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Turning Liabilities into Leverage
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Clarifier Optimization; Does your clarifier look like this or this?

WHAT DO I NEED TO DO TO OPERATE IT EFFECTIVELY?

The purpose of the clarifier is two-fold. One is to thicken the solids and then settle them out. The second is to produce a clear effluent off the settled solids. Clarifiers in activated sludge systems must be designed not only for hydraulic overflow rates, but also for solids loading rates. This is because both clarification and thickening are needed in activated sludge clarifiers. At higher mixed liquor suspended solids (MLSS) values (i.e., more than 3000 mg/l), the ability of the clarifier to thicken solids becomes more important, and the solids loading rate becomes critical.

Keep in mind that a major portion of the bacteria is returned to the front of the plant. They do not stop growing in the clarifier. Many people cause most of the growth of filaments in the clarifier or create conditions that promote the growth of filaments by holding solids too long in the clarifier.

There are numerous control options that plants use to run their clarifier more efficiently.

Monitor the flow through the secondary clarifier.
Flow rates greater than the design overflow rate may result in an increase in the effluent solids content.
This picture shows hydraulic overloading in a clarifier.

Monitor the influent and effluent suspended solids concentration to determine percent solids removal efficiency.
An influent solids loading rate (dry pounds or tons of solids/sq. ft. /hour or day) greater than the design rate can

result in a decrease in the solids removal efficiency. Also, the collector mechanism may become torque overloaded.

Monitor the influent wastewater temperature.

A decrease in temperature reduces the settling rate, which can result in a decrease in solids removal efficiency. An increase in the wastewater temperature can cause short-circuiting through the clarifier, reducing removal efficiency.

Monitor the settleability of the influent solids.

Periodic volumetric settling tests using a settleometer will indicate a change in the suspended solids characteristics, which may result in a reduction in solids removal efficiency. This will indicate a change in the biomass that may be due to filaments or young or old floc. It may also indicate changes in the process that will impact the biomass characteristics.

Monitor the secondary clarifier effluent pH.

A drop in pH along with the presence of gas bubbles in the final settling tank usually indicates a septic sludge bed condition. Check for gassing and ashing.

Monitor the dissolved oxygen content of the influent and effluent of the clarifier.

The dissolved oxygen content of the secondary clarifier effluent should be periodically monitored by taking samples from inside of the effluent weir. A large drop in dissolved oxygen from the influent to the effluent of the secondary clarifier indicates that the biological sludge activity is high in the clarifier and the water contains a substantial BOD demand. Operational corrections of the upstream biological process need to be adjusted in order to achieve final effluent BOD removal.

Maintain the effluent weirs in a clean and level condition.

Weir maintenance is also critical, as well as the outer track. Algae on the weirs will significantly contribute to TSS and BOD in the final effluent. These need weekly maintenance, either spraying or cleaning with brushes. Algae can fix nitrogen if the environment is correct, and this can impact or give false reading as the efficiency of nitrification in the system. If excess BOD is still present or nutrients are in the system, algae or cyanobacteria can grow. Proper preventative maintenance of the weirs can alleviate this.

There are numerous companies that make automated cleaning systems that can significantly reduce manpower hours, increase efficiency in a system and cut back TSS and false BOD violations. The cost

of the equipment is easily recaptured in ROI.
Weir Washer Automated Cleaning System (ACS) http://www.nwpeco.com/ic5.htm
Maintain the equipment per the manufacturer's instructions so that process performance will not be compromised by equipment malfunction or failure.

Monitor the sludge blanket depth and adjust blowdown frequency and/or rate accordingly.
Measure the sludge blanket depth and adjust the blowdown rate to keep the blanket at the optimum depth. The optimum depth is that which produces the desired underflow concentration for the type of solids being separated but does not reduce the tank volume for the necessary flocculent settling rate. Best operation in terms of effluent clarity is typically attained with as small a sludge inventory (sludge bed) as possible. The sludge depth can be manually measured by such means as using a 'Sludge Judge", or automatically by sludge depth meters.

· The volume of sludge to blowdown per unit time (gpm) to maintain the sludge bed at the proper depth can be estimated from the influent and effluent suspended solids, influent flow rate, and the underflow concentration.
· Anaerobic decomposition of organic solids can develop in the sludge bed if the sludge retention time in the bed is excessive. This decomposition produces gas bubbles, which will cause the sludge to float to the clarifier's surface.

Monitor the settleability of the influent solids.
Periodic volumetric settling tests using a settleometer will indicate a change in the suspended solids characteristics, which may result in a reduction in solids removal efficiency. Such a change could require a reduction in the influent rate, adjustment of the upstream biological process to change the nature of the solids, revisions to the current chemical program, or the need for chemical treatment, if not currently being used. A change in settling characteristics may also indicate equipment failure or a change in the mill or manufacturing plant process.

Sludge recycle flow rates for activated sludge systems should be as constant and continuous as possible.

The solids concentration of the underflow sludge (blowdown) from the secondary clarifier affects:
- The operational control of the activated sludge process in terms of sludge recycle rate, which in turn affects the aeration basin mixed liquor suspended solids, food (BOD) to mixed liquor suspended solids ratio, and sludge age.
- The cost of sludge disposal such as transportation, drying, incineration, or lagoon capacity when disposing of the sludge in the wet form.
- Various sludge dewatering costs related to operating time, power usage, conditioning chemicals, and dewatered cake dryness for equipment such as belt filter presses, vacuum filters, centrifuges, plate and frame presses, and screw presses.

Optimization of the secondary clarifiers will greatly improve the health of the secondary systems and decrease the amount of filaments and foaming problems that occur in the activated sludge tanks.

Using the Sludge Judge as a way to measure Depth of BED:

What is a sludge judge or core sampler?

A sludge judge is a core sampler that may consist of three to five foot long sections of plastic tubing, each clearly marked at 1 foot intervals and fitted with screw connections for ease of assembly. The 1-ft markings allow for quick and acurate assessment of the depth of settled solids in the bed of the clarifier.

The bottom section of the core sampler is fitted with a check valve, which opens as the unit is lowered into the liquid. When the unit has reached the bottom of the clarifier & the liquid level equilibrated at surface level, tug on the retraining rope on the top section, this will set the check valve and retain the sample in the tubing, allowing the position of the liquid and solid interface to be determined as the section is withdrawn from the water. To release the material in the unit, touch the pin extending from the bottom section against a hard surface. This opens the check valve to drain the sample.

If there are too many solids in the bed there may be inconsistencies in the bed measurement. This makes it hard for a consistent RAS to be drawn off the bottoms, which impacts the returns of biosolids to the aeration basins. Holding solids in the clarifier too long generates systems conducive to filamentous growth or floating sludge or foaming, as the air, nutrients and proper conditions for growth are changed.

Black layers were visible in the sludge judge indicating septic conditions and solids holding times that are too long in the clarifier. This is automatically a warning sign if you see this in your sludge judge. Your biosolids are turning septic in the clarifier and running out of air. Get rid of some of the solids in the clarifier. Either by RAS or Wasting, that will depend upon the sludge age of your MLSS in the Aeration Basin. If you are running a high F/M and have many amoebae and flagellates, you probably do not want to increase wasting. If instead, you have a ton of worms and rotifers and do not need to keep a very old sludge age due to nitrification or hard to degrade compounds, you need to increase wasting for a short time. Either way, the solids are being held too long in the clarifier and need to be moved somewhere!!!

During a training class of 12 operators, we had them all pull a sludge judge to see if every operator pulled it at the same spot in the clarifier and pulled it at the same time according to the position of the rakes.

It was very interesting to see how the testing and the interpretations of the results varied according to operators.

Typically you want to place the sludge judge 1/3 in from the outer edge of the clarifier.

Most plants place the sludge judge in the water when the rake is perpendicular to the walkway and away from your sampling point.
Check out the variations in the bed when pulled with the rake at different intervals.
Optimization of the secondary clarifiers will greatly improve the health of the secondary systems and decrease the amount of foaming.

Sludge Blanket Depth

Sludge blanket depth in the clarifier should be measured at the same time each day. The best time is during the period of maximum daily flow, because the clarifier is operating under the highest solids loading rate. Adjustments in the RAS flow rate should be needed only occasionally if the activated sludge process is operating properly and the anaerobic treatment system is running smoothly. We ran various sludge judge tests during a period of 15 minutes depending upon where the rakes were perpendicular to the walkway, and at other points. We got 5 very different readings, some of which had very black sludge in the bottom, one with only 2 ft. of gold sludge, one with 2 zones of black and one with 5 feet of sludge. It appears that the rakes are rolling around a large mass of floc. This may indicate the sludge is not properly settling or drawing down through the bottom tubes.

This clarifier and the draw down mechanisms will have to be checked and cleaned out during scheduled maintenance. The appearance of the surface of the sludge thickener tank showed too much water, which also might indicate “rat-holing" occurring in the clarifier.

An additional advantage of monitoring the sludge blanket depth is that problems, such as improperly operating sludge collection equipment, will be observed due to irregularities in the blanket depth. A plugged pick-up on a clarifier sludge collection system would cause sludge depth to increase in the area of the pick-up, and decrease in the areas where the properly operating pick-ups are located. These irregularities in sludge blanket depth are easily monitored by measuring profiles of blanket depth across the clarifier. This appeared to be somewhat the case of what we were seeing when we pulled various blanket measurements depending upon where the rake position was.

Holding solids too long generally causes not only septic conditions, which can generates odors, but also generates low DO conditions which can generate specific compounds with sulfides and/or organic acids. Limited nutrients are available also to the bacteria in the clarifier. All of these conditions promote the growth of filamentous bacteria. Holding times of influent should always be kept to a minimum. Generation of septic conditions can also contribute to ashing in the clarifier. Since the solids are turning anaerobic in the bottom of the clarifier and generating gases that cause clumps of solids to float to the top, this increases solids carryover. Polymer consumption goes up, solids handling is increased. Since many plants have a limitation on sludge dewatering, either due to draw down on the clarifier, pumping capabilities or mechanical sludge dewatering abilities, these variables are critical.

Find out more about our Troubleshooting and Training programs or consider having a Waste Audit performed on your plant with our Consulting Engineers.

