By Jeff Lamfers, Consultant, KRWA

The Settleability Test – A Great Tool for Improved Operation of an Activated Sludge Plant

This photo shows a typical aeration basin in an activated sludge plant. This is where samples for settleability testing should be collected (with the blowers operating).

The purpose of this article is to describe, in detail, how to run settleability tests on the mixed liquor in activated sludge sewage treatment plants regardless of operating mode. Whether the plant is a conventional plant or operated in extended aeration mode, running settleability tests can make the operator a better operator and the plant operate better. Data and observations from settleability tests often can make the difference between meeting or not meeting permit effluent limits. Running settleability tests allow operators to evaluate current conditions and anticipate problems that could develop in the future. Such testing can also help determine whether more or less wasting or sludge return is needed. In short, settleability tests are an essential tool to help operators run their plants as well as possible.

Settleability testing is one of several test methods that can be used for evaluating the activated sludge process. And compared to other available tests, it is the easiest, quickest and least expensive alternative. While many of the larger activated sludge plants in Kansas have their own labs and can frequently run a whole battery of tests to evaluate processes, smaller plants don't always have the same capability. But they can always run settleability tests, regardless of size or whether they have an elaborate laboratory. I occasionally will hear operators of small activated sludge plants say they have neither the equipment nor the expertise to run settleability tests. I find that very hard to believe. A settleability test can be run if an operator has something as simple as a sun tea jar and a timer. And the expertise will come over time when an operator runs settleability tests on a frequent basis. Yes, practice makes perfect.

Data and observations from settleability tests often can make the difference between meeting or not meeting permit effluent limits.

While each activated sludge plant is slightly different, running settleability tests frequently makes for better operators who understand how their particular plant operates. It allows for operating the plant at optimal conditions. It can also allow

When running settleability tests, the operator is basically mimicking conditions in the final clarifier.

for anticipating problems. Operators who routinely run settleability tests begin to develop observational skills that allow them to glean abundant information from such testing. Reference books will refer to running 30- or 60-minute settleability tests; there are benefits to both. But one of the biggest mistakes I see when running settleability tests is setting the test up, walking away, and returning 30 or 60 minutes later to see the final outcome. That misses the whole point for running the test.

When running settleability tests, the operator is basically mimicking conditions in the final clarifier. The operator needs to know if the sludge settles slow or fast. The operator also needs to know if smaller particles are joining together to form larger particles that settle better or not. Is the sludge on the bottom of the settleometer compacting or not? What is the consistency of that sludge blanket? The operator needs to see if the liquid above the sludge (the supernatant) becomes clear or remains cloudy. The only way to obtain such information is to check the settleometer at 5-minute intervals during the length of the test. Otherwise, much valuable information is lost.

Equipment needed

The following equipment is needed to run settleability tests:

1) A clean settleometer. Sure, you can buy expensive settleometers from supply houses, but you can also use lab equipment that may already be available or any clear glass or plastic container (not opaque) that can be marked off in 10% increments (such as a sun tea jar). Preferably you want a container that is similar in shape to your final clarifier where diameter exceeds depth. If you have a graduated cylinder or beaker, they can be used. Any of these options work for running meaningful settleability tests. Whatever container is used, it should be cleaned after each use so a scum does not develop and affect your observations and results.
2) A paddle or stir stick for thoroughly mixing the mixed liquor sample before settling starts.
3) A timer. I typically use the stopwatch on my phone.

Sample collection

The first step in running a settleability test is to collect a sample of the mixed liquor from the aeration basin. It must be well mixed and representative of the liquid in the basin. It is usually good to collect all future samples at the same location and depth so that observations and measurements can be compared and not influenced by collecting samples at different locations. And finally, testing needs to start very soon after sample collection. Starting within five minutes is usually considered acceptable. Do not shake the sample and introduce air.

This settleability test just ended at 30-minutes. Note the sludge depth of 50 percent. The supernatant is relatively clear with a few straggler floc. The color of the sludge is also very good with a chocolate-brown color.

This photo shows results after 30 minutes with a very cloudy supernatant. While there could be other reasons for the cloudiness, the sludge settling too fast could be a contributing factor.

These are examples of old glass containers that have been adapted for running settleability tests and monitoring sludge depths at 5-minute intervals. Note both are very cloudy. The one on the left appears to be a Mason jar.

30-minute settleability test procedure

1) Once the mixed liquor sample is collected, it should be slowly mixed and then poured gently into the settleometer. If running the test outside, the settleometer should be placed so it is not affected by direct sunlight.
2) Use the paddle or stir stick to gently mix the sample in the settleometer one last time.
3) Start the timer so that the settleometer can be checked every 5-minutes for the next 30-minutes.
4) Begin making observations of both the sludge and supernatant every 5-minutes; note the sludge depth each time so that a determination can be made as to how fast or slow the sludge settles.

What should the operator be looking for? The following should be closely observed and noted for both the sludge/solids and supernatant:

- What color is the sludge in the settleometer? Is it light, almost blonde color? Is it brown? Is it black?
- What is the consistency of the sludge? Is it light and fluffy or is it more granular?
- Do you see smaller floc particle joining together to form larger floc particles that may settle better?
- How fast is the sludge settling? This will be best determined by recording the depth of sludge in the bottom of the settleometer every 5 minutes.
- Does the sludge at the bottom of the settleometer appear to be well compacted?
- Is the supernatant clear or cloudy?
- Are there straggler floc left behind, suspended in the water column?

What do these observations and measurements mean in relation to plant operation? While I am going to make some generalizations here, they usually apply to all plants.

Granted, there are always exceptions to any rule and I may try to discuss those in another future article. If the sludge is dark brown to almost black, granular in shape and fast settling, it most likely is an older sludge. Consequently, the operator may want to increase sludge wasting in order to lower sludge age. If the sludge has a light, fluffy appearance and contains large, lightly-colored floc that settles slowly, it most likely is a young to very young sludge. In this case you want to decrease wasting in order to increase sludge age and possibly increase the rate of return sludge to the aeration basin.

Ultimately what the operator wants to see is the following:

- Chocolate-brown sludge with a medium-sized floc that settles slow enough to collect all straggler floc floating in the water column.
- Floc that usually settles down to 25 to 50 percent of the settleometer within the first five to ten minutes. Again, these are rough approximations. If the container is marked off in millimeters, then the sludge should settle down to 750 to 500 ml during the first five to ten minutes.
- Sludge that forms a distinct blanket on the bottom of the settleometer and is at a mostly uniform depth.

In this case you want to decrease wasting in order to increase sludge age and possibly increase the rate of return sludge to the aeration basin.

- A clear supernatant with no straggler floc.

There are forms on-line that can be used to graph the sludge settling rate at each 5-minute interval and then compare to what experts see as a normal settling rate. But the above approximations should work. The point is that if the sludge settles too quickly, it will leave behind straggler floc, which will then be discharged in the effluent, possibly resulting in violations. If the sludge is young and settles very slowly, the sludge particles themselves could end up in the effluent causing effluent violations. Thus, the operator wants a sludge that settles as described above and leaves a clear supernatant void of stragglers or floc.

The sludge layer is a good brown color and has consistency. It's not extremely compacted like an old sludge, but not fluffy like a younger sludge. While a few stragglers are left behind in the supernatant; the operator did not use a clean beaker.

While the observations and results of settleability tests are very important and extremely helpful in operating a plant correctly, they should be viewed in context with other observations and data. For instance, the amount and type of foam on the surface of the aeration basin can provide helpful information. Obviously using a DO meter to measure dissolved oxygen levels in the aeration basin is critical. And lastly, using a microscope to determine the type and predominance of microorganisms in the mixed liquor can help determine sludge age and if you have the desired mix that's needed for effective treatment.

I hope this article will help operators of activated sludge plants across the state. I would also encourage operators to attend one of KRWA's activated sludge workshops entitled the "ABCs of Activated Sludge". The presenter is Don Van Veldhuizen who has thirty years of experience in the water and wastewater fields and does an excellent job in teaching the ABCs of activated sludge. And the on-site workshops include hands-on exercises such as running 30-minute settleability tests. I encourage operators to attend one of Don's future workshops. Check the KRWA website at www.krwa.net under "Training Schedule" for a listing of his future workshops. If I can be of help in the meantime, please feel free to contact me by phone at 913-850-8822 or email at jeff@krwa.net.

Jeff Lamfers began work for KRWA in November 2008. Jeff has more than thirty years of regulatory experience in the oversight and operation of water and wastewater systems with the Kansas Department of Health and Environment. He is a graduate of the University of Kansas with a degree in Environmental Studies with an emphasis in aquatic biology.