FIELD SERVICE REPORT

Customer Name	Graphic Packaging	**Purpose of Visit**	Polydisk Thickener Inspection
Location	Middletown OH	**Valmet SO #**	N176593-001
Contact Name	Jamie Buchheit	**Customer PO#**	4505379393
Valmet Rep	Jimbo Doucette	**Equipment**	12'-6" x 17 Polydisk 3000
Dates On-Site	May 18 & 19, 2021	**Serial #**	SD-349
		Date of Report:	June 14, 2021

JOB DESCRIPTION

- ☒ **Mechanical Inspection**
- ☐ **Electrical Inspection**
- ☐ **Erection**
- ☐ **Start-Up**
- ☐ **Training**
- ☒ **Repair**
- ☒ **Shutdown**
- ☒ **Process Audit**
- ☐ **No Charge/Warranty**
- ☐ **Aftermarket Plus**
- ☐ **FMS**
- ☐ **Erection**
- ☐ **Emergency**
- ☐ **Sales Support**
- ☐

WEEKLY TIME

	Date			17 May 21		18 May 21		19 May 21		20 May 21					
	Day	**Sunday**		**Monday**		**Tuesday**		**Wednesday**		**Thursday**		**Friday**		**Saturday**	
Travel	**Start**			10:30					15:30	5:15					
Travel	**Stop**			18:00					16:00	17:15					
Travel	**Total**			**7½**					**½**	**12**					
Work	**Start**					7:00		8:00							
Work	**Stop**					17:00		15:30							
Work	**Total**					**10**		**7½**							

James A. Doucette

Valmet Representative

Authorized Customer Rep

Signature acknowledges hours worked and work performed by Valmet.

EXECUTIVE SUMMARY

The Polydisk Filter filters dirty water from the cylinder board machine and thickens paper machine screen rejects using its own recovered stock as sweetener to form a filtering mat. Though the vacuum valve does not leak and there has never been water in the worm drive, no one at the mill, going back 25 years, can recall the vacuum valve ever being rebuilt. There was no support structure for the rigging that would be needed to perform a valve rebuild until some steelwork was recently erected.

The area under the vacuum valve is bone dry, covered with spider webs. No signs of leakage. The front cover on the worm drive was removed to inspect the gears and drive internals. There was no sign of water or rust or bronze gear filings, and the ring gear is centered with the bearing housing. Though this is very unusual after so many years of operation, it is the Valmet representative's recommendation that the valve be left alone.

Filler stock that was once thickened by the Polydisk now goes to a CDI disc filter. This has reduced the flow to the Polydisk, and half of its discs have been removed. However, the droplegs that handle its filtrate and generate vacuum are unchanged and likely too big for the application. Despite this, vacuum is sufficient to provide the capacity needed for handling the hydraulic load at a reasonable disc speed and to discharge stock at an acceptable consistency that requires dilution.

The cleaning showers are less than effective. After replacing plugged nozzles, greater pressure is needed. Poor cleaning and stickies in the furnish are blinding over the polypropylene filter media. S/S mesh would be better.

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HISTORY or BACKGROUND INFORMATION

The Polydisk® Thickener was installed in 1980. It once served as a saveall for excess white water ("Dirty Water") from a cylinder board machine and a thickener for the filler ply fine screen accepts. Since a CDI disc filter was installed in 2013 to thicken the filler ply fine screen accepts, half the discs were removed from the Polydisk, which now works as just a saveall to filter Dirty Water and thicken the paper machine screen rejects.

Sweetener is added to the Dirty Water (silo overflow and recirculated filtrate) to form a filtering mat. Sweetener can be Recovered Stock (thick stock from the Polydisk), Refiner Feed Stock (thickened OCC from the CDI) or Broke. The use of broke is problematic because of plugging in the valve and the stock line. The use of Refiner Feed Stock adversely affects stock freeness to the paper machine, so it is only used in an emergency. Most of the time, the sweetener stock is Recovered Stock, which augments the stock in the paper machine screen rejects.

The discs have been upgraded to HQ Cassette-Mounted Grid Sectors with poly bag covers.

No one at the mill can remember the vacuum valve on the Polydisk being rebuilt – ever – in 25 years. It doesn't leak, but because rebuilding it requires a 3-day outage, the mill wants to be prepared to rebuild it if necessary. Some steelwork for lifting was erected over the drive end of the machine. The purpose of this inspection was to advise on the need for a valve rebuild and identify any maintenance or process issues that should be addressed.

SAFETY

All catwalks, stairs, railings and toe-boards were in good condition. Lighting and ventilation were good, with only one lamp burned out at the drive end of the Polydisk. An emergency eyewash station and fire extinguisher were near the back end of the Polydisk. The machine drive guards were in place and in good condition. Wash-up hoses were coiled up out of the way.

A local disconnect for the main drive makes it easy to lock and unlock the drive quickly so it can be safely used to jog the discs for maintenance. A local control panel has buttons for switching the main drive and two oscillating shower drives from Auto to Off or Manual operation. The panel also has an emergency stop button.

Gates in the pedestrian walkways through the mill are tied in an open position. This was reportedly done when the pandemic first started as a means of minimizing hand contact with the gate surfaces and the potential spread of germs.

The Polydisk was never locked out for work. The mechanic used the local disconnect without a lock while performing disc maintenance. When the worm drive cover and rear bearing cap were removed, he did apply a lock to the local disconnect.

Hands broke the plane of the confined space inside the Polydisk vat when servicing the knock-off showers, shaking the discs and removing/installing sectors. This poses minimum risk, though some mills forbid breaking the plane unless the machine is locked out and sniffed.

The mechanic also placed a board with cleats on the discharge chutes at missing disc locations to get close access to the base of the sector holder for inspection and welding repair, without a harness or lifeline. The risk of falling in the vat is minimal, but the potential exists for carbon monoxide or hydrogen sulfide to rise up into the Polydisk vat from the Recovered Stock Tank, and the vat should have been sniffed and air quality should have been monitored.

Unofficially, the contractor assisting the mill mechanic was serving as the hole watch and should not have left the hood opening to retrieve additional welding rods from the cabinet at the end of the machine while the mechanic was in the vat.

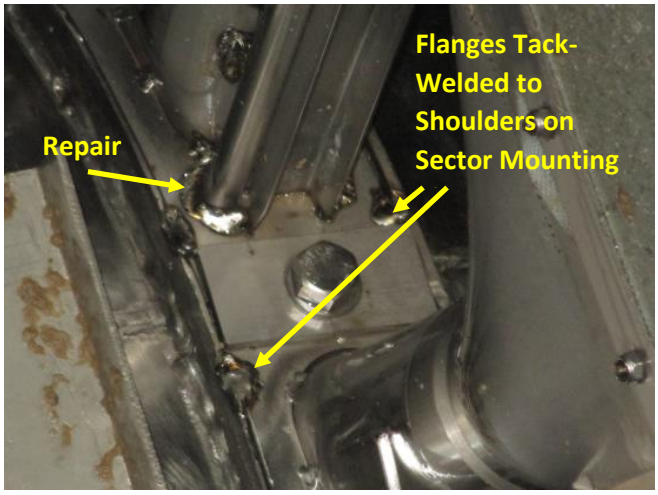
WORK PERFORMED

The mill was down upon the Valmet representative's arrival. The power was shut off at the Polydisk from 7:55 to 10:20. No work on the Polydisk was accomplished until power was restored.

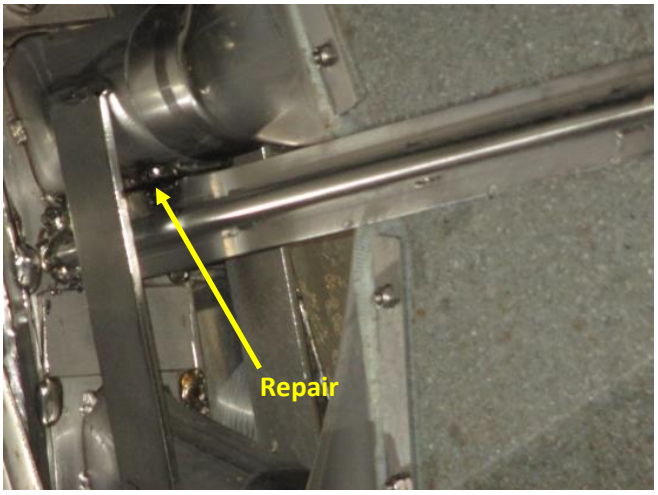
Discs. With Disc #1 being the one closest to the vacuum valve (i.e., the drive end), the installed discs were in positions #1, 3, 5, 8, 10, 12, 14, 16 &17. A mill mechanic and a contracted helper inspected the discs for damaged filter media and broken tie-rods. Broken tie-rods were identified by shaking the disc assembly at the OD; broken tie-rods allow a noticeable increase in side-to-side movement when the discs are shaken. Three loose tie-rod assemblies were found in Disc #5.

The customer said that bolts securing the holders to the centershaft have backed out in the past. They did not use Loctite. Their practice is to tack weld the holder flanges to the shoulders on the sector mounting rings.

The first broken tie-rod had broken welds at the base. The mill maintains a stick welder at the back end of the Polydisk with some 316L welding rod. The mechanic re-welded the base of the tie-rod to the holder flange. (See photo below left.)



Tie-Rod Re-Welded to Flange



Tie-Rod Re-Welded to Receiver Tube

The trailing edge of one sector had come out of the channel in the trailing tie rod. This was because the trailing tie-rod had broken away from the receiver tube and dropped downwards. The mechanic re-welded the tie-rod to the receiver tube. (See photo above right.)

The third failure was crack in the holder flange at the middle of the receiver tube, aligned with the centershaft axis. The mechanic welded the crack.

One segment was replaced because the zipper on the bag had pulled apart. It was observed that the bag was installed with its zipper on the sector's leading edge. This allows drag forces during operation to pull at the zipper. Filter bags should be installed with the zipper on the trailing edge (the edge with the round outlet).

Split Zipper

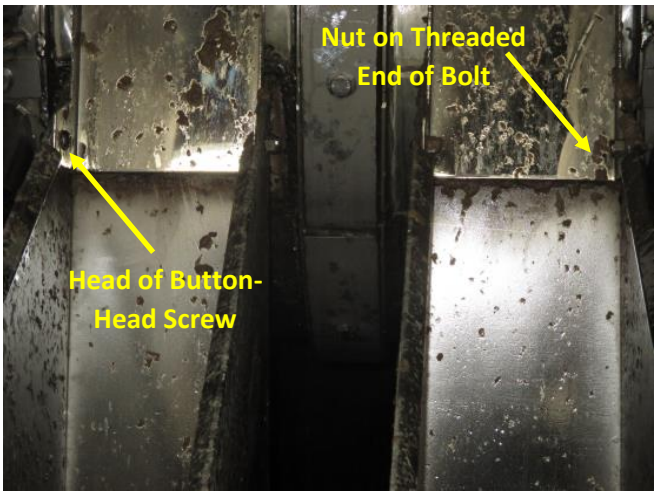
Hole in Bag

Another sector was replaced because it had a hole in the bag on the non-drive side near the OD. Most of the disc assemblies have bent tie-rods that lean away drive end. This puts the disc OD on the non-drive end very close to the chute walls, intensifying friction and drag force on the synthetic fabric.

Stock Build-Up. Stock had piled up at the location of the missing disc #7. Stock at the bottom of the pile was black and rotten. Valmet can supply deflector plates shaped like pup tents to cover the vat opening at the missing disc locations to prevent stock from piling up there. All chutes are in good condition and would readily accept deflector plates.

The OEM sluice shower header is not connected to a water source and the original sluice showers have been removed. At the back end of the machine, the mill has installed external sluice showers that pierce the top of the hood to lubricate the last five sluice pans. The sluice pan between discs 16 and 17 was intentionally removed by the mill because stock would pile up on it. This means that stock will now pile up on the centershaft and be carried by shaft rotation back to the feed side of the vat. Another pile of stock had formed on the narrow sluice pan at the drive end.

External Sluice Showers



Sluice Pans

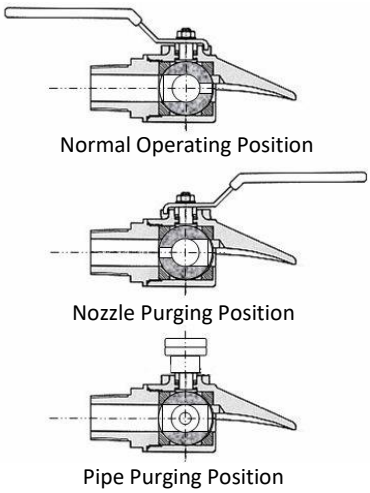
The sluice pans are secured with two button head bolts. Button head bolts were used by Beloit to minimize the projection of the bolt head into the sluice pan and therefore minimize the potential for pulp mats to hang up on the bolt heads. Unfortunately, the bolts on all but one sluice pan are installed with the nut and the threaded end of the bolt projecting over the sluice pans. It is recommended that the missing sluice pan be re-installed and the bolts on all sluice pans should have the button head inside the sluice pan.

Centershaft Covers. The shaft openings at the missing disc locations are covered with plates made by the mill. Each rolled plate covers two shaft openings and is secured by a single bolt in the middle. Some cover plates are made of diamond plate (see photo at left). It is unknown whether the gasket underneath the plates is a single piece of rubber going around the centershaft or individual gaskets, whether a single gasket going around the centershaft makes more than one winding. These gaskets and covers are a potential source of fiber and vacuum leaks.

The OEM covers for the centershaft had a single length of rubber gasket going around the shaft twice, clamped with a two-piece belly band bolted together at the ends. This ensured there were no openings in the gasket that could leak.

Knock-Off Showers. The mill is using Decker Blaster spray nozzles for the knock-off. These are a flat spray nozzle with an internal ball that can be reversed so header pressure can clear a plugged orifice. The ball can also be rotated half-way to clear the shower pipe of debris. (See sketch at right).

The deflector in the nozzle assembly is machined to make a well-defined fan when the ball is in the operating position. When reversed to the orifice clearing position, the fan is more poorly defined.



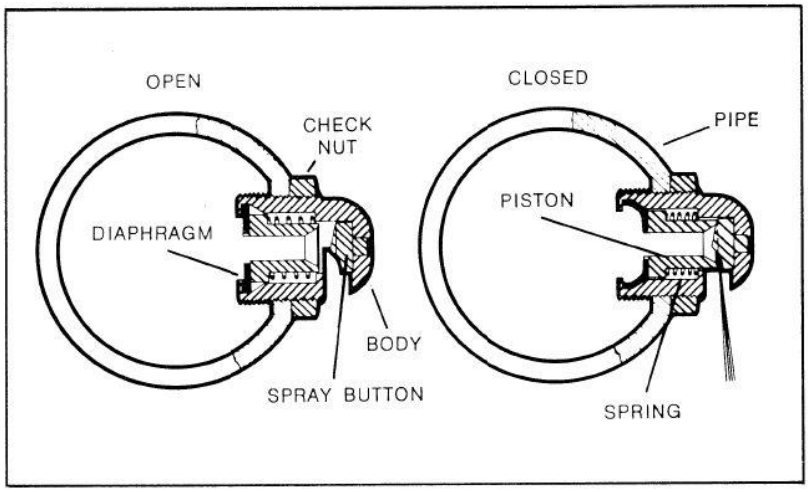
When the ball is in the pipe purging position, there is no fan – just a brute force blast of water at a much higher flow rate than that produced in the operating position. Guess which ball position the operators use.

The mill has had issues with knock-off shower pressure being insufficient to peel the mats and uses a booster pump for the knock-off showers but not for the oscillating cleaning showers.

The mats on the valve side of disc #14 were not peeled off. The nozzle and piping were found to be plugged and were cleaned out by the mill mechanic.

Oscillating Cleaning Showers. The discs in the Polydisk has are cleaned by two oscillating showers, one at each end of the machine. The two independent shower headers are supported by a common hanger bearing assembly in the center of the filter. The customer has connected a grease lubrication line to the bearing assembly (see photo below left). The headers looked to be well centered with the ends of the bearing housing, though the one at the drive end of the machine may have dropped a bit.

Hanger Bearing



Self-Purging Nozzles

The oscillating shower uses self-purging nozzles. These have an internal spring-loaded piston that retracts when shower water pressure drops, and a rubber diaphragm that compresses the spring and moves the piston against the shoer button when pressurized. When the piston is retracted, the nozzle orifice is equivalent to a ¼" diameter. In the few seconds it takes pressure on the diaphragm to become great enough to compress the spring, the enlarged orifice gets flushed out by the shower water. (See schematic above right).

Purging of the nozzles is accomplished by periodically shutting off the shower water until the shower pipes drain, then turning the water back on. Timers and a control valve are recommended to automate this process, purging the nozzles three times an hour for 20-40 seconds. Sometimes fiber in the shower water leaks past the diaphragm and collects between the diaphragm and the piston, preventing the piston from retracting when shower pressure drops. Then the nozzle needs to either be replaced or disassembled and cleaned. The nozzles can also be rebuilt with replacement springs and diaphragms.

It was not determined whether the nozzles were being purged regularly. The Valmet representative did not hear the cleaning shower water shut off at any time while the machine was running.

Each downpipe has two shower nozzles: one on the inner side of the downpipe, near the bottom, and one in the pipe cap at the bottom end of the downpipe. The nozzles produce a flat 40° spray fan with a 12° deflection angle.

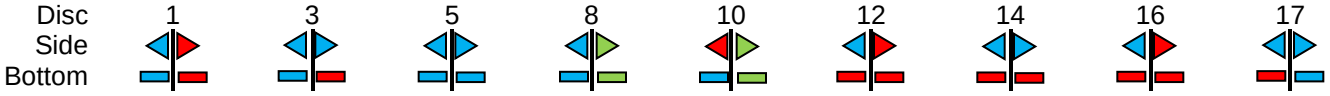
The oscillation travel as currently adjusted swings the shower pipes out past the disc OD (see photo at right). Presumably the travel was set this way to allow the deflected fan from the side nozzle to reach all the way to the disc OD.

This causes the bottom nozzle spray (and some of the side nozzle spray) to blow past the discs and is unnecessary. The knock-off showers clean the outer 4-6" of the disc surface with every revolution of the disc.

Most bottom nozzles are rotated inward at a 45-60° angle from the perpendicular with the disc surface, presumably to reduce the amount of spray that blows past the disc OD. However, this greatly increases the distance the water must travel to contact the disc and severely diminishes its impact as a cleaning shower.

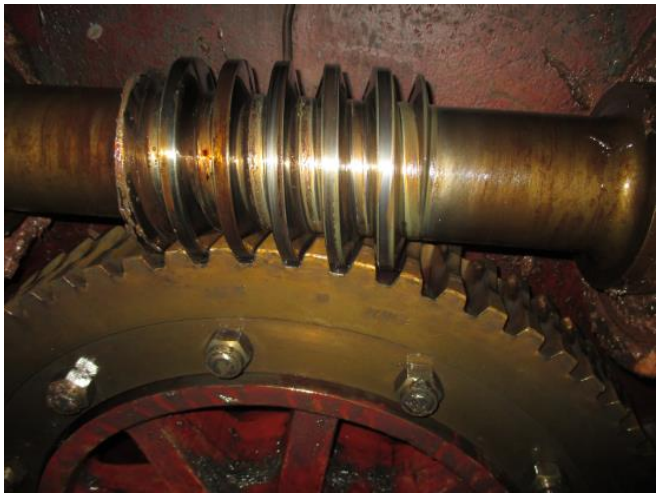
It is recommended that the cleaning showers be jogged to their outermost position. Then, with someone holding onto one of the shower pipes, the clamp in the oscillation mechanism that grasps the header should be loosened until the pipes start to fall back into the vat. The pipes should be positioned about 2" from the disc OD and the clamp re-tightened. Then the bottom shower nozzles should be re-positioned to put their spray fans perpendicular to the disc surface.

Water was applied to the cleaning showers to check for plugged nozzles. When viewed from atop the feed box, the following conditions were observed with the left and right side and bottom nozzles at each disc:



In the schematic above, spray fans colored blue represent nozzles that were working well, spray fans colored green represent nozzles that were partially plugged and ineffective, and spray fans colored red represent nozzles that were completely plugged. Of the 36 spray nozzles, 13 (35%) were plugged and 4 (11%) were partially plugged and ineffective, leaving only 19 (53%) doing any cleaning, and with the bottom ones rotated 45-60° way from a perpendicular to the disc surface, the 7 (19%) bottom nozzles that were working would have little impact upon cleaning.

Worm Drive. When work on the disc assemblies and knock-off showers was finished, the oil was drained from the worm drive and the gearbox cover was removed for inspection. The gearcase internals had no indications of water, rust or bronze filings, with only relieved grease from the bearings in the bottom of the housing. Wear on the worm and ring gear teeth was minimal, and the worm was fully engaged with the ring gear. The ring gear hub was well centered with the main bearing housing behind it.



Worm and Ring Gear

Worm Input Shaft Bearing

With no evidence of filtrate leakage from the vacuum valve and the worm drive in excellent condition, there is no need to rebuild the valve. Rebuilding it as a preventative maintenance task risks creating a leak where there is none.

The bore of the stainless steel valve casting slides on the snout of the cast iron gearbox and is loaded against the wear plate on the end of the centershaft by three springs. Typically, the valve seal lasts 5-7 years before it leaks, letting water pass through the main bearing and into the worm drive. Sometimes, as the cast iron rusts, the valve gets stuck in position and no longer slides. Wear of the sealing surfaces can stop unless fiber gets into the interface. This might explain the unusually long service life provide by this valve seal.

However, a grease fitting that was not supplied by Beloit has been added to the top of the hub on the vacuum valve casting, allowing grease to be injected between the valve bore and the snout on the drive housing. The fitting had fresh grease. The presence of the grease fitting suggests that the valve was rebuilt at least once and makes it less likely that the valve would is stuck upon the gearbox snout. Why there is no water in the worm drive and the area around the vacuum valve is bone dry with spider webs will remain a marvel for which we can be grateful.

Rear Bearing. The cap was removed from the pillow block bearing at the back end of the Polydisk. There was no evidence of corrosion or water in the grease (see photo at right), and the cap was put back on.

Polydisk Operation. The Polydisk was observed in operation the following day. Vat level was good at a couple inches below overflow (86.5% setpoint). Disc speed was relatively slow, clocked at an average of 0.4 RPM (7 sectors in 69 seconds). The disc speed could be seen to accelerate and decelerate over the course of the minute. Indicated main drive motor speed on the DCS was 240-300 RPM

The following observations were recorded regarding the individual discs, again with disc #1 being at the valve end:

Disc 1 Thin or non-existent mats on both sides

Disc 3 Mats on the back side were squeezed against the chute and tended to slough off. Good mats on the valve side, with vat stock lifted from the vat and into the chute by disc rotation (“carry-over”)

Disc 5 Same as disc 3

Disc 8 Good mats on both sides

Disc 10 Mats on the back side were squeezed against the chute and tended to slough off, losing vacuum with filtrate pouring out the trailing edge. Mats on the valve side were good and didn’t slough off.

Disc 12 Same as disc 10

Disc 14 No mats or poor mats on the back side. On the valve side, the mats were good sometimes and non-existent at other times

Disc 16 Fair or no mats on the back side, poor or no mats on the valve side

Disc 17 Heavy mats on both sides.

The thin and non-existent mats were attributed to fouled and blinded filter media. The filter mesh was covered with stickies, which like polypropylene. Stainless steel mesh is easier to keep clean in applications with post-consumer waste.

Flow Balance. Feed to the Polydisk as indicated by the DCS was:

350	GPM Sweetener (Recovered Stock)
1700	GPM Dirty Water
1250	GPM PM Screen Rejects
3300	GPM Polydisk Feed

The DCS display indicated a vat consistency of 0.8%, but it was unclear how that value was determined. The feed flow looked thin, as did the stock between the discharge chutes at the missing disc locations. Perhaps additional filtrate was being added to the feed somewhere.

Droplegs. The clear leg is 12” OD and the cloudy leg is 8” OD. These are tubes and not scheduled pipe. At the recommended filtrate velocity range of 9-13 feet per second, the legs are rated for a total flow of 4600-6600 GPM. The valve is rated at 6000 GPM. The dropleg were obviously sized for higher flow conditions that included the primary fine screen accepts for the filler ply.

Clear and cloudy filtrate from the CDI thickener flows by gravity from separators to the Polydisk's clear and cloudy chests. An operator stated that when the recycle plant cannot use all the filtrate, the Polydisk has the capacity to handle take addition water. (The water goes right back into the filtrate chest via the droplegs.)

A Polydisk feed of 3300 GPM would yield an average dropleg velocity of 6½ ft/sec. Droplegs can generate vacuum at low velocities, but the ability of the droplegs to transport air becomes very limited at low velocities. High velocity is needed to provide the momentum necessary to ram the air down to the bottom of the pipe and push it out into the filtrate chest. Because the air volume reporting to the droplegs is directly proportional to disc speed, low dropleg velocity can limit the working speed range of the Polydisk.

The mill is injecting recirculated cloudy filtrate into the top of the cloudy leg through a 3" OD tube to increase dropleg velocity and improve vacuum. An analog gauge on the cloudy leg read about 10" Hg, which was in the ballpark of the pressure transmitter reading of 8-9" Hg on the DCS. A spring relief valve (vacuum breaker) on the cloudy leg was bleeding in air. The analog gauge on the clear leg read 22" Hg, and its vacuum breaker was not on. Vacuum breakers are recommended to limit vacuum to 10" Hg in order to minimize fatigue of the centershaft channels and the filter media. The clear leg, which had no additional water being injected was unlikely to be generating 22" Hg of vacuum, especially considering that some mats were sloughing off the discs.

As to whether the dropleg produce sufficient vacuum, the proof of the pudding is this: If the Polydisk can handle the feed flow without overflowing while running at a reasonable speed, and the discharged mat consistency is acceptable, then there is enough vacuum. Vat level was in control, disc speed was about ½ RPM and consistency dilution to the Recovered Stock pump suction was 40% open, so it would appear that vacuum levels are sufficient.

The cloudy dropleg looks to have dropped about 1½". It is not well aligned with the horizontal pipe connection on the vacuum valve. The droplegs are supported by horizontal U-bolts, and the one on the cloudy leg has obviously slipped downward. Riser clamps should be used for horizontal support of droplegs. U-bolts should only be used for vertical supports.

Shower Pressure. The six barrel filters straining the clear filtrate for shower water had an indicated feed pressure of 105 psi and an outlet pressure of 90 psi. The DCS screen indicated 83 psi, but it was unclear where the transmitter was located. 80 psi is considered a minimum acceptable pressure for the cleaning and knock-off showers. 80 psi should sting one's fingers, and the Valmet representative did not find this to be the case with the Polydisk showers.

DISCUSSION

Troubleshooting High Filtrate Solids. With the filtrates from the CDI combining with those of the Polydisk, identifying the source of long fiber in the filtrate could be problematic. The Polydisk is a short walk and a few stairs away from the control room, whereas the CDI requires descending to the ground floor and then climbing a lot of stairs, so the operators would likely check the Polydisk for leaks first.

If a disc filter has good vacuum, a leak that lets fiber into the filtrate will likely also suck air as the leak emerges from the vat stock. Identifying leaks typically requires listening at each hood opening for one revolution of the discs on the side where the sectors rise out of the vat. Slurpy leaks indicate the mixing or air and water, which primarily occurs at the base of the sector. Leaks closer to disc OD can make a whooshing sound (big leak) or a squeal (tiny leak).

When looking for a leak, don't forget the cover plates on Polydisk centershaft and CDI rotor at the location of missing discs.

Sector Re-Bagging. The O-rings should be replaced when the sectors are re-bagged. Several of the re-bagged sector on the catwalk had flattened O-rings, indicating they had preciously been put into service.

Sweetener. Using recovered stock for sweetener is generally ill advised. The Polydisk reclaims fines from the Dirty Water and the paper machine screen rejects and discharges those fines with the recovered stock. The potential for fines to accumulate in the Recovered Stock Tank can make recovered stock less effective as a sweetener. Think of it as toilet paper: it is less effective with each subsequent use.

When fines levels in the dirty water are low, and turnover of the Recovered Stock Tank is quick enough, fines will not accumulate to bothersome levels. And the inflow of new screen rejects helps to keep drainage rate from diminishing. Currently, recovered stock as a sweetener source causes less issues that with the alternatives of broke and refiner feed stock. Operations should be aware of the potential for fines accumulation in the recovered stock and be prepared to introduce other stocks to the Polydisk feed when needed.

RECOMMENDATIONS

1. Review safety policies for working on the Polydisk. Consider requiring the vat to be sniffed prior to going inside to make weld repairs.
2. When re-bagging the sectors, take care to locate the zipper on the trailing edge next to the filtrate outlet, and be sure to replace the O-ring.
3. Sector holder fasteners should be installed with 242 Blue Loctite and torqued to 100 ft-lb_f.
4. Consider adding deflector plates to the missing disc locations to prevent stock from accumulating and rotting on top of the chutes.
5. Re-install the missing sluice pan between discs #16 & 17 with the head of the button head screw on the inside of the pan to minimize the potential for pulp to become hung up on the fastener. Reverse the other button head screws that are installed with the nut inside the sluice pan.
6. Replace or rebuild the plugged and partially plugged cleaning shower nozzles. Lodding #17 buttons are recommended. Adjust the swing of the showers so shower pipes stop a couple inches from the disc OD and the nozzles do not spray past the disc OD. The spray fans on the bottom nozzles should be perpendicular to the disc surface to shorten the distance the spray must travel and maximize its impact. Use timers as needed to purge the nozzles three times an hour for 30 seconds or so --- however long it takes for the shower pipes to drain. Also, the cleaning showers need more water pressure to be effective.
7. Build a frame on the operating floor to support the weight of droplegs and replace the U-bolt supports on the droplegs with horizontal riser clamps (see photo at right). Raise the cloudy leg into alignment with the pipe connection on the vacuum valve and clamp into position.

POINTS TO FOLLOW UP

- Quote a deflector plate for one 12’-6” Polydisk 3000 discharge chute, P/N 000971N68-10.
- Quote sixteen (16) replacement poly bags (P/N 1004 1948-01) and O-rings (P/N 6094 0870-41) for 12’-6” HQ cassette sectors.
- Quote sixteen (16) HQ grid sectors with 20-mesh flat stainless steel panels (P/N 6097 8264-70) with retainer rings (P/N 1002 0881-25)
- Quote replacement single spray, 40°, 0.114” equivalent orifice self-purging cleaning shower nozzles (P/N PN-18U-S-V-040114)