By Charlie Schwindamann, KRWA Wastewater Tech

# Activated Sludge: Basic Operations and Troubleshooting

Kyle Headrick, Wastewater Operator at the city of Hesston, performs a settleability test. The Hesston plant consistently has non-detects on BOD and TSS in the effluent discharge.

Activated sludge is a process by which air is added to the system to treat wastewater. The object is to provide oxygen for organisms or bacteria to grow and reduce the organic waste (BOD) in the wastewater. All wastewater treatment facilities should follow the operation and maintenance guidance provided when the system was constructed. Following the O&M manual originally provided should allow the plant to produce the best effluent quality for the system.

There are four main pieces of equipment that operators should have available that will provide basic information needed for the proper treatment of the waste. This article reviews the equipment and information that equipment provides. It should be understood that no one piece of equipment is more or less important that the other, but that all are needed for proper system evaluation and process control. Combined with additional operating data, operators can use the information to provide the best effluent quality for activated sludge plants. Also remember every treatment plant and the influent waste are different, so what works well for one may not work as well in another system.

**All wastewater treatment facilities should follow the operation and maintenance guidance provided when the system was constructed.**

## Dissolved Oxygen Meter

The Dissolved Oxygen meter or commonly called the "DO meter" can vary in cost from $700 to over $1,500. These also vary in how often they need to be calibrated and their maintenance cost. Choose the right one for your system. Remember, maintaining the proper DO in your system will save in electrical costs over time and could pay for the better DO Meter.

In most cases the DO should not drop below 1 mg/l in the system, and depending on the system, it may be necessary to maintain the DO as high as 2 or 3 mg/l. Maintaining a DO much higher than these levels is generally a waste of electricity. Some of the newer wastewater treatment facilities are using variable frequency drives (VFD's) connected to the DO probe that will ramp the blowers up or down to maintain proper DO for the system. Also, remember that DO will be higher when weather conditions are cold rather than warm.

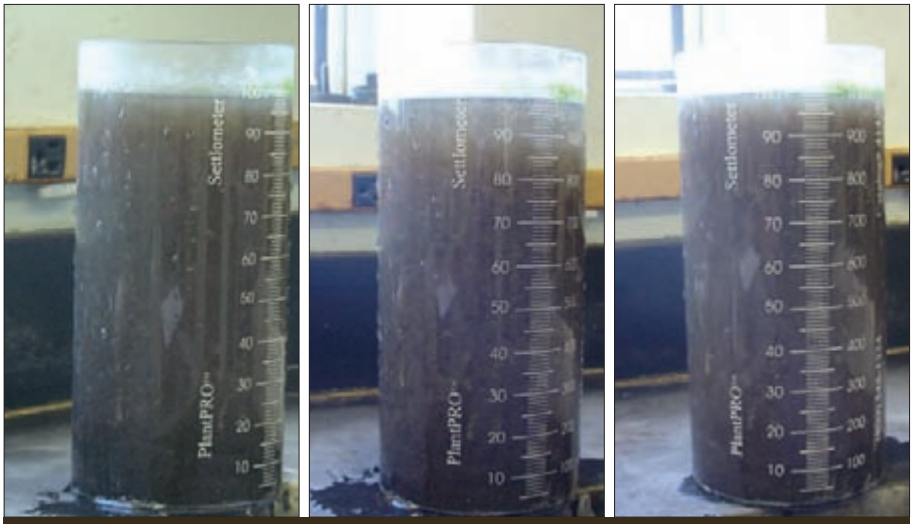
If the DO drops much below 1 mg/l, the system may be starving the bacteria of needed oxygen. When the Return Activated Sludge is returned to the start of the treatment works, operators may want the DO to be in this lower range so that the bacteria will strip the oxygen from nitrates and nitrites and convert it to nitrogen for nutrient removal.

## Settleometer

The Settleometer has a purchase cost of between $50 to $175. A settleometer is usually at least a liter in volume, however, some operators prefer the two-liter graduated cylinder. Some of the observations an operator should be looking at are: color, odor, floc, surface, supernatant, voids, and time it takes sludge to settle.

If the sludge in the sample is a light brown color, this is usually an indication of a young sludge. While performing

the settleability test, if the sample has an odor similar to the influent, then it is probably a young sludge. Young sludge will have a small floc and may have solids on the surface. The supernatant for young sludge will have solids floating and be cloudy in appearance. There should be no voids noticed in the settled floc for young sludge. The young sludge does not settle quickly. In the first five minutes it may settle less than 50 mg/l, so the reading would be around 950 mg/l on the jar; this will settle only about 100 mg/l total to about 900 mg/l.



These photos show the start of the settleability test.

Since these settleometer results could also be a sign of old sludge, an operator may want to dilute the sample using 50 percent effluent water and 50 percent sample, and compare it to an undiluted sample. Both tests need to be conducted at the same time. This will require two settleometers – one with diluted sample and the other undiluted. If the sludge in the diluted sample settles significantly faster than the undiluted sample, this indicates old sludge, which may have filamentous micro-organisms, and "wasting" is recommended.

"Wasting" is a term used for removing excess sludge from the treatment process. If operated correctly, all activated sludge plants eventually build up an excessive concentration of biological floc (bacteria). To prevent "overcrowding", sludge wasting is employed. Wasting is used to keep the ratio of the biological floc to food supplied in balance. The sludge is usually drawn from a digester after sufficient processing; it can be dewatered or dried and then be land applied, taken to a landfill or used in a composting operation.

The color for adult/normal sludge is light chocolate brown. This is where operators will most likely want the sludge at the plant to be. There should be no odor and the surface of the sample should be relatively clear with possibly only minimal floating debris. There may be a small amount of floating material, depending on the exact age of the sludge. For adult sludge age, the supernatant will be clear and there will be voids in the settled sludge. When the sludge settles in this stage, the five-minute settling rate should be about 150 mg/l to 300 mg/l, or the reading should be 850 mg/l to 700 mg/l. The 30-minute settling rate should be about 200 to 300 mg/l.

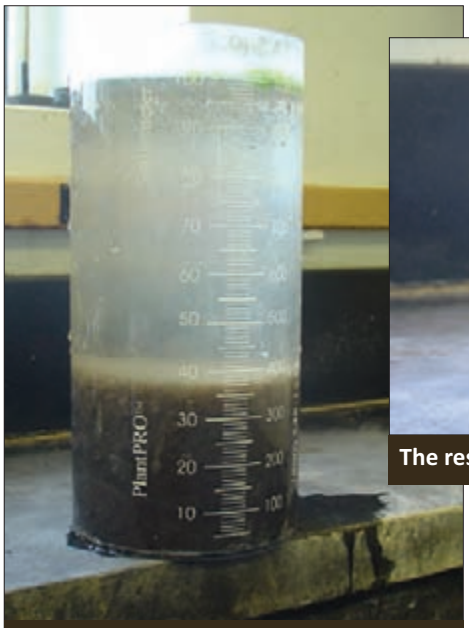
When sludge is too old, the color will be dark brown to gray/black; the operator will most likely want to start wasting some of this sludge. The sample may smell like methane, hydrogen sulfide or musty and may be covered by ashing. The older sludge will be cloudy with some pin floc noticed. Voids will be extremely small in the older sludge. Settling for this age sludge varies but will settle to about 300 mg/l or more in five minutes and to 200 mg/l or less in 30 minutes. This is when the operator may also want to waste more sludge.

Wasting consistently in small increments is better than wasting a lot all at once. For example, it's better to waste 1,000 gallons per day than to waste 7,000 gallons once per week. Wasting large amounts of sludge at any one time which can have a negative effect on plant performance and plant effluent.

## Microscope

The next piece of equipment that will greatly assist an operator with evaluating treatment processes is the microscope. Microscopes can range in price from $500 to $1,500 or more. Generally a simple microscope with 100 power and reasonable resolution will work well for most systems.

Depending on the microscope, in young sludge the operator should see substantial free-swimming ciliates and zoo flagellates. Then, as the sludge gets to the adult or normal stage, the operator will see less of those mentioned above and see more stalked ciliates, a few free-swimming ciliates from the young sludge, and a few rotifers. As the sludge age progresses, the operator will see mostly rotifers and a few stalked ciliates. As sludge is wasted, there may be no discernable change in the microorganisms under the microscope but as long as it is in the normal range the system should operate fine. The problem occurs when there is too much or too little sludge wasted. If the operator does not consistently waste, the cycle will start again which could upset the balance of the treatment works.




The results of the settleability test after five minutes


The results after 30 minutes

## Centrifuge

Another helpful piece of equipment is the centrifuge; this is used to determine solids concentration. The following is an example of how to convert the sludge volume in mg/l to a concentration in percent. If a 15-ml centrifuge tube is used, the tube factor would be 100 divided by 15 for a tube factor of 6.67. After spinning, if the sludge volume is 1.2, then the percent concentration would be 1.2 x 6.67 = 8.0 percent. Using the same procedure, if 50-ml tube is used, the factor would be 2. Using the same sludge volume of 1.2, this would be 1.2 x 2 = 2.4 percent.

This article, as stated in the title, provides the very basics of activated sludge operation and troubleshooting. There are numerous training manuals on the subject. In my opinion, one of the foremost manuals is that by Tim Hobson entitled “Activated Sludge-Evaluating and Controlling Your Process”. With a retail price of approximately $20, copies can be ordered www.hobsonschoicepress.com. I relied on information from the training manual; I also reviewed California State University, Sacramento training manuals, “Advanced Wastewater Treatment” and “Operations of Wastewater Treatment Plants” for reference materials for this article.



*Charlie Schwindamann has been Wastewater Tech at KRWA since September 1999. Charlie holds Class II Water and Class I Wastewater Operator certification. He is a member of the Marysville, KS City Council.*