hold button with one sole control for both segments up to an intermediate position.

To close both segments

- Push close illuminated push button (IPB1).
- Push button will light.

Hood caps will close to an intermediate position dictated by limit switches (W.E. LS2 and D.E. LS5).

To Open both segments

- Push open illuminated push button (IPB2).
- Hood caps will open to an intermediate position dictated by limit switches (W.E. LS2 and D.E. LS5)
- From the intermediate position, the controls are done by independent jogs for each cap W.E. and D.E. up to a working position.

To close Wet End Cap only.

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- Hood must be at intermediate position (LS2)
- Push close push button for Wet End only (PB1).

Hood will continue to close while button is depressed. It will stop when you release the button. The maximum close position is dictated by a limit switch (LS3).

To close Dry End Cap Only.

- Hood must be at intermediate position (LS5).
- Push Close Push Button (PB3).

Hood will continue to close while button is depressed. It will stop when you release the button. The maximum close position is dictated by a limit switch (LS6).

To open Wet End Cap only.

- Hood must be closer to Yankee than intermediate position (LS2).
- Push open Push Button (PB2).

Hood will continue to open while button is depressed. It will stop when you release the button or when the hood reaches the intermediate position.

To Open Dry End Cap only.

- Hood must be closer to Yankee than intermediate position (LS5).
- Push Open push button (PB4).

Hood will continue to open while button is depressed. It will stop when you release the button or when the hood reaches the intermediate position.

2) Hood Supply and Bypass Damper Control

Note:

In the closing procedure of the Hood, when it reaches intermediate position, the supply damper will start opening and only after the pneumatic cylinder reaches full stroke, will the recirculation bypass damper start closing.

The same procedure will occur when the hood is opening from the intermediate position. The recirculation valve will begin to open and only after the pneumatic cylinder reaches its full stroke will the supply damper begin to close.

This sequencing of closing and opening dampers is necessary to avoid shocks on the ductwork during change of flow direction.

Wet End- Louver Register Control (S 327)

A. Hot Air Supply Louver Register (HV 327.C) will close and Bypass Louver Register (HV 327.B) will open if:

- Open Signal for hood is activated
- or
- Shut-off valve (thick stock) is closed.

B. Hot Air Supply Louver Register (HV 327.C) will open and bypass Louver Register (HV 327.B) will close if:

- Hood in operating position
- and Shut-off valve (thick stock) is open.

Dry End-Louver Register Control (S 328)

A. Hot air supply louver register (HV 328.C) will close and Bypass Louver Register (HV 328.B) will open if:

Open signal for hood is activated.

or

• Shut-off valve (thick stock) is closed.

B Hot air supply Louver Register (HV 328.C) will open and bypass Louver Register (HV 328.B) will close if:

- Hood is in operating position.
 and
- Shut-off valve (thick stock) is open.

Note:

A. An air recirculation signal and lamp will be activated if Bypass Louver Register open and Hot air supply Louver Register is closed.

B. Louver Register in operating position will be indicated if bypass louver register is closed and hot air supply louver register is open.

C. A louver register bypass fault will be activated if after 30 seconds following a bypass louver register movement, the limit switch does not sense louver position (if valve did not move in desired direction).

D. A louver register hot air supply fault will be activated if after 30 seconds following hot air supply louver register movement, the limit switch does not sense louver position (similar to C above).

Start-up and Operating Procedures

Note:

Special care must be exercised during start-up, especially if automatic control loops are bypassed and start-up is activated in manual mode.

Start-up Position for dampers with manual controls

D.EW.E. Recirculation	100% closed
D.E. Makeup Air	100% closed
W.E. Exhaustion:	100% open.

Following Start-up, these dampers should be adjusted to achieve balanced conditions shown in operating parameters.

1. Exhaust Fan (HBM321)

Interlocks

- Inlet vane closed (HIC 324)
- Lube Flow Switches indicating Lube flow to motor and rotor bearings.

Start button activates fan drive motor.

After a brief delay (ie. 20 seconds) which allows the fan to reach rotational stability, the inlet vane is activated to a ready-to-run status.

2. Wet End and Dry End Combustion Fans (HBM322 and HBM324)

Interlocks

- Exhaust Fan must be on.
- Timer elapsed (approx. 3 min)

Start button activates fan drive motor.

3. Wet End and Dry End Recirculation Fans (HBM323 and HBM325)

Interlocks

- Inlet vane closed (HIC322 and HIC323)
- Lube flow switches indicating lube flow to motor and rotor bearings.
- Exhaust Fan on and timer elapsed (approx. 3 min)

Start Button activates fan drive motor. After a brief delay (ie. 30 seconds) which allows the fans to reach rotational stability, the inlet vane is activated to a ready-to-run status.

Status:

Exhaust Air Fan-on (provided interlocks are satisfied)

Circulation Air Fans-on (provided interlocks are satisfied)

Combustion Air Fans-on (provided interlocks are satisfied)

Burner control system checks circulation air and combustion air pressure with pressure switches. If a fault is detected, an alarm (Panel/Desk Top Control) will denote failure.

If air pressures ok, a signal is relayed to a pre-purged timer. This timed interval allows a purge of all air lines before the gas is introduced to the system.

Once the timer has elapsed, the control system checks for low gas pressure (PS 1) and high gas pressure (PS 2). If fault detected, an alarm (panel/DTC) will denote failure.

A flame safeguard device which is the controller for the flame is energized initially and detects a flame failure. If the flame is extinguished, an alarm (panel/DTC) will denote the failure.

Once the high air temperature switch has been energized, a signal is relayed to the external security device. If for some reason the following conditions occur, the Burners will shutdown because this signal will be interrupted:

- Low Gas pressure failure.
- High gas pressure failure.
- High air temperature failure.
- Flame failure.

If these conditions are not present, then the control system checks the external security device for the following interlocks.

- Yankee Dryer Run.
- Exhaust Fan "on".
- Exhaust Fan inlet van (HIC324) "Ready for Operation".

If these interlocks are satisfied, and the air gas shut-off valves are closed, the Burner "ready-to-start" signal is activated (Panel/DTC)

Burner can be started at Panel or DTC.

Once Burners are started, then the flame safeguard device activates the burner release to modulation signal. This control regulates the natural gas/combustion air mixture. There are interlocks associated with the "burner release to modulation command" (in addition to the External Security interlocks).

- Hood in operating position.
- Stock on Wire (stock gate valve open)

Once the burner has been released to modulation, a signal will be sent to the panel and DTC.

The ignition transformer, pilot gas valve, and low fire start switch have all been energized through the flame safeguard device. Therefore, once the burner release to modulation command has been satisfied then the main gas shut-off valves open and introduce natural gas to the pilot flame and combustion air.

Burner is now Operational.

An ultraviolet device monitors the colour of the flame (blue-yellow). If the colour changes as described in the ultraviolet device, it will shut the system down. (Part of the the flame safeguard device).

The burner release to modulation will be interrupted if the process interlocks are not satisfied and the supply of gas will be shut-off and run with pilot flame only.

- Hood not in operating position.
- Stock off wire (stock gate valve closed).

Once the Hood is in operating position and the stock is on the wire, the set point air temperature should be selected and inputted to the controllers TIC 320-W.E. and TIC 321-D.E.

Reset Buttons (Panel and DTC)

The reset buttons will return all failures and timers to their initial position. These include:

- Circulation air failure.
- Combustion Air Failure.
- Low Gas Pressure Failure.
- High Gas Pressure Failure.
- High Air Temperature Failure.
- Pre-purge Timer.

Maxon Control Panel (CB5)

Light Indicators

- Low Gas Failure
- High Gas Failure
- Circulation Air Failure
- Combustion Air Failure
- Burner Ready To Start
- Burner Release To Modulation
- High Temperature Failure
- Flame Failure
- Power On

Push Buttons

- Burner On
- Burner Off
- Reset
- Reset
- Switch For Access To Panel.

Contacts

Low Gas Pressure Failure:	CR1
High Gas Pressure Failure:	CR2
Circulation Air Failure:	CR3
Combustion Air Failure:	CR4
High Air Temperature Failure:	CR5
Flame Failure:	CR6
Burner Ready To Start:	CR7
Burner On/Off:	CR8
Burner Release to Modulation:	CR9

Shutdown Procedures

- For short down periods without shutting down the hood ventilation system.
- 1. Close the recirculation inlet vanes by means of HIC 323 and HIC 322.
- 2. After 3 minutes, close exhaust inlet valve by means of HIC 324. This is to avoid air contamination with gas and a possible explosion.
 - The Long Shutdown sequence for fans is: Press Auto-Stop Control Sequence
 - i. Recirculation Fans Off.
 - ii. 30 sec. Air Combustion Fans off.
 - iii. 3 minutes switch off exhaustion fan.

1. Exhaust fan will stop if:

- E/stop activated.
- MCC fault detected.
- Lube Pump Off.
- W.E. Recirculation Fan Off.
- D.E. Recirculation Fan Off.
- W.E. Combustion Fan Off.
- D.E. Combustion Fan Off.
- Stop Procedure Initiated.

2. W.E. and D.E. Combustion Fans will stop if:

- E/Stop Activated.
- Burner Control Unit Initiates Shutdown.
- MCC Fault Detected.
- Stop Procedure Initiated.

3. W.E. and D.E. Recirculation Fans will stop if:

- E/stop Activated
- Burner Control Unit Initiates Shutdown.
- MCC Fault Detected.
- Lube Pump Off.
- Stop Procedure Initiated.

Appendix I

Instrumentation Tags For Burners

1. Denotes W.E. System	2. Denotes D.E. System
Low Gas Pressure Switch	PS1
High Gas Pressure Switch	PS2
Circulation Air Pressure Switch	PS3
Combustion Air Pressure Switch	PS4
Pilot Gas Valve:	SV1
Main Gas Shut-off valve:	SV2
Main Gas Shut-off valve:	SV3
Burner Release To Modulation:	SV4
Low Fire Start Switch:	LS 1
Pre-Purge Timer:	TR 1
Flame Safeguard:	U1
High Air Temperature Switch:	U2
Flame Monitor :	UV1
Ignition Transformer Burner:	ITR
External Security:	EXT

Push-Buttons

Reset-Panel		PB1
Reset-DTC		PB2
Burner Stop		PB3
Burner Stop	DTC	PB4
Burner On	DTC	PB5
Burner Off	Panel	PB6

	-

CREPING

Purpose

To remove the web from the Yankee surface. To impart cross-machine directional wrinkles in the paper to increase bulk and stretch.

Process Description

After achieving a dryness level of approximately 93% (7% moisture), the web is removed from the Yankee surface with a doctor blade (ie.,creping blade). As the blade removes the web, it also imparts cross machine directional wrinkles at the point of webblade contact.

The CD wrinkles increase the bulk of the finished sheet. Bulk is defined as the ratio of thickness to the basis weight of paper. Hence, assuming that the basis weight of the sheet remains the same, the creping action increases the thickness (or caliper) of the sheet and alters the ratio.

The creping action also causes the web to become shorter in the machine direction. This reduction in MD length requires the subsequent sections of the paper machine ie., calender and reel need to be run slower to prevent pulling all of the crepe out of the paper. Also, because of the low basis weight sheet, the web is still not too strong and will not sustain a very strong pull without breaking.

The increase in bulk and stretch are obtained with a reduction in web strengths. The creping action breaks some of the fiber bonds because of the force required to remove the web from the Yankee surface. Increased bulk will improve water absorbency and softness. (the degree of "softness" is also highly dependent on the web dryness at which the creping is performed and improves with increasing dryness.) Increased stretch can be obtained with a tighter crepe, however, more force is required at the blade-web contact to tighten the crepe (ie., more wrinkles per cm of paper).

Therefore, a balance exists between bulk and stretch development vs sheet strengths.

To enable the doctor blade to produce the requisite number of wrinkles in the paper, it is essential that two major factors influencing the process are controlled; web/dryer ad-

hesion and the mechanical forces acting at the point of web release. These two factors will be analyzed in greater detail in a subsequent section.

The tissue machine is also equipped with two additional doctor blades (other than the creping blade); knock-off (cut-off) blade and the cleaning blade. The function of the knock-off blade is to remove the web from the Yankee surface while the blade is changed at the creping blade holder. Normally, when the sheet is removed with the knock-off blade, it is directed into the broke chute. Following the blade change, the creping blade is reintroduced to the Yankee surface and the knock-off blade is unloaded.

The function of the cleaning blade is to contact the Yankee surface and reduce coating or even coating development. This blade does not remove the sheet as did the two previous blades. The cleaning blade normally operates at a lower linear pressure than the knock-off and creping blades. It is usually operated on a discontinuous basis to reduce coating thickness.

All three doctor blade holders will laterally oscillate when loaded to the Yankee. An electromechanical system controls the oscillation to prevent uneven wear or "scoring" to the Yankee surface. The doctor blades must oscillate at all times when loaded to the Yankee.

Basic Components

1) 7 Stepped groove standard blade holder.

This type of blade holder is used for the knock-off and cleaning doctors. The doctor blade is introduced to the holder from the tending side. An adjustable tongue can be positioned in each of the seven step grooves to adapt to doctor blades of varying width. Thus, it is possible to utilize doctor blades from the maximum width of 100mm to minimum widths of approximately 60mm. The doctor blade holder is supported and attached to the paper machine frame.

2) Heavy Duty Conformatic 201 blade holder.

This type of blade holder is used for the creping doctor only. The doctor blade is also introduced to the holder from the tending side. The position of the blade inside the holder can also be adjusted with an adjusting tongue. This doctor blade holder is equipped with a conformatic strip which ensures uniform blade pressure across the entire width of the blade holder. A counter blade (or backing blade) is also utilized to support the doctor blade and prevent excessive deflection during operation. There is greater deflection at greater load pressures. The doctor blade holder is supported and attached to the paper machine frame.

3) Pneumatic Cylinders

Each doctor blade holder is equipped with two double acting air cylinders (tending and drive sides). The pneumatic cylinders assure the adjustable application pressures as well as loading and unloading the doctor blade holder. The cylinders are supported by doctor stands attached to the paper machine frame. The cylinder pistons are connected to the doctor blade holder shaft by a head and pin arrangement. When the doctor blade is oscillating the cylinders pivot on an oscillating fixation point while the doctor blade holder shaft moves in a spherical bushing.

4) Forks

The forks are metal clamps which are attached to the doctor blade holder shafts on the drive side. When the doctor blade holder is loaded, the fork contacts the eccentric shaft of the oscillation mechanism and the doctor blade holder starts to oscillate. When the doctor blade holder is unloaded the fork does not contact the eccentric shaft and therefore the holder no longer oscillates.

5) SEW Speed Reducer and Electric Motor

The SEW Speed Reducer translates the fast rotational movement of the electric motor shaft to a lower rotational movement which turns the eccentric shaft. The Speed

Machine Manual

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Reducer is connected to the eccentric shaft through a flexible coupling. The motor is started by pushing a button located at control box (CB4) on machine frame.

6) Eccentric Shaft

The eccentric shaft converts circular motion into back-and-forth motion through an off-centre shaft. If the doctor blade fork is in contact with the eccentric shaft, the holder will oscillate with a pull stroke of 15mm (7.5 mm to each side).

Creping

Technical Data

Knock-off Doctor

Type:

Lodding- stepped 7 grooves standard

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Linear Pressure:

2.5 kN/m

Blade Contact Angle:

20°

Creping Doctor

Type:

Lodding- Heavy Duty Conformatic 201

equipped with teflon hose

Contact Linear Pressure:

2.5 kN/m

Blade Contact Angle:

20°

Cleaning Doctor

Type:

Lodding- stepped 7 grooves standard.

Contact Linear Pressure:

0.8 kN/m

Blade Contact Angle:

20°

Creping Blades

For start-up and following Yankee grinds:

Material:

Bronze No 176

Dimensions(mm)

Thickness:

1.27

Width:

100

Length:

3215

For normal continuous operation:

Material:

Hardened Steel No. 172

Dimensions (mm):

same as above

Theory of Operation

The desired degree of creping demands a delicate balance between the adhesive forces holding the web to the dryer surface and the release forces generated at the contacting edge of the doctor blade. And unfortunately, many process variables interfere with this equilibrium and can create serious problems during creping. MAJOR FACTORS influencing the process are the web/dryer adhesion and the mechanical forces acting at the point of web release.

(A) WEB/DRYER ADHESION

The web-to-dryer adhesion and subsequent release at the creping blade is an operating variable which must be controlled with exacting precision. Non-uniform adhesion or release can result in many operational difficulties which can impact both the product and machine operation.

A good coating is a uniform coating. The best way to judge a coating is to look for even reel buildup, good blade life, and uniform sheet basis weight and caliper. Good coating development equals high bulk and even reel building. Good uniform adhesion should also produce a tight crepe reflected in the caliper and stretch values.

A controlled Yankee coating will improve sheet quality and reduce the frequency of blade changes. A good coating can also result in better reel building, and a more uniform moisture profile. Coating uniformity builds crepe uniformity and parent roll uniformity and quality. Uniform roll quality is critical to converting operations.

Low adhesion is exhibited by the sheet leaving the cylinder early (ie., prior to the creping blade) which results in low frequency and possibly high amplitude. High adhesion is exhibited by the sheet adhering to the Yankee up to and even beyond the creping blade. This condition results in high frequency and low amplitude.

The extent of web/dryer adhesion is reported to be highly dependent upon the formation of a sticky organic layer which develops on the Yankee surface. As this film develops, it smooths out any dryer surface irregularities which improves the effective web/dryer contact area thus improving overall sheet adhesion.

It also maintains a more uniform drying surface, ie., evening out hot and cold spots. It minimizes doctor and dryer wear by reducing the frictional forces at blade/dryer contact. It can also reduce or eliminate carbon streaks which appear as pencil-like lines which are frequently caused by carbon deposits from the creping blade onto the hot Yankee.

Creping 7

Natural coatings can be found in the *hemi-cellulose* (a natural adhesive) contained in the pulp. The coating begins to form when water flashes soluble organics and inorganics are deposited in the surface along with fines from the sheet. The inorganic coating provides a skeletal framework to entrap organics. The main disadvantage associated with natural coating development is that it is uncontrollable and varies continuously.

Chemical coatings set and form quickly when sprayed directly on the dryer surface. The mechanism of the setting of the coating is dependent on dryer heat to dehydrate and chemi-physical attraction to cross link. The chemicals are designed to effectively conduct heat and remain pliable throughout the range of Yankee surface temperatures. Shower applications offer better control over coating development because of the direct application as opposed to applying the chemical to the wet end stock. The chemicals are also designed to stay on the dryer surface as opposed to migrating to the sheet which can occur with natural coating development.

There are two main types of chemical coatings - crystalline and amorphous polymers. Both have certain advantages and disadvantages. For example, an amorphous coating due to its nature is less sensitive to moisture and pH fluctuations. The amorphous coatings tend to be slightly less tacky than the crystalline coatings (wet strength additives).

The amorphous coating goes through several phases from the time it revolves once around the dryer can and back to the starting point:

A) Crosslink

- At this point, the chemical is applied to the Yankee (in the area between the creping doctor and suction roll at the underside of the Yankee).
- Area where the polymer bonds with itself and the *hemi-cellulose* deposited on the Yankee suface.

B) Glass Transition

- Heat is starting to set the chemical
- Melting phase where the polymer enters a liquid tacky state.

C) Rewetting

- Contact with the sheet and suction roll
- Area where the active sites on the polymer interact with the sheet and physical bonds develop (at pressure roll nip).

D) Setting

- Longest interval where it travels from the pressure roll over to the creping doctor and full heat setting effect is taking place.
- Polymer forms bonds with the cellulose and the dryer surface as it dehydrates.

E) Doctoring

- Part of the coating is doctored off with the sheet.
- The doctor blade is the tool to control coating thickness ie., must be well aligned and the blades properly ground.

F) Curing

• The residual chemical after doctoring cures to a relatively hard coating that tends to form the hard substrate that the doctor blade rides on (as opposed to directly contacting the Yankee dryer).

YANKEE RELEASE

If sheet adhesion is too great, creping problems are created ie., holes and breaks. Release agents are additives formulated to give sheet "release" from the dryer surface. These products are generally blends of oils, solvents and/or surfactants which put a thin lubricating film on the Yankee surface. A release agent has three functions:

- Provides a lubrication barrier between the coating and the doctor blade.
- Controls the amount of sheet adhesion to the dryer surface.
- Controls the amount of coating on the dryer.

The combination of Release agent with organic coatings can reduce the bonding of the coating itself, and to the sheet. Release agents rise to the surface of the coating where they provide a lubrication barrier for the doctor blade and thus help cool the blade to reduce wear. By using a good uniform tacky coating, it is possible to control the amount of coating, as well as control coating hardness and adhesive properties when using release agents. The result of the combination of Release agent with organic coatings is a coating layer effect in which three regional layers form;

- 1. A hardened, fully cured or polymerized layer against the dryer which passes under the blade and protects the Yankee surface from blade wear.
- 2. A softer coating which is easily doctored off and has been softened by the Release agent.

Creping 9

3. A fully softened material which contains the bulk of the release and lubricates the blade.

Overuse or misuse of release aids can hurt coating and adhesion. When added to the wet-end, oil-based products (release aids or defoamers) will kill foam, but when over used will also strip Yankee coating and may contribute to machine, felt and press roll deposits. Excessive release agent prevents cross-linking and may result in sheet blistering and corrugation.

PROPORTIONING THE CHEMICAL ADDITIVES

The proper ratio (adhesive:release) yields the desired sheet and operational characteristics. A general rule states that adhesive chemical addition is usually three times greater than the release agent rate (3:1). Overuse of one leads to overuse of the other.

Too much release oil or defoamer can hurt wet strength performance. Rather than cut back on the release agent, some operators will increase wet strength usage. This can lead to more foaming, which requires more defoamer, then more wet strength, and the spiral continues.

(B) Doctoring Action

Doctor Blade Properties

1) Blade Geometry

The various angles used to define doctor blade geometry in dry-creping are shown in Smook p. 296 Fig. 20-15:

- Blade contact angle
- Blade level angle
- Cutting angle
- Takeoff angle

A) Blade Contact Angle

Manufacturers recommend that the blade contact angle (measured between the lower face of the creping blade and the tangent to the Yankee surface) should be between 15°-35°, preferably at a minimum to avoid Yankee surface damage. Lower blade contact angles promote a "peeling" action as opposed to a "cutting" action. Also, a lower angle can improve the creping frequency, (ie., fineness), which is expressed as crepe ridges/cm.

The designed value is preset at 20° and not variable during operation. The doctor blade holder is designed with "steps" which enables us to maintain the designed contact angle for varying widths of doctor blades.

B) Blade Level Angle

Measured between the end and the side edges of the creping blade. Normally, creping blades are supplied with bevelled edges ground to an angle of 90°, 45°, or 30°. The blades used in our operation have a 90° angle (and can range to 80°).

C) Cutting Angle.

Measured between the contacting end edge of the creping blade and the tangent to the Yankee surface. This angle determines the tightness and coarseness of the crepe. As this angle decreases, the crepe is tighter and less coarse whereas if the angle increases, the crepe is loosened and more coarse. Different cutting angles are used on different grades to impart the desired characteristics to the sheet. This variable can be changed only by using different blades with varying blade level angles.

Creping 11

D) Takeoff Angle

Measured as the angle between the line tangent to the Yankee surface and the plane of the sheet leaving the surface between the blade and the reel.

2) Blade Thickness, Pressure and Friction

These properties are particularly important in terms of blade wear. As a blade wears, the effective doctoring force will be reduced unless the loading pressure is accordingly increased. Consequently, in situations in which the web/dryer adhesion is very high, typical blade loading pressures of 0.9 - 2.6 kN/m will become inadequate as the blade wears and the blade should be changed.

Blade thickness can impact the extent of fine vs coarse crepe. Generally, a thicker blade will produce a coarser crepe. The blades supplied for start-up will have a thickness of 1.27mm.

Recent studies illustrate the correlation between a thick adhesive layer and a reduction in doctor blade wear. The adhesive layer and release agent reduces the coefficient of friction and acts as a lubricant for the doctor blade.

3) Crepe Ratio

A means of expressing the degree of crepe that exists in a sheet. It indicates the extent to which it will stretch or can be pulled out before breaking and it is usually expressed in length of extension or in a percentage. Creping causes the web to become shorter in the machine direction, so subsequent sections of the machine (reel) need to be run slower to prevent pulling all the crepe out of the paper.

The degree of creping is defined as:

(V1 - V2) X 100%

V1

where:

V1 = dryer cylinder velocity (Yankee Speed)

V2 = web takeoff velocity (Reel Speed)

(C) Condition of the Dryer Surface

Formation of the adhesive layer is extremely dependent on the nature of the dryer cylinder surface. An extremely smooth, clean surface will lead to better layer development. Even the presence of fine-scale roughness can profoundly influence liquid spreading and surface wettability. It is therefore critical to maintain a clean surface on the Yankee and to avoid any surface damage e.g. blade grooves, nicks.

Operating Parameters

The following operating parameters reflect the points previously discussed: web adhesion and release and mechanical forces acting at the point of web release.

Web adhesion and release

This operating variable is somewhat controlled through the ratio of adhesion chemical to release agent. We have more control over coating development with the use of the shower header at the Yankee, however, chemical (ie., kymene) addition in the wet end is a viable option.

When adjusting the chemical dosage rates to achieve uniform adhesion and release, avoid chasing one with the other. This spiralling cycle can lead to overdosages and further operational problems. When the dosage rates exceed the norms, ask yourself the following questions.

- Does the problem lie only with the chemical addition rate?
- If I change another variable (ie., blade pressure) can I impact creping to an extent where further chemical addition is unnecessary?

Mechanical forces acting at the point of web release

A) Blade Contact Angle.

This angle will change if the blade wear is excessive or the blade is placed incorrectly in the holder. A general rule is the blade should extend approximately 30mm above the doctor holder lip (or 13 mm above the backing blade). If the doctor blade extends beyond these values the contact angle will be less than 20°. If the doctor blade is too low in the holder the angle will be greater than 20°.

Creping 13

B) Blade Level Angle.

This angle can only be changed by replacing the current blade with a blade grinded to a different blade level angle. At angle values less than 90° the crepe will be coarser (not as tight) while the converse is the norm for angle greater than 90°. Altering this angle will also change the cutting angle for a given reel speed.

C) Take-Off Angle.

This angle can be adjusted by changing the crepe ratio for unchanged doctor blade geometry. Slowing the reel speed increases the crepe ratio for a set Yankee speed and will increase the takeoff angle. Conversely, increasing the reel speed will reduce the crepe ratio and takeoff angle. In most cases, the crepe ratio remains constant for the product being produced.

D) Blade Loading Pressure.

The blade loading pressure can be increased to a maximum value of 2.5 kN/m. Pressures greater than this value can lead to contact between the doctor blade and the Yankee surface, which in turn reduces blade life and could lead to a premature Yankee grind.

Start-up And Operating Procedures

The Doctor Blades are activated through a control box (CB4-TM) located beside the tending side of the doctors (fixed to vertical column). The controls for the knock-off doctor is located at the top of the control box face followed by the creping and cleaning doctors.

Each doctor is equipped with a linear pressure scale. The scale represents the linear pressure for a given blade in kN/m on the top portion. The bottom portion of the scale shows the equivalent units for pressure (loading) in MPA. Hence, for each doctor blade the maximum linear pressures have corresponding load pressures.

	Maximums	Scale	Gauge
Knock-off	2.5 kN/m	0.47 MPa	470 kPa
Creping doctor	2.5 kN/m	0.47 MPa	470 kPa
Cleaning doctor	0.8 KN/m	0.16 MPa	160 kPa

The scales allow a quick reference for linear pressure values when adjusting the load pressure.

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The amount of loading on the front and back of the doctor blade can be adjusted independently through pressure regulators. The pressure regulators are labelled-tending side load and drive side load. Turning the pressure regulators in a clockwise direction increases load pressure. It should be noted however, that the optimal run conditions will be achieved when the tending and drive side loads are equal. Cocking the loads (ie.,more pressure on one side) may damage the surface of the Yankee through uneven wear. If for some reason the blade pressure must be cocked, it should be analyzed and rectified in order to avoid potential damage to the Yankee surface.

The amount of loading on each side of the blade is indicated on two pressure gauges. The pressure gauge units are in kPa. Therefore in order to load the creping blade to a point where linear pressure is equal to 2.5 kN/m, the load must be adjusted on both the tending and drive side. The corresponding load pressure from the scale is 0.47 MPa and because the pressure gauges indicate kPa the correct loading pressure would be 470 kPa.

Each doctor blade is also equipped with a lever which loads and unloads the doctor blade. The blade will load when the lever is moved upwards (on) and will unload when moved downwards (off). When the doctor blade is loaded the pneumatic cylinders position the doctor blade holder towards the Yankee where the blade contacts the Yankee surface. The fork device on the drive side engages the eccentric shaft and the doctor unit begins to oscillate. If the doctor unit does not oscillate, retract the unit and inspect. Do not contact the blade to the Yankee surface, if the unit is not oscillating.

Start-up

Assuming that the Yankee dryer is operating and the paper machine is in a start-up mode.

- 1. Start oscillator motor with switch located on control panel with doctor blade controls (CB4).
- 2. Ensure doctor blades have been positioned in each doctor blade holder.
- 3. Ensure that the dryer coating and release agent chemical pumps are operational.
- 4. Check the coating/release agent shower bar for spray or plugged nozzles. Allow coating spray to contact Yankee surface to begin coating development.
- 5. Load the cleaning doctor briefly to remove any debris which may have accumulated on the Yankee surface.
- 6. Prior to lowering the pickup shoe which can be done through control box (CB4) load the creping blade to the required load pressure.
- 7. Lower pickup shoe (assuming press section operational). When sheet contacts the creping blade ensure that the sheet is directed into the broke chute.

- 8. Thread tail by allowing tail to contact Fibron system
- 9. When tail is at reel and being blown into broke chute, widen the sheet using the full width or widen button, located on control box or at Reel console.
- 10. When full sheet is established at the reel, inspect the condition of the sheet for "pick-outs" or holes which may originate at the creping blade.
- 11. When the creping blade must be changed, load the knock-off blade first and ensure that the sheet is removed at the knock-off blade.

Following this action, unload the creping blade holder and remove the blade from the tending side. Replace with new blade and reload the creping blade holder. When the creping blade is loaded and oscillating, unload the knock-off blade and rethread the tail.

Shutdown Procedure

Ensure that the sheet is off the paper machine before lifting either the knock-off or creping doctor.

When sheet is off machine, lift blades and inspect each blade for wear; replace if necessary.

If shut down is for a long duration, stop electric motor at SEW reducer (stops oscillating mechanism).

Avoid contacting the doctor blades to the Yankee surface for long periods of time with no sheet on the paper machine.

Safety Precautions

Never handle doctor blades without protective gloves.

Always handle the blades with care to prevent damage to the blade and possible injury to self and other team members.

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Trouble Shooting

There are many variables which impact the creping process. In order to effectively trouble shoot the problems associated with creping, it should be determined whether its a coating problem or a mechanical difficulty at the creping doctor. Creping problems are not isolated to the area near the creping doctor but can extend back to the slice and initial formation zone.

(A) Tight Adhesion

Possible Causes and Some Suggested Remedies

- 1. Yankee surface temperature too high.
 - Check steam pressure and reduce slightly.
- 2. Hood supply and exhaust nozzles may be plugged.
 - If the nozzles are plugged moisture variations could be creating the creping problem. Open the hood and clean.
- 3. Basis weight variations.
 - High BW value in the CD direction can result in excessive adhesion.
 - Check BW trend (MD) and profile (CD) and correct high spots.
- 4. Too much dryer coating.
 - Decrease dryer coating addition to reduce tackiness and layer thickness.
- 5. Too little release agent.
 - Check release agent addition rate and increase slightly. Avoid high addition rates.
- 6. Creping pressure may be too low.
 - Raise creping pressure slightly.
 - Do not exceed maximum value and avoid excessive removal of Yankee coating.
- 7. Creping Blades may be Worn.
 - Change Creping blades.

8. Creping blade contact angle is incorrect.

• Adjust creping blade to a position where approx. 38.0mm (1 1/2") extends above the doctor holder.

9. Creping doctor misaligned.

• Use knock-off doctor until maintenance can realign the holder.

(B) Loose Adhesion

Possible Causes and the Suggested Remedies.

1. Yankee surface temperature low.

• The sheet will release more readily from a "cool" surface. Check steam pressure and increase slightly.

2. Hood supply and exhaust nozzles may be plugged.

• If the nozzles are plugged, moisture variations could be creating the creping problem. Open hood and clean.

3. Basis weight variations.

- Low BW values can result in poor adhesion.
- Check BW trend (MD) and profile (CD) and correct low spots.

4. Too little dryer coating.

• Increase dryer coating addition slightly to improve tackiness.

5. Too much release agent.

• Reduce release agent addition slightly. The release agent may be disrupting the coating formation and this decrease could lead to better coating development.

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(C) Caliper (Bulk) Variations in Cross Machine Direction (CMD).

Suggested Remedies

1. Check Basis Weight profile.

- Variations to BW profile can contribute to poor creping and uneven doctor blade wear.
- Correct high or low spots to attain a uniform profile.

2. Check moisture profile.

- Variations to the moisture profile can contribute to poor creping and uneven doctor blade wear.
- Correct high or low spots to attain a uniform profile.

3. Check wires for streaking.

Nonuniformity in the sheet following the formation stage can impact creping.

4. Check felt condition.

• A plugged or dirty felt can cause moisture variation at the creping doctor.

5. Check press loading.

• An improperly loaded or crowned suction press or pressure rolls can cause moisture variations at the creping doctor.

6. Check drying section.

• Partially blocked areas in the hood supply air nozzles can result in non-uniformities resulting in poor creping.

7. Dirty or worn creping blade.

• Check and replace if necessary.

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(D) Crepe - Too Coarse

If the crepe is too coarse (less soft) check:

1. Creping blade level angle.

• Increasing this angle will produce a finer (tighter) crepe.

2. Creping blade thickness.

• A thinner blade will contribute to a finer crepe.

3. Crepe Ratio.

- Adjust crepe ratio by slowing the reel speed.
- A tight draw between the Yankee and the reel may be pulling the crepe out of the sheet.

4. Sheet Moisture.

- If the sheet is too wet at blade contact, the crepe will be coarse.
- Adjust the moisture target or increase steam pressure.

5. Felt Condition.

• If felt is worn or streaks have developed it may lead to poor moisture profiles which will impact creping.

6. pH Fluctuations.

• If the pH at the headbox is out of the neutral range (6.8 - 7.2 pH) it may impact coating development and should be readjusted to achieve neutrality.

7. Oil in the system.

• With oil based defoamers, the release from the Yankee can be affected. If defoamer addition is high reduce if possible (ie., no impact on sheet formation).

(E) Crepe - Too Fine

If the crepe is too fine, check:

- 1. Creping blade level angle.
 - Decrease this angle to produce a coarser (loose) crepe.
- 2. Creping Blade Thickness.
 - A thicker blade will contribute to a coarser crepe.
- 3. Crepe Ratio.
 - Speed up the reel and open the sheet slightly.
- 4. Sheet Moisture.
 - If the sheet is too dry at blade contact, the crepe will be fine.
 - Adjust the moisture target or decrease steam pressure slightly.

(F) Low Caliper (Bulk)

Note: Low bulk equals poor stretch

Possible Causes and Suggested Remedies.

- 1. Poor adhesion rate.
 - Check adhesion chemical addition rate; increase if required.
 - Check release chemical addition rate; reduce if required.
- 2. Position and condition of doctor blade and holder.
 - Check creping blade and pressure loading; adjust if required.
- 3. Tight draw between creping blade and reel.
 - Tight draw will pull crepe out of sheet reducing caliper and stretch.
 - Reel speed should be decreased.

4. Over pressing.

- Decrease press loading if above standard.
- 5. Excessive pressure at reel secondary arms.
 - Reduce pressure slightly. Can compact the sheet as reel builds.
- 6. Calendering load excessive.
 - Reduce calender nip load and monitor caliper.

(G) High Caliper (bulk)

Possible Causes and Suggested Remedies.

- 1. Tight Adhesion.
 - Check adhesion chemical addition rate; decrease if required.
 - Check release chemical addition rate; increase if required.
- 2. Position and condition of doctor blade and holder.
 - Check creping blade and pressure loading; adjust if required.
- 3. Slack draw between creping blade and reel.
 - Increase reel speed.
- 4. Under pressing.
 - Increase press loadings if below standard.
- 5. Low pressure at reel secondary arms.
 - Increase pressure slightly and monitor caliper.
- 6. Calender nip load low.
 - Increase calender nip pressure.

(H) Picking

Picking occurs when the fiber/cylinder adhesion is greater than the fiber/web cohesion.

Possible Causes and Suggested Remedies.

1. Dirty dryer surface.

- Put the cleaning blade against dryer to clean off as much as possible.
- Cut back on dryer coating.
- Change creping doctors frequently.

2. Sheet sticking to dryer

- Cut down on dryer adhesion chemical.
- Reduce dryer surface temperature by reducing steam pressure.

3. Creping doctor geometry wrong.

- Check doctor blade position and adjust if out of specs.
- Set doctor blade 1/2" above in doctor blade holder backing blade. (or 1 1/2" above doctor holder lip).

4. Creping doctor pressure too low.

• Increase slightly but only to a maximum value. Maximum creping pressure is 2.5kN/m.

5. Too much time between blade changes.

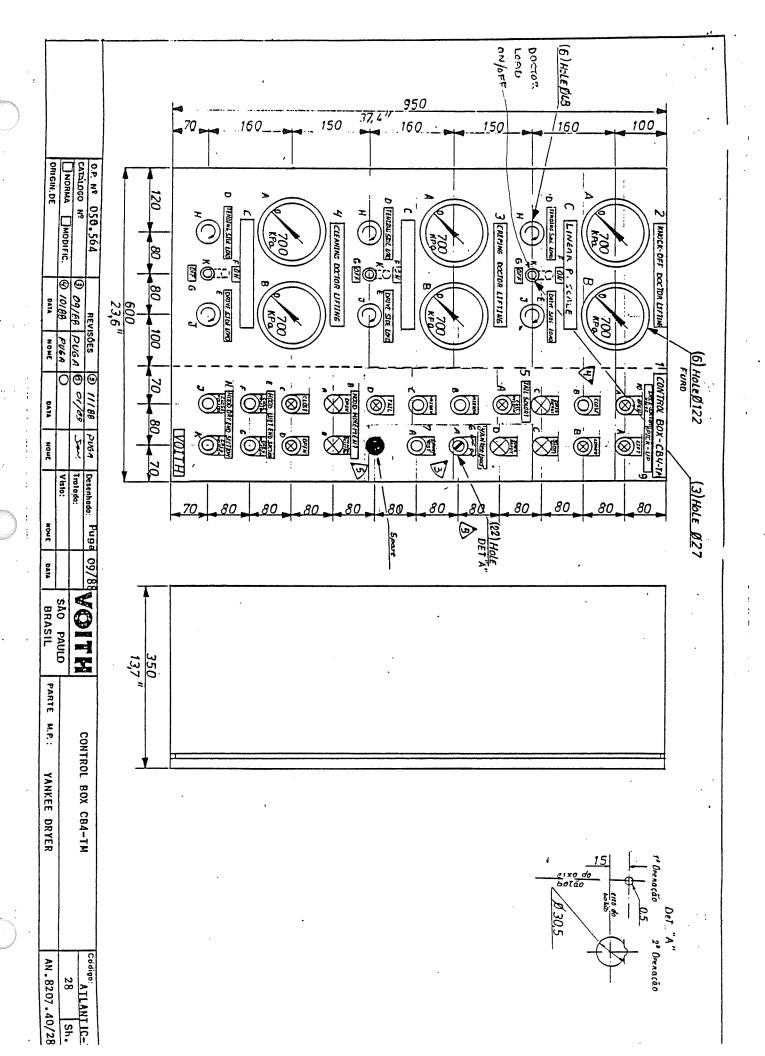
Change creping blades more frequently when getting doctor picks.

6. Over-refining.

• Excessive amount of fines can result in picking; reduce 0 SDM refiner load slightly.

7. pH fluctuations.

• Check headbox pH and adjust if necessary (neutral pH 7.0).



H- 0210 BRI - PRESSURE REGULATOR (TENDING SIDE)	A- CLEANING DUCIOR LIFTING A- 0210 ANI - PRESSURE GAUGE (TENDING SIDE) E- 0210 ANZ - PRESSURE GAUGE (DRIVE SIDE) C- LINE PRESSURE SCALE AN.8402.11/7	J- 0209 DR1 - PRESSURE REGULATOR (DRIVE SIDE) K- 0209 WMI - HAND VALVE	SSURE SCALE AN.8402.11 NE ABOVE	5- 0209 AND - PRESSURE GAUGE (DRIVE SIDE) 6- 0209 AND - PRESSURE GAUGE (DRIVE SIDE)		F- ON G- OFF H- 0208 DRI - PRESSURE REGULATOR (TENDING SIDE) .		1- CONTROL BOX CB4-TM 2- KNOCK-OFF DOCTOR LIFTING A- 0208 ANI - PRESSURE GAUGE (TENDING SIDE) B- 0208 ANZ - PRESSURE GAUGE (DRIVE SIDE) C- LINE PRESSURE SCALE AN.8402.11/5
	IO- STOCK SHUT-OFF VALVE A- 0236 IPBI - OPEN B- 0236 PBI - CLOSE C- 0236 LI - OPERATION READY	9- PICK-UP A- 0200 IPB2-LIFT B- 0200 IPBI-LOWER C- 0200 LI - 30mm LIMIT D- 0200 L2 - OPER.READY	H- HOOD DRY END SECTION J- 0326PB3-CLOSE POSITION K- 0326PB4-OPEN POSITION		8- HOOD NOVEMENT A- 0326 LI OPEN B- 0326 L2 OPERATION POSITION (5) C- 0326 IPBI CLOSE	A- 0211:SSI - OFF - ON 7- 0153 PB4- LAMP TEST	6- YANKEE DOCTOR OSCILLATION	¥ 5- TAIL SQUIRT A- 0180 IPB3 = FULL WIDTH B- 0180 PB3 - NARROW C- 0180 PB4 - WIDEN D- 0180 IPB4 - TAIL

34 ;

K- 0210 WMI - HAND VALVE

NORMA ORIGIN. DE

MODIFIC.

| REVISÕES | Ø /

Visio: Imiodo: waco-

HOME

SÃO PAULO BRASIL

PARTE M.P.: YANKEE DRYER

AN. 8207.40/2

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111-2

CONTROL BOX CB4-TM

11/185

PUGA Desenhodo: Puga 08/88

02,09.11 DATA

CATALLOGO Nº

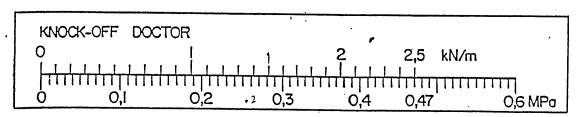
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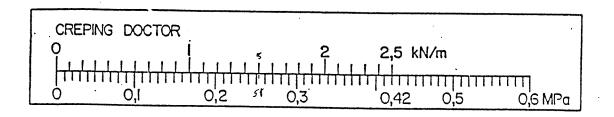
J- 0210 DR2 - PRESSURE REGULATOR (DRIVE SIDE)

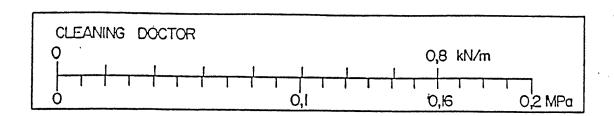
Doctors are fitted with pneumatic cylinders for achieving linear pressure on blade contact.

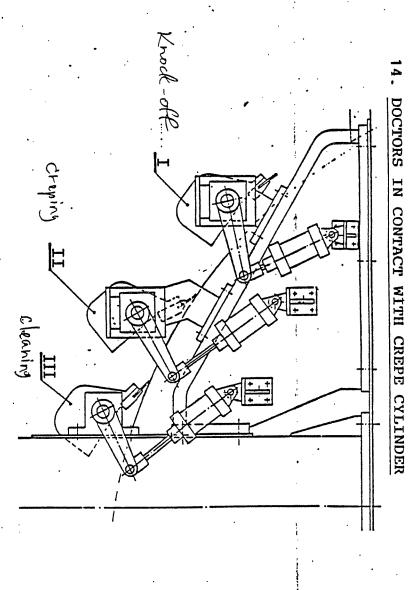
As a function of configuration for installation, each doctor has a linear pressure scale.

CB-4



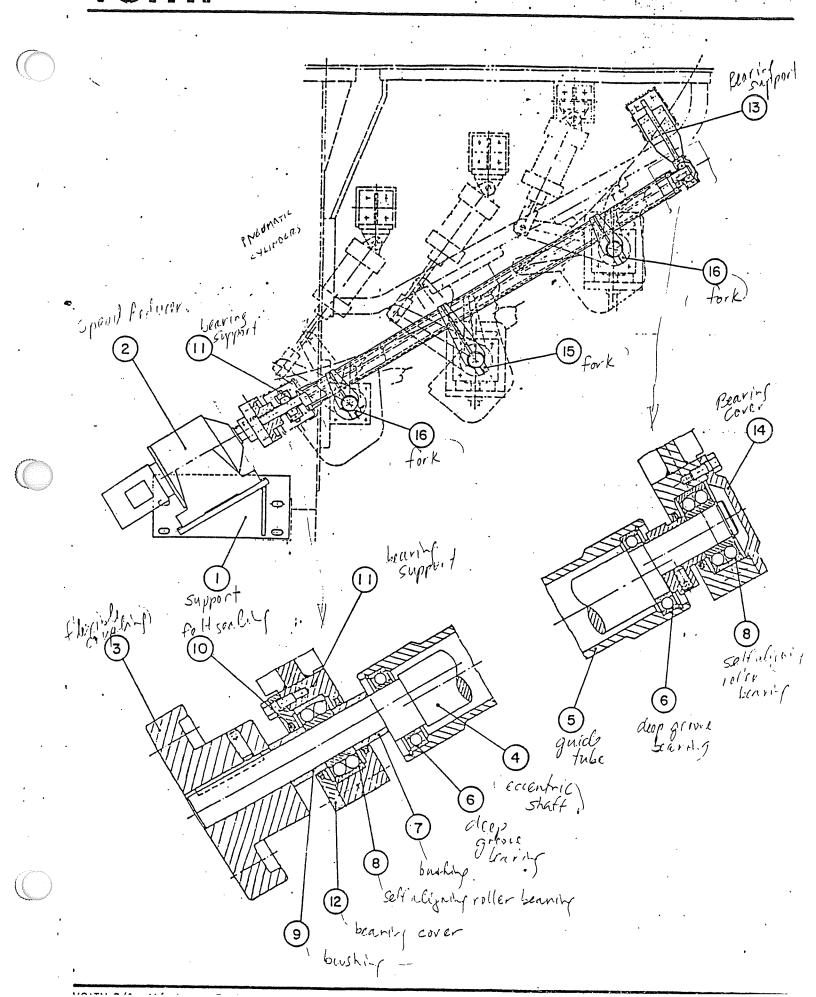


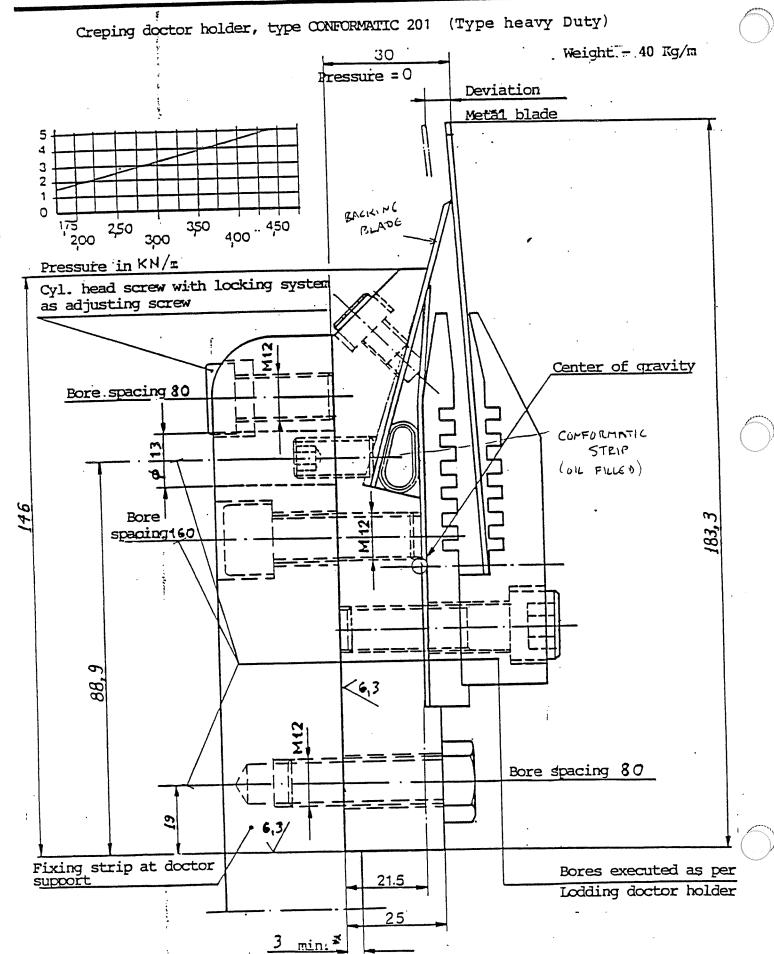




conditions. Machine is fitted with three doctors in the following

			1	Z	•,
=		•		NO.	
111 Cleaning	Creping	Take-off		FUNCTION	
Stepped- 7 grooves-std	Heavy duty	Stepped-7 grooves-std.		BLADE HOLDER	•
0,8	2,5	2,5	M/NA	LINEAR P	
4,5	14	14	IB/IN	CONTACT LINEAR PRESSURE	
20º	20º	20º		ANGLE OF ATLACK OF BLADE	ATTACK



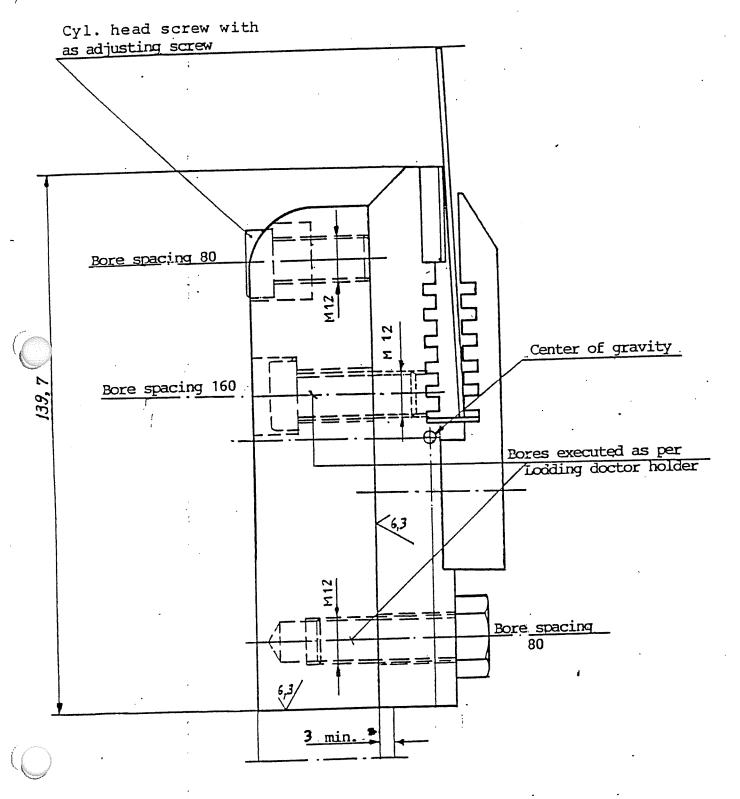




Fixing strip at the doctor support for creping doctor holder - type III (Ladder cleanning and knoch - STD)

KNOCK OFF + CLEANING

Weight = 26,53 Kg/m



^{*}For useful lengths over 4000 mm = shoulder 5 mm

		,	

Calender Stack

Purpose

To control the bulk or caliper and provide a smooth finish to the sheet of paper.

Process Description

The calender stack consists of two aquitherm rolls, a hydraulic loading mechanism, a bottom roll misaligning device, paper guide rolls, doctors and tail transfer system.

The sheet is creped-off the Yankee surface and directed through the single nip calender stack. The bottom roll is loaded against the top roll to form a hard nip between the two steel rolls. The maximum nip loading pressure is 30 kN/m. The tending side and drive side loads can be independently adjusted to control the edges of the sheet.

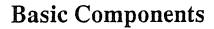
Low pressure condensate is delivered to the Aquitherm rolls from Seperator Flash Tank 2 by pump (CP-03). The pump delivers approximately 37000 kg/hr at 90°C to the tending side inlet of the calendering rolls. Condensate exits the calender rolls on the tending side (separate ports) and either flows back to S2 or the suction of pump CP-03. Basically, this loop provides hot water for the calender rolls which heat the sheet and assist in the calendering operation.

A control loop (TIC 309) controls the temperature of the condensate feeding the calender rolls to a maximum of 90° C. A sensor is located in the return line from the calender rolls which measures the return water temperature. The controller regulates two valves which either directs the water back to S2 or to the suction of the pump (CP-03). The water added at the suction of the pump will be slightly cooler than the condensate in S2 due to heat transfer at the rolls and losses in the loop. This water addition would regulate the inlet water to the pump (which in S2 is approximately 111°C). In this manner, the temperature to the calender rolls is controlled to set point.

The sheet exits the calender nip and is directed to the reel drum and wound onto reel spools.

The sheet is threaded onto the reel spools from the Yankee doctor by the Fibron durrand system. A 6 inch tail is threaded via conveyors and air jets to the reel drum. The sheet is then widened out and wrapped onto the reel spools.

2 Machine Manual



The major components of the calender stack are:

- Aquitherm Rolls
- Hydraulic Loading Mechanism
- Bottom Roll Misaligning Device
- Guide Rolls
- Doctors
- Fibron Durrand Tail Transfer System

1. Aquitherm Rolls

Purpose

To improve the finish of the creped sheets by utilizing controlled temperature rolls.

Description

Hot water (condensate) from separator 2 is pumped by CP-03 to the tending side of the two controlled temperature (Aquitherm) rolls. The hot water circulates through the shell roll and exits out the tending side (separate port). The hot water uniformly heats the internal surface of the calender roll which raises the temperature of the outside surface of the rolls. This uniform hot surface imparts a smoother surface finish to the sheet. (See Smook Figure 17-37).

A control loop controls the temperature of the condensate feeding the calender rolls to a set point (maximum temperature 90°C).

Technical Data

Aquitherm Roll Diameters 450 mm
Bearing Centreline Distance 3800 mm
Drives (Top and Bottom Rolls) ASEA

Drives (Top and Bottom Rolls)

Water Temperature

ASEA

90° C (max)

Nip Pressure 30 kN/m (max)

Roll Surface Stainless Steel
Hot Water Joint: Inlet Tending side

Outlet Tending Side

2. Hydraulic Loading Mechanism

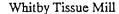
Purpose

To lift and load the bottom calender roll against the stationary top calender roll.

Description

High pressure hydraulics are used to lift the bottom roll and also load the bottom roll against the stationary top roll. The nip pressure variation is determined as a function of the hydraulic pressure on the cylinders as per dials on control panel CD2-TM.

Graph 1 illustrates that a hydraulic pressure of 20 kgf/cm² on each cylinder (TS and DS) is required to lift the bottom roll into contact with the top roll. Maximum nip pressure of 30kgf/cm² requires a hydraulic pressure of 42.5 kgf/cm² (kN/m) on each cylinder.



3. Bottom Roll Misaligning Device

Purpose

To align the top and bottom calender rolls to ensure a uniform nip impression across the entire width of the calender stack.

Description

The misaligning device is used to align the bottom calender roll with the top calender roll. Generally, this procedure is required after a roll change. The maximum lateral movement of the bottom calender roll is + or - 10 mm.

Nip impression paper is used to determine the nip pressure profile between the top and bottom rolls. For the most accurate nip impression, the calender stack should be in operating condition (ie., heated rolls). The bottom roll is realigned using the misaligning device. A new nip impression should be taken until the nip pressure profile is uniform across the width of the machine. (see fig. 3).

4. Guide Rolls (Paper Rolls)

Purpose

6

To direct the sheet (web) from the creping doctor to the calender stack and from the calender stack to the reel drum.

Description

There are two guide rolls between the creping doctor and the reel drum. One guide roll is located between the Yankee and the calender to guide the web into the calender stack. The other guide roll is situated between the calender and the reel to guide the web through the Measurex scanner and under the spreader roll (the spreader roll will be discussed in the reel section). The two guide rolls have a diameter of 214 mm. Each roll is equipped with associated bearings and roll supports.

5. Doctors

Purpose

To ensure that the sheet does not wrap either the top or bottom calender rolls. Also, to keep roll face clean from dust, paper fragments and dirt.

Description

There are two doctor blades in the calender section. One doctor is loaded onto the top roll and one doctor is loaded onto the bottom roll.

Each doctor is fitted with K35A lodding accumate type blade holder and policlouth super blades and is operated with a nip pressure of 13.3 g/cm on the top roll and 12.5 g/cm on the bottom roll. The doctor linear pressure is due to the dead weight of their blade holder bodies and pneumatic cylinders are used for lifting them off.

The doctor bearings are fitted with ball bushings providing a soft cross sliding of doctors. Hydraulic doctor oscillation is made with the aid of micro-pistons installed on the tending and drive sides for a 7.5 mm stroke.

6. Fibron Durrand Vacuum Tail Transfer System

Purpose

To pass a 6 inch tail from the creping doctor to the reel drum. This is required during start-ups and machine sheet breaks.

Description

The durrand vacuum tail transfer system consists of three vacuum tail transfer conveyors, two reel threader units and several air jets used to guide the tail from each conveyor to the next.

Conveyors "A" and "B" are located between the Yankee creping doctor and the calender stack. Both conveyors are located on the drive side of the sheet run. The vacuum tail transfer conveyors consist of the following:

- 1. Conveyor Frame
- 2. Slotted Cover
- 3. Drive Pulley
- 4. Drive Belt
- 5. Idler Pulley
- 6. Conveyor Stand
- 7. Motor
- 8. Paper Shoe
- 9. Air Deflector
- 10. Air Jets
- 11. Spiraflex Belt 8" wide by 90"
- 12. Pneumatic Cylinder
- 13. Vacuum Hose Connection

The tail is blown off the creping doctor by an air jet 330 mm long mounted on the creping doctor holder at the drive side of the machine. The air jet guides the 6 inch tail to the leading edge of conveyor "A". The tail is then drawn to the moving belt by vacuum supplied by a fan unit. The tail is conveyed along the belt to the trailing edge, where an air jet is used to break

the vacuum and release the tail. The tail continues onto conveyor "B" which is of similiar design as conveyor "A".

The tail is then directed through the open calender stack, by another air jet located at the trailing edge of conveyor "B", to conveyor "C". At the trailing edge on conveyor "C" air jets are used to direct the tail to the first of two deflectors (reel threaders). This defelector utilizes air jets to direct the sheet around the reel drum. The second deflector directs the sheet over the reel drum and into the nip between the reel spool and reel drum and down into the dry end pulper.

After the tail has stabilized (running into the pulper) the sheet is widened out by the controls on CB-4 (see page 33-37 Duoformer Section), while another operator blows the tail onto the reel spool. At this point the sheet is on the reel full width and the spool is lowered by the primary arms into the secondary arms where the reel is built.

Conveyors "A" and "C" are equipped with pneumatic cylinders which pivot the conveyors out of the way from the walkway and the Measurex scanner respectively.

The air jets are supplied with a minimum pressure of 0.4 bar very dry air. A 10F fan unit located between the Measurex system and the reel drum supplies the required vacuum to the three conveyors.

All the conveyors travel faster than the paper speed, with each conveyor travelling a bit faster than the preceding one. These speed differentials pull the tail tight. The vacuum under the belt prevents the tail from wandering or fluttering and combined with the speed differentials and air jets permits accurate transfer of the tail from one conveyor onto another conveyor.

Initially, the air flow from the paper shoe plenum chamber will have to be adjusted to provide only sufficient backflow of air to separate the paper from the belt as it passes around the trailing edge pulley - too much air will blow the paper off the belt and create turbulent conditions - too little air will not separate the paper from the belt, paper would then engage the paper shoe and jam up. Upon achieving the proper air flow, lock needle valve using locknut supplied.

The air jets are used to create a platform of air for transferring paper from the conveyors. It can also be used to direct the paper in other than a straight line by changing the angular position of the discharge holes using set screws in the locking collar. After setting both the angular position and the optimum air flow required, lock both the set screw in the locking collar and use the lock nut on the needle valve to securely fasten both items.

Note:

The air supply on both types of air jets should be kept to the optimum. Unwanted turbulent air is detrimental to these tail transfer systems.

Technical Data

Conveyor "A"

Length: 914 mm
Width: 200 mm
Belt Length: 2286 mm

Pneumatic Cylinder: Yes

Belt Speed: 10% (faster than paper speed)

Motor: 3 hP 3600 rpm

Conveyor "B"

Length:635 mmWidth:200 mmBelt Length:1727 mm

Pneumatic Cylinder: No

Belt Speed: 10% (faster than Conveyor "A")

Motor: 3 hP 3600 rpm

Conveyor "C"

Length:1372 mmWidth:200 mmBelt Length:3200 mm

Pneumatic Cylinder: Yes

Belt Speed: 10%(faster than Conveyor "B")

Motor: 5 hP 3600 rpm

Fan Unit

Inlet Diameter: 200 mm
Impeller Diameter: 381 mm
Impeller Bore Diameter: 35 mm

Outlet Diameter: 152 mm (flexible hose connection)

Motor: 7 1/2 hP 3600 rpm

Technical Data-Calender Stack

Trim: $2650 \text{ mm } 12.5 \text{g/m}^2 - 40 \text{ g/m}^2$

Operating Speed: 524-1677 m/min
Designated Speed: 1800 m/min

Nip Pressyre: 30 kN/m (maximum)

Roll Diameter: 450 mm
Bearing Centerline: 3800 mm

Hot Water Rolls

Temperature: 90° C (maximum)

Central Lubrication

The bearings for the calender rolls and guide rolls are all connected to the paper machine central lubrication system. Therefore, an interlock between the drive and lubrication flow will prevent the calender to be started with no lubrication flow to the bearings. Also, during operation if the liubrication system fails the calender drives will stop.

Operating Parameters

With the calender stack, caliper, smoothness and surface finish can be controlled by:

- Nip Pressure
- Temperature.

1) Nip Pressure

The nip pressure can be controlled from 0 kN/m to 30 kN/m (see graph). The nip pressure can be applied uniformly across the stack by adjusting the drive side and tending side dials on CD2-TM simultaneously. Also, the drive side and tending side dials can be adjusted independently to offset reel profiling irregularities. The operator will have to set the nip pressure to correspond with converting specifications to achieve desired results, this will be determined over time. The sheet can also be run on the reel with the stack open to achieve no calendering, especially with towel grades where high caliper and high bulk are desired.

2) Temperature

The temperature can be adjusted by changing the set point to the desired value to achieve optimum surface furnish characteristics without affecting the caliper of the sheet. The higher the temperature the smoother the finish to the sheet without a resulting change in caliper.

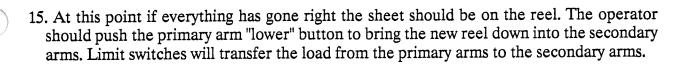
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Start-up and Operating Procedures

(after a shut down for maintenance)

The calender stack is cold and is in the open position during shut downs to prevent roll barring.

- 1. Check that all central lubrication hoses are connected to all bearings in the calender section (ie., hot water rolls and guide rolls).
- 2. Check that doctors are unloaded
- 3. "Close" calender stack
- 4. Start pump CP 03 to circulate hot water (condensate) through rolls.
- 5. Push "crawl" to start stack up.
- 6. Load doctor blades (top and bottom rolls).
- 7. After the calender rolls reach the desired temperature, push "run" to speed it up to operating speed. The paper guide rolls, calender and reel should be synchronized and adjusted for the creping ratio.
- 8. "Open" the calender rolls to enable threading of the tail and consequently the web.
- 9. "Start" the fan unit for the tail transfer conveyors (the pilot light should be on).
- 10. Swing pivoting conveyors "A" and "C" into thread position.
- 11. Start the three conveyors.
- 12. If the tail squirt was in automatic mode, then the break detector photocell will set the tail squirt in the tail position. If the tail squirt is in manual mode, then the operator will have to push the "tail" button on CB 4 to set up the tail for threading. (see pages 33-37 Duoformer Section).
- 13. Start the tail threading from the creping doctor drive side. Use a short air blast to deliver a 6 inch tail to conveyor "A". Do not leave the air on at the creping doctor for very long as it could displace the tail on the conveyor. When threading the tail someone should be situated at the reel drum to make sure the tail goes into the broke chute and not on to the reel spool.
- 14. When the tail stabilizes while running down at the reel drum, the operator pushes the "full width" button on CB 4 while the second operator blows the tail up and onto the reel spool.



- 16. "Stop" the three conveyors.
- 17. Swing pivoting conveyors "A" and "C" into park position.
- 18. Stop the fan unit for the tail transfer conveyors.
- 19. "Close" the calender stack. (Make sure calender stack is at the desired speed).
- 20. "Load" the calender stack to the desired nip pressure (30 kN/m maximum).
- 21. "Start" the Measurex scanner.

Note:

Procedures 8-21 should be followed for every sheet break at the Yankee creping doctor.

Shutdown Procedure

- 1. "Stop" the calender drives.
- 2. "Open" the calender stack.
- 3. "Unload" the doctor blades. Inspect for wear, change if required.
- 4. Shut pump Cp 03 to stop the hot water circulating through the rolls.

Note:

Lock out drives when working around the calender stack.

Troubleshooting

1. Calender Cuts

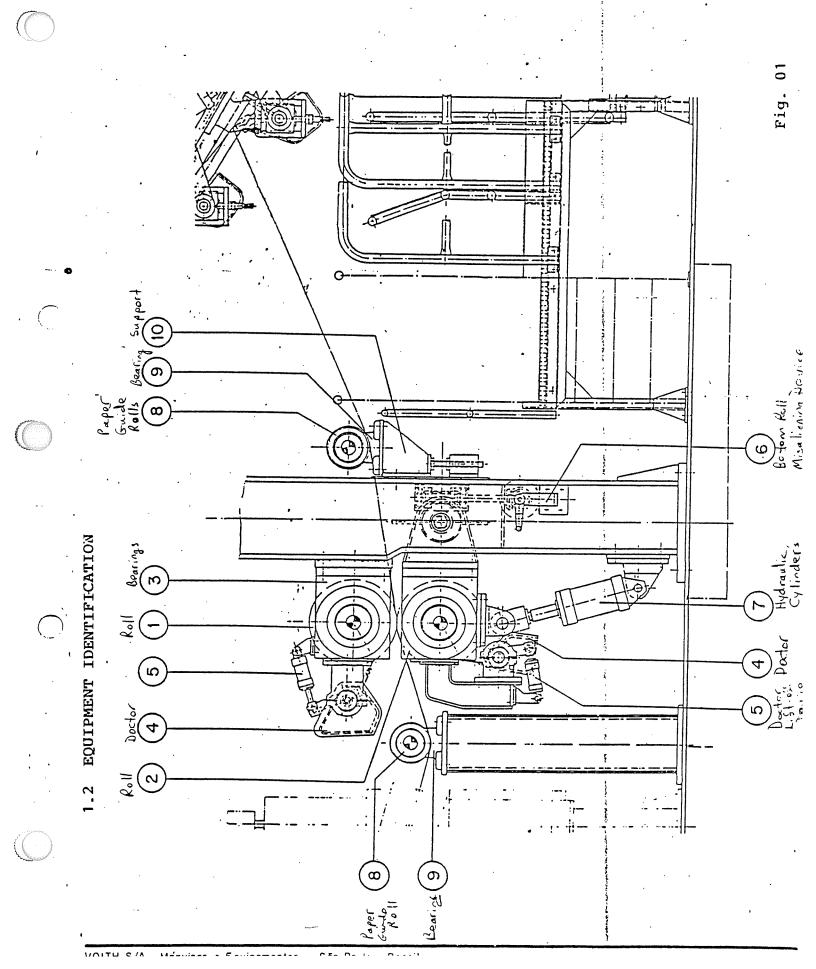
- Check draws
- Check basis weight and moisture profile, especially for wet streaks. If excessive, correct at slice.
- Draw swinging Adjust accordingly.

2. Barring

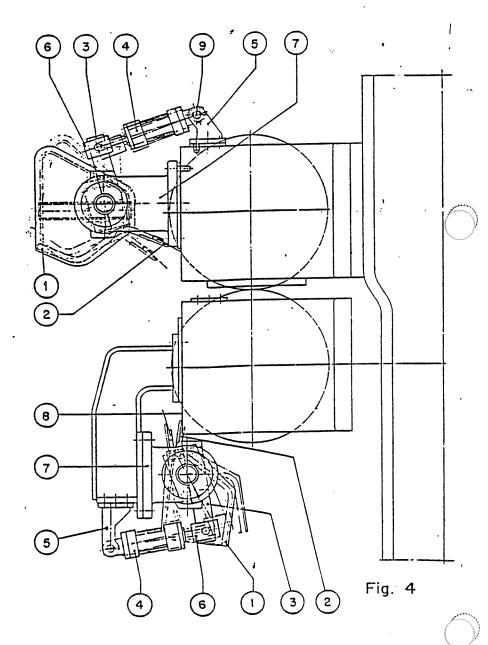
Barring is usually caused by high frequency vibrations and is usually corrected by offsetting rolls (design).

3. Breaks

- Check draws- Adjust accordingly. If draws are swinging notify electrician.
- Holes on edge of sheet Check wet end for lumps, felt edges filled up, dirt falling off on press.
- Pick ups at stack Check wet end for lumps and dirt.
- Sheet too dry Adjust steam pressure accordingly.
- Press felt too narrow This will cause a moisture streak to pick up at the stack. Move automatic guide palm to move felt accordingly.



- 1. Doctor body top bottom
- 2. Blade holder
- 3. Lift-off lever
- 4. Pneumatic cylinder
- 5. Support
- 6. Fork
- 7. Bearing housing top bottom
- 8. Blade
- 9. Ball socket joint



Alavanca 36431.8012

Lever Shaft

Eixo 36431.8012

Coroa do sem fim 36431.8014 Wormgear

Worm pinion Pinhão sem fim 36431.8014

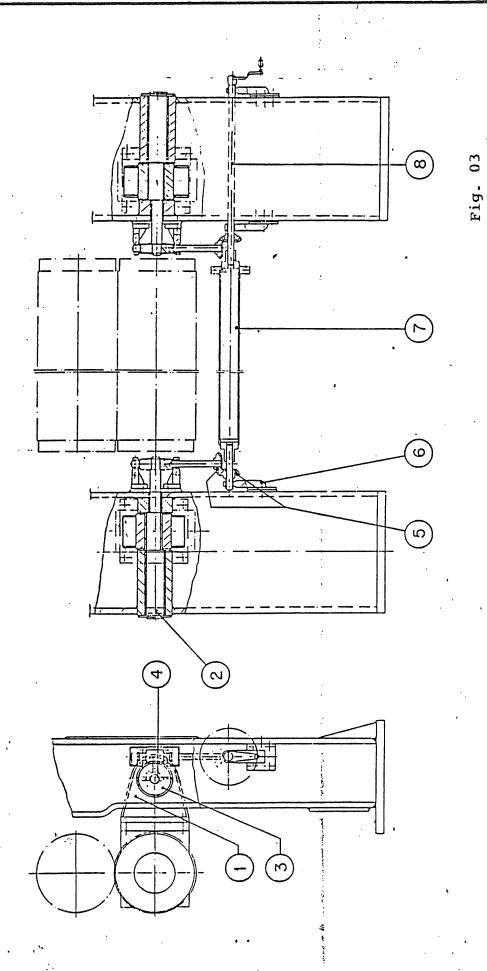
Engrenagem conica 36431.8014 Bevel gear Suportes 36431.8014

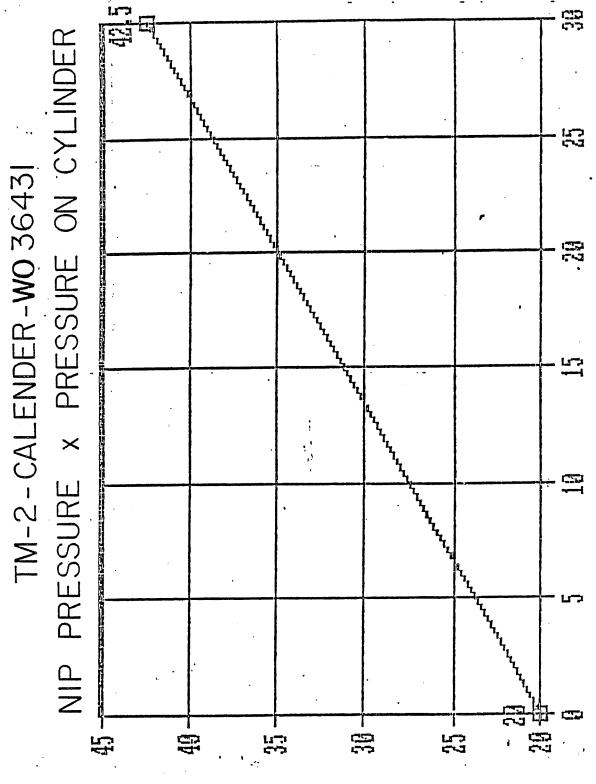
Acoplamentos 36431.8014

Eixos 37431.8014

Couplings Supports

Shafts

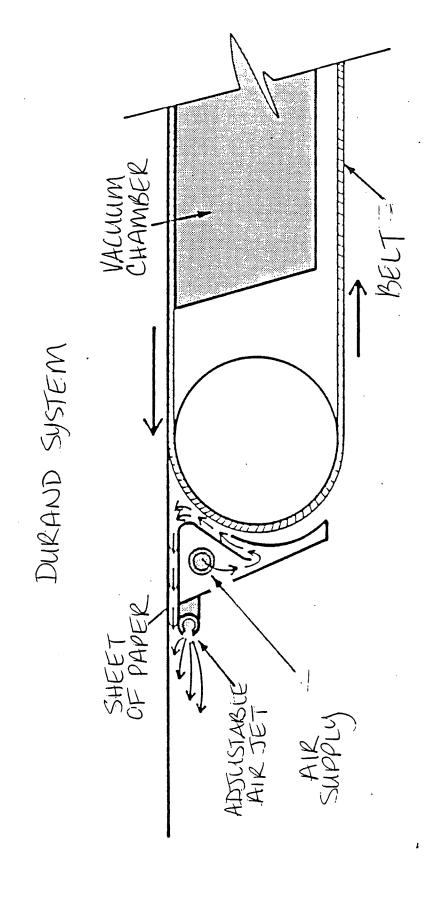


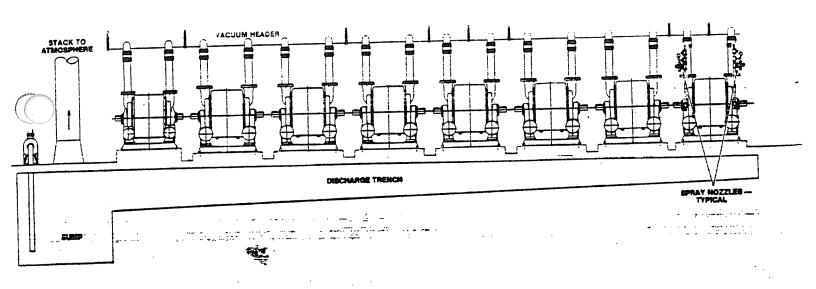


PRESSURE ON CYLINDER (Kgf/cm²)

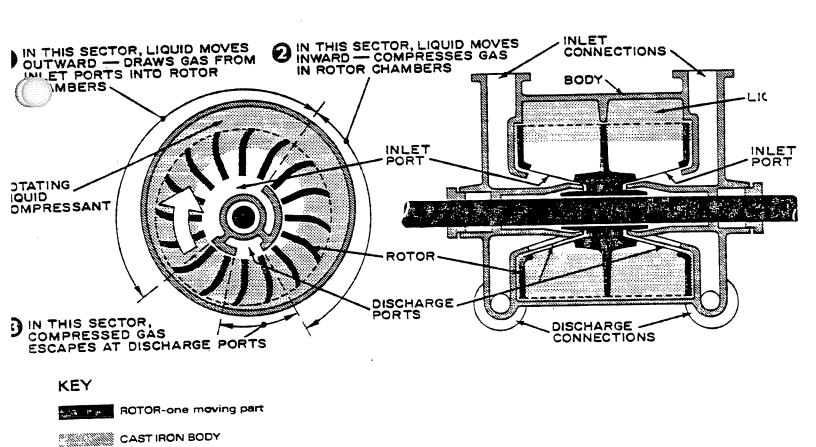
 \Box PC=20,00 + 0,75 · PL + Emb/haste = 6/2,5 (in

NIP PRESSURE (Kgf/cm)





. 16-90. Schematic diagram of paper machine vacuum system (Nash Engineering Co.).



ig. 16-91. Schematic of water-ring vacuum pump (Nash Engineering Co.).

LIQUID COMPRESSANT

Technical Data

Vacuum Pumps (Operating Instructions No. 2144e)

Type

15E

P54

Pressure:

(13 in Hg)

Air Flow Rate:

4.5mWg 263.95 m³/min

(9300 cfm)

Operating Water Flow Rate:

155 l/min

Drive:

Belt and pulley arrangement

Impeller Speed:

255 rpm

Pulley Diameter:

2000 mm

Motor

Manufacturer:

WEG

Power:

500Hp

Speed:

1180 rpm

Pulley Diameter:

432 mm

Seal Water Flow Rate:

50 l/min

P55

Pressure: 5.0 mWG (14.5 in Hg)

Air Flow Rate: 233.2 m³/min (8235 cfm)

Operating Water Flow Rate: 175 l/min

Drive: Belt and pulley arrangement

Impeller Speed: 235 rpm
Pulley Diameter: 2000 mm

Motor

Manufacturer: WEG

Power: 450 Hp

Speed: 1180 rpm

Pulley Diameter: 398 mm

Seal Water Flow Rate: 50 l/min

Note:

Bearings are grease lubricated with a recommended regreasing interval of 3 months.

P53 -Centrifugal Pump

Function

To pump extracted water from the collection trench to the vacuum pumps (ie., operating water) and to Tank 30 under level control.

Operating Data

Designation SL-205-GIII 10/12.5

Q = 1100 l/min

Pump Head 12 mWG

Start-up and Operating Procedures

(Machine Vacuums 10310)

Vacuum system should only be started when the fabrics are running.

Group XI - 3 events

- (1) Pump P53
- (2) Vacuum Pump P54
- (3) Vacuum Pump P55

Note:

Ensure all drains and header interconnecting valves (if both vacuum pumps running) are closed before starting.

1. Start P53 (VAM-295)

Permanent Interlocks

• Level in collection trench must be greater than or equal to 30%.

Process Interlocks

- First event of three events in Group XI.
- Signal transmitted to control parameters for group to signal pump is on.
 - Seal water valves
 - Level control collection trench
 - Temperature control operating water
- 1. Open seal water valve for pumps.
- 2. Open operating water valves at both vacuum pumps.

2. Start P54 (VAM-295)

Permanent Interlock

• Seal water valve must be open (SV-280/VAA-298) at Measurex.

Process Interlock

- Second event of three. P53 must be running before P54 will start.
- Check pressure gauge at position 5. Pressure should indicate approximately 4.5 mWG (13.0 in Hg).

3. Start P 55 (VAM-297)

Permanent Interlock

• Seal water valve must be open (SV-281/VAA-299) at Measurex.

Process Interlock

• Third event of three. P54 must be running before P55 will start.

Check pressure gauges at the following positions:

1	5.0 mWG (14.5 in Hg)
2	3.0 mWG (8.7 in Hg)
3	5.0 mWG (14.5 in Hg)
4	3.0 mWG (8.7 in Hg)
6	2.5 mWG (7.2 in Hg)

Shutdown Procedures

When shutting down the vacuum system ensure that the sheet is off the machine and the fabrics are running.

- Stop P55 vacuum at position 1,2,3,4,6.
- Stop P54 vacuum at position 5
- Stop P53 no operating water to vacuum pumps.

Close operating water and sealing water valves when vacuum system is down. Usually, an adequate amount of operating water remains in the vacuum pump so that upon restarting, the full suction is immediately available. For an extended shutdown and if the water is likely to freeze, flush the pump with clear water and drain the water that is trapped in the casing through the drain plugs.

Troubleshooting

Always analyze the process conditions first (ie., moisture/basis weight).

A. Pressure gauge indicates low vacuum

- 1. Check control valve; open if required.
- 2. Check position of edge deckles. If edge deckles are out too far, drawing air from atmosphere which reduces vacuum. Adjust deckles inward.
- 3. Check suction pipe and flanges for leakage. If leak detected, plug hole and notify maintenance department.
- 4. Check supply of operating water. If excessive water is in the pump it will reduce the vacuum level. Before adjusting operating water check vacuum levels at all positions connected to that pump. If vacuum level low at all points, slightly reduce the operating water flow with the valve and monitor vacuum levels.
- 5. Check operating water temperature. Vacuum pump efficiency improves with lower operating water temperatures. If set point greater than 26°C, reduce set point to a value no less than 23°C.
- 6. If all steps above, do not improve vacuum level, at the next shutdown the suction piping should be inspected for clogging and the clearance between the impeller and the casing should be checked. If clearance is extremely large it could represent the cause for vacuum loss.

B. Pressure gauge indicates high vacuum

- 1. Check control valve position; close slightly if required.
- 2. Check supply of operating water. The vacuum pump will develop more vacuum at lower flow rates. Before adjusting operating water check vacuum levels at all positions connected to that pump. If vacuum level is high at all points, slightly increase the operating water flow with the valve and monitor vacuum levels.
- 3. Check operating water temperature. Vacuum pump efficiency declines with increasing operating water temperatures. If set point less than 25° C, increase set point to a value no greater than 28° C.

Shower System

Purpose

To supply fresh water and clear (i.e., clarified) water to the shower points on the Tissue Machine.

Process Description

(refer to AN 3401.99)

This process description will outline the two water systems used for shower applications on the paper machine. Each system has a supply tank with centrifugal pump discharge. Booster pumps are also used to increase water pressure for higher pressure shower applications (i.e., fabric cleaning).

A detailed description can be found in the appropriate section of the training manual.

The fresh water is collected in Tank 32 from a variety of sources (outlined in diagram and appendix). The level in Tank 32 is controlled by loop LIC AHL 200 with fresh water addition (LV 200) from the main fresh water header. The discharge pump (P 48) supplies fresh water direct to the Tissue Machine and to the inlet of three booster pumps (P 49,P 50,P 51).

The clarified water is the clear water recovered from the Disc Filter and KROFTA 3 in Tank 30. The level in Tank 30 is controlled by loop LIC 234 with fresh water addition (LV 234). The discharge pump (P 34) supplies clear water direct to Tissue Machine and to the inlet of booster pump P 52.

Table 1 Fresh Water Showers

Operating	Data For Showers			
Shower #	Application	Pressure	Flow (l/min)	Operation
P 48	D 11 10	2 5	212	Cont -Non Osc
20	Roll 13	2 bar		
20	Roll 15	2 bar	212	Cont -Non Osc
20	Roll 16	2 bar	212	Cont -Non Osc
19	SPR Deckles	bar	70	Cont -Non Osc
21	PR Cover Cooling	2 bar	60	Cont
17	Pickup Shoe	2 bar	53	Cont -Non Osc
P 49				
2	Tail Cutter	12 bar	0.6	Discont -Osc
3	Trim Squirt	12 bar	0.6	Cont
6	Inner Wire Edge Cleaning	12 bar	82	Cont -Non Osc
13	Outer Wire Edge Cleaning	12 bar	82	Cont -Non Osc
P 50				
23	Felt Cleaning Shower	40 bar	54	Discont -Osc
P 51				
5	Inner Wire Clean.Shower	60 bar	110	Discont -Osc
14	Outer Wire Clean.Shower	60 bar	110	Discont -Osc
18	Suction Roll Clean.Shower	60 bar	82	Discont -Osc

Shower Section

Table 2 Clear water Shower System

Shower #	Application	Pressure	Flow (l/min)	Operation
P 34				
1	Inner Wire Suction Box	2 bar	52.5	Discont -Non Osc
4	Roll 2 Cleaning	3 bar	164.0	Cont-Non Osc
8	Inner Wire Clean.Shower Chemical	3 bar	149.0	Discont-Non Osc
12	Outer Wire Clean.Shower Chemical	3 Bar	149.0	Discont-Non Osc
9	Inner Wire Guide Roll	3 bar	203.0	Cont-Non Osc
10	Outer Wire Guide Roll	3 bar	203.0	Cont-Non Osc
11	Outer Wire Stretch Roll			
	Cleaning	3 bar	203.0	Cont -Non Osc
16	Headbox Lip Cleaning	2 bar	28.0	Cont -Non Osc
P 52				
7	Inner Wire Knock-off	12 bar	282	Discont -Non Osc
15	Outer Wire Knock-off	12 bar	282	Discont -Non Osc

Start-up and Operating Procedures

Clarified Water System

- 1. Open clear water valve to the Duoformer (1359).
- 2. If level of Tank 30 is established (auto or manual) start P 34. This pump will supply low pressure clear water to the following application points:

Shower #	Application
1	Inner Wire Suction Box (no sheet on machine).
4	Roll No. 2 cleaning shower (inner wire).
9/10	Guide Rolls (nos. 4 and 6) cleaning showers (both wires).
11	Roll No. 7 stretch roll outer wire.
16	Headbox lip cleaning shower and when using chemicals on wires.
8/12	Cleaning showers with chemical addition.

3. When wire section is running (ASEA 152.3) and valve at inlet to booster pump P 52 (1353) is opened start P 52. This pump will supply higher pressure (12 bar) clarified water to the knock-off showers for both wires (showers 7 and 15). These showers should be activated

when sheet is being established or removed from paper machine. They should not be activated when sheet is on the tissue machine (no break condition).

Fresh Water System

- 1. Set level controller for Tank 32 to either control level automatically or open fresh water makeup valve. This ensures that fresh water is continuously flowing to the tank.
- 2. If level is greater than or equal to 30% start P48. This pump will supply low pressure (3 bar) fresh water to the following application points:

Shower #	Application
20	Felt Rolls 13,15,16.
19	Suction Roll Deckle Lube.
21	Pressure Roll Cover Cooling Shower.
17	Pickup Shoe Lube Shower.
24	Uhle Box Sealing (Lube) Showers.

It will also supply water on a discontinuous basis to the reel drum (Shower 25) for turn up.

3. In order to prepare the Duoformer for operational conditions, when wire section is at run condition (ASEA) open valve at suction booster pump P49 (Valve 1302). Start P 49. This pump will supply fresh water at 12 bar to the following application points:

Shower #	Application
2	Tail Cutter
3	Trim Squirts
6	Inner Wire Cleaning
13	Outer Wire Cleaning

4. In order to accomplish effective high pressure cleaning of the fabrics and felt two booster pumps are used.

P 50 supplies fresh water at 40 bar to the felt at shower position 23. Open valve 1304 only if the felt section is in run condition (ASEA 152.5). Start P 50.

P 51 supplies fresh water at 60 bar to the cleaning showers at the Duoformer (5 and 14). It will also supply high pressure fresh water to the suction roll cleaning shower. If both the felt and wire section is in the run condition (ASEA) open valve 1306 at suction of P 51 from Measurex. Start P 51.

Appendix

Pumps and Tanks

Tank 32 (10m³)

Shower Feed Tank -Fresh Water Only

IN:

- Fresh Water -Level control (LV 0200) normal 685 l/min minimum 493 l/min.
- Condenser -Steam and condensate heat exchanger normal 88 l/min maximum 642 l/min.
- Oil Cooler Lube System -82 l/min.
- Oil Cooler Unit Hydraulic System -133 l/min.
- Oil Cooler HDC 24 (pulper) -76 l/min.
- Oil Cooler Unit Hyd. 10 ZSE.

Gear Boxes

Yankee:

184 l/min.

Duoformer:

33 l/min.

Suction Press:

33 l/min.

Pressure Roll:

33 l/min.

• Return Water from Pressure Roll Cooling

60 l/min.

OUT:

• Suction of P 48 (main fresh water pump) normal 1225.4 l/min maximum 1588 l/min.

Tank $30 (50 \text{m}^3)$

IN:

- Clear Water -Disk Filter.
- Clarified Water -KROFTA 3.
- Recovered Water Vacuum System.
- Fresh Water Makeup -Level Control.

OUT:

- Tank 33 -Consistency dilution water.
- Showers system for paper machine.
- White water silo showers.
- Vibrating screen shower.
- Flush/dilution for KS cleaner troughs and T1 cleaner.
- Fiber saving water for tertiary cleaners (KS 160/6R-Approach Flow).
- Flush Water 0 SDM refiner.
- Process water in stock pump.
- Level Control Wire Pit.
- Showers for Broke Pulper.
- Disc Filter high pressure showers; cake removal and fabric cleaning.

P 48 - Main Shower Pump

Function

To pump fresh water in Tank 32 through a filter to the following showers:

- a) Suction of P 49 (booster pump).
- b) Suction of P 50 (booster pump).
- c) Suction of P51 (booster pump).
- d) Shower at felt return rolls 13,15 and 16.
- e) Shower at suction roll deckles.
- f) Shower at pressure roll cover cooling.
- g) Shower for sealing and lube at uhle boxes.
- h) Shower prior to pickup shoe.
- i) Shower at reel drum for sheet turn-up.

7

Operating Data

Designation: L-309-GIV-12.5/15

Q = 1800 l/min Pump Head: 41 mWG

P 49 -Booster Pump

Function

To increase fresh water pressure from 3 bar to 12 bar for the following showers:

- a) Edge cleaning shower -Bottom Wire.
- b) Edge cleaning shower -Top Wire.
- c) Tail cutter and trim squirts.

Operating Data

Designation: Booster Pump

Q = 180 l/min

Pump Head: 95 mWG

P 50 -Booster Pump

Function

To increase fresh water pressure from 3 bar to 40 bar for the listed showers:

• a) Felt cleaning shower

Operating Data

Designation: Booster Pump

Q = 70 l/min

Pump Head: 375 mWG

P 51 -Booster Pump

Function

To increase fresh water pressure from 3 bar to 60 bar for the following showers:

- a) Bottom wire cleaning
- b) Top wire cleaning
- c) Suction roll cleaning

Operating Data

Designation:

Booster Pump

Q =

360 l/min

Pump Head:

575 mWG

P 52 -Booster Pump

Function

To increase clear water pressure from 3 bar to 12 bar for the following showers:

- a) Knock-off Bottom Wire
- b) Knock-off Top Wire

Operating Data

Designation:

Booster Pump

Q =

650 l/min

Pump Head:

95 mWG

Broke System 5



Discharge Consistency

Discharge Consistency:

4%

The dry-end pulper discharge operates under a control loop (NIC 0230). The slurry is diluted with clear water from Tank 33 at the suction of the pump P 33.

Pulper Tub Level

The level in the pulper tub should not exceed the level of the tub itself (ie., it should not rise above the tub and onto the broke chute). A level control loop (LIC 0229) functions to control the level by recirculating the slurry back to the pulper to maintain set point or to Tank 28 when level exceeds set point value.

Shower Water Valves.

In the case of the showers which must be activated during a paper break, you must ensure that valves are opened and the showers are on. When the break is over, make sure that the showers have been turned off.

Safety Precautions

- 1. Ensure all guards are fitted and properly secured before operation.
- 2. Before servicing the broke pulper, drain the tub and lock-out the drive motor from all power sources.

Troubleshooting

A. Insufficient Defibering

- Consistency too high. Decrease as required to improve operation.
- Consistency too low. Increase as required to improve operation.
- Stock level too high. Lower to rated operating level.
- Stock level too low. Raise as required to improve operation.
- Extraction plate may be plugged. Lower level in pulper and inspect.

If these checks are completed and the problem still persists, then on shut down inspect:

- Extraction plate for damage.
- Rotor and extraction plate clearance. Readjust if required to 0.76 mm. (0.03").
- Rotor Blade condition. Excessive wear may be the cause for insufficient defibering
- Check Belts. Slippage may result in poor pulping efficiencies.

B. Inadequate Circulation and/or Submergence in the Pulper Tub.

- Consistency too high. Decrease as required.
- Stock level too high. Decrease as required.
- Aerated stock or possible vapor pocket around rotor. Check for gland damage or wear, aerated stock or fill water, or high stock temperature.
- Control system imbalance on continuous operation. Check showers, broke chute, and controllers associated with broke pulper.

C. Splashing or Erratic Stock Circulation Pattern

- Consistency too low. Increase as required.
- Stock level too low. Raise as required.

D. Excessive Pulper Vibration

- Stock level too low. Raise as required.
- Rotor blade may be restricted due to possible plugging between rotor and extraction plate.

On shut-down check:

- Pulper base and/or tank foundation
- Drive motor coupling imbalance
- Mechanical failure due to worn or damaged bearings or bent shaft (vibration analysis)

E. If Pulper Will Not Start

- Check interlocks and E/stop button.
- Check rotor blades; the blades may be seized.
- If checks are completed and the pulper still does not start, notify maintenance team.

F. If There is a Problem In Maintaining Operating Level Or Consistency (continuous operation only)

- Control system imbalance. Check controllers, shower operation and control valve movement.
- Pump P33 may not be operating efficiently. On shut down, inspect pump impeller and gland for damage.

T1 Centrifugal Cleaner

Purpose

To remove contaminants and foreign material by centrifugal force.

Process Description

The T1 high consistency centrifugal cleaner is used to clean slushed broke at approximately 4% consistency. The centrifugal forces remove heavy impurities such as bolts, glass and stone. The slushed stock in Tank 28 is further diluted approximately 3.5% consistency (NIC 232) and pumped to the inlet header of the T1 cleaner.

The stock which enters the cleaner tangentially is caused to rotate rapidly by the rotor. The impurities are flung by centrifugal force against the wall of the separating cone where they sink into the reject trap at the bottom of the cleaner. The reject trap can be emptied either manually or automatically during operation. The accepted stock flows through the central section before discharging through the central branch. The addition of a small amount of fiber-saving water is used to prevent good fibers from settling into the reject trap.

Fluctuations in throughput and stock consistency have no adverse effect on the stock cleaning efficiency of this cleaner. The T1 cleaner can be bypassed and, therefore, the stock could be pumped directly from Tank 28 to the inlet of the 1E deflaker.

Basic Components

1) Inlet Branch

The stock enters at the top of the cleaner through the Inlet Branch.

2) Outlet Branch

Accepted stock exits the cleaner through this branch located in the central section.

3) Cone

The portion of cleaner between inlet and reject trap is the Cone. The tapering characteristic of the cone develops greater centrifugal forces towards the bottom portion which enhances separation of the "heavies" and stock slurry.

4) Sight Glass

The Sight Glass is located between the cone and reject trap. This allows the operator to view cleaning action and the position of the "separation zone".

5) Reject Trap

A collection zone for rejects is located at the bottom of the cleaner unit. It is equipped with two knife-gate valves for trap "dumping".

6) Rotor

The Rotor induces centrifugal force required for contaminant separation. It is driven with a belt-pulley arrangement located at the top of the cleaner.

7) Motor

The Motor is frame mounted at top of cleaner. It is possible to mechanically adjust the speed, but the operator is not able to control this variable.

8) Shaft Assembly

A housing contains the shaft, bearings, and packing. The top end of the shaft is equipped with a belt sheave whereas the bottom end is fitted with the rotor.

Technical Data

Stock Consistency

2.0 - 5.5%

Throughput:

1000 - 2000 l/min

Pressure Loss:

1.3 bar at 5.5% consistency

Maximum Inlet Pressure:

6 bar

Flushing Water Flow Rate:

20 - 40 l/min depending on inlet pressure.

. Seal Water Flow Rate:

5.0 l/min

Reject Trap Capacity:

40 litres

Drive:

Belt and Pulley Arrangement

Motor

Manufactured by:

WEG

Power:

5.0 hP

Motor Speed:

1180 rpm

Pulley Diameter:

158 mm

Rotor

Speed:

620 rpm

Pulley Diameter:

267 mm

Broke System 11

Operating Parameters

The three variables that an operator can adjust for the T2 Cleaner are: 1) the Pressure Drop, 2) Inlet Consistency and 3) the Flushing Water.

1. Pressure Drop

• 1.3 bar at 5.5% consistency.

A regulating valve is located on the discharge header from the cleaner to the inlet of the 1E Deflaker. Throughput is varied by opening or closing this valve to achieve the designed pressure drop. A valve is also located on the inlet header and is normally open during operation.

2. Inlet Consistency

• 2.0-5.5%.

The inlet consistency for the cleaner is regulated by the addition of white water at the suction of the feed pump (P 35). This control loop (NIC 232) should be set to deliver a stock slurry in the prescribed range. Ideally, this inlet slurry should be controlled to 3.6% consistency but this may vary depending on the process demands.

Note:

The application of the rotor permits the T1 cleaner to operate through a range of both pressure drop and inlet consistencies.

3. Flushing Water

Ensure that the flushing water addition is adjusted to prevent the rotating column of stock from reaching into the reject trap or rising too high to be seen in the sight glass.

Safety Precautions

- 1. Ensure that all guards are fitted and properly secured before operation.
- 2. Before opening the machine, empty the unit and lock-out the drive motor from all power sources.

Trouble Shooting

1) Insufficient Throughput

If it appears that there is insufficient flow through the cleaner, the operator should first check the differential pressure. This is done by reading the inlet and output pressure gauges. The inlet pressure minus the outlet pressure equals the differential pressure. If the differential pressure is less than 1.0 bar, the operator should increase the differential slightly by opening the outlet valve. If the throughput does not increase, the cleaner may be plugging. If possible, shut down equipment and check for plugs.

2) No Visible Rotation of Stock

If the stock is not rotating in the sight glass, the separation zone may be too high. The operator may adjust the dilution water. Usually the dilution water flow can be decreased until the stock becomes visible.

3) Stock Rotating Down Into Reject Trap

If the stock appears to be flowing into the reject trap, the separation zone may be too low. The operator must determine the cause and adjust the operating variables to raise the zone until the stagnant area becomes visible. Information concerning the operating variables can be found in Operating Parameters.

4) Plugging of the Cone

If the cone becomes plugged, the operator should try to clear the plug by repeated flushing. If this does not free the plug, the cleaner must be by-passed and unplugged through the reject trap.

5) Motor Failure

The motor may fail if lightweight particles become trapped between the rear of the motor and the cleaner cover. The dirt must be removed before the motor will run properly.

Emptying The Reject Trap During Operation

Note:

The discharge must always take place in the specified sequence. After each dirt discharge, the reject trap must be filled with water prior to the reopening of the isolation valve since the stress from the "water hammer" effect could damage the plexiglass windows.

Manual Control of The Reject Trap

To manually control the reject trap, the operator must comply with the following instructions.

- 1. Close the fiber saving dilution valve.
- 2. Close the valve above the reject trap. The cleaner will continue to separate rejects which will accumulate on the knife-gate valve.
- 3. Open the discharge valve.
- 4. Open dilution valve briefly to flush trap.
- 5. Close discharge valve.
- 6. Open filling water valve and fill reject trap until water spills out of vent hole.
- 7. Open valve above reject trap. The dirt which has accumulated in the glass cone during the reject discharge will now sink into the reject trap.
- 8. Adjust fiber-saving water rate to optimize the separation zone.

Automatic Control of Reject Trap

A Control Box will automatically purge the reject trap in predetermined time intervals. The control program will follow the basic sequence of a manually performed reject "dump". Relays control the timing of the top and bottom reject valves. The sequence is as follows. It will close the top valve, open the bottom valve, time the interval to allow the reject trap to empty and flush, close the bottom valve, time the interval necessary to permit the reject trap to fill with water, and open top valve allowing contaminants to discharge into the trap.

Note:

When determining the interval for flushing, it should be kept as short as possible to prevent the formation of a dense plug of contaminants above the top valve.

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1E Double Disk Deflaker

Purpose

To provide additional defibering of fiber bundles which broke pulping could not break up.

Process Description

The disk assembly consists of three perforated disks; while the two outside disks are stationary, the inner disk rotates at high speed. The accepted stock from the T1 centrifugal cleaner flows to the center of the deflaker casing where the rotor disk is located. The stock then passes through the disk perforations in a uniform distribution on either side of the disk. As the stock passes through to the outside of the disk it is subjected to large acceleration and deceleration forces. This action induces high frequency impulses, intense turbulence, and internal fiber friction which "opens up" the fiber bundles and specks.

The broke from T1 cleaner (or direct from Tank 28 when cleaner is bypassed) flows into the inlet port of the 1E deflaker. The broke discharges at the outside diameter between the two disk cleaners, leaving the deflaker through the discharge outlet and flows to the machine chest (Tank 24).

Basic Components

1) Housing And Cover

The casing that encloses the perforated deflaker disks is removable to facilitate disk changes.

2) Stator Disks

The Stator Disks are the two stationary perforated disks located inside the housing. They are situated on either side of the Rotor Disk.

3) Rotor Disk

The Rotor Disk is a rotating perforated disk located between the two Stator Disks. It is attached to a drive shaft through the rotor hub.

4) Rotor Hub

The Rotor Hub connects the rotor disk to the drive shaft.

5) Shaft

The Shaft is used to drive the rotor disk. It rides on a double row angular ball bearing and a cylindrical roller bearing. The Shaft is coupled to the drive motor. A protective sleeve surrounds the exposed part of the shaft.

6) Inlet Port

Stock is introduced to the deflaker disks through the Inlet Port. It is located in the center of the housing cover.

7) Outlet Port

Deflaked stock is discharged at the outside diameter between the two disk clearances. It is located in the top of the housing.

8) Stuffing Box

A ring, packing and gland are fitted into the Stuffing Box. It is located along the shaft at the rear wall of the housing.

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9) Disk Tackle

The Disk Tackle is designed for specific grade applications. It needs to be replaced over time.

10) Motor

The Motor drives the rotor disk. It is coupled to the drive shaft.

11) Sealing Water

A 20 mm diameter pipe is connected to the seal water ring and provides sealing water to the deflaker. The pressure for the fresh water supply must be at least 1 bar higher than stock pressure.

12) Flushing Water

A 20 mm diameter pipe is connected to the inlet line to provide flushing water to the deflaker unit. This is also fresh water supplied at a pressure of 5.5 to 6 bar.

Broke System 17

Technical Data

Throughput: 55 ton/day (maximum)

Stock Consistency: 6.0% (maximum)

Maximum Outlet Pressure: 40 mWG

Flush Water Pressure: 3.0 - 4.0 bar

Seal Water Flow Rate: 5.0 l/min

Motor

Manufactured by: WEG
Power Output: 150 Hp

Speed: 3600 rpm

Coupling: FALK 11F

Operating Parameters

This fiber-preserving treatment deflakes the stock without any appreciable increase in the freeness.

The deflaking effect depends on:

- Disk Clearance
- Throughput
- Stock Consistency
- Condition of Deflaker Tackle

1) Disk Clearance

An instruction plate attached to the deflaker casing indicates the disk clearance. But this was adjusted by Voith prior to shipment. For our application, a clearance of 1.55 mm (0.061") will be set.

Note:

The disk clearance cannot be varied during operation.

2) Throughput

The throughput can be controlled by a regulating valve on the discharge line. The Deflaker may operate against a closed discharge valve or at zero throughput for only a brief period (2-3 minutes). If the deflaker is run under these conditions for longer duration, it may become damaged by the high steam pressures. The pressures come from the rapid heating of the stock due to supplied mechanical energy.

Warning:

This condition can present a direct hazard to operators and must be avoided.

3) Stock Consistency

The stock consistency can be controlled by the dilution water added to the suction of Pump (P 35) which feeds the Deflaker.

4) Condition of Deflaker Tackle

To check the deflaker tackle for wear, remove the inspection hole cover. If wear has enlarged the clearance to such an extent that the deflaking efficiency decreases, or if the edges of the deflaker disk holes have been rounded off by wear, the plane surfaces must be re-machined. If only the edges of the holes are slightly rounded off on one side due to the wear, while the disk clearance is still satisfactory, the direction of rotation should be reversed so that the opposite edges of the holes become effective.

The type of deflaker tackle used is designed for good deflaking of a specific type of stock. Because of wear, the tackle should be changed after a set period of time.

Broke System 19

Trouble Shooting

1. If Deflaker Fails To Start follow these instructions.

- Thoroughly flush the deflaker.
- Check the ammeter and report any irregularities to the electrical department.
- If the Deflaker fails to start after these actions, the operator may have to open the unit and inspect the dewatering tackle for foreign materials.

2. If Deflaker fails During Operation.

- Remove any foreign matter from the stock flow.
- Check the outlet piping for a plug. A hollow sound will produce a "cold" pipe. If it appears that a plug has formed, thoroughly flush the deflaker.

3. If the Stuffing Box Heats Up.

- Check the sealing water line for flow. Open the valve or check for a plug.
- Notify the maintenance department. They can slacken the gland, re-pack the stuffing box or replace the shaft protective sleeve.

4. If No Sealing Water Flows Through The Stuffing Box.

• Notify the maintenance department to clean the sealing water ring and re-pack the stuffing box.

Options

Bypass the drainators (valve 1483). Accepts from T1 Cleaner can be directed to the inlet of the deflaker.

Start-up and Operating Procedures (Group X Start)

1. Start 1E Deflaker

The 1E Deflaker is the first of four events in Group Start X

Permanent Interlocks

• Selection of disk direction (forward or reverse).

2. Start T1 Cleaner

The T1 Cleaner is the Second event of Four in Group Start X.

Permanent Interlocks

• Control box must be switched on (Status indicating "Ready")

3. Start Pump P 35

Pump 35 is the third of four events in Group Start X.

Permanent Interlock

• Level in Tank 28 greater than or equal to 30%.

4. Start Pump P 33

Pump 33 is the fourth of four events in Group Start X.

Permanent Interlock

• Level in Tank 27 (Broke Pulper) must greater than or equal to 30%.

Process Interlocks

• Level in Tank 28 less than or equal to 95%.

Broke System 21

Associated Interlocks

1E Deflaker

Reverse mode	AFM - 269 (1/2)	AFM - 269B
Forward mode	AFM - 269 (22/2)	AFM - 269A
Flush	SV - 254	AFA - 270

T1 Control Box

- No permanent or process interlocks. Activated through a key switch at control box.
- Ready to run status.

Broke Chest Agitator (Tank 28)

- On level 40%
- Off level 30%

Group X - (associated motors and valves under control)

1E Deflaker - Forward	AFM 269A
1E Deflaker - Reverse	AFM 269B
1E Deflaker - Flushing water	AFA 270
T1 Cleaner	AFM 267
T1 Cleaner/CB1	AFM 268
Pump P35	AFM 266
Tank 28 Agitator	AFM 265
Pump P 33	AFM 264
Dry End Pulper	AFM 263

Group X - Shutdown Procedures

(Assuming no broke introduced to pulper tub ie., machine down).

- 1. Pump to low level in Broke Pulper (Tank 27).
- 2. Stop P 33.
- 3. Stop P 35 (Tank 28) at low level.
- 4. Allow cleaner and deflaker to flush for brief period.
- 5. Stop T1 cleaner.
- 6. Stop 1E deflaker
- 7. Close dilution/flush water valves at cleaner and empty reject trap.



Pumps

P 33 -Dry End Pulper Pump (Tank 27)

Function

To blend broke from pulper with consistency control (NIC 230) dilution water from Tank 33 and deliver the slurry to Tank 28 (broke chest) and also recirculated for level control of pulper.

Operating Data:

Designation

SL 280- GIII - 12.5/15

Q=

1800 l/min

Pump Head

26 mWG

P 35 - Broke chest pump (Tank 28)

Function

To blend broke with consistency control dilution water from Tank 33 and deliver the slurry to inlet of T1 cleaner.

Operating Data

Designation

L 309 GIII12.5/15

Q =

1800 l/min

Pump Head

40 mWG

Tanks

Tank 27- Dry End Pulper

In:

- Trim from sheet
- Slab-offs and waste at reel
- Sheet during paper breaks or start-up

Out:

- Inlet of T1 cleaners
- Inlet to 1E deflaker when T1 cleaner bypassed
- Direct to Tank 24 (machine chest) when cleaner and deflaker bypassed.

Agitator: Heavy-duty broke agitator.

Broke Chest (Tank 28) 100m³

In:

• Broke from dry end pulper

Out:

• Inlet of P 35 to T1 cleaner, 1E deflaker, and machine chest.

Agitator: 1150 MAS

Machine Chest (Tank 24) 60 m³

In:

- Stock from Tank 16
- Broke from discharge of 1E deflaker (dry end pulper).

Out:

- Inlet of P 36 (machine chest pump).
- Inlet of P 43 (sweetner- disk filter).

Agitator: 1000 MAS

White Water Clarification

Introduction

A paper mill uses a tremendous amount of water daily. If all water used in the mill is fresh water and all process waters are dumped to sewer, it would not take us long to go out of business on our fresh water costs alone. Therefore, water introduced to the process must be used in the most optimal and efficient manner.

White water clarification is the process of recovering water for reuse in the mill.

Benefits include:

- a) Recovery of fibers.
- b) Removal of inks, clays, fillers, ash and other solids from the process.
- c) Clarification of the white water (lower solids content for reuse in process applications).
- d) Minimizing fresh water usage.
- e) Recovery of heat and chemicals.
- f) Improved wet-end stability.

A fully "closed" paper mill water system is one in which all water introduced to the system is reused and there is no discharge. Keep in mind that even with a totally closed mill, for every ton of production, 1 to 2 tons of water must leave the plant through the drying process (up the stacks). Solids which enter the plant with the waste paper, or as additives, must leave either as rejects (sludge) or with the final product.

With only these options of water exit from the mill, a fully "closed" system due to constant recirculation may possibly result in:

- a) A build up of dissolved and suspended solids.
- b) An increase process water temperatures.

These factors could adversely affect the wet-end of the paper machine; impacting on quality, increasing corrosion and deposits formation, and /or cause increases in foam, slime and bacterial odors.

In theory it might be possible to fully "close" a water system but it has not been commercially feasible to do so.

Low volumes of water discharged with a low solid content have been the goal.

Most of the points of fresh water application are located at pump and agitator packings and paper machine showers. The in-leakage from these various process points will always result in an excess of water. We must strike a *BALANCE* between the benefits of water clarification and the known problems it may create. And since there will always be some volume of discharge, any excess water must contain a minimum of suspended solids before it is discharged to the sewer.

To meet the requirements of both ecology and economy, the reusable fibers in the white water must be recovered and reintroduced into the machine stock flow. To accomplish this, "savealls" which are separation devices are used in the mill to reclaim fibers from the white water.

The two types of savealls in our mill used to accomplish these objectives are:

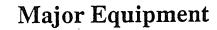
a) Flotation Units

The Flotation Units recover water by attaching fine air bubbles to the solid particles and floating these materials for removal by a skimming device.

b) Disk Filter

The Disk Filter consists of a series of disks mounted on a hollow centre shaft. The water flows through the filtering medium into each sector and then through the core of the rotating shaft.

In the Tissue Mill, we have four process loops which accomplish our clarification objectives stated above. Three of the four loops are of the flotation cell type and the other is the disk filter. Water recovery and processing can best be understood if the mill is considered as having three basic and separate circuits: stock, white water, and broke. The white water and broke circuits are processed to balance the benefits and cost of white water clarification and returned to the stock circuit.



The Major Equipment utilized in the White Water Clarification process are;

- Krofta
- Turbo Filter
- Disk Filter

A. KROFTA

Purpose

4

To remove impurities (i.e., solids) in the white water by floating them to the surface for removal.

Process Description

Description of Process A - KROFTA No. 1 (refer to AN. 3401.92)

Water extracted by the eight drainators (ink detachment) flows to Tank 10 at 0.84% consistency. P 06 delivers the white water to the inlet of the Turbo Filter.

The Turbo Filter is equipped with a 0.3 mm holed screen which filters the water. Filtered water flows to the inlet of KROFTA no. 1 under pressure of P 06. "Heavies" or unfiltered water flows through the reject port and air bleed to Tank 13 (pulper head tanks supply chest).

White water introduced into the KROFTA supracell is continuously drawn out of the cell by a centrifugal pump (P 56). The pump delivers the flow through an air dissolving tube and back into the inlet of the KROFTA. In the air dissolving tube, air is dispersed throughout the fluid to achieve flotation in the cell.

The "sludge" is scooped from the surface of the KROFTA and flows to Tank 20, where it is pumped to the sludge chest. Clarified water at 0.14% consistency flows over a weir to Tank 13 to be reused in the pulper head tanks and in Tank 4.

In this process loop, the white water extracted in the first stage washing (usually considered the "dirtiest") is reused in the pulping process.

Description of Process B - KROFTA No.2 (refer to fig. AN 3401.92)

Water extracted by the HYDRODISK 12/12 (additional units) flows to Tank 14 at 0.15% consistency. P 18 delivers the white water to the inlet of KROFTA 2 (no Turbo Filter).

White water is continuously drawn from the supracell by a centrifugal pump (P 57) and pumped through an air dissolving tube and back to the inlet of KROFTA. The sludge is

White Water Clarification 5

scooped and flows to Tank 20 while the clarified water flows to Tank 12 where it is reused in many process applications.

Description of Process C - KROFTA No.3 (refer to fig. AN 3401.91)

White water collected in the wire pit, plus the overflow from the W.W. silo is pumped to the inlet of KROFTA 3. White water is continuously drawn from the supracell by a centrifugal pump (P 58) and pumped through an air dissolving tube and back to the inlet of the KROFTA.

The sludge is scooped from the surface and flows to Tank 20, where it is pumped to the sludge chest. Clarified water at 0.04% consistency flows over the weir and into Tank 30 (clear water tank) where it is reused in many process points which we will discuss later.

Basic Components

1) Air Dissolving Tube

The dissolving tube is a device designed to give fast mixing and dissolving of air into the water stream in a minimum of space. White water enters the tube at the inlet nozzle cone tangentially which causes it to "spin" in the tube.

Special porous plastic panels insert compressed air into the spiralling water. The rapid mixing of the small air bubbles dissolves the air into the water. The amount of air added is a very small percentage of the water and is metered precisely by an Air Meter. The compressed air enters the dissolving tube through a regulator and pressure gauge. Minimum gauge pressure should be 85 psi (or about 5 psi higher than the tube pressure). Any air which is not dissolved collects in the centre vortex and is removed through the bleed off vent.

Pressure gauges are located at the inlet and outlet of the tube. Maximum inlet pressure in the dissolving tube is 100 psi.

The minimum outlet pressure is 55 psi.

A valve, located just after the tube discharge, is used to control the differential pressure in the tube. The recommended differential is in the range of 4-7 psi. In this range, the dissolving efficiencies are maximized. If the differential pressure falls below 4 psi, this may indicate a low throughput and the pressure release valve should be opened slightly. At differential pressures higher than 7 psi, the throughput is too great and the pressure release valve should be throttled slightly.

General Rule:

If Differential greater than 7 psi, close outlet valve slightly. If Differential less than 4 psi, open outlet valve slightly

Make small adjustments and then monitor the results until the process stabilizes and then make a second adjustment if necessary. Usually the KROFTA process will operate at the same valve position continuously, but you should be aware of the actions to be taken if the differential falls outside of its control range.

2) Supracell

From the air dissolving tube, the aerated white water flows into the supracell which is a large circular tank (cell). The open tank has a depth of 650 mm. Water is processed from inlet to outlet in approximately 2-3 minutes.

The aerated water enters the supracell at the centre through a rotary joint and flows into the cell through the distribution duct. The flow from the duct is designed to eliminate turbulence to maximize the flotation process. Turbulence slows the flotation of the fiber and raises the solid levels in the clarified water. A balance between the rotation movement of the distribution duct and the out-flowing water must be present so that the water achieves "zero velocity".

If we looked at the supracell from the top as the water enters, the flow direction is opposite the distribution duct direction. If the duct is moving counterclockwise, the water flow is moving clockwise at the same speed. The water stays in one spot in the tank without any movement during flotation.

3) Scoop

The floated solids are removed from the surface of the supracell with a rotating SCOOP. The scoop is designed to remove the solids with a minimum amount of surface disturbance. Solids removed by the scoop flow to the stationary centre section of the supracell into a collection pipe which flows to a collection tank (Tank 20 for all 3 KROFTAS -sludge collection chest).

4) Rake

A "Rake" also reduces turbulence caused by the inlet flow. For optimum results, under normal operating conditions, the top of the rake should be at the level in the clarifier. Changes in water level should be followed by adjustments to the rake. Vertical adjustment (up and down) of the rake is made manually using the hand crank.

5) Slotted Extraction Pipes

The clarified water flows through Slotted Extraction Pipes. The pipes are connected to the wall of the moving centre part. The water flows into the centre section, which is isolated from the clarifier section by a rubber seal. The "clean" water flows over a central weir into a collection pipe which directs the flow to the clarified water chests; Tank 13 (process A), Tank 12 (process B) and Tank 30 (process C).

6) Rubber Wiper Blades

A small amount of settled material (i.e., sand, grit, scale) must be removed from the bottom of the supracell to improve water clarity and prevent clogging. Rubber wiper blades remove any scum that may collect and deposits it into small sump. During a mill shutdown, the supracell should be drained and cleaned.

Technical Data

KROFTA No. 1 and 3

Diameter:

5500 mm

Depth:

650 mm

Flow Rate:

3000 l/min

KROFTA No. 2

Diameter:

11000 mm

Depth:

650 mm

Flow Rate:

11870 l/min

Air Dissolving Tubes

Pressure Drop:

4-7 psi

Inlet Pressure:

60-80 psi

Compressed Air Pressure:

80-100 psi or(5 psi higher than tube pressure.)

White Water Clarification

Operating Parameters

The reason the solids will float, even if they are heavier than water, is that small air bubbles attach themselves to the particles (or flocs) and make them buoyant. Dissolved air flotation creates very small, dispersed bubbles which are best suited for attachment to the solids.

As the water enters the clarifier, the dissolved air begins to rise to the surface. On the way to the surface, the air bubbles collide and attach themselves to the solids. The larger the particle size, the better the chances are of air bubble-particle contact. This leads us to a later discussion of chemical "polymers" which link up solids and maximize the efficiencies of the flotation process.

Level Adjustments

The level in the supracell determines the consistency of the solids removed. The level is controlled with a small hand wheel which opens or closes a valve regulating the outgoing clarified water flow.

a) Low Level

- Removing clarified water.
- Lower water level in supracell.
- Partial removal of the sludge.
- Results in a thicker floated sludge layer.

b) High Level

- Retaining clarified water.
- Increases water level in supracell.
- Remove more sludge.
- Thins-out the sludge layer.

Following a water level adjustment, it will take up to one half to one hour before the sludge thickness reaches equilibrium.

Machine Manual

Chemical Addition

The purpose of the chemical "polymers" used in the KROFTAS is to increase the flotation efficiencies in the supracell. The KROFTA is efficient in floating relatively large solid particles but colloidal particles (i.e., clays, ash) which are very small compared to the fibers and uncrystalline, resembling jelly or glue, are difficult to remove. The efficiency of flotation is improved by attracting the colloidal particles to one another through electrostatic attraction (+ and -) thus "floccing" or linking the particles.

The chemicals are metered into the aerated water stream just prior to the inlet of the supracell with a small pump (usually positive displacement).

Example:

Cellulose fibers are negatively charged (-). Some colloidal particles are also negatively charged (-).

Remember:

Opposites Attract And Like Repel.

If left in this state, the fibers and colloidal particles would not be attracted to one another and therefore each negative particle would need an air bubble to attach to it and float to the surface. The fibers tend to be large enough in size that a bubble will collide with them and float to the surface. However, the colloidal particles, which are often less than one-tenth of a micron in size, stand little chance of attaching to the air bubbles.

Now add a chemical polymer with a positive charge (+). The long chained polymer attracts the very small negatively charged colloidal particles and the negatively charged fibers, bridges (flocs) them together, and because of their increased size improves the chances of bubble-particle attachment.

Always monitor and control the KROFTA pH. Optimum pH range for good performance of the polymers is usually between 7.0 - 9.0 pH. At pH values outside this range, you reduce the efficiency of the polymer and therefore reduce the efficiency of the flotation process.

White Water Clarification 11

Start-up and Operating Procedures

- 1. Open seal water at pumps, agitators and Turbo filter.
- 2. Ensure suction and discharge valves fully open at each pump.
- 3. Close all drain valves, especially on the air dissolving tube and supracell.
- 4. Check air pressure (80-100 psi).
- 5. Make sure the valve at the outlet of the dissolving tubes are open at least one and a half turns.

Group IV -Start Process A and B

11 events in Group Start

- 1. Krofta 2 Drive (SPM-063)
 - No Permanent Interlocks
- 2. Krofta 2 Scoop (SPM-064)
 - No Permanent Interlocks
- 3. Krofta 1 Drive (SPM-058)
 - No Permanent Interlocks
- 4. Krofta 1 Scoop (SPM-059)
 - No Permanent Interlocks
- 5. Turbo Filter (SPM-057)
 - No Permanent Interlocks

6. PO6 (SPM-056)

Permanent Interlocks

• Level in Tank 10 must be greater than or equal to 30%.

Process Interlocks

- Level in Tank 13 less than or equal to 30%.
- Level in Tank 20 less than or equal to 95%

7. P 56 (SPM-060)

Permanent Interlocks

- Air Supply OK (PSI)
- 8. Nalco unit Krofta 1-Polymer (SPM-061)
 - No Permanent Interlocks.
- 9. P 18 (SPM-062).

Permanent Interlocks

• Level in Tank 14 greater than or equal to 30%.

Process Interlocks

- Level in Tank 13 less than or equal to 95%.
- Level in Tank 20 less than or equal to 95%.

10. P 57 (SPM-065)

Permanent Interlock

• Air Supply OK (PS2).

11. Nalco Unit Krofta 2 -Polymer (SPM-066)

• No Permanent Interlocks.

White Water Clarification 13

Adjust differential pressure in air dissolving tubes to 4-7 psi range and at Turbo Filter to achieve a pressure drop of no greater than 0.2 bar.

Adjust KROFTA levels to optimize sludge layer removal.

Adjust polymer addition rate if required.

Group Start 4 - Motor Listing

Pump P 06:	SPM 056
Turbo Filter:	SPM 057
Krofta 1 Drive:	SPM 058
Krofta 1 Scoop:	SPM 059
Pump P 56:	SPM 060
Krofta 1 Nalco Unit:	SPM 061
Pump P 18:	SPM 062
Krofta 2 Drive:	SPM 063
Krofta 2 Scoop:	SPM 064
Pump P 57:	SPM 065
Krofta 2 Nalco Unit:	SPM 066

Group VIII -Start Process C.

7 events in Group Start.

1. Krofta 3 Drive (AFM-256)

• No Permanent Interlocks.

2. Krofta 3 Scoop (AFM-257)

• No Permanent Interlocks.

3. P 42 (AFM-257)

Permanent Interlock

• Level in the wire pit greater than or equal to 30%.

Process Interlocks

- Level in Tank 30 less than or equal to 95%.
- Level in Tank 20 less than or equal to 95%.

4. P 58 (AFM-258)

Permanent Interlock

• Air supply OK (PSI).

5. Nalco Unit Krofta 3 - Polymer (AFM-258)

• No Permanent Interlocks.

The following pumps are also part of Group VIII start:

6. P 46 (AFM-260)

Permanent Interlocks

- Level in Tank 30 greater than or equal to 30%.
- Level in wire pit greater than or equal to 15%.
- Valve at BrokePulper (HV 239) open greater than or equal to 15%.
- Solenoids activated at broke pulper. (SV-251) (SV-252).

7. P 34 (AFM-252)

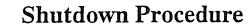
Permanent Interlocks

- Level in Tank 30 greater than or equal to 30%.
- Adjust KROFTA levels to optimize sludge layer removal.

Group Start 8 - Motor Listing

P 42 (Feed Pump):	AFM 255
Krofta 3 Drive:	AFM 256
Krofta 3 Scoop:	AFM 257
Krofta 3 P 58:	AFM 258
Krofta 3 Nalco Unit:	AFM 259
P 46:	AFM 260
P 34:	AFM 252

White Water Clarification 15



Following each shutdown,the KROFTAS should be drained and washed to remove deposits.

KROFTA 1

- 1. Nalco Unit Pump
- 2. P 56
- 3. P 06
- 4. Turbo-filter
- 5. Krofta Scoop
- 6. Krofta Drive

KROFTA 2

- 1. Nalco Unit Pump
- 2. P 57
- 3. P 18
- 4. Krofta Scoop
- 5. Krofta Drive

KROFTA 3

- 1. Nalco Unit Pump
- 2. P 58
- 3. P 42
- 4. Krofta Scoop
- 5. Krofta Drive

Troubleshooting KROFTAS

A. High solids in the KROFTAS.

• Check consistencies in supply chests to KROFTAS. High consistencies will overload the supracell and must be reduced for proper operation. Do not run the supracell when filled with heavy sludge as it can cause mechanical strain and even possible breakage of centre pits.

B. Clarified water not clear enough.

- Symptoms include: Very small particles remaining in the clarified water.
- Check chemical pump operation, pump settings, and chemical lines.
- Check polymer: Out of chemical? Has the chemical thickened?
- Check pH of water. Adjust if not in operating range (7-9 pH).

C. "Greasy" or very flat sludge.

- Symptoms include: sludge feels greasy, large particles in the water to which the air will not stick.
- Check chemical addition rate.
- Over dosages will result in the "greasy" sludge. All chemical adjustments should be made gradually, as changes can take from 3 to 30 minutes to take full effect.

D. Excessive foaming or frothing at the surface; excessively large turbulent bubbles at the inlet and foamy sludge.

- Check air gauges. Too much air in dissolving tube (greater than 100 psi) will result in foaming in the supracell.
- Check stock prep defoamer addition points. Excessive foaming at the clarifier could indicate problems in other process areas. Has anything in the process changed?
- Has a detergent, caustic, or other foaming agents been added to the water? Reduce chemical addition.
- Check supply chest level. Is the feed pump sucking air or cavitating?

E. Watery sludge, sludge not floating, or very flat appearance of water in clarifier.

• Check air lines for plug or a reduction in air pressure (should be at least 85 psi). Make sure that the air pressure to the dissolving tube is 5 psi greater than the inlet water pressure. White water pressure at the inlet of the dissolving tube should never be higher than 100 psi. The outlet minimum pressure is 55 psi.

F. Sludge too thick or too thin.

- The optimum thickness for the sludge is 4 to 6 inches.
- Too thin -Lower the water level with the hand wheel.
- Too thick Raise the water level.
- A watery sludge can cause some problems at the sludge press (more water to be removed). Always try to maintain a constant sludge layer.

G. Drive wheel slipping, spinning or stalling of the centre drivewheel.

- Excessive solid loading in the clarifier will place more strain on the component parts and may result in damage.
- Take the required steps to lower inlet consistencies. Add some dilution water if available.
- Check the wheel track of the clarifier for foam or polymer. This could cause a slippery surface which in turn causes the driven wheel to slip.
- Check drive wheel for wear or damage. Notify maintenance of any problems.
- Check for a chemical overdose (i.e., too much defoamer.)

Appendix

Review - KROFTA Operation

- 1) The water is pressurized to 60-80 psi with a standard centrifugal pump.
- 2) Compressed air at 85 psi is added through special plastic dispersing panels in a "dissolving tube".
- 3) The water and air are mixed rapidly in the dissolving tube for approximately 10 seconds and the undissolved air is separated out by the "bleed-off".
- 4) The pressure is released after the water passes through a valve controlling tube differential. The water can no longer hold the extra air which was absorbed, so that small bubbles form spontaneously throughout the liquid.
 - 5) A chemical "polymer" is added prior to the inlet of the supracell.
 - 6) The aerated water flows into the supracell.
- 7) The air bubbles and "flocced" solids collide and are floated to the surface, scooped off, and flow through a pipe in the centre of the supracell to a "sludge" collection chest.
- 8) The clarified water flows through slotted pipes into the center of the supracell, over a weir, and into a collection chest.

B. Turbo Filter

Purpose

To screen solid particles (i.e., fibers) from the filtrate water collected in Tank 10.

Process Description

Filtrate water extracted at the Drainators flow to Tank 10. P 06 pumps the filtrate into the inlet port of the Turbo Filter. The Turbo Filter is equipped with a screen basket with 0.3 mm diameter holes. The solids larger in size than the perforations will flow out of the Turbo Filter through the heavy reject and lightweight contaminant ports. The rejects flow to Tank 13 where they are returned to the process via the pulper head tanks.

The filtrate which passes through the perforations flows to Krofta No. 1 where the water is clarified.

Basic Components

1) Housing

The housing is the casing portion of the Turbo Filter.

2) Cover

The cover is the cap which seals the machine and forms the top portion of the housing.

3) Inlet Port

Filtrate enters the Turbo Filter tangentially, under pressure from supply pump (P 06) into the inlet zone located above the screen basket.

4) Screen Basket

The screen basket is equipped with 0.3 mm diameter holes.

5) Rotor

The rotor is caused to rotate by a belt-pulley drive connected to the electric motor.

6) Motor

The motor is bracket mounted to the housing and is equipped with a belt sheave.

7) Belt Guard and Cover Plate

The guard protects the operator from possible contact with the external moving parts of the Turbo Filter.

8) Accept Port

The water must pass through the screen basket openings to exit at the accept port.

9) Reject Port and Air Bleed

The solids (i.e., fibers) which are unable to pass through the openings in the screen basket exit the Turbo Filter through these outlets to Tank 13.

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Technical Data

Type: 10

Screen Design: Centrifugal, inlet-side foils
Screen Basket Openings: 0.3 mm diameter holes
Throughput: 18 tons per 24 hours

Feed Consistency:

O.8 - 2.0 %

Pressure Drop:

up to 0.2 bar

Reject Rate:

up to 30 %

Maximum Inlet Pressure:

6.0 bar

Minimum Outlet Pressure:

0.8 bar

Drive: Belt and pulley arrangement

Motor

Manufactured by: WEG
Power: 65 Hp
Speed: 1750 rpm
Pulley Diameter: 234 mm

Rotor

Speed: 720 rpm
Pulley Diameter: 568.8 mm
Seal Water Flow Rate: 5.0 l/min

Operating Parameters

There are three variables that the operator can adjust. These are:

- Feed Consistency
- Pressure Drop
- Reject Rate

1) Feed Consistency

- 0.8 % (optional)
- 2.0 % (maximum)

The inlet consistency is dictated by the filtrate consistency from the Drainators. The operating parameters of the Drainators will impact the filtrate consistency. There is no consistency control loop associated with the Turbo Filter.

2) Pressure Drop

• 0.1 - 0.2 bar

A regulating valve is located on the accept discharge pipe. Pressure drop is adjusted by opening or closing this valve. A valve is located on the inlet header and is normally open during operation.

3) Reject Rate

• Up to 30%

A regulating valve is located on the reject discharge pipe which is used to adjust the reject rate. The rejects are reintroduced to the process at Tank 13 along with a continuous air bleed from the Turbo Filter.

Troubleshooting

To troubleshoot the Turbo Filter, please refer to the troubleshooting chart for PS 23 screens in the stock preparation manual (p. 51).

Removing/Replacing the Screen Drum

Warning:

Before opening screen, ensure it is completely locked-out from all power sources.

- 1. Completely empty the Turbo Filter.
- 2. Loosen hold-down bolts and lift cover.
- 3. Remove bolts from thrust ring.
- 4. Insert eyebolts into the thrust ring and withdraw the basket.
- 5. Thoroughly clean the basket and rotor.
- 6. Replace in the reverse sequence.

C. Disk Filter Size II 10/10

Purpose

To clarify white water from the wire pit through a filter mesh in order to reuse very low consistency (0.005%) water in place of fresh water in many process applications.

Process Description

White water collected in the wire pit (Tank 26) is blended with thick stock (i.e., sweetner) at the suction of the Disk Filter supply pump (P 41). The "sweetner" acts as a natural filter in the unit and is added to improve filtering efficiencies. The blended slurry at 0.8% flows to the inlet box of the Disk Filter.

The inlet flow to the Disk Filter is controlled with a flow control loop (FIC 0236). A flow transmitter (FT 0235) measures the flow delivered from P 41. A second transmitter measures the flow of cloudy water (from Tank 29) recirculated to the inlet (FT 0236). The total inlet flow is a combination of both of these flows and is regulated with a control valve on the cloudy water line. Therefore, the flow from P 41 remains constant while either more or less cloudy water is recirculated to achieve the flow set point.

From the inlet box, the slurry flows into the Disk Filter vat. A hollow shaft with ten filter discs are arranged horizontally in the vat. The incoming slurry is thickened on the filter surfaces with the water removed through the hollow shaft to two filtrate tanks; cloudy - Tank 29 and clear - Tank 30. The thickened stock is blasted off to filter surfaces with a high pressure shower (i.e., cake removal) and is discharged into a screw conveyor referred to as a repulper. The theory of operation for the Disk Filter will be discussed in a subsequent section.

The cloudy water collected in Tank 29 is recirculated back to the Disk Filter through pump P 45. It is used for:

- Residual cleaning shower water for collection trough.
- Consistency control loop at Tank 31 (NIC 0238) where the water flows to the pulper trough and the suction of P 44 to achieve a discharge consistency of 3.5%.
- Recirculated to the inlet box of the Disk Filter (FIC 0236).

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The clear water collected in Tank 30 is used in a variety of process applications as a substitute for fresh water. A booster pump (P 47) increases the water pressure and directs clear water to the cake removal and oscillating shower headers at 0.9 MPa. The remaining clear water is supplied to the process through P 34 and P 46.

The thick stock recovered in Tank 31 is pumped (P 44), under consistency control, to the suction of the machine chest pump (P 36) at 3.5%. This arrangement ensures that the recovered stock is pumped to the paper machine and is not reused as "sweetner".

Inflows

4880/	3.81/	0.08 (79%)
1302/	45.65/	3.5 (21%)
6182/	49.46/	0.8
6182/	49.46/	0.8
1986/	3.98/	0.2
8168/	53.44/	0.65
	1302/ 6182/ 6182/ 1986/	1302/ 45.65/ 6182/ 49.46/ 6182/ 49.46/ 1986/ 3.98/

Other Inflows

a) High pressure showers (P 47)	940/		
(cake and oscillating)			
b) Consistency dilution water	655/	1.31/	0.2
at the pulper trough (P 45)			
c) Residual cleaning shower (P 45)	110/	0.22/	0.2
Total inflows:	9873 l/min ·		

Outflows

Cloudy water to Tank 29:	3078/	6.16/	0.2	
Clear water to Tank 30:	5716/	0.33/	0.005	
Thick stock to Tank 31:	1079/	48.50/	4.5	
Total outflows:	9873 l/min			

Inflows = Outflows

Basic Components

1. Inlet Box

Blended slurry (white water, sweetner and recirculated cloudy water) flows into the Disk Filter at the inlet box and into the vat through three ports.

2. Vat and Cover

Structure for the tub where the slurry level is maintained and the cover prevents splashing from the showers and operation. Stainless steel construction.

3. Hollow Shaft

Arranged horizontally in the vat and driven at one end with a variable speed motor (stuffing box seal). Sixteen disk segments are arranged on the circumference of the roll to construct one disk. Extracted water (cloudy and clear) flow separately out of the other end (not drive motor side) to the respective collection tanks.

4. Suction Head

Stationary piece on water discharge end of hollow shaft. Sealed to hollow shaft with wear strips adjusted with compression springs. Constructed with adjustable gates to alter suction zones for cloudy and clear filtrate and shower water outlet zone. Two vacuum breakers are also arranged along the suction head.

5. Barometric Legs

Straight pipes which extend from suction head to the sealing zones of the collection tanks. Must remain sealed to induce the vacuum required to remove water and form the fiber net. Equipped with vacuum gauges to indicate vacuum levels.

6. Shower Water Outlet

A third leg which extends from the suction head to Tank 29. It is not submerged as were the barometric legs. Allows water collected in the showering phases (cake removal and high pressure cleaning) to flow out of the unit.

7. Filter Segments

Filter mesh fixed to segment framing. One disk is constructed of sixteen segments.

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8. Cake Removal Shower

High pressure shower (0.9 MPa) which removes the fiber mat (11%) from the filter mesh as it emerges from the vat (non-oscillating). Equipped with pressure gauge (PI 1046) and supplied by P 47 clear water. The shower/fabric angle must be adjusted to achieve a clean discharge of the sheet.

9. Residue Cleaning Shower

Low pressure shower (0.1 to 0.2 MPa) which cleans the collection troughs following the cake removal (non-oscillating). No pressure gauge and supplied by P 45 cloudy water.

10. Fabric Mesh Cleaning Shower

High Pressure shower (0.9MPa) which cleans the mesh openings before it submerges into the vat. Oscillation on a 60° swing through a gear motor. Equipped with a pressure gauge and supplied by P 47 clear water. All nozzles must remain unplugged in order to clean all area of the disk.

11. Cake Collecting Troughs

Troughs which direct the cake to the repulper unit. Sometimes referred to as crenalations

12. Repulper

Screw which blends the thick stock and consistency dilution water prior to discharge into Tank 31 located directly below. The screw is driven with an electric motor. Dilution water is added at the drive end of the repulper.

Technical Data

Size:

Number of Disks: 10 (1disk = 16 segments)

Capacity: up to 50 l/min per m² filter area

Disk Diameter: 3800 mm

Useful Filtering Area: 10.5 m² per disk

Total Useful Area: 20 m² per disk

Direction of Rotation: Clockwise

(Viewed from drive journal)

Disk Rotation: 0.2 to 1.6 rpm Consistency: Inlet: 0.8% optimum

Outlet: 12.0% maximum

Sweetner Consistency: 3.0 to 4.0%

Motor

Manufactured by:

Power: 10 hP variable speed

Speed: 200-1600 rpm

Pulper Motor

Manufactured by:

Power: 10 hP Speed: 1750 rpm

Direction of Rotation: counter clockwise

(viewed from pulping drive journal)

Pulper Speed: 81 rpm (Gear motor)

Oscillating Shower Drive Data

Motor:

Manufactured by:

Power: 2.0 hP Speed: 1750 rpm

Shower Speed: 7 rpm (Gear motor)

Filter Segment Data (ITELPA) Synthetic Wire Bags

Execution: Heat shrunk bags

Mesh: 14 cm

Mesh Characteristics: Trevira monofil

Material: polyester

Type: Plastimesh

Bag Enclosure: Manual seam

Fixing to the segment base: By means of covered clamp

Barometric Leg Data

Turbid and Clarified water barometric legs

Minimum Flow Rate:

Medium Flow Rate:

2.5 m/s

Maximum Flow Rate:

2.9 m/s

Minimum Height of Legs:

Leg Diameter:

Clear:

2.0 mm

Cloudy: 150 mm

Relative Vacuum in the Legs: 5mWC (maximum)

2mWC (minimum)

Cloudy/Clear Water Ratio: 30 to 40 % cloudy

70 to 60 % clear

Oscillating Shower for Disk Cleaning

Pressure: 0.9 MPa
Consumption: 8.5 l/min

Fan Jet Nozzle Type: 2.5 mm diameter @ 60 /STAMM

Number of Nozzles per Disk: 8

Cake Removal Shower

Pressure: 0.9 MPa
Consumption: 13.0 l/min

Fan Jet Nozzle Type: 3.0 mm diameter @ 80/LODDING

Number of Nozzles per Disk: 2

Residual Cleaning Shower

Pressure: 0.1 to 0.2 MPa

Consumption: 5 to 10 l/min

Straight Jet Shower: 23.8 mm i.d.

Number of Showers: 1 + number of disks

Theory of Operation

The Disk Filter consists of 10 circular disks with sixteen filter sections per disk fastened to a hollow shaft. The hollow shaft lies horizontally in an enclosed tank and is driven at one end by a drive motor. At the other end of the shaft is the suction head. The suction head has a cloudy water outlet, clear water outlet and shower water outlet. There are also areas which allow no outlet (i.e., vacuum breaker zones). The suction head remains stationary and is sealed against the rotating hollow shaft.

To understand the disk filter operation, let's study one revolution of one segment beginning with the segment immersing in the vat slurry.

A. Segment Filling-Up Zone

The segment begins to immerse in the vat liquid. In this zone no vacuum is applied due to the vacuum breaker portion of the suction head. This area allows the segment to be fully submerged and therefore sucking no air prior to vacuum applications.

B. Cloudy Water Suction Zone

The segment is now fully submerged and vacuum is induced in this area by the flow of water to the centre shaft and down the barometric legs. This hydraulic vacuum draws the water, fines and ash through the fabric mesh while fibers begin to accumulate on the surface of the fabric. These fibers will form a natural filter which will be used to achieve low solids content in the clear water. This zone may be minimized by closing gate (a) while it can also be maximized by opening (a) and closing gate (b).

C. Transition Zone

This is the zone between the two gates (a) and (b). By adjusting these gates, you can either minimize or maximize the cloudy and clear water suction zones. Increasing one zone (i.e., cloudy water) can only be done by sacrificing some of the clear water suction zone.

D. Clear Water Suction Zone

The segment is beginning to move upwards in the vat liquid. A fiber mat has formed on the fabric surface which acts as an additional filter. Small particles which were able to pass through the mesh openings are no longer able to pass through the fiber mat and therefore the clear water will contain low solids. Like the cloudy water suction zone, the flow of water from the hollow shaft and down the barometric legs induces the vacuum which aids in the filtering action. This zone may be minimized by closing gate (b) and can be maximized by opening gate (b) and closing gate (a).

E. Second Vacuum Breaker Zone

The segment is about to rise out of the vat slurry. In this zone, no vacuum is applied due to the vacuum breaker portion of the suction head. This area allows a break in the vacuum while the segment rises out of the liquid which will slightly loosen the fiber mat on the fabric surface.

F. Cake Removal Zone

The segment has emerged from the liquid and a non-oscillating, high pressure, single nozzle shower blasts (peels) the fiber mat from the fabric surface. The cake falls off the fabric surface into the cake removal troughs into the repulper located directly below the troughs.

G. Wire and Trough Cleaning Zone

In this zone, the cake collecting trough and filter segments are cleaned. The first shower is the non-oscillating, low pressure, single nozzle shower which is positioned at the top of the collection trough to ensure that the residue (of the cake) is washed away into the repulper. Monitor the volume of this shower as it may lead to over-dilution in the repulper.

The second shower is an oscillating, high pressure shower with four nozzles per disk which is used to clean the fabric before it resubmerges into the filter vat. The shower arm oscillates at a 60° angle. The nozzles direct the water at the fabric as the shower arm sweeps the fabric surface.

H. Shower Water Removal Zone

Shower water from the cake removal and oscillating cleaning shower which has passed through the filter is discharged through the suction head and out a separate port to Tank 29. This pipe extends from the disk filter to Tank 29 but is not submerged as were the barometric legs.

Machine Manual

Control Loops Associated With Disk Filter

Flow Control - Inlet Box at Disk Filter

The inlet flow to the Disk Filter is controlled with a flow control loop (FIC 0236). A flow transmitter (FT 0235) measures the flow delivered from P 41. A second transmitter (FT 0236) measures the flow of cloudy water (from Tank 29) recirculated to the inlet box. The total inlet flow is a combination of both of these flows and is regulated with a control valve on the cloudy water line. Therefore, the flow from P 41 remains constant while either more or less cloudy water is recirculated to achieve set point.

In the case described in the process flow diagram the inlet flow to the Disk Filter is:

P 41:	6182/	49.46/	0.8 (76%0)
Cloudy Water (P 45):	1986/	3.98/	0.2 (24%0)
Total Inlet Flow:	8168/	53.44/	0.65

Hence the minimum flow to the Disk Filter could be only the slurry supplied from P 41. The control system allows recovered cloudy water to be reintroduced into the Disk Filter for a system balance. The impact of this reintroduction of cloudy water is a reduction of inlet consistency from 0.8% to 0.65%.

Level Control - Disk Filter Vat

The level of the vat in the Disk Filter is sensed by LT 0227 and controlled with the adjustment of the Disk Filter drive speed (SC 0227). As the level in the vat rises above set point, the drive rotation is reduced to slow the speed of the disks (as the level drops below set point the drive is increased). The speed of the disk rotation impacts the drainage time through the mesh;

Faster Speed; Reduced Drainage; Level goes up
Slower Speed; Increased Drainage; Level goes down

The slower the filter runs, the better pad is formed and cleaner white water is removed. The maximum level in the filter vat is set at 20 mm below the top of the cake removal trough (crenalations) and the minimum vat level is set at 60 mm below the top of the crenalations. Therefore, the vat level control zone is only 40 mm wide.

When the vat level is at the maximum point (i.e., 20 mm below trough) the efficiency of the disk filter is maximized (i.e., more water removed per time - 1/min). However, if the disk drive speed was to remain constant, the vat level would drop because of the higher efficiencies. As the level in the vat drops, less filter area is submerged in the vat and in extreme cases vacuum could be lost and filter efficiency reduced dramatically. The subsequent control action to the falling vat level is an increase in the disk filter drive speed. As

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the speed increases, the retention time of the filtered area in the vat is reduced and therefore efficiency is also reduced (i.e., mat does not set up as well at lower retention times). This reduction in efficiency results in less water being filtered which in turn increases the vat level.

As the vat level begins to rise, more filtered area is submerged in the slurry. The level must not exceed 20 mm below the cake collecting troughs because it will overflow into the repulper and dilute the thick stock chest (Tank 31). Hence as the vat level approaches the maximum, the drive speed is reduced and filtering efficiencies are increased. This results in more water removed and a reduction in the vat level.

Level Control - Tank 29 and 30

The level of Tank 29 is controlled (LIC 0233) with the addition of fresh water to the seal pit portion of the tank. Likewise, the level in Tank 30 is controlled (LIC 0234) with fresh water addition to the seal pit. The seal pits overflow into the respective tanks to maintain level and seal the barometric legs. If the level in the tanks is stable and the Disk Filter is operational, the barometric legs should remain sealed without fresh water addition. The extracted water overflows the seal trays and into the appropriate tank.

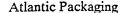
This control loop should be monitored frequently to maximize disk filter efficiency and minimize fresh water usage.

Consistency Control - Tank 31

A consistency control loop (NIC 238) regulates the discharged thick stock consistency from Tank 31 to the suction of P 36 (machine chest pump). This stock must be controlled to the set point established at the machine chest discharge so that no diluting or thickening occurs at P 36.

A senser/transmitter (NT 238) measures consistency and regulates the dilution water addition through two valves (NV 238A and NV 238B). The first valve controls dilution water addition at the suction of P 44 while the second valve controls dilution water added at the repulper. Both valves function to achieve a discharge consistency in the range of 3.0 to 4.0%. The objective should be to achieve a discharge consistency equal to the consistency in the machine chest (3.5%).

If the valve NV 238A is positioned at less than 40%, then valve NV 238B would close to allow the first valve to control in 50% open range. Conversely, if NV 238A is opened greater than 60% then NV 238B would open to dilute the slurry so that the first valve can control in 50% open range.



Operating Parameters

There are four factors which the operators can control. These are;

- Sweetner Addition Rate
- Sweetner Consistency
- Shower Conditions
- Vacuum in the Barametric Legs

1. Sweetner Addition Rate

In most process applications, the amount of sweetner and white water are metered to obtain a preset ratio i.e., 20% sweetner and 80% white water. For our Disk Filter system, there is no ratio control. The amount of sweetner can be adjusted by opening or closing the valve located on the sweetner line at the suction of P 41(1452).

In the example outlined on the diagram An.3401.91, the sweetner addition represents 21% of the total outflow from P 41. This flow rate represents 87% of the Q value for the sweetner pump P 43. Therefore, the ratio of sweetner to white water could range between 0 (valve fully closed) to 21%.

Due to the fact that there is no ratio control in this system, we must monitor the mat formation at the Disk Filter and adjust the sweetner addition accordingly. A thick dry mat on the filter after emergence from the vat represents too much sweetner addition. A thin, wet mat which falls off the filter surface prior to being removed with the shower represents too little sweetner addition. A balance must be found where the mat adheres to the filter surface and is showered off with relative ease. This balance can be found only through experimentation.

2. Sweetner Consistency

Although sweetner consistency will impact mat formation (higher consistency, better matting) adjusting the sweetner consistency will impart the thick stock consistency to the tissue machine. Consistency in the machine chest is diluted at the suction of P 36 in order to deliver a 3% consistency slurry to the O SDM refiner. In order to raise the sweetner consistency, the stock from Tank 16 and Tank 28 must both be increased which would impact the amount of dilution water required to achieve the 3% discharge required at P 36.

Controlling the machine chest consistency at 3.5% and altering the addition of sweetner to the suction of P 41 is the better method of optimizing Disk Filter operation.

3. Shower Conditions

By shutting off the cake removal showers at one disk you can reduce the filtering area and in turn reduce the efficiency of the unit for lower throughput rates. This would be a short term fix and the true cause for the reduction in throughput should be analyzed and corrected.

4. Vacuum in the Barometric Legs

The induced vacuum can be slightly adjusted by opening bleed valves on the barometric legs (1509 and 1510). The vacuum level must not fall below the minimum of 2 mWC nor rise higher than 5mWC in order to ensure adequate filtering with good fiber mat formation.

Start-up and Operating Procedures

(Group IX -Events 9-17/17)

- 1. Open control valves for fresh water (1503/1504) which allows fresh water to fill the seal tanks. This action seals the barometric drop legs from the Disk Filter and establishes water level in both tanks until the Disk Filter is operational.
- 2. Close the vacuum breaker valves at the barometric legs. Check drive gear box lubrication level.
- 3. Open shower header valves at Disk Filter (1492,1493,1494).
- 4. Start fabric mesh cleaning shower oscillation motor (AFM 247). No permanent interlocks.
- 5. Start Disk Filter drive motor (AFM 245) at lowest speed (level control-manual).

Permanent interlock

- Level in Disk Filter vat greater than or equal to 10% but less than or equal to 60% (maximum operating level in vat).
- 6. Start Pump P 45 (AFM 249) -water from Tank 29 for low pressure residue shower.

Permanent interlock

- Level in Tank 29 greater than or equal to 30%.
- 7. Start Pump P 47 shower booster pump (AFM 248).

Permanent interlock

- Level in Tank 30 greater than or equal to 30%.
- 8. Start repulper drive motor (AFM 246).
 - No permanent interlocks.

Status

- Disk Filter drive motor on.
- Showers on Cake Removal, Residue Cleaning, Oscillating, High Pressure Cleaning.
- Repulper on.
- 9. Start Pump P 41 (AFM 244) supply pump to Disk Filter from wire pit.

Permanent interlock

• Level in wire pit greater than or equal to 30%.

ProcessInterlock

- Level in Tank 31 must be less than or equal to 95%.
- Watch filter vat level and place controller in automatic mode when level approaches minimum value (approx. 60 mm below collection trough).
- 10. Start Pump P 43 (AFM 243) sweetner pump at machine chest.

Permanent interlock

- Level in machine chest (Tank 24) greater than or equal to 30%.
- 11. Start Pump P 44 (AFM 251) Thick stock in Tank 31 to suction of machine chest pump (P 36).

Permanent interlock

- Level in Tank 31 greater than or equal to 30%.
- 12. Set consistency control for Tank 31 discharge to 3.5%. Cloudy water will flow to repulper and suction of P 44 to control consistency.

Check vacuum gauges at barometric legs. The vacuum level in the cloudy water leg must be equal or higher than the clear water leg. Maintain a minimum vacuum level of 2mWC in each drop leg.

Monitor the consistency of the sweetner indirectly through the consistency control loop at P 36 (thick stock to paper machine). Fluctuations must be avoided in order to keep the Disk Filter operation efficient and constant. If P 41 consistency is maintained at approximately 0.8%, the minimum volume of cloudy water will lower consistency to 0.6%.

The residue cleaning shower may act as a stock dilutant in the repulper if the flow rate is excessive. The shower water from the cake removal and oscillating shower passes through the fabric mesh into the suction head and is removed through the shower water outlet to Tank 29.

The amount of sweetner can be added at the suction of P 41 by opening or closing valve 1452. If a thick mat is not forming on the filter surface, more sweetner may need to be added to establish a better fiber network.

Adjust the gates at the suction head. The ratio of cloudy to clean water may be varied from 20:80 to 50:50. A recommended run ratio is 30 (40):70 (60).

If the clear water solids level increases, start to close the clear water separating gate and subsequently open the cloudy water gate.

After each adjustment (i.e., filter rotation speed, inlet flow modification) check the vacuum gauge in each barometric leg. Adjust the vacuum breaker valves if required.

Interlocks

1. P 47 - Disk Filter booster pump for H.P. showers will stop if:

- Level in Tank 30 less than or equal to 30%.
- Oscillating motor for H.P. cleaning shower stops.

2. Disk Filter drive will stop if:

- Level in vat less than or equal to 10% or equal to or greater than 60%.
- Repulper drive motor stops.
- Oscillating motor for H.P. cleaning shower stops.

3. P 45 - Tank 29 discharge pump will stop if:

- Level in Tank 29 less than or equal to 30%.
- P 41 stops.
- Level in Tank 31 greater than or equal to 95%.

4. P 41 - wire pit supply pump will stop if:

- Level in wire pit less than or equal to 30%.
- Level in Tank 31 greater than or equal to 95%.
- Disk Filter drive stops.
- P 45 stops.

5. P 43 - Sweetner pump will stop if:

- Level in machine chest less than or equal to 30%.
- P 41 stops.

6. P 44 - Thick stock from Tank 31 to P 36 will stop if:

- Level in Tank 31 less than or equal to 30%.
- P 36 stops.

Shutdown Procedures

- 1. Stop P 43 Sweetner pump at machine chest.
- 2. Operate filter vat level and inlet flow control loops on manual. This ensures that the Disk Filter drive will not speed up as filter vat level drops and the cloudy water control valve at the inlet box does not open fully to compensate for a lack of flow when supply pump is stopped.
- 3. Stop P 41 -Supply pump from wire pit.
- 4. Allow time for showers to blast the filter surfaces to ensure that they are clean before shut down.
- 5. Stop P 47 booster pump for showers; cake removal and oscillating cleaning shower.
- 6. Stop shower oscillation motor.
- 7. Stop Disk Filter drive.
- 8. Ensure repulper is flushed and stop drive motor.
- 9. Stop pump P 45 -Cloudy water Tank 29.
- 10. Stop pump P 44 -Tank 31 to suction of machine chest pump.



11. For extended shut downs, drain vat through drain valve (1524) to Tank 31. Clean the repulper blades with water.

Troubleshooting

- A) Stock level in vat drops below the level (20 mm minimum 60 mm maximum).
 - 1. Check the white water flow to Disk Filter P 41.
 - 2. Reduce the filter rotation.
 - 3. Reduce vacuum slightly (minimum 2 mWC) by opening vacuum breaker valve.
 - 4. Neutralize 1 or more disks, shutting off the water supply to the corresponding showers (cake removal and wire cleaning showers).
- B) Stock level rises above the 20 mm minimum.
 - 1. Check the white water to Disk Filter P 41.
 - 2. Increase the filter rotation.
 - 3. Increase vacuum level slightly (Maximum 5mWC) by closing vacuum breaker valve.
- C) Vacuum gauges build up or only a thin layer of fiber builds up on the disk faces and there is no stock thickening inside the filter vat.
 - 1. Increase the sweetner quantity.
 - 2. Increase the sweetner consistency.
 - 3. Reduce the filter rotation.
 - 4. Check the stock level in the vat and raise it if required.
 - 5. Check the suction head seal as to tightness. With air penetration the vacuum drops and does not permit a good cake build up on the disk faces.
- D) Vacuum gauges at barometric legs indicate no (or insufficient) vacuum.
 - 1. Check vacuum breaker valves and ensure they are closed.
 - 2. Check the segments as to existence of damaged wires.
 - 3. Check valves at barometric leg and ensure that they are fully open.
- E) High solids(ppm) in clear water.
 - 1. Control the sweetner supply.
 - 2. Reduce the filter rotation and vacuum (minimum 2mWC).
 - 3. Keep the freeness value of white water low and constant as much as possible.

F) Cake removal shower plugged.

- 1. Shut off the water supply to this shower (P 47).
- 2. Open shower and clean.

G) Irregular removal of the cake from the disk filter.

- 1. Check cake removal shower pressure (0.9MPa).
- 2. Check the correct position of the water jets.
- 3. Check nozzles for plugging.

H) Unsatisfactory cleaning of segment wires.

- 1. Check the wire cleaning shower pressure (0.9MPa).
- 2. Plugged nozzle. Shut off the water supply and remove the plugging.

Appendix

Pumps and Tanks

Let's look at the various components associated with these process stages (refer to process diagram).

A. Equipment:

KROFTA - Process A. B, and C.

DISK FILTER Size II 10/10

TURBO FILTER - Process A

B. Pumps:

P 06 - Tank 10 discharge pump (A)

P 10 - Tank 20 discharge pump (ABC)

P 18 - Tank 14 discharge pump (B)

P 34 - Tank 30 discharge pump (CD)

P 41 - Tank 26 discharge pump (D)

P 42 - Tank 26 discharge pump (C)

P 44 - Tank 31 discharge pump (D)

P 45 - Tank 29 discharge pump (D)

P 46 - Tank 30 discharge pump (D)

P 47 - Tank 30 discharge pump (D)

C. Tanks:

Process A - No. 10, 13, 20 Process B - No. 14, 12, 20

Process C - No. 26, 30, 20

Process D - No. 26, 29, 30, 31

KROFTA No. 1 KROFTA No. 1 Feed Pump (P 06 - Tank 10)

Function

To pump stock at consistencies less than 1.0% from Tank 10 to the inlet of the Turbo Filter and under pressure from this pump the filtered water flows to KROFTA No. 1 and the unfiltered water flows to Tank 13.

Operating Data

Designation:

L 12.5/15

0 =

3500 l/min

Pump Head:

33 mWG

Tank 10 (12 m³)

In:

Water from Drainators

Out:

• Water to inlet of Turbo Filter

No agitator.

Tank 13 (80 m^3)

In:

- Clarified water from KROFTA No.1
- Unfiltered stock and air bleed from Turbo Filter
- Accepts from Pressure Screen Size 13 Type W-A when level in Tank 7 greater than 95%.
- Accepts from Pressure Screen Size 13 Type W-B when level in Tank 7 greater than 95%.

Out:

- Pulper head Tanks 1,2,3.
- Tank 4
- No agitator

KROFTA No. 2

KROFTA No. 2 Feed Pump (P 18 - Tank 14)

Function

To pump stock at consistencies less than 1.0 % from Tank 14 to the inlet of KROFTA No. 2.

Operating Data

Designation:

L 25

Q =

11000 l/min

Pump Head:

mWG

Tank 14 (35 m^3)

In:

• Extracted water from HYDRODISK 12/12.

Out:

• Inlet of KROFTA No. 2

No agitator

Tank 12 (100 m³)

In:

- Clarified water from KROFTA No. 2.
- Water from Belt Thickener M2 1500.
- Level control clarified water from the paper machine.

Out:

- Dilution water at deflaker.
- Secondary fine cleaning dilution water.
- Tertiary fine cleaning dilution water.
- Secondary screening dilution water.
- Dilution water in Tank 9.
- Consistency control at inlet of P 08.
- Shower water for flotation cells.
- Dilution water for tertiary fine cleaner reject tips.

No agitator.

KROFTA No. 3 Feed Pump (P 42 - Wire Pit - Tank 26)

Function

To pump white water at consistencies less than 0.3% from Wire Pit to the inlet of KROFTA No. 3.

Operating Data

Designation:

Q =

Pump Head:

Disk Filter

Disk Filter Feed Pump (P41 - Tank 26 discharge pump)

Function

To blend white water from the wire pit with thick stock from the machine chest and pump the dilute slurry at consistencies of less than 1.0 % from Wire Pit to the inlet of Disk Filter.

Operating Data

Designation:

L 350 -GIV -20/25

0 =

7100 l/min

Pump Head:

18 mWG

"Sweetner" Pump (P 43 -Machine Chest - Tank 24)

Function

To pump "sweet" stock at 3.5 % from Machine Chest to the inlet of P 41 (Disk Filter Feed Pump).

Operating Data

Designation:

L 230 -GIII -12.5/15

O =

1500 l/min

Pump Head:

16 mWG

"Clean" Water Discharge Pumps (P 34 -Tank 30 discharge pump)

Function

To pump "clear" water from Tank 30 at very low consistency to:

- a) Tank 33 Consistency dilution water.
- b) Shower system for paper machine.
- c) White Water silo showers.
- d) Vibrating screen shower.

- e) Flush/dilution water for KS cleaner troughs and T1 cleaner.
- f) Fiber saving water for tertiary cleaners (KS 160/6R -Approach flow).
- g) Flush water 0 SDM refiner.
- h) Process water in stock prep.

Operating Data

Designation:

L 360 - GIV - 20/25

Q =

6000 l/min

Pump Head:

53 mWG

P 46 -Tank 30 diskharge pump

Function

To pump "clear" water from Disk Filter at very low consistency to:

- Level control wire pit.
- Showers for broke pulper.

Operating Data

Designation:

L 275 -GIII -12.5/15

P 47 -Tank 30 discharge pump

Function

To pump "clear" water in Tank 30 at very low consistency to showers in the Disk Filter.

Operating Data

Designation:

Pump for pressure increase

Q =

1050 l/min

Pump Head:

9mWG

"Cloudy" Water Discharge Pump (P 45 -Tank 29 discharge pump)

Function

To pump "cloudy" water from Drum Filter at 0.2 % consistency to:

- a) Repulper at Disk Filter inlet of Disk Filter.
- b) Consistency dilution water at discharge Tank 31.
- c) Inlet of Disk Filter under flow control loop.

Operating Data

Designation:

L 260 -GIII -12.5/15

0 =

3500 l/min

Pump Head:

18 mWg

Thick Stock Discharge Pump (P 44 -Tank 31)

Function

To pump thickened stock from Disk Filter at 3.5 % consistency to inlet of machine chest pump (P 36).

Operating Data

Designation:

L 220 -GIII -12.5/15

Q =

1600 l/min

Pump Head:

14.5 mWG

Tank 26 (Wire Pit) (35 m³)

In:

- Extracted water from Suction Pressure Roll saveall tray.
- Wire and press shower water.
- Overflow from the white water silo.

Out:

- Inlet of KROFTA No. 3.
- Inlet of Disk Filter.

No agitator.

Tank 30 (50 m^3)

In:

- Clarified water from KROFTA No. 3.
- Clear water from Disk Filter.
- Clear water from vacuum pumps.

Out:

- Tank 33 -consistency dilution water.
- Showers system for paper machine.
- White water silo showers.
- Vibrating screen shower.
- Flush/dilution water for KS cleaner troughs and T1 cleaner.
- Fiber saving water for tertiary cleaners (KS 160/6R -approach flow).
- Flush water 0 SDM refiner.
- Process water in stock prep.
- Level control wire pit.
- Showers for broke pulper.
- Disk Filter high pressure showers; cake removal and fabric cleaning.

No agitator.

Tank 29 (25 m^3)

In:

• "Cloudy" water from Disk Filter.

Out:

- Thick stock trough in Disk Filter.
- Consistency dilution water at discharge of Tank 31.
- Inlet of Disk Filter flow control.

No Agitator

Tank 31 (12 m³)

In:

• Thickened stock from Disk Filter.

Out:

• Suction of machine chest pump P 36.

No agitator.

Sludge

Sludge Chest Feed Pump (P 10 -Tank 20)

Function

To pump sludge from Tank 20 to Sludge Chest in warehouse (Building W).

Operating Data

Designation:

1-275 -GIII -12.5/15

Q =

1300 l/min

Pump Head:

28.5 mWG

Tank 20 (45 m^3)

In:

- Rejects from Flotation Machine (secondary stage).
- Sludge from KROFTA No. 1, 2, and 3.

Out:

To Sludge Chest.

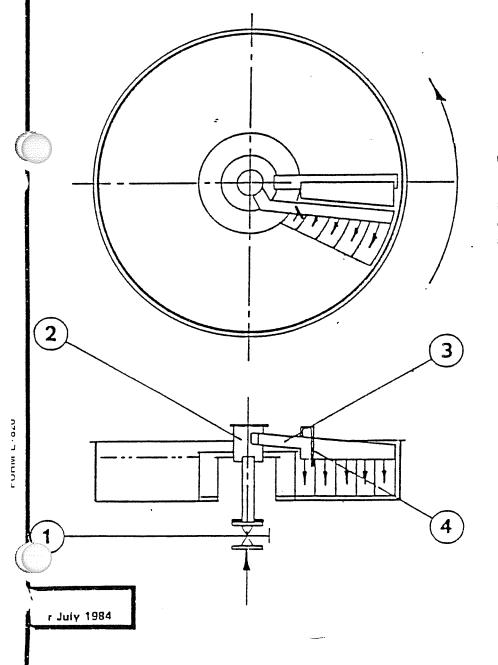
Agitator: 850 MAS



SUPRACELL DESCRIPTION

General Principle

SUPRACELL removes solids by means of air flotation and sedimentation. Turbulence caused by water movement is a very important factor in flotation and greatly reduces the efficiency of the other types of flotation units. In conventional, stationary units, there must always be water movement in order for the water to flow from inlet to outlet. With the SUPRACELL, the inlet and outlet are not stationary, but are rotating about the center. This rotation is synchronized so that the water in the tank achieves "ZERO VELOCITY" during flotation. This means that the afficiency of flotation is greatly increased to near the maximum theoretical limits. In practical terms, this allows better clarification in smaller surface areas and in a much shallower tank. The open tank has a depth of 16 inches. Water is processed from inlet to outlet in 2 — 3 minutes.



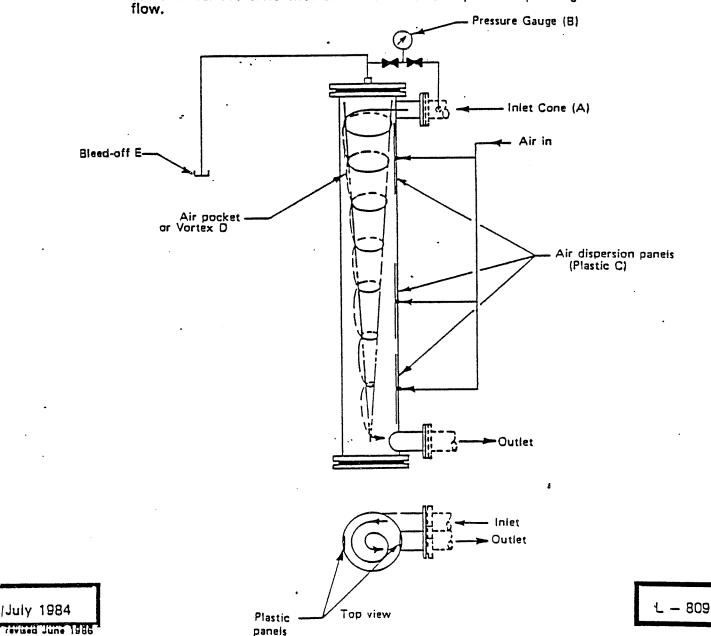
Inlet Flow

Air is dissolved into the water by means of KROFTA AIR ABSORPTION SYSTEM, (not shown). At the pressure release valve (1) absorbed air is released into the water. The water flows in at the exact center, through a rotary joint (2) and into the distribution duct (3). Coarse air is released through a vent pipe (4) in the duct. The flow is directed so as to eliminate turbulance. Since the inlet distribution is moving backward at the same speed that the water is flowing out, the water stays in one spot in the tank without any movement during flotation.



THE KRUFTA AIR DISSOLVING TUBE

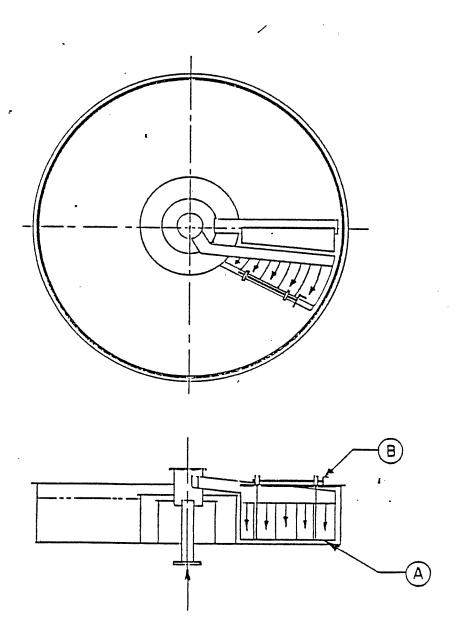
The unique Krofta Air Dissolving Tube (pat. pending) is a device designed to give fast mixing and dissolving of air into the water stream in a minimum of space. Water enters the tube at the inlet nozzle cone (A) and is given a high velocity which makes it spin around in the tube at a high rate. Pressure gauge (B) can be used to measure the pressure drop through the cone which is an accurate flow measurement. Special porous plastic panels (C) insert compressed air into the rapidly moving spiralling water all along the length of the tube. The rapid mixing of the small air bubbles and water under pressure dissolves air into the water. Any air which is not dissolved collects in the air pocket or center vortex in the tube (D) and excess air is removed by the "bleed-off" vent (E). The dissolving tube can be installed in either the horizontal or vertical position. They come in various sizes with different numbers of panels depending on the flow.





Inlet Distribution Rake

All KROFTA SUPRACELLS are equipped with an adjustable inlet distribution rake (A). When properly adjusted this rake reduces turbulance caused by the inlet flow. Vertical adjustment of the rake is made manually by rotating the attached hand crank (B). For optimum results, under normal operating conditions, the top of the rake should be at the level in the clarifier. Changes in water level should be followed by adjustments to the distribution rake.



r July 1984

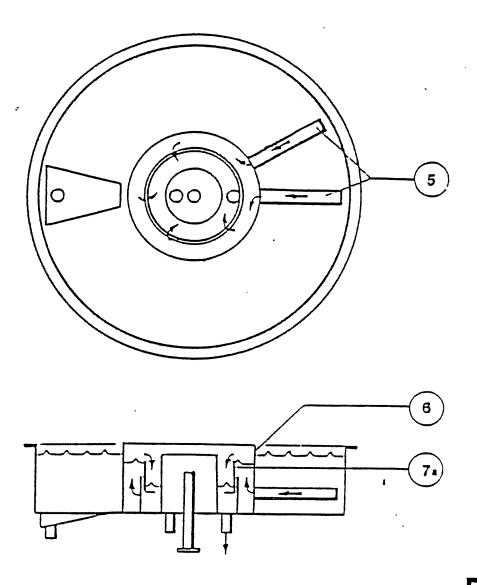
L - 288/aa



Clarified Water Outlet (with central - INSIDE clarified water overflow)

The clarified water, near the bottom, is removed by slotted extraction pipes (5). The pipes are attached to the wall of the moving center part. The water flows into the center section (6), which is isolated by a simple rubber seal at the bottom. The clean water then flows by gravity over a central weir (7a), operated by a hydraulic control.

The clarified water normally contains less than 30 PPM of floatable and settleable solids.



r July 1984

L - 288/bb

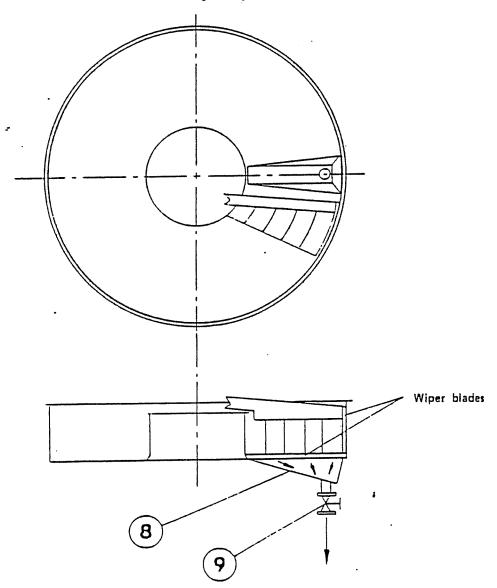


Removal of Settled Material

Every flotation process produces a small amount of settled material which must be removed from the bottom to prevent clogging and improve water clarity. This is especially true when any sand, grit or scale is present. There is also a tendency for scurn to build up on the sides of the tank.

The SUPRACELL has rubber wiper blades built in to remove any scum that accumulates. The settled material drops into the sump, built into the tank (8).

The solids which collect in the sump are purged through the bottom opening by means of an automatic valve (9). The SUPRACELL is therefore self-cleaning during continuous operation.



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revised July 1978

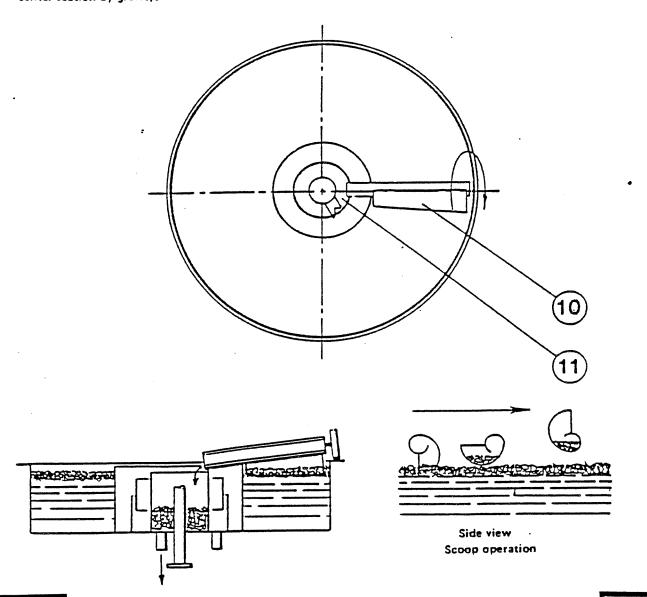
L - 288/d



Removal of Floated Material

The floated material is recovered from the top surface by means of the patented KAOFTA SPIRAL SCOOP (10). The scoop is designed to remove the floated material at the highest possible consistency, with minimum surface disturbance. The level of water determines the consistency of the floated material removed.

The scoop discharges into the stationary center section (11), and the floated material flows from the center section by gravity.





7.2 Main Parts List for Minisorter Size 050-052 (see drawing No. 7.2.1, 7.2.2 and 7.3.1)

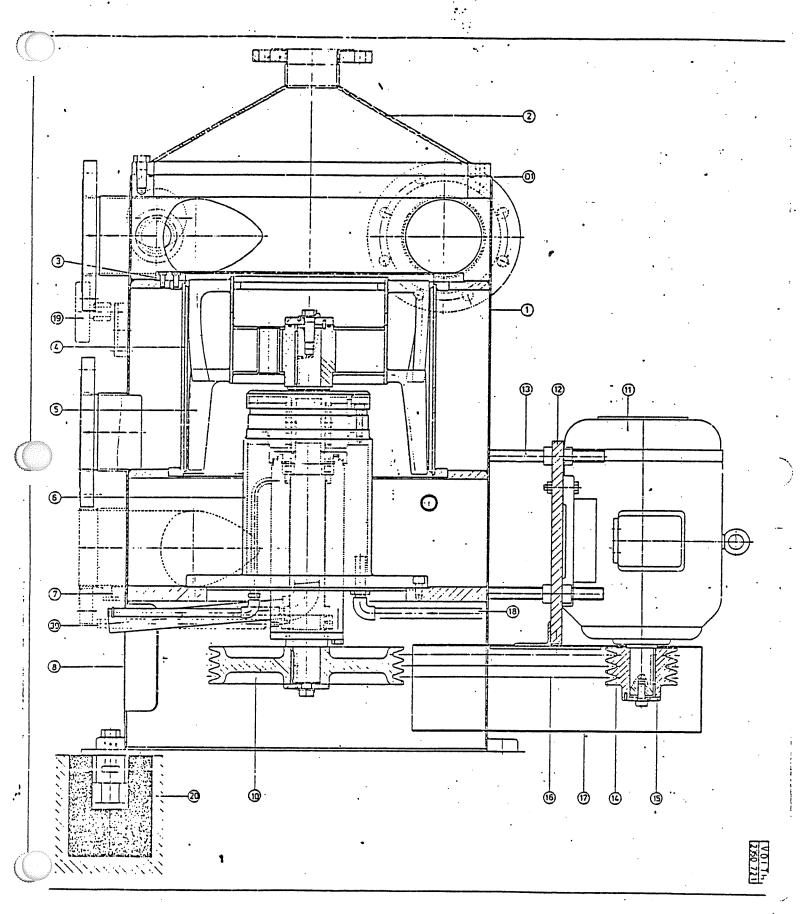
- 1 Casing
- 2 Cover
- 3 Screen drum retaining ring
- 4 Screen drum
- 5 Rotor
- 6 Bearing housing
- 7 Discharge' boss
- 8 Cover, plate .
- 9 Bearing cap
- 10 Rotor belt pulley
- 11 Motor
- 12. Motor base plate
- 13 Tensioning bolt
- 14 Motor belt pulley
- 15 Tensioning disc
- 16 Driving belt
- 17 Guard
- 18 Seal water connection
- 19. Pressure gauge
- 20 Foundation blocks
- 21 Rotor retaining disc
- 22 Rotor retaining bolt
- 23 Rotor shaft
- 24 Spacer
- 25 Stuffing box gland
- 26 Packing ring
- 27 Shaft protective sleeve
- 28 Seal water ring
- 29 Stuffing box housing
- 30 Base ring
- -31 Labyrinth ring
- 32 Retaining ring
- 33 . Cylindrical roller bearing
- 34 Bearing housing

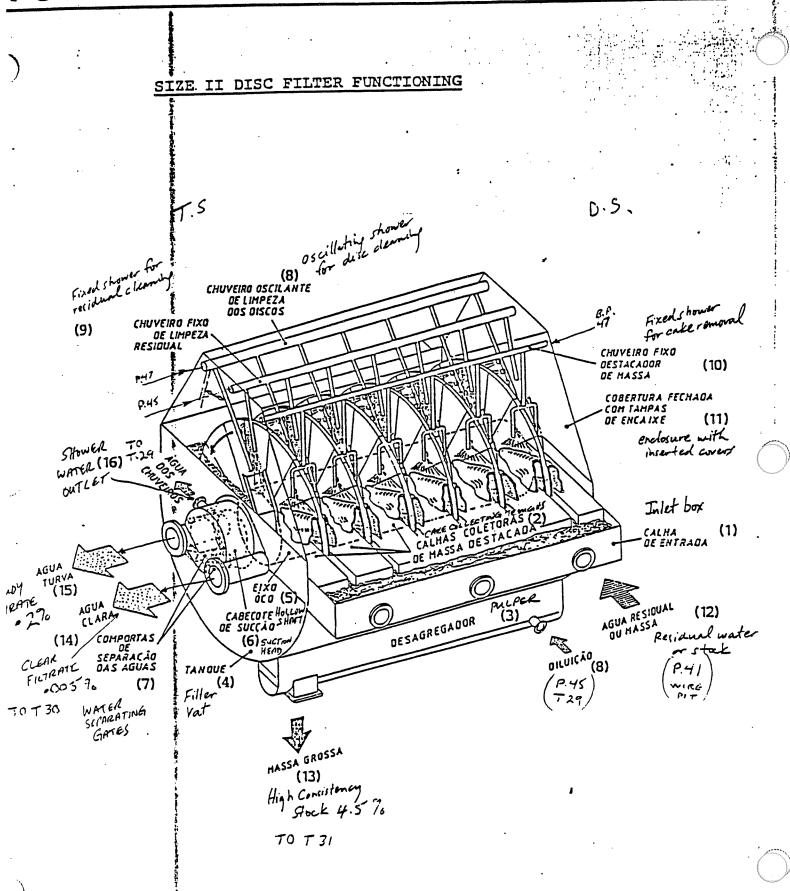


- 35 Self-aligning roller bearing
- 36 Tensioning disc
- 37 Hex. bolt
- 38 Spacer sleeve
- 39 Connecting Facility for Pulse Gauging Line (only upon customer's request)

Seals:

- D1 Round seal ring 525 x 5
- D2 Seal ring 15.3 x 2.4
- D3 Round seal ring 59 x 5
- D4 Round seal ring 50 x 3
- D5 Round seal ring 40.2 x 3
- D6 Round seal ring 47 x 3
- D7 Round seal ring 140 x 5
- D8 Round seal ring 340 x 5
- D9 Round seal ring 18 x 3
- D10 Round seal ring 12.3 x 2.4

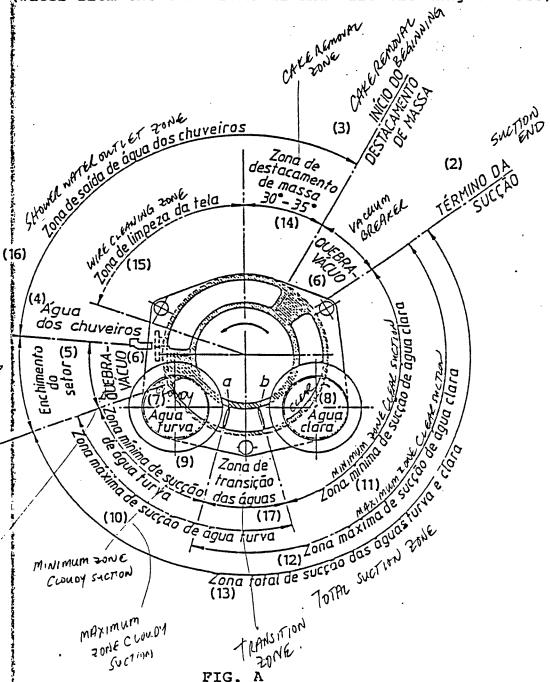




(no vacuum actuation), by means of the cake removal shower with position adjustment.

Wire cleaning zone: zone where de disc segment wires are cleaned by the oscillating showers.

Shower water outlet zone: total zone of segment drainage (water from the cake removal and wire cleaning showers).



WATER FROM SHOWERS

> SEGMENT FILLING UP

SUCTION BEGINNING
(1)
INICIO DA
INICIO DA

VACUUM
BREAKER

				0
			·	

REEL

Purpose

To collect the paper after creping and calendering in a convenient and efficient form and prepare it for further processing at the converting division.

Process Description

The tail is threaded from the creping doctor to the drum reel by the Fibron Durrand system (see Calender Stack Section). The tail wraps around the drum reel and into the nip formed by the reel spool and the reel drum. The tail is widened out and a jet of water is sprayed onto the core to wrap the full width of the sheet onto the core and spool.

The spool is lowered by the primary arms to the guide rails, the secondary arms are then brought in and take over the pressure control of the reel build. As the reel gets larger in diameter, the secondary arms pivot while the reel spool moves along the guide rails.

When the reel reaches the desired diameter, the turn-up or change-up can be performed in two different methods. The first method utilizes a water spray, while the second method utilizes an intermediate brake and air jets. Both these methods will be outlined in the operation section.

After turn-up has occurred the reel is directed by the secondary arms to the final brake. The reel is stopped by applying a hydraulic brake pad on both the tending and drive sides of the reel spool journal. When the reel comes to a stop the weigh button is pushed and the reel is weighed.

The weighed reel is then lifted by the overhead crane and transported to the core extractor. The core extractor removes the reel spool from the core, so the spool can be reused for another reel. The roll of paper (on the core) is lowered to the basement and loaded onto trucks for the Converting Division.

The empty spool at the core extractor is fitted with another core and lifted by the crane and deposited back into the empty spool storage area above the reel drum. The empty spool will eventually be lowered by the feeding arm into the primary arms and the process is repeated again for changing up.

The reel takes about 30 to 35 minutes to build, therefore approximately 40 reels are produced per day. The designed production is 80 tons per day.

Major Components

The following components make up the reel section on TM2:

- Reel Drum
- Primary Arms
- Secondary Arms
- Feeding Arms
- Empty Spool Storage
- Spreader Roll
- Doctor
- Air Jets
- Water Spray
- Guide Rails
- Reel Spool Starter
- Intermediate Brake
- Final Brake
- Weigh Scale
- Reel Spools
- Cores

1) Reel Drum

Purpose

The reel drum enables the web of paper to be conveniently collected on the reel spools by forming a nip with the paper spool. The reel is driven (ASEA) under sufficient load to ensure adequate tension on the sheet from the calenders.

Description

The drum consists of an iron cylinder 900 mm in diameter and 2770 mm in length. Its surface is ground with spiral grooves to remove air entrained between the drum and the sheet and to properly hold the sheet prior to the nip formed between the reel spool and drum.

During normal operation, the sheet wraps around the drum and feeds into the nip formed between the drum and the reel of paper held by the secondary arms. Paper builds up on the spool and is then "turned-up" at the desired diameter. The maximum reel diameter is 2300 mm.

The reel drum is driven by an ASEA drive and is generally operated slower than the Yankee cylinder for tissue and towel creped grades.

2) Primary Arms

Purpose

4

The primary arms support the empty spool on top of the drum when reeling (threading the sheet). The primary arms are also used to lower the new reel (spool and web) into the secondary arms.

Description

The primary arms (one on the tending side and one on the drive side) are made of steel and pivot around the drum shaft. The primary arms consist of the lock mechanism, cradle mechanism, release mechanism, raise/lower mechanism and the synchronization mechanism.

1) Lock Mechanism

The lock holds the empty spool against the cradle. It consists of a steel arm (tending side and drive side) which are connected to hydraulic cylinders. The locking arms pivot to the open and close position by a three position selector switch (Open/0/Close). An indicator light displays when the lock is in the closed position.

The locking mechanism should be closed whenever a spool is in the primary arms to ensure that the spool will not eject from the primary arms.

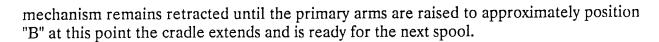
2) Cradle Mechanism

The cradle mechanism is used to support the empty spool whenever the primary arms are not in the lowered position. It is also used to release the new reel when the primary arms are lowered to the guide rails.

This mechanism consists of a steel bracket (tending side and drive side) connected to hydraulic cylinders which extend or retract the brackets as required.

This mechanism does not have a selector designated to it. The limit switches for the primary arms extend and retract it.

The cradle mechanism retracts when the primary arms are at the lowest position (position "C") and the secondary arms are in contact and under pressure with the reel and spool. The



3) Release Mechanism

The release mechanism controls the pressure of the spool (and web) against the drum. This ensures an even density at all times when transferring the new reel from position "B" to position "C" when the secondary arms take over pressure regulation of the reel. The Voith reel is designed to allow the operator to lower the primary arms without placing the secondary arms in the operating position. If the pressure applied by the lock mechanism is not even, the release mechanism will ensure an even pressure at the nip.

The release mechanism includes a hydraulic cylinder (tending and drive sides) attached to the base of the primary arm and pushes against the spool's support. A cam installed on the synchronization shaft for the primary arms activates a pressure regulator which controls the nip pressure, until the secondary arms take over pressure control.

The release mechanism starts when the primary arms are in the transfer position (position B) and the lock mechanism is activated. It turns off when the primary arms are completely lowered to the guide beams and the secondary arms have taken over pressure control for the reel.

The load at the nip between the drum and spool is determined by the weight of the paper and the pressure applied to the spool by the lock mechanism and the release mechanism. The cam is programmed to compensate for the weight of the spool in relation to the position of the primary arms. When the spool is in the transfer position ("B") the pressure caused by the weight of the spool is the major contributor to the load while the pressure in the cylinder is the major contributor to the load when the primary arms are in lowered position ("C").

4) Raise/Lower Mechanism

The raise/lower mechanism consists of a hydraulic cylinder (tending and drive side) with one end connected to the base of the primary arm by a pivot. The other end is connected to the drum support also by a pivot.

The primary arms pivot on the drum shaft. The supports are installed off center from the arms which enables the spools to be placed in the primary arms at position "A" (up position) without touching the drum. When lowering the arms to the transfer position ("B"), the spool comes into contact with the drum.

To lower the primary arms, the cylinders must stretch out; to raise the primary arms the cylinders must contract. A three position spring selector switch is located on CD2 TM labelled Primary Arm. The three positions are (Down/0/Up).

Machine Manual

5) Synchronization Mechanism

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The synchronization mechanism is used to synchronize the arm's movement so that they raise or lower at the same time. It consists of a cross shaft with a toothed wheel on both ends. The bottom part of the primary arms have been designed to form a gear which is connected to the toothed wheels for the cross shaft.

When the arms are raised or lowered the teeth on the primary arms mesh with the teeth on the cross shaft to form a gear which ensures the arms move up and down in unison.



Purpose

To hold the reel against the drum while winding the web. They apply a constant nip pressure throughout the building of the reel. The pressure must remain constant at both ends (tending and drive) and even in order to maintain a constant density.

Description

The secondary arms consist of a steel arm with one end connected to a pivot so that the arm can move to the final brake by forming an arc. The other end is composed of a stationary piece which holds the reel against the drum and a moveable end which ejects the spool.

When the secondary arms are in the retracted position ("C") at the beginning of a reel, the moving end of the arm also retracts. As the reel gets larger, the moving end gradually moves behind the spool support. When the secondary arms move to eject the reel, the moving end pushes the spool towards the final brake.

The secondary arms are equipped with three mechanisms:

- 1. Pressure Control Mechanism
- 2. Synchronization Mechanism
- 3. Intermediate Brake Mechanism

1) Pressure Control Mechanism

The pressure control mechanism consists of a hydraulic cylinder with one end connected to the frame of the drum and the other end attached to the arms by a pivot to enable movement with the arms.

On control desk CD2-TM, there is a pressure regulator for the drive and tending side secondary arm loading adjustment. There are corresponding pressure gauges as well. Also on CD2 TM there is a three position spring selector switch which allows the operator to move the secondary arms "in" or "out" (i.e., retract or extend). An indicator light displays when the secondary arms are in the operating position.

The purpose of the reel section is to roll the paper onto the spools (and cores) so that converting operation can unwind it very quickly without breaking it. The density is defined

Machine Manual

as the quantity of paper (volume) divided by its total weight. The density represents the strength of the paper wound onto the reel. Any variation could cause a break in the converting operation.

The density is determined by the tension applied to the sheet between the reel and the calender and by the secondary loading arms.

The pressure control mechanism creates pressure at the nip solely by the pressure applied by the hydraulic cylinders on the secondary arms. The weight of the roll is independent of the nip pressure as the spool sits on the guide beams.

2) Synchronization Mechanism

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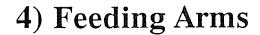
The synchronization mechanism keeps the arms parallel so that they move the reel uniformly out from the reel drum during reel building. This mechanism consists of a loop stretcher with one end connected to the synchronizing cross shaft and the other connected to the secondary arm.

3) Intermediate Brake Mechanism

The intermediate brake moderates the speed of the reel after it leaves the reel drum when turning-up. There is an intermediate brake associated with both the tending and drive sides secondary arms. It consists of a steel arm with one end connected to a pivot. The other end of the arm is connected to the secondary arm by a pivot which adjusts the spool when activated. A hydraulic cylinder is raises and lowers the brake. One end of the cylinder is attached under the arm by a pivot, and the other end is attached to the base of the secondary arm by a pivot.

The brake is activated by illuminated push button located on CD2 TM.

The intermediate brake is used when using the Nordic method of turning up the reel.



Purpose

To transfer the empty spools from the storage area to the primary arms.

Description

One end of the feeding arm (T.S. and D.S.) is attached to a pivot and the center is attached to a hydraulic cylinder. The other end of the arm is equipped with a bumper to hold the spool. The bracket is designed so that when the arm raises to pick up an empty spool it pushes against the adjacent spool. Therefore only one spool is picked up at a time.

The controls in CD2-TM enable the feeding arms operation by using the push-buttons up and down. There is also an E-stop button to stop the feeding arms in an emergency.

5) Empty Spool Storage

Purpose

To store a maximum of four empty spools and supply them one by one to the primary arms in order to prepare for turning up the web onto the new spool.

Description

The top part of the spool storage consists of two steel beams on which steel tracks are mounted. The tracks are aligned parallel to the spool journals and are slightly sloped towards the dry end (front) of the machine. This allows the empty spools to automatically move to the front of the spool storage.

The back end of the spool storage is designed lower than the main tracks and therefore form a stop. This stop holds the spool in place when removing the hooks from the crane.

At the front there is a bumper and at the back there is a guide used for placing the spools onto the stop.

The stop mechanism is used to raise the empty spool from the stop onto the tracks and to move the spool to the front of the storage area. It consists of a small arm with one end connected to a pivot and the other end connected to a cylinder.

The push button for the "stop on storage" located in CD2 TM initiates the stop mechanism to transfer the spool from the stop to the tracks. This button is connected to a time switch, it operates for 5 seconds and then returns to the stop position automatically.

The feeding arms are used to pick up an empty spool in the storage and place it into the primary arms. This system enables us to create an automatic load cycle.

One end of the arm is attached to a pivot, while the middle of the arm is attached to a hydraulic cylinder. The top part of the arm is equipped with a bumper at one end to cradle the empty spool to be transferred to the primary arms. The other end consists of a bumper which is designed to pick up only one spool at a time.

There are three push buttons in CD2 TM used to control the feeding arms (Up/E-stop/Down).

Recl 11



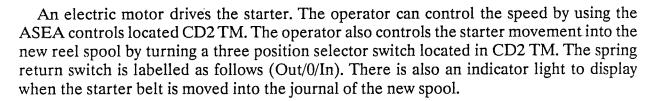
6) Reel Spool Starter

Purpose

The starter turns the empty spool at the same speed as the reel drum so that the reel can be automatically turned-up.

Description

The starter consists of a rubber belt about 150 mm wide which turns around two pulleys mounted on bearings. The belt arrangement is approximately 1 m in length and pivots so that the belt contacts the end journal of the empty spool. The belt pivots back to a park position when the new spool is up to operating speed.





7) Spreader Roll

Purpose

To evenly spread the web before it is wrapped onto the reel.

Description

The spreader roll is located between the Measurex scanner and the reel drum. It is 138 mm in diameter and 2770 mm in length.

The spreader roll is operated in conjunction with the reel drum. When the reel drum is started, the spreader roll is also started.

10) Water Jets

Purpose

To wet the core on the new reel spool and initiate paper adherence to the core. This procedure is used for change-ups and also for start-ups.

Description

The water jet is used to spray the center of the core on the new spool when transferring the sheet from the reel to the new core. The water causes the sheet to adhere to the core and wrap the new spool. This shower is labelled No. 25 in our shower diagram. The shower is discontinuous with a single water jet.

The illuminated push button on CD2 TM is used to open the valve and spray the core.

11) Guide Rails

Purpose

To support the reel during production and to provide the track for discharging the reel to the final brake after turning up.

Description

The guide rails for the reel extend out from the reel drum to the weigh scale and final brake. The spool journals are supported by the rails from when it is lowered by the primary arms to the secondary arms until it is stopped and weighed at the final brake station. There is room for one jumbo reel to be positioned at the weigh station and one being made on the machine.



Purpose

To slow down the reel slightly when using the Nordic turn up method.

Description

The intermediate brake is used to slow down the reel slightly as the reel is moved approximately 30 mm from the reel drum. As soon as the intermediate brake is applied, the bottom blow tube opens up and blows the resulting bag in the web upwards. The web forms a loop around the empty spool, which is rotating at transfer position "B". The web then wraps around the reel spool and forms the new reel.

13) Final Brake

Purpose

The final brake is used to stop the finished reel after a turn-up.

Description

The final brake is mounted at the end of the guide rails. It consists of an arm with one end connected to a pivot and the other end connected to a hydraulic cylinder. A shoe pad is mounted on the top of the arm. The shoe pad is brought in contact with the spool journal to stop the discharged reel.

A three position spring return selector switch is used to operate the final brake (Release/0/Brake). An indicator light comes on to display when the brake has been activated.



Purpose

To weigh each reel so that the total weight produced on the machine can be calculated.

Description

The scale is located at the end of the guide rails where the final brake is activated. It consists of a hydraulic cylinder and a load cell on both the tending and drive sides.

The electronic scale is activated by the illuminated push button located in CD2 TM. The cylinder lifts up the reel in order to weigh it. This button is connected to a timer. After 5 seconds has elapsed, the cylinder automatically returns the reel to the guide rails.

Note:

To operate the weigh mechanism, the final brake must be released. The weight and tare are recorded and displayed on CD2 TM for each reel weighed.

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15) Reel Spools

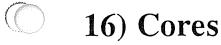
Purpose

To hold the core stationary while the web is wound onto the new spool.

Description

The web is wound onto cores, which are then transported to our converting division. The cores are eased on to the reel spools and then a quick connect air hose is hooked up to the spool. Air pressure is used to load shoes from the spool onto the inside surface of the core to keep the core from turning on the spool during reel build.

The spools consist of iron material with air loaded shoes to hold the core in place. The spools are stored in the empty spool storage area (maximum of 4) above the reel drum. The feeding arm lowers the spool into the primary arms to prepare for changing up. The spool starter is used to bring the new spool up to the reel speed.



Purpose

To provide a solid tube to wind the web onto for easy collection and for transporting to the converting division.

Description

The cores are made of pressed cardboard and have a diameter slightly greater than the reel spools. The reel spools hold the cores in place while the sheet is wound onto the cores.

The reel spools are removed from the cores at the core extracting device. The reel and core are then lowered to the basement and loaded onto trucks to be taken to our converting division.



Technical Data

Reel

Type:

TR90

Paper Width:

2650 mm (Maximum trim)

Paper Diameter:

2300 mm (Maximum)

Distance Between Rail

Centerlines:

3530 mm

Operating Speed:

524-1677 m/min

Design Speed:

1800 m/min

Product:

 $12.5-40 \text{ g/m}^2$

Reel 23

Operating Parameters

The main operating parameter is the secondary arm loading pressure regulation. This pressure must be adjusted carefully to avoid any adverse effects to the reel. The pressure gauges and regulators for the T.S. and D.S. are located in CD2-TM. the T.S. and D.S. can be adjusted separately however, great care must be taken at all times when cocking the reel loading. Corrugation sheet breaks can occur.

The operator should try to make the adjustments that are required to build a good even reel. The operator should monitor the reels carefully to achieve a uniform build, therefore troubleshooting a reel build problem becomes easier to pinpoint back to a change in stock or sheet forming process and not the reel pressure build.

Start-up and Operating Procedures

The following procedure outlines the method used to turn-up a reel or get the sheet on the reel after a break.

- 1. "Start" hydraulic pump # 2 or 3.
- 2. Start the Reel Drive (Asea) with the controls located in CD2-TM.
- 3. Set-up the desired crepe ratio for the grade being produced. Check the speed of the reel with the Yankee to confirm.
- 4. Turn Key Selector Switch to "Operation".
- 5. Set Spool Change selector switch to "Manual".
- 6. Use the crane to lower an empty spool into the **stop** at the back of the empty spool storage. Remove crane.
- 7. Activate the Stop On Storage push-button (606-PB1) to kick the spool out of the stop.
- 8. Repeat items 4 and 5 until there are four empty spools in the storage area.
- 9. Activate push-button (605-PB2) for the Feeding Arm to lift the feeding arms up to accept a new spool from the storage area.

The following interlocks must be satisfied before the feeding arm will activate up:

- The spool to be lowered is at the front bumper.
- The primary arms are empty and in the up position.
- The feeding arms are empty.
- The primary arms locking device must be open.
- Hydraulic pump 2 or 3 must be on.
- 10. Activate push-button (605-PB1) for the Feeding Arms to lower the feeding arms and the new spool into the primary arms at position "A".

Interlocks:

- The feeding arms are occupied.
- The primary arms are in the up position.
- The primary arm lock is open.
- Hydraulic pump 2 or 3 is on.

8) Doctor

Purpose

To prevent the paper from wrapping around the drum during reeling.

Description

It consists of a flexible metal blade inserted into a holder. The operator can adjust the pressure of the blade against the drum by varying the air pressure in the rubber tubes which load the blade.

There are two operations associated with the drum doctor, manual and automatic. The air doctor selection switch is located in CD2 TM. It has three positions; manual, off and automatic. In automatic the doctor will load and unload within the reeling sequence. In manual mode the doctor is loaded by the operator. An indicator light comes on when the doctor is loaded against the drum.

9) Air Jets

Purpose

To transfer the sheet from the drum to the reel spools when reeling.

Description

There are two sets of air jets, top and bottom. The top air jets consist of two single jets, one at the tending side and one at the drive side. The jets, when turned on will blow the sheet down around the reel drum to the nip between the drum and spool.

The bottom air jets consist of several air jets across the width of the reel drum. These jets are used to blow the sheet onto an existing reel after a break. The existing reel is in the secondary arms and the sheet is blown up and around the partial reel to get the web back on the reel.

There are two selector switches on CD2 TM labelled Top Blow Pipe and Bottom Blow Pipe. The three position selector switches and indicator lights operate exactly the same as the doctor controls.

Rcel

25



- 11. Switch the **Reel Spool Clamp** selector (613-SS1) to the "close" position to lock the empty spool into the primary arms.
- 12. Start the Reel Spool Starter Drive (ASEA) by activating the "run" button. Adjust the speed to equal the reel speed and wait until the speed match light is on.
- 13. Move the reel spool starter into the new spool by switching the Reel Spool Starter Movement selector (612-SS1) to the "IN" position. The indicator light will come on.
- 14. When the spool is up to the reel speed, switch the **Primary Arm Selector** (611-SS1) to "**Down**". The primary arms will lower the spool to the transfer position (position "B") and stop automatically. The reel spool starter will automatically stop and return to the park position (i.e., out).

Interlocks:

- The feeding arms are in the lowered position.
- The primary arms locking device is closed.
- 15. Activate the Air Doctor for the reel drum by turning the selector to manual. The doctor must be loaded against the reel drum before turning up.



- 16. The reel is generally slowed down slightly when turning up. A water nozzle sprays a thin water jet on the empty spool (core). The wet core causes the web to adhere to it and wrap on to the spool.
- 17. The secondary arms are moved out to the final brake stop by selector switch (618-SS1) to out.
- 18. When the reel comes to a stop activate the Weight Station button to weigh the reel.
- 19. After the change-up lower the **Primary Arms** to position "C" by switching the selector (611-SS1) to **down**.
- 20. The cradle mechanism for the primary arms opens automatically to enable transfer to the secondary arms. The lock mechanism is used to apply load against the drum until the secondary arms take over the reel loading.
- 21. The Secondary Arms are brought into the new reel by selector switch (618-SS1) to in.
- 22. After the secondary arms come into contact with the reel spool, the secondary arms will automatically take over the pressure loading of the reel from the primary arms. The main winding of the reel now starts, if required adjust the loading pressure with regulators on CD2-TM.

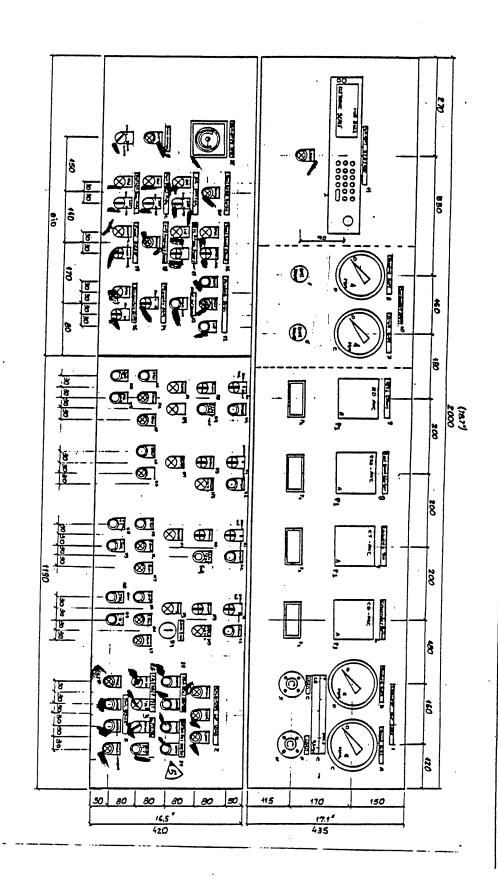
Interlocks:

- Either T.S. or D.S. limit switches for load position enabled.
- 23. When the secondary arms take over the loading of the reel, the primary arms automatically return to position "A" to receive the next empty spool.

The automatic mode will perform the turn-up as above as long as all the interlocks are satisfied.

The Nordic Turn up method utilizes the bottom air jets and the intermediate brake. The water jet is not required for this process. The secondary arms move the reel away from the reel drum approximately 30 mm. The intermediate brake is applied at the same instant to slow the reel down slightly. The bottom air jet also comes on simultaneously to blow the bagged web up and over the empty spool. The web wraps the empty spool at position "B" (transfer position) and starts the new reel. After the transfer is completed the intermediate brake is automatically released and the bottom blow tube shuts off tomatically. The primary arms then transfer the new reel to the secondary arms and the reel is built.

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3 - Doctors oscillation - 65 S3 -S7 <u>s</u> PI - Assa Ammeter - 1801bB1 -P2 -5 01801PB2 - ILL. Pushbutton - Tail F- Load D.S C- 0400AM2 - Pressure Gauge (Drive Side)
D- 0400AM1 - Pressure Gauge (Tending Side)
E--Line Pressure Scale AN. 8402.11/8 7 0405SSI - Selector Switch - prr/Amo - Calender Botton Roll/CB-AKC 1- 0400DBI - Pressure Regulator (Tending Side) H- 04000B2 - Pressure Regulator (Drive Side) r 0180PB1 - 0180PB2 0153PB2 - Pushbutton - Lamp Test Tail Squirt 04001PB2 - ILL. P.B. - Close 04001PB1 - ILL. P.B. - Open 04001PB3 - ILL. Pushbutton -Calender Nip Load Load T.S Drive Side Calender Nip Load Tending Side Pushbutton - Jog Rev Pushbutton - Jog FWD Asea Potentiometer Sel. Sw. -/ Draw/ + (Spring Return) Sel. Switch. Draw Set/ O / Draw (Spring Return) Ind. Light - Speed Match Pushbutton Speed Assa Display ind. Light - Ready ILL. PB - Run ILL. PB - Crawl Pushbutton - Stop - Pushbutton - Widen - Pushbutton - Narrow ILL. Pushbutton - Full Width 9 Load S 1 1 1 S7 S! - Sel. Sw. Spring Ret. Drew Set/O/Drew \$5 1 1 PI - Asea Ammeter S2 - Pushbutton - Speed SI - Sel. Switch Spring Return Return Draw Set/ 0 / Draw - Real Spool Starter / RSS-AKC P! - Assa Ammeter Si - Sel. Switch - Draw Set/ O / Drew (Spring Return) S2 - Pushbutton Speed PI - Asea Ammeter Celendar Top Roll/CT - AKC Reel Drum/ RD -Sei. Sw. Spring Ret - / Drew / + Pushbutton - Speed Pushbutton - Jog FWD Pushbutton - Slack Take - Up Assa Display Ind. Light - interlock Pushbutton -Pushbutton - Stop Sel. Sw. Spring Return - / Draw / + Sel. Sw. Spring Return - / Drew/ + ind. Light - Ready ILL. PB - Run Pushbutton - Stop Pumhbutton Jog FWD Pushbutton Jog Rev. Pushbutton - Slack Take - Up Ind. Light + Speed Match Ind. Light Ready Assa Display Ind. Light. Ready Pushbutton - Stop Assa Display Illum. PB - Crawl ILL. PB - RUN ILL. PB - Run ILL. PB - Crawl Jog Rev AKC

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A- DRIVE SIDE 10- SECONDARY ARM

8- TENDING SIDE

C- 0618 - AMZ - PRESSURE GAUGE DRIVE SIDE

D- 0618 + AMI - PRESSURE GAUGE TENDING SIDE

E- 0618 - DR7 - BIAS RELAY- DRIVE SIDE

F- 0618 - DR6 - BIAS RELAY - TENDING SIDE

11- WEIGHT STATION

A- ELETRONIC SCALE

A IPBI.ILLUM. PB WEIGH (0635)

12- FEEDING ARM

0605 - PB2 PUSH BUTTON -UP

|- 0605 - PB3 MUSH ROOM PUSH BUTTON - E - STOP

6-0605 -- PB1 PUSH BUTTON - DOWN

13- STOP ON STORAGE

6 0606 PB1- PUSH BUTTON - KICK-OUT

14- PRIMARY ARM

0611 SS1- SEL. SW. SPRING RET. DOWN/O/UP

15- SECONDARY ARM

0618 SSI- SEL. SN. SPRING RET OUT .. /0/ IN

B- 0618 L1 - IND. LIGHT - OPERATION

16- REEL SPOOL CLAMP

60613 SS1- SEL. SW. SPRING RET OPEN/O/CLOSE

0613 L1 - IND. LIGHT - OPERATION

17- REEL SPOOL STARTER HOVEMENT

0612 SS1 - SEL. SM. SPRING RET OUT/O/IN
0612 L1 - IND. LIGHT - "IN"

18-INTERMEDIARY BRAKE

0629 IPBI- ILL.PB-BRAKE

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19- EINAL BRAKE

0630 SS1- SEL. SW. SPRING RET RELEASE/O/BRAKE

C- 0630 L1 - IND. LIGHT BRAKING

20- REEL SPOOL SPRAY

4- 0634 IPB1 - ILL. PB - SPRAY

2]- AIR DOCTOR

A- 0624 SS1- SEL. SW. -MANUAL/OFF/AUTO

-0624 L1 - IND. LIGHT -ON

C- TOP BLOW PIPE

0624 SS3- SEL. SN. - MANUAL/OFF / AUTO

F- 0624 L3- IND. LIGHT - ON

F- BOTTON BLOW PIPE

TO 0624 SSZ - SEL.SH. MANUAL/ OFF/ AUTO

₩ 0624 L2 - IND. LIGHT - ON

22- .TRANSFER TIME

→ 0607 TR1- TIME DELAY (TON)

B- SPOOL CHANGE

0607 IPB1- ILL. PB. START

🕩 0607 SSI - SEL. SW. MANUAL/SEMI AUTO

23- YOTH NAMEPLATE

0405 PB3- PUSHBUTTOM LOAD 24 - BOTTOM ROLL DOCTOR ٨

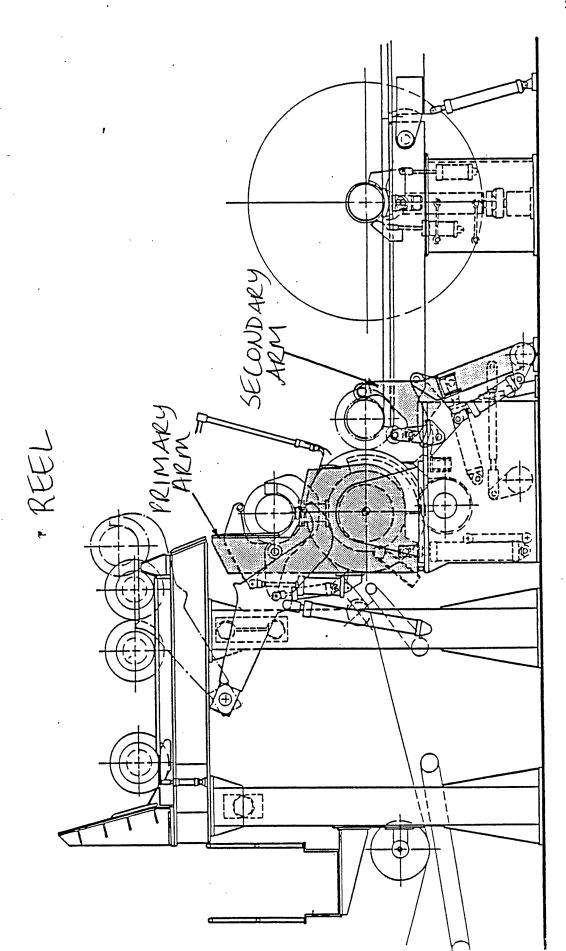
25-TOP ROLL DOCTOR
P-0405-F87-PUSHBUTTOM-LOAD
0405-P82-PUSHBUTTOM-UNLOAD

26-CALENDER TEST

-0400 L1-IND. LIGHT - TEST

-0400 KS1-SELECTOR KEY SWITCH-OPERATION/TEST

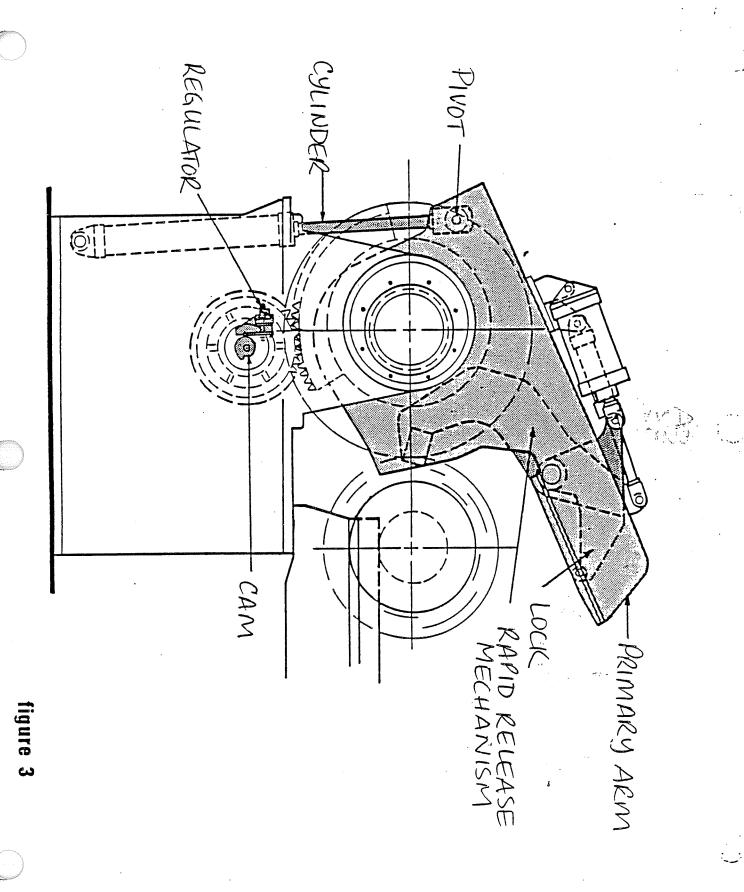




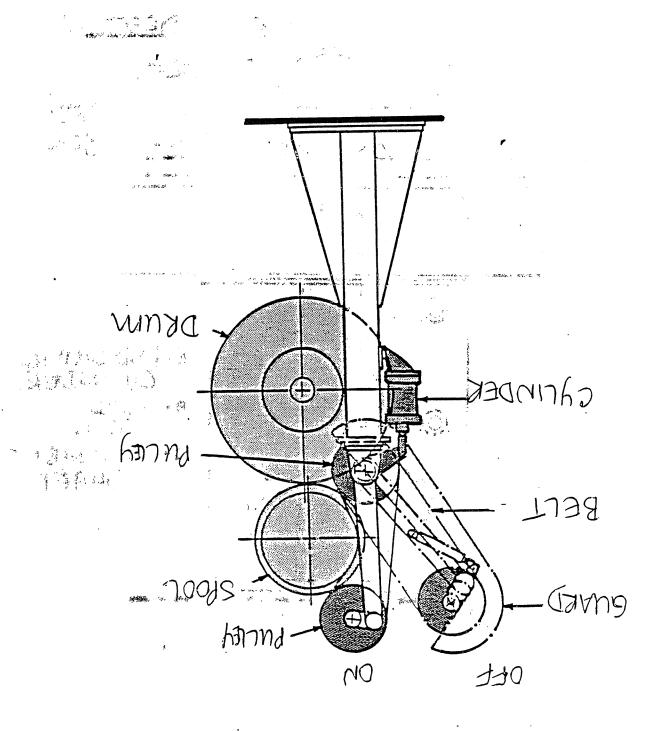
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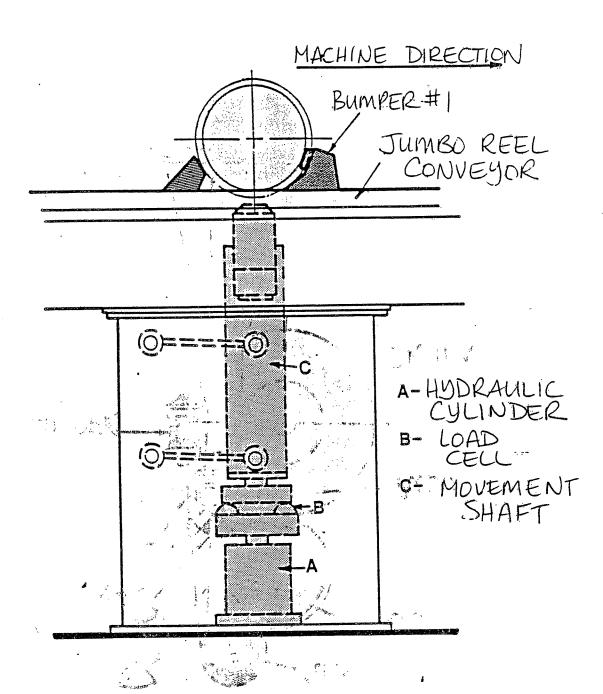


SPOOL STARTER

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SCALE



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