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KROFTA AIR DISSOLVING SYSTEM

A) General Principles

The Krofta Flotation System removes the solid impurities in the water by floating them to the surface for removal. The reason that the impurities will float, even if they are heavier than water, is that small air bubbles attach themselves to the particles (or flocks) and make them buoyant. Dissolved air flotation creates very small, dispersed bubbles which are best for attachment to the solids.

The mechanism for forming the air bubbles is as follows:

1) The water is pressurized to 60-80 PSI with a standard centrifugal pump.

2) Compressed air is added through special dispersing panels.

3) The water and air are mixed rapidly in the "air dissolving tube" for 10 seconds and undissolved air is separated out by the "bleed-off".

4) The pressure is released after the water passes through the holes on the release manifold. The water can no longer hold the extra air which was absorbed, so that small bubbles form spontaneously through the liquid. The bubbles formed are very small in size, approximately .00004 inches in diameter or less. Individual bubbles are visible to the naked eye, giving clear water a "milky" appearance. Proper sized bubbles will rise in a container at approximately 8-12 inches per minute.

B) Operational Description

(See accompanying drawing L-1184/A for layout of air system).

Chemical Addition

A tap on the inlet pipe is used for addition of the metered chemical flocculants into the system. The chemicals are fed by a small metering pump. (The chemicals are diluted with fresh or clarified water before entering the unit). Chemicals are used to increase the Clarifier efficiency by "floccing out" small and colloidal particles that otherwise would float or settle in the Clarifier.

Air Metering

The amount of air needed by the system depends on the water flow into the Clarifier. The amount added is a very small percentage of the water and is metered precisely by an Airmeter (5).

The compressed air enters through a regulator and pressure gauge. Minimum gauge pressure should be 80-100 PSI (or about 5 PSI higher than the tube). The needle valve is adjusted for the proper reading on the air meter. The line contains a shut-off valve and a check valve. The air is metered into the Dissolving Tube where it is mixed with the water by plastic dispersing panels. Note: Air pressure must always be uniform and higher than the water pressure.

Dissolving Tube (2)

This tank is designed to retain the water and air under pressure. The pressure and agitation in the tank cause the air to become dissolved into the water.

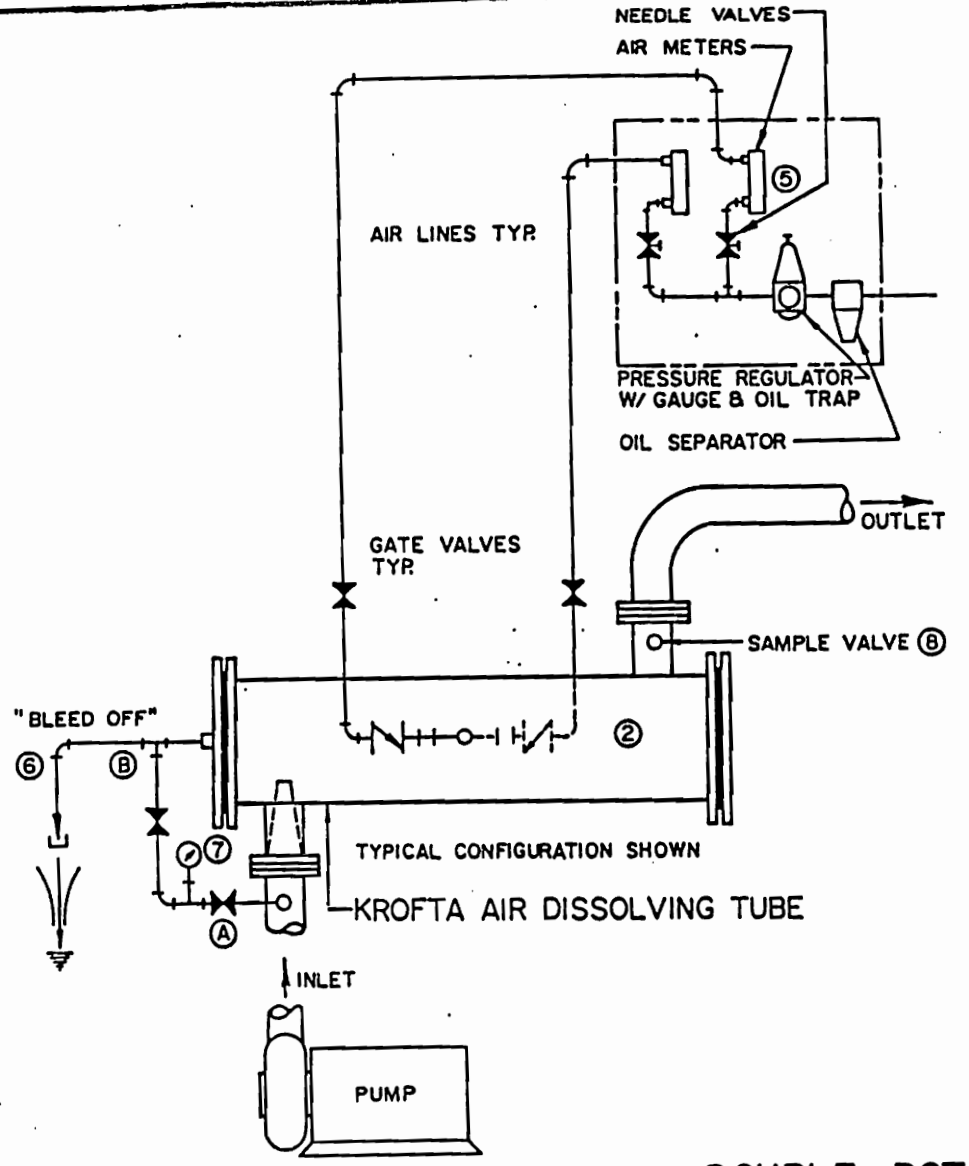
Water enters the dissolving tube through a restricted opening (orifice), which speeds the water up and causes a spinning motion of the water in the tube.

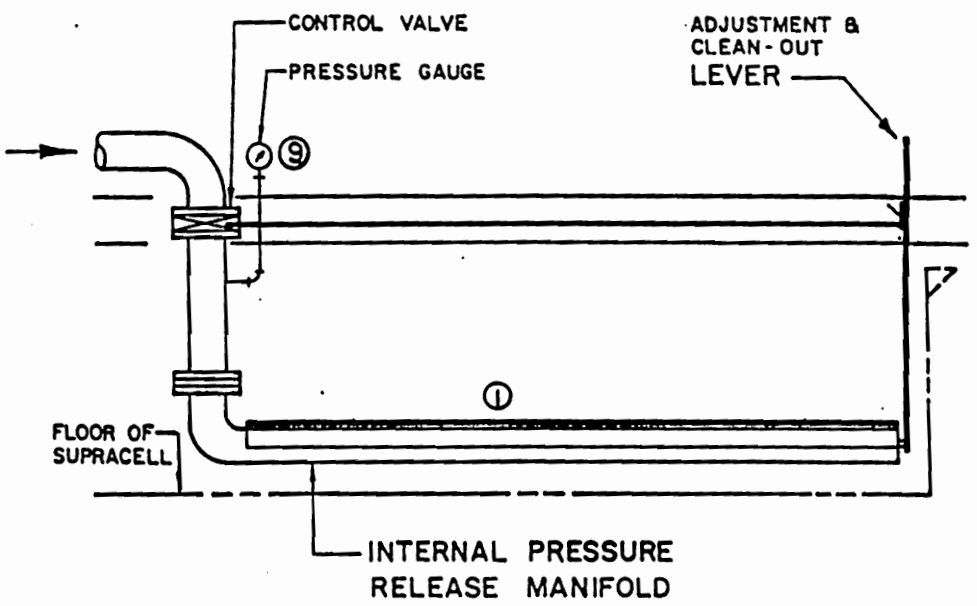
As the water spins around the Tube, the compressed air from the panels is subjected to violent agitation. The large undissolved air bubbles are trapped in a pocket in the center of the Tube. This air is removed by the "Bleed-off" Vent (6) to prevent the tank from filling with air.

Flow and pressure in the tube can be determined by Gauge (7). In normal operation, this gauge can be read for pressure only. To check the flow through the Dissolving Tube, the pressure at point A (inlet) is read first, then pressure at point B (tank) is read. The difference between the two pressures is the pressure drop through the nozzle. The pressure drop can be used to measure directly the flow into the tank. This should be at least 4 PSI or 70% of rated flow for proper operation. A drop over 8 PSI indicates higher than rated flow, which may affect dissolving efficiency.

Sampling Valve (8)

Sampling at the inlet and at valve (8) is used to determine if the air absorption system is operating properly. Samples are drawn off at this Valve to observe the flotation characteristics just before the Flotation Clarifier. This is an important tool for looking at Clarifier operation.





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DOUBLE ROTARY JOINT SUPRACELL: TYP.

PRESSURIZED WATER RELEASE CONFIGURATION

MAY 1985

REV. 4/89

L-1184/A

Aerated Water Release Manifold (1)

The purpose of this manifold is to release the pressure so that the small air bubbles necessary to flotation can be formed, also the aerated water is distributed evenly at the bottom of the main tank where it is most effective for flotation.

C) Adjustments (Operating Instructions)

Under normal operation, no adjustment should be needed for any component of the air absorption system. When an operating upset occurs, make the following checks in order:

1) Take a sample from the sampling valve or the inlet area of the clarifier. This is the best indication of the air system operation. The sample should be drawn off into a tall graduated cylinder or other glass container. By looking at the flotation in the cylinder, you can observe how much air is in the water. The air bubbles should be very small, giving the water a milky appearance. Larger bubbles should not be present. If there is enough air, the flocks should rise to the surface at the rate of 1 foot per minute or better, leaving clear water underneath. If the sample floats well as described, do not adjust the air absorption system, since the problem must be in the Clarifier.

If the sample shows large air bubbles and poor flotation, then check items 3 and 4 below.

If there appears to be plenty of air in the form of fine, dispersed bubbles, but the flock appears weak and the water does not become clear, then check the chemical addition (item 2 below). If there is not enough air, then check items 3 and 4.

2) Chemical additon: First always check to be sure that the chemical pump is working by visually observing the amount of chemical going into the unit. It is necessary to turn off the dilution water to check this carefully.

If the chemical pump is operating properly, then check that the chemical feed pipe is not clogged.

Adjustments (Operating Instructions)

Chemical addition (Con't)

Increasing the amount of chemical added will often improve the flotation. The chemical should be increased in small amounts, with at least 5 to 10 minutes between changes to allow for the delays in the system.

In general, if there is an upset in the process, so that much more than the usual amount of solids are going into the Clarifier, then the amount of chemical needed should also be increased in proportion.

Overdosing with chemical can sometimes cause "slippery" flocs which "do not stick" to the air and thus sink. Overdosing would cause the sludge to appear wet and "greasy" and it would be very slippery to the touch.

3) Dissolving Tube Bleed-Off (6) This is an important check which can give a good indication of the tank operation. The discharge from the Bleed-Off should be a mixture of air and water.

If water only is discharged,then more air can be added and dissolved. First check to be sure that the system is operating with the proper pressure and flow, and increase the air addition. Continue to add air in small amounts until a mixture of air and water appears in the Bleed-off. If the bleed-off is right, it should make a sharp "crackling" sound.

If air only is discharged from the bleed-off, then there is probably too much air in the system. This extra air will sometimes cause turbulence in the Clarifier or excessive foaming. The amount of air is cut back by simply reducing the air meter settings.

Note: Overaeration of the water can cause excessive foaming and turbulence during flotation. Do not add more air than is required to get good flotation in the inlet sample.

4) Pressure and flow adjustments. The pressure can be checked at three points in the system:

a) Center of Dissolving Tube. Should be 60-80 PSI (item 7, point B).

b) Inlet to Dissolving Tube (item 7, point A). Should be 5-8 PSI higher than the reading in the tank. A higher pressure difference indicates that the flow is too high and a lower difference indicates the flow is too low.

c) Before the inlet manifold (item 9). This should be slightly lower than the tube reading, but not lower than 55 PSI. This pressure gauge is used for adjusting the valve when the gauge at the tube can't be seen (and used for double-checking reading for faulty gauges).

Flow through the system can be checked by measuring the clarified water overflow or by checking the pressure drop at the Dissolving tube. CAUTION: Always check to be sure that the pressure gauges are operating and the pressure release manifold is not clogged before adjusting the pressure. NEVER ADJUST THE PRESSURE ABOVE 100 PSI.

Pressure can be increased or decreased by adjusting the handwheel on the inlet manifold.

D) Shut-down and start-up procedure.

For short duration shut-down, the pump should simply be turned off and no further adjustment made. (Leave compressed air on).

For longer shut-downs (over 24 hours) or for clean-up, the Dissolving Tube should be drained by opening the drain valve. Also, all connecting pipelines should be drained. Compressed air can be turned off.

At start-up close all drain valves, turn on the air compressor and start the pressure pump. All pressure gauges should be checked for the correct readings. A sample of the clarified water should be taken after the operation stabilizes. If the clarified water is not sufficiently clear, follow the check-out procedures outlined.

Airmeters and pressure gauges should be checked at every start-up for clogging and also for proper readings.

Note: Do not run the pressure pump with the compressor off. This will clog the plastic panels in the tank and back water into the compressor. If more than 10 PSI is required to push air into the Dissolving Tube, (when empty) the plastic panels inside must be replaced. Pressure drop on panels should be checked monthly.

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II SUPRACELL DESCRIPTION

A. General Principles

After the air is dissolved in the water and bubbles are formed, the impurities must float or settle and the floated, settled and clear water must be separated. (NOTE: Only a small amount of settling is expected.)

In the SUPRACELL, the separation is done in the main tank, as described below in the following pages:

B. Operating Description

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 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. The rotation is synchronized so that the water in the tank achieves "ZERO VELOCITY" during flotation. This means that the efficiency 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 two to three minutes.

III SUPRACELL OPERATION

This section describes the general operating procedure for a SUPRACELL system.

A. Start-Up Procedures (First Time)

Note: This procedure is needed only for system start-up.

1. Close all drain valves, especially on the dissolving tube and SUPRACELL. Close all sampling valves. Close all air inlet valves. (check that automatic bottom purge valve is closed).

2. Make sure all valves in front of the inlet manifold are open all the way, and the inlet manifold is open ,

3. Start the drive motor(s) for the SUPRACELL drive and scoop. Adjust the drive speed so that the SUPRACELL center revolves approximately once every three minutes.

4. Turn on the recycle pump and air compressor and open air addition needle valves a few turns. Adjust pressure at the release manifold. Adjust the air addition needle valves until the rotameters read about 1/2 scale or the recommended reading. Then recheck the pressure. Note that that the air pressure must be higher than water pressure to prevent backing of water into the air lines.

5. Start the chemical flocculant pumps.

6. Turn on the raw water feed pump.

7. Set the level control so that Scoop is removing sludge.

8. The exact speed setting of the drive motor should be calculated or set by observing the water in the tank. The speed should be set at the speed which gives the least amount of turbulence in the flotation tank. The flow can be fine-tuned by adjusting the individual inlets.

9. The level in the main SUPRACELL should be re-set for proper sludge thickness. Lower level makes a thicker floated sludge; higher level thins out the sludge. It will take up to one half to one hour before the sludge thickness will reach equilibrium. Fine tuning of sludge thickness is with the scoop speed.

10. The settled sludge purge should be set depending on how much settled material collects in the system. The purge should look dirty at first and then be clear. Typical purge time would be 5 to 10 seconds every half hour.

B. Start-Up Procedures (Normal)

1. The level, feed valve, air and chemical settings should not have been changed at shut-down and should therefore be OK at start-up. Make sure that all drain valves are closed before starting.

2. Start the chemical feed pumps and open compressed air main valve.

3. Start the SUPRACELL drive motor.

4. Start the pump.

5. Check that the dissolving tube pressure is 60-80 PSI and that the clarified water is clear. If not, follow the procedures in part D (Trouble Shooting Tips).

SUPRACELL OPERATION

Start-Up Procedures (Normal) (Con't.)

6. If the Clarifier is started up before process start-up, the Clarifier will operate and continously recirculate and clean the clarified water. This will help prevent solids in the clarified water during start-ups.

C. Shut-Down Procedures

1. Turn off the chemical pumps.

2. Turn off the pressure pump.

3. Turn off motor(s) for Scoop and drive wheel.

4. The water does not have to be drained out unless the shut-down is for a long period or complete wash-up is necessary.

5. If the SUPRACELL is drained - hose all parts down thoroughly.

NOTE: Clean-up is easier if the SUPRACELL is allowed to run for awhile when the process is down. Clarified water will recirculate and most of the solids will be flushed from the system. Sludge should never be allowed to dry in the tank, because this makes later clean-up twice as difficult. Always wash the inside of the SUPRACELL at shut-down.

D. Trouble Shooting Tips

1. If the water is not clear enough. This can caused by mechanical problems such as overloading, not enough air, or not enough chemical. Take a sample at the inlet. The sample will tell you if the problem is in the aeration, chemical treatment or is in the flotation unit itself. Unclear water is usually a symptom of almost every problem. The following are some common areas to check if there are problems:

2. Overloading. Unusually heavy solids loads on the Clarifier, such as at washups, or heavy dumping from the plant can cause unclear water and, in extreme cases, clog the system. The solution here is to stop the dumping into the system if possible. If the overload clogs the system with sludge the system will unclog itself when the overload stops, unless the thick sludge is allowed to clog the clarified water pipes. Overloads can sometimes be compensated for by adding more chemical.

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Trouble Shooting Tips (Con't.)

Do not run the Clarifier completely filled with heavy sludge. This can cause strain and possibly breakage of center parts.

3. Chemical Addition. This is normally not changed in day-to-day operation.

NOT ENOUGH CHEMICAL: Symptoms include very small particles remaining in the clarified water, slow flotation, or thin floated sludge. Check the following items:

* chemical pump or lines plugged?

* out of chemical?

* have pump settings been changed?

* If the amount of solids in the incoming water have changed or there is some change in the pH, defoamer addition, etc., this may change the chemical demand so that higher amounts are needed.

TOO MUCH CHEMICAL: Symptoms of chemical overdosing include a very "greasy" sludge, a very watery or "flat" sludge and very large particles in the water to which the air will not stick (This could also indicate the presence of defoamer in the system.). A slippery or greasy feel in the clarified water can also indicate overdosing resulting in chemical carry-over into the clarified water.

ALL CHEMICAL ADJUSTMENTS should be made SLOWLY, as CHANGES CAN TAKE FROM 3 to 20 MINUTES TO TAKE FULL EFFECT. IF THE CLEAN WATER IS RECYCLED, changes can take HOURS to be fully felt.

4. Air addition. The air meter settings are usually determined at start-up and do not need to be changed in normal operation.

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Trouble Shooting Tips

Air Addition. (Con't.)

TOO MUCH AIR: Indicated by foaming or frothing at the surface, excessive, large, turbulent bubbles at the inlet, foamy sludge. Before changing settings, check the following:

* dissolving tube air bleed-off plugged? (This can cause large bubbles in inlet).

* has air pressure to the unit changed?

* feed pump pulling in air or cavitating?

* has detergent, caustic or other foaming agent been added to the water?

* solids in the feed water unusually low?

NOT ENOUGH AIR: Indicated by watery sludge, sludge not floating or floating slowly, very "flat" appearance of inlet water.

* Is air line plugged or pressure dropped lower than pressure in dissolving tube?

* Is Air pressure reduced, causing reduced air flow?

* Check for: chemical problems such as defoamer in system, chemical overdose.

* Very reduced water flow caused by a plugged valve or cavitating of the feed pump may greatly reduce dissolving efficiency.

* Unusually high solids in the incoming water may also cause the above symptoms. This can sometimes be corrected by increasing air addition.

5. Flow and pressure adjustments

* The pressure and flow in the system is usually determined at start-up and is not changed. Changes in pressure and/or water flow indicate either pump problems (such as cavitation) or inlet plugging problems or bleed-off plugging problems.

* The difference in pressure from the inlet to the center of dissolving tube should be 4 to 7 PSI. Higher difference may indicate higher-than-rated flow, lower difference a lower-than-rated flow.

Trouble Shooting Tips (Con't.)

* The pressure at the inlet manifold prior to release into the Clarifier should not be lower than 55 PSI for efficient air release. Pressure in dissolving tube should never be over 100 PSI. The lever at the inlet manifold should be used to adjust both the flow and pressure in the system.

6. Adjustment of Scoop speed and water level. These can be used to control the thickness of the sludge in the Clarifier. Raising the water level will thin down the sludge; lowering it will thicken the sludge. Faster Scoop operation will thin the sludge and increase the amount removed. Slower operation will reduce the amount of sludge and cause it to build and thicken in the Clarifier.

* For units of 12 foot diameter and larger, separate Scoop speed control is provided. For these units, level can be changed rarely and sludge can be controlled with Scoop speed only.

* If the Scoop is run too slowly and the sludge is allowed to build too thick in the Clarifier, then clogging and poor water quality will result. (Normal maximum thickness of sludge layer is 4 to 6 inches). Clogging with sludge over 6 inches deep may cause wheel slipping or mechanical damage.

* The sludge can be thinned down as much as desired by speeding up the Scoop and/or raising water level. Too much water in the sludge may cause problems with sludge disposal equipment.

7. Bottom purge valve. The automatic valve on the bottom of the Clarifier is used to remove sediments that build up on the bottom of the Clarifier. Too much sediment in the bottom can cause "flakes" or clumps of sediment, to appear in the clarified water. Very heavy sediment in the bottom can overload the moving parts and cause damage to extraction pipes or spinning of the drive wheel.

The bottom purge should be set so that all sediment is removed in each purge cycle. Each time the purge valve opens, the last one or two seconds of purge should be clear water. Normal purge cycles are in the range of 3 to 10 seconds open every 15 minutes to 1 hour.

Trouble Shooting Tips (Con't.)

8. Drive wheel slipping. Spinning or stalling of the center drive wheel is usually a symptom of other problems in the system. The friction drive is a torque overload control. If there is a heavy load on the system, the wheel should slip before any serious mechanical damage is done. Typical causes of slipping are:

* Excessive load of solids in the Clarifier. If the Clarifier is allowed to fill with floated sludge, the force required to move the center part is much higher. The overload condition should be fixed by draining the sludge out and starting over again if possible or by raising the level and speeding up the Scoop. If the sludge is very thick, water dilution may be necessary at first. This kind of condition should be corrected as soon as possible to avoid damage of the center parts.

* Excessive settled sludge in the Clarifier. This usually is the result of non-function of the bottom purge or of some upset in the Clarifier which has caused excessive settling. The bottom purge should be operated frequently until the condition is cleared. A sample scraped from the bottom of the unit or taken from the bottom purge line can help identify this problem.

* Foam or polymer on edge. Excessive foaming can result from chemical problems in the process or improper air addition. Foam can carry a high load of flocculant polymer which is very slippery. This should be thoroughly washed off.

* Mechanical malfunction. The general cleanliness of the unit and the function of the bearings, especially the centering bearings, should be checked thoroughly. The unit should be emptied and cleaned thoroughly and run around empty with all mechanical clearances (especially of the outside edge) checked.

* Check if the drive wheel is worn down or damaged. If so, that usually indicates the presence of other problems mentioned. (Normal tire life is 1 - 2 years.)

APPENDIX B

Maintenance Procedures:

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1. OILING

a) The gear box oil should be replaced after the first 200 hours and every three months (continuous service) thereafter, according to manufacturer's recommendations. The variable speed DC Motor is permanently lubricated.

b) The following bearings require greasing once per month:

All chains sprockets.
Scoop outer shaft bearing (1 flange bearing).
Rotary joint (center pipe).
All stainless steel wheels.

All other wheels in the system have high-weight plastic bearings which are designed for a minimum life of five years. These should be checked every six months. No oiling is required for these bearings. Worn bearings should be replaced to avoid damage to the mechanism.

OTHER MAINTENANCE

a) Every six months the rubber gaskets should be inspected when the system is empty.

b) Inspection should include:

- the main sweep arm, side and bottom;
- the clarified water seal (on moving wall);
- the center rotary joint (remove cover);
- the polyurethane-covered drive wheel;
- all plastic wheel bearings (all should turn freely).

c) During shutdown, all pipes including the clarified water pipes and inlet and outlet should be inspected for slime or scale build-up (especially check clarified water pipes and slotted pipes in Clarifier).

d) Pressure drop in the plastic panels for the Dissolving Tube should be checked monthly. Excessive drop (more than 10 PSI) indicates fouling. The panels can be blown clean or cleaned with fresh water in place. Panels should be checked and cleaned one at a time, uncleanable panels must be replaced.

e) Pressure gauges should be cleaned as necessary. Do not take apart sealed isolation diaphragm for cleaning.

f) Air meters and check valves must be kept clean and freely operating.

g) Wash Down At Every Opportunity. A clean SUPRACELL is a HAPPY SUPRACELL!!