In order to remove the very small suspended solids (colloids) and dissolved solids, wastewater treatment plants include Secondary Treatment. This process produces an overall plant removal of suspended solids and BOD of 90% or more. The three most common secondary treatment processes are trickling filters, rotating Biological Contactors (RBC) and Activated Sludge. This section will deal with Trickling Filters and RBC’s.

**TRICKLING FILTERS**

**DESCRIPTION OF A TRICKLING FILTER**

Most trickling filters are large diameter, shallow, cylindrical structures filled with stone or plastic media and having an overhead distributor. Many variations of this design have been built. When natural media (stones) are used, the trickling filter is usually cylindrical with a shallow bed;
when synthetic media (plastics) are used, the filter could be cylindrical or rectangular with a much deeper bed. Structures containing deep beds of synthetic media may be called filter towers or biofilter towers.

**PRINCIPLES OF TREATMENT Process**

Trickling filters consist of three basic parts:
1. The media (and retaining structure).
2. The under drain system.
3. The distribution system.

The media provide a large surface area upon which a biological slime growth develops. This slime growth, sometimes called a Zoogleal Film, contains the living organisms that break down the organic material. The media may be rock, slag, coal, bricks, redwood blocks, molded plastic, or any other sound durable material. The media should be of such sizes and stacked in such a fashion as to provide empty spaces (voids) for air to ventilate the filter and keep conditions aerobic. For rock, the size will usually be from about two inches to four inches in diameter. Although actual size is not too critical, it is important that the media be uniform in size to permit adequate ventilation. The media depth ranges from about three to eight feet for rock media trickling filters and 15 to 30 feet for synthetic media.

The underdrain system of a trickling filter has a sloping bottom. This leads to a center channel which collects the filter effluent. The underdrain systems include the use of spaced redwood stringers or prefabricated blocks constructed of concrete, vitrified clay, or other suitable material.

The distribution system, in the vast majority of cases, is a rotary-type distributor which consists of two or more horizontal pipes supported a few inches above the filter media by a central column. The wastewater is generally gravity fed from the column through the horizontal pipes and is distributed over the media through orifices located along one side of each of these pipes (or arms). Rotation of the arms is due to the rotating water-sprinkler reaction from wastewater flowing out the orifices. The distributors are equipped with mechanical-type seals at the center.
column to prevent leakage and protect the bearings. Also attached to the center column are stay rods for seasonal adjustment of the distributor arms to maintain an even distribution of wastewater over the media, and quick opening/arm dump gates at the end of each arm to permit easy flushing.

**Principals of Operation**

The maintenance of a good growth of organisms on the filter media is crucial to successful operation. The term “filter” is rather misleading because it indicates that solids are separated from the liquid by a straining action. This is not the case. Passage of wastewater through the filter causes the development of a gelatinous coating of bacteria, protozoa, and other organisms on the media. This growth of organisms absorbs and uses much of the suspended, colloidal, and dissolved organic matter from the wastewater as it passes over the growth in a rather thin film. Part of this material is used as food for production of new cells, while another portion is oxidized to carbon dioxide and water. Partially decomposed organic matter together with excess and dead film is continuously or periodically washed (sloughed) off and passes from the filter with the effluent.

For the oxidation (decomposition) processes to be carried out, the biological film requires a continuous supply of dissolved oxygen which may be adsorbed from the air circulating through the filter voids (spaces between the rocks or other media). Adequate ventilation of the filter must be provided; therefore the voids in the filter media must be kept open. Ventilation may be by either natural ventilation or by a forced air ventilation system. Clogged void space can create operational problems including ponding and reduction in overall filter efficiency. The void space provided by synthetic (plastic) media is about 95% of the total filter volume, thus providing space for biological slimes to slough and pass through the media. Rock media contains about 35% void space. Trickling filters with plastic media may be loaded at much higher rates than rock media without developing plugging, ponding, and fly or odor problems. Highly loaded filters may be called roughing filters and are commonly combined with other biological treatment processes to achieve higher levels of BOD removal.

A method of increasing the efficiency of trickling filters is to add recirculation. Recirculation is a process in which filter effluent is recycled and brought into contact with the biological film more than once. Recycling of filter effluent increases the contact time with the biological film and helps to seed the lower portions of the filter with active organisms. Due to the increased flow rate per unit of area, these higher flows tend to cause more continuous and uniform sloughing of excess or aged growths. Sloughing of growths prevents ponding and improves ventilation through the filter. Increased hydraulic loadings also decrease the opportunity for snail and filter fly breeding. The thickness of the biological growth has been observed to be directly related to the organic strength of the wastewater (the higher the BOD, the thicker the layers of organisms). By the use of recirculation, the strength of wastewater applied to the filter can be diluted, thus helping to prevent excessive buildup of growth.

Recirculation may be constant or intermittent and at a steady or fluctuating rate. Sometimes recirculation (recycling) is practiced only during periods of low flow to keep rotary distributors in motion, to prevent drying of the filter growths, or to prevent freezing. Recirculation in proportion to flow may be used to reduce the strength of the wastewater applied to the filter, while steady recirculation tends to even out the high and lows of organic loading. Steady recirculation, however, requires the use of more energy. Some plants operate intermittently at high recirculation rates (all recirculation pumps on) for two or three hours each week. This high rate will cause sloughing on a regular basis rather than allowing the slime growths to build up and slough under uncontrolled conditions.

**Classification of Filters**

Depending upon the hydraulic and organic loadings applied, filters are classified as standard-rate, high-rate, or roughing filters. Further designations such as single-stage, two-stage, and series or parallel are used to indicate the flow pattern of the plant. The hydraulic loading applied to a filter is the total volume of liquid, including recirculation, expressed as gallons per day per square foot of filter surface area (GPD/sq ft). The organic loading is expressed as the pounds of BOD applied per day per 1,000 cubic feet of filter media (lbs BOD/day/1,000 cu ft). Where recirculation is used, an additional organic loading will be placed on the filter; however, this added loading is omitted in most calculations because it was included in the influent load.

**Standard-Rate Filters**

The standard-rate filter is operated with a hydraulic loading range of 25 to 100 gal/day/sq ft and an organic BOD loading of 5 to 25 lbs/day/1,000 cu ft. The filter media is usually rock with a depth of 6 to 8 feet, with application to the filter by a rotating distributor. Many standard-rate filters are equipped to provide some recirculation during low flow periods.

The filter growth is often heavy and, in addition to the bacteria and protozoa, many types of worms, snails, and insect larvae can be found. The growth usually sloughs off at intervals, noticeably in spring and fall. The effluent
from a standard-rate filter treating municipal wastewater is usually quite stable with BODs as low as 20 to 25 mg/l.

**HIGH-RATE FILTERS**

High-rate filters usually have rock or synthetic media with a depth of 3 to 5 feet. Recommended loadings range from 100 to 1,000 gal/day/sq ft for rock and 350 to 2,100 gal/day/sq ft for synthetic media and 25 to 100 lbs BOD/day/1,000 cu ft for rock and 50 to 300 lbs BOD/day/1,000 cu ft for synthetic media. These filters are designed to receive wastewater continually, and practically all high-rate installations use recirculation.

Due to the heavy flow of wastewater over the media, more uniform sloughing of the filter growth occurs from high-rate filters. This sloughed material is somewhat lighter than from a standard-rate unit and therefore more difficult to settle.

**ROUGHING FILTERS**

A roughing filter is actually a high-rate filter receiving a very high organic loading. Any filter receiving an organic loading of 100 to over 300 lbs of BOD/day/1,000 cu ft of media volume is considered to be in this class. This type of filter is used primarily to reduce the organic load on subsequent oxidation processes such as a second-stage filter or activated sludge process. Many times they are used in plants which receive strong organic industrial wastes. They are also used where an intermediate (50-70 percent BOD removal) degree of treatment is satisfactory. Most roughing filters have provisions for recirculation.

**FILTER STAGING**

Figures 7.2 shows various filter and clarifier layouts. The decision as to the number of filters (or stages) required is one of design rather than operation. In general, however at smaller plants where the flow is fairly low, the strength of the raw wastewater is average and effluent quality requirements are not too strict, a single-stage plant (one filter) is often sufficient and most economical. In slightly overloaded plants, the addition of some recirculation capability can sometimes improve the effluent quality enough to meet receiving water standards and NPDES permit requirements without the necessity of adding more stages.

In two-stage filter plants two filters are operated in series. Sometimes a secondary clarifier is installed between the two filters. Recirculation is almost universally practiced at two-stage plants with any different arrangements being possible. The choice of a recirculation scheme is based on consideration of which arrangement produces the best effluent under the particular conditions of wastewater strength and other characteristics.

**OPERATIONAL STRATEGY**

In actual operation, the trickling filter is one of the most trouble-free types of secondary treatment. This process requires less operating attention and control than other types. Where recirculation is used, difficulties due to shock loads are less frequent and recovery is faster. This is because the filter can act like a sponge and treat great amounts of BOD for short time periods without a severe upset. Suspended solids in the trickling filter effluent tend to make the effluent somewhat turbid; thus a poorer quality effluent due to shock loads may not be visibly evident. Recirculation is used to maintain a constant load on the filter and thus produce a better quality of effluent. However, there are some problems which include ponding, odors, insects, and in colder climates, freezing. These problems are all controllable, and in most cases, preventable.

**RESPONSE TO ABNORMAL CONDITIONS**

Every wastewater treatment plant will face unusual or abnormal conditions. How successfully these unusual situations are handled depends on the advance planning and preparations taken by the plant operator. Abnormal operating condition in one plant may be handled as a routine procedure in another plant because the operator took the time to review the potential situations and developed a plan to cope with unusual events.
PONDING
Ponding results from a loss of open area in the filter. If the voids are filled, flow tends to collect on the surface in ponds. Ponding can be caused by excessive organic loading without a corresponding high recirculation rate. Perhaps the most common source of ponding is from the lack of good primary clarification prior to the filter. Another cause of ponding can be the use of media which are too small or not sufficiently uniform in size. In nonuniform media, the smaller pieces fit between the larger ones and thus make it easier for the slimes to plug the filter. If this condition exists, replacement of the media is the most satisfactory solution. Other causes of ponding include a poor or improper media permitting cementing or breakup, accumulation of fibers or trash in the filter voids (spaces between media), a high organic growth rate followed by a shock load and rapid uncontrolled sloughing, or an excessive growth of insect larvae or snails which may accumulate in the voids.

The cause of ponding should be identified as it will affect the corrective steps taken to solve the problem. The following are several methods which can be used to solve ponding problems,

1. Spray filter surface with a high pressure water stream.
2. Hand turn or stir the filter surface with a rake, fork, or bar. Remove any accumulation of leaves or other debris.
3. Dose the filter with chlorine at about 5 mg/l for several hours.
4. Flood the filter, keeping the media submerged for 24 hours will cause the growth to slough.
5. Shut off flow to the filter for several hours allowing the growth to dry out.

ODORS
Since operation of trickling filters is an aerobic process, no serious odors should exist unless odor producing compounds are present in the wastewater in high concentrations. The presence of foul odors indicates that anaerobic conditions are predominant. Anaerobic conditions are usually present under that portion of slime growth which is next to the media surface. As long as the surface of the slime growth (Zoogleal film) is aerobic, odors should be minor. Corrective measures should be taken immediately if foul odors develop. The following are guidelines for maintaining trickling filters to prevent odor problems.

1. Maintain aerobic conditions in the sewer collection system and in the primary treatment units.
2. Check ventilation in the filter. Heavy biological growths or obstructions in the underdrain system will cut down ventilation.
3. Increase the recirculation rate to provide more oxygen to the filter bed and increase sloughing.
4. Keep the wastewater splash from the distributors in the filter and away from exposed structures, grass, and other surfaces.

FILTER FLIES
The tiny, gnat sized filter fly (Psychoda) is the primary nuisance insect connected with trickling filter operations. They are occasionally found in great numbers and can be an extremely difficult problem to plant operating personnel as well as nearby neighbors. Preferring an alternately wet and dry environment for development, the flies are found most frequently in low rate filters and are usually not much of a problem in high rate filters. Control usually can be accomplished by the use of one or more of the following methods.

1. Increase recirculation rate. Synthetic media will require higher hydraulic loadings or the use of weekly flushing by turning on all the filter pumps.
2. Keep orifice openings clear, including end gates of distributor arms.
3. Apply approved insecticides with caution to filter walls and to other plant structures.
4. Flood filter for 24 hours at intervals frequent enough to prevent completion of insect life cycle. This cycle is as short as seven days.
5. Shrubbery, weeds, and tall grass provide a natural sanctuary for filter flies. Good Housekeeping and grounds maintenance will help to minimize fly problems.

SLOUGHING
One of the most common problems with trickling filter operation is the periodic uncontrolled sloughing of biological slime growths from the filter media. Increasing the recirculation pumping rate to the filter on a weekly basis may help to induce controlled sloughing rather than allow the slime growths to build up.

POOR EFFLUENT QUALITY
Check the organic load on the filter when the treated effluent quality is poor. Measure both the soluble and total BOD in the final effluent. The results will indicate if the poor effluent is caused by BOD associated with escaping solids (high total BOD) or whether the poor effluent results from the trickling filter BOD removal capacity being exceeded (high soluble BOD).

COLD WEATHER PROBLEMS
Cold weather usually does not offer much of a problem to wastewater flowing in a pipe or through a clarifier. Occasionally, however, wastewater sprayed from distributor nozzles or exposed in thin layers on the media may reach
the freezing point and cause a buildup of ice on the filter. Several measures can be taken to reduce ice problems on the filter.

1. Decrease the amount of recirculation, provided sufficient flow remains to keep the filter working properly
2. Operate Two Stage Filters in parallel rather than in series.
3. Adjust or remove orifices and splash plates to reduce the spray effect.
4. Construct wind screens, covers, or canopies to reduce heat loss.
5. Physically break up and remove the larger areas of ice buildup.

Although the efficiency of the filter unit is reduced during periods of icing, it is important to keep this unit running. Taking the unit out of service will not only reduce the quality of the effluent but may lead to additional maintenance problems, such as ice forming, with the possibility of structural damage. Also, moisture may condense in the oil and damage the bearings.

**MAINTENANCE**

**Bearings and Seals**

The bearings in distributors may be located in the base of the center column or at the top. Both types will have a water seal at the base to prevent wastewater leakage. This is to avoid uneven distribution of the wastewater over the media, and also to protect the bearings when they are located in the base. Many older distributors used a mercury seal. Mercury should not be used because mercury is toxic to living organisms, including operators.

Generally, the bearings ride on removable races (tracks) in a bath of oil. The oil usually specified is turbine oil with oxidation and corrosion inhibitors added. The manufacturer’s literature or the plant O & M manual should specify what type of oil to use.

Be sure to monitor the oil very carefully. The level and condition of the oil are crucial to the life of the equipment, and should be checked weekly. To check, drain out about a pint of oil into a clean container. If the oil is clean and free of water, return it to the unit. If the oil is dirty, drain it and refill with a mixture of approximately ¼ oil and 3/4 solvent (such as kerosene), and operate the distributor for a few minutes. Drain again, and refill with the correct oil. (Note; Drawing off some of the oil to check it is important. You can see if the oil is contaminated and verify that the oil level sensing line is not plugged.)

WATER in the oil will appear at the bottom of the oil in the container. If water is found in the oil, either the sealing fluid is low or the gasket must be replaced in mechanical seals.

**Distributor Arms**

Work on distributor orifices only after the arms have stopped moving. The distributor arms should be flushed weekly by opening the end dump gates one at a time. Also clean debris off of the filter surface each day, cleaning the orifices as often as needed. Observe the distributor daily for smooth operation. If it becomes jumpy, seems to vibrate, or slows down with the same amount of wastewater passing through it, the bearings and races are probably damaged and will require replacement. Adjust the turnbuckles occasionally on the guy rods to keep the rotating distributor arms at the proper level to provide even flow over all of the media.

The speed of rotation of the distributor should not be excessive. Rotation of the distributor is due to the reaction of the water flowing through the orifices. This is similar to the backward thrust of a water hose or the spinning of some types of lawn sprinklers. Speed is controlled by regulation of flow through the orifices. (On larger distributors, approximately 1 RPM is normal.) If the distributor rotates too fast, it may damage the bearing races on the turntable.

To reduce the speed of rotation, provision usually is made on the front of each arm for orifices (see diagram found at the beginning of the chapter). The reaction of the water flowing through these orifices cancels some of the thrust of the regular orifices.

Since most distributors appear rather large and bulky, many operators are surprised to find that they are delicately balanced. As soon as wastewater begins to flow from the orifices, the distributor arm should start to move. The fan like pattern as the wastewater leaves the deflecting plates should be uniform. If the plates have developed a slime growth that is affecting uniform distribution, the slime should be brushed off.

**Underdrains**

The underdrains are buried under the filter bed. Usually cleanouts of flusher branches are located on the head end of each line or channel for flushing to remove sludge deposits or debris from the underdrain system. If flushing will not clear the line and your agency or city’s collection system maintenance section has a high velocity cleaner for cleaning sewer lines, borrow their services and have them clean the underdrains. You may wish to schedule this cleaning procedure every three to six months in order to keep the underdrain system open and clear.
**SAFETY**

In order to work around a trickling filter safely, several precautions should be taken. **FIRST SHUT OFF THE FLOW TO THE FILTER AND ALLOW THE DISTRIBUTOR TO STOP ROTATING BEFORE ATTEMPTING TO WORK ON IT.** The force of the rotating distributor arms is about the equivalent of a good sized truck. YOU JUST CAN’T REACH OUT AND STOP ONE WITHOUT ENDANGERING YOURSELF. Serious injuries can result.

The slime growth on a filter is very slippery. **EXTREME CARE SHOULD BE TAKEN WHEN WALKING ON THE FILTER MEDIA.** Rubber boots with deeply ridged soles will help you keep your footing. Do not carry or use glass containers when working on the media surface.

**ROTATING BIOLOGICAL CONTACTORS**

Rotating biological contactors (RBC’s) are a secondary biological treatment process for domestic and biodegradable industrial wastes. Biological contactors have a rotating “shaft” surrounded by plastic discs called the media. The shaft and media are called the drum. A biological slime grows on the media when conditions are suitable. This process is very similar to a trickling filter where the biological slime grows on rock or other media and settled wastewater (primary clarifier effluent) is applied over the media. With rotating biological contactors, the biological slime grows on the surface of the plastic disc media. The slime is rotated into the settled wastewater and then into the atmosphere to provide oxygen for the organisms.

The plastic disc media are made of high density plastic circular sheets usually 12 feet in diameter. These sheets are bonded and assembled onto horizontal shafts up to 25 feet in length. Spacing between the sheets provides the hollow (void) space for distribution of wastewater and air.

**End View of RBC Air and Wastewater Exchange**

The rotating biological contactor process uses several plastic media drums. Concrete or coated steel tanks usually hold the wastewater being treated. The media rotate at about 1.5 RPM while approximately 40 percent of the media surface is immersed in the wastewater. As the drum rotates, the media pick up a thin layer of wastewater which flows over the biological slimes on the discs. Organisms living in the slimes use organic matter from the wastewater for food and dissolved oxygen from the air, thus removing wastes from the wastewater. As the attached slimes pass through the wastewater, some of the slimes are sloughed from the media as the media rotates downward into the wastewater being treated. The effluent
with the sloughed slimes flows to the secondary clarifier where the slimes are removed from the effluent by settling.

Figure 7.6 shows the location of a rotating biological contactor process in a wastewater treatment plant. The process is located in the same position as the trickling filter or activated sludge aeration basin. Usually the process operates as a once through system, with no recycling of effluent or sludge, which makes it a simple process to operate.

The major parts of the process are listed in the attached table along with their purposes. The concrete or steel tanks are commonly shaped to conform to the general shape of the media. This shape eliminates dead spots where solids could settle out and cause odors and septic conditions.

The rotating biological contactor process is usually divided into four different stages (see figure next page). Each stage is separated by a removable baffle, concrete wall or cross tank bulkhead. Wastewater flow is either parallel or perpendicular to the shaft. Each bulkhead or baffle has an underwater orifice or hole to permit flow from one stage to the next. Each section of media between bulkheads acts as a separate stage of treatment.

Staging is used in order to maximize the effectiveness of a given amount of media surface area. Organisms on the first stage media are exposed to high levels of BOD and reduce the BOD at a high rate. As the BOD levels decrease from stage to stage, the rate at which the organisms can remove BOD decreases and nitrification starts.

Rotating biological contactors are covered for several reasons relating to climatic conditions:
1. Protect biological slime growths from freezing
2. Prevent intense rains from washing off some of the slime growth
3. Stop exposure of media to direct sunlight to prevent growth of algae
4. Avoid exposure of media to sunlight which may cause the media to become brittle; and
5. Provide protection for operators from sun, rain, snow or wind while maintaining equipment.

<table>
<thead>
<tr>
<th>Part</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete or Steel Tank Divided into Bays (Sections) by Baffles (Bulkheads)</td>
<td>Tank. Holds the wastewater being treated and allows the wastewater to come in contact with the organisms on the discs.</td>
</tr>
<tr>
<td>Orifice or Weir Located in Baffle</td>
<td>Bays and baffles. Prevent short-circuiting of wastewater.</td>
</tr>
<tr>
<td>Rotating Media</td>
<td>Controls flow from one stage to the next stage or from one bay to the next bay.</td>
</tr>
<tr>
<td>Cover over Contactor</td>
<td>Provide support for organisms. Rotation provides food (from wastewater being treated) and air for organisms.</td>
</tr>
<tr>
<td>Drive Assembly</td>
<td>Protects organisms from severe fluctuations in the weather, especially freezing. Also contains odors.</td>
</tr>
<tr>
<td>Influent Lines with Valves</td>
<td>Rotates the media.</td>
</tr>
<tr>
<td>Effluent Lines with Valves</td>
<td>Influent lines. Transport wastewater to be treated to the rotating biological contactor.</td>
</tr>
<tr>
<td>Underdrains</td>
<td>Influent valves. Regulate influent to contactor and also isolate contactor for maintenance.</td>
</tr>
<tr>
<td></td>
<td>Effluent lines. Convey treated wastewater from the contactor to the secondary clarifier.</td>
</tr>
<tr>
<td></td>
<td>Effluent valves. Regulate effluent from the contactor and also isolate contactor for maintenance.</td>
</tr>
<tr>
<td></td>
<td>Allow for removal of solids which may settle out in tank.</td>
</tr>
</tbody>
</table>

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Figure 7.7 - Typical Flow Layouts in RBCs

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7-9
<table>
<thead>
<tr>
<th>INDICATOR/OBSERVATION</th>
<th>PROBABLE CAUSE</th>
<th>CHECK OR MONITOR</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Place another RBC in service if available.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Remove bulkhead between stages 1 and 2 for larger first stage.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>4. Recycle effluent as a possible short-term solution.</td>
</tr>
<tr>
<td></td>
<td>1b. Hydraulic overload.</td>
<td>1b. Check peak hydraulic loads — if less than twice the daily average, should not be the cause.</td>
<td>1b. 1. Flow equalization; eliminate source of excessive flow.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Balance flows between reactors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Store peak flows in collection system, monitor possible overflows of collection system.</td>
</tr>
<tr>
<td></td>
<td>1c. pH too high or too low.</td>
<td>1c. Desired range is 6.5 - 8.5 for secondary treatment; 8 - 8.5 for nitrification.</td>
<td>1c. 1. Eliminate source of undesirable pH or add acid or base to adjust pH. When nitrifying, maintain alkalinity at 7 times the influent NH₃ concentration.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Sodium bicarbonate can be used to increase both pH and alkalinity.</td>
</tr>
<tr>
<td></td>
<td>1d. Low wastewater temperatures.</td>
<td>1d. Temperatures less than 55°F will reduce efficiency.</td>
<td>1d. 1. Cover RBC to contain heat of wastewater.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Heat influent to unit or building.</td>
</tr>
<tr>
<td>2. Excessive sloughing of biomass from discs.</td>
<td>2a. Toxic materials in influent.</td>
<td>2a. Determine material and its source.</td>
<td>2a. 1. Eliminate toxic material if possible — if not, use flow equalization to reduce variations in concentration so biomass can acclimate.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Recycle effluent for dilution.</td>
</tr>
<tr>
<td></td>
<td>2b. Excessive pH variations.</td>
<td>2b. pH below 5 or above 10 can cause sloughing.</td>
<td>2b. Eliminate source of pH variations or maintain control of influent pH.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2c. Eliminate/reduce variations by throttling peak conditions and recycling from the secondary clarifier or RBC effluent during low flows.</td>
</tr>
<tr>
<td></td>
<td>2c. Unusual variation in flow and/or organic loading.</td>
<td></td>
<td>2d. Monitor industrial contributors for flow variations.</td>
</tr>
<tr>
<td>3. Development of white biomass over most of disc area.</td>
<td>3a. Septic influent or high H₂S concentrations.</td>
<td></td>
<td>3a. Pre-aerate wastewater or add sodium nitrate or hydrogen peroxide or place another RBC unit in service. Prechlorination of influent will also control sulfur-loving bacteria.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3b. Improve pretreatment of plant.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Place another RBC in service, if available.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3. Adjust baffles between first and second stages to increase total surface area in first stage.</td>
</tr>
<tr>
<td>4. Solids accumulating in reactors.</td>
<td>4a. Inadequate pretreatment.</td>
<td>4a. Determine if solids are grit or organic.</td>
<td>4a. Remove solids from reactors and provide improved grit removal or primary settling.</td>
</tr>
</tbody>
</table>
OBSERVING THE MEDIA
Rotating biological contactors use bacteria and other living organisms growing on the media to treat waste. Because of this, you can use your senses of sight and smell to identify problems. The slime growth or biomass should have a brown to gray color, no algae present, a shaggy appearance with a fairly uniform coverage, and very few or no bare spots. The odor should not be offensive, and certainly there should be no sulfide (rotten egg) smells.

BLACK APPEARANCE
If the appearance becomes black and odors which are not normal do occur, then this could be an indication of solids or BOD overloading. These conditions would probably be accompanied by low DO in the plant effluent. Compare previous influent suspended solids and BOD values with current test results to determine if there is an increase. To solve this problem, place another rotating biological contactor unit in service, if possible, or try to pre-aerate the influent to the RBC unit. Also review the operation of the primary clarifiers and sludge digesters to be sure they are not the source of the overload.

WHITE APPEARANCE
A white appearance on the disc surface also might be present during high loading conditions. This might be due to a type of bacteria which feeds on sulfur compounds. The overloading could result from industrial discharges containing sulfur compounds upon which certain sulfur loving bacteria thrive and produce a white slime biomass. Corrective action consists of placing another RBC unit in service or trying to pre-aerate the influent to the unit. During periods of severe organic or sulfur overloading, remove the bulkhead or baffle between stages one and two.

Another cause of overloading may be sludge deposits that have been allowed to accumulate in the bottom of the bays. To remove these deposits, drain the bays, wash the sludge deposits out and return the unit to service. Be sure the orifices in the baffles between the bays are clear.

SLOUGHING
If severe sloughing or low growth of biomass occurs after the start-up period and process difficulty arises, the causes may be due to the influent wastewater containing toxic or inhibitory substances that kill the organisms in the biomass or restrict their ability to treat wastes. To solve this problem, steps must be taken to eliminate the toxic substance even though this may be very difficult and costly. Biological processes will never operate properly as long as they attempt to treat toxic wastes. Until the toxic substance can be located and eliminated, loading peaks should be dampened (reduced) and a diluted uniform concentration of the toxic substance allowed to reach the media in order to minimize harm to the biological culture.

Another problem which could cause low growth of biomass is an unusual variation in flow and/or organic loading. In small communities one cause may be high flow during the day and near zero flow at night. During the day the biomass is receiving food and oxygen and starts growing; then the night flow drops to near zero, available food is reduced and nearly stops. The biomass starts sloughing off again due to lack of food.

MAINTENANCE
Rotating biological contactors have few moving parts and require minor amounts of preventive maintenance. Chain drives, belt drives, sprockets, rotating shafts and any other moving parts should be inspected and maintained in accordance with manufactures instructions or your plants O & M manual. All exposed parts, bearing housing, shaft ends and bolts should be painted or covered with a layer of grease to prevent rust damage. Motors, speed reducers and all other metal parts should be painted for protection.

References
Office of Water Programs, California State University, Sacramento, Operation of Wastewater Treatment Plants, Volume 1, 4th ed., Chapters 6, & 7