Activated Sludge

Three Steps to Improve Your Process Efficiency Q&A

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Q&A Session from an Activated Sludge Webinar
Dr. Robert Smith, Q&A 0315

(The following Q&A was from a YSI-hosted webinar in March, 2015 titled 'Activated Sludge - Three Things You Need to Know to Improve Process Efficiency')

Question: What is an appropriate sludge blanket thickness we should try for in our secondary clarifiers?

Dr. Smith: Well, you guys are really starting off with the tough questions. This is really a philosophical discussion, as many things in wastewater treatment are. There are those out there that advocate maintaining a minimum sludge blanket. It makes some sense to me. But I think the most important thing is to do what works for your system the best and maybe to prevent the sludge blanket from getting too deep or deeper than you can manage.

Question: We keep high DOs to prevent denitrification from lifting the sludge in our clarifier. What else can be done for this problem?

Dr. Smith: When I've been out and about, I've heard this a lot when I talk about the subject. And, you know, I mention to people that you should always maintain minimum DOs. And two is enough, and they say, "Well, if we keep it that low, the DO will be popping sludge out of our clarifier." And that can be a genuine problem. So a couple of things you could do, again if it's within your capabilities with your equipment and such, is maintain minimum sludge blankets. I guess this is a nice, little follow up question to the previous question about sludge thickness. But, if you have the capability, maybe do some denitrification in the front end of the aeration tank with maybe an anoxic tank. I know some of our customers have taken that task on themselves and basically built a small anoxic zone into their aeration tank and it's worked out really well for them.

Question: Can nitrate measurement also be used for aeration control?

Dr. Smith: That's another very good question and it can be. I mean, as you know, your nitrate is a product of nitrification. So as ammonium goes down, nitrate goes up. But more commonly, it is the ammonium that's measured for aeration control. So that, for instance, as the ammonium concentration goes up, the aeration rate increases. And when your ammonium concentration goes down, the aeration rate decreases. So, I suppose the oxic could be used to control aeration via nitrate measurement. Good question.

Question: The next question deals with instrumentation. How reliable are the probes and how does the operator know when results are drifting?

Dr. Smith: Well, reliability is good. I mean compared to the traditional style. With dissolved oxygen, for instance, online sensor calibration can last for two years. So there you've taken the calibration out of the equation. But also as far as the instrument goes and cleaning, no longer are we talking about replacing membranes and such. You really just have to clean off the sensor cap or the sensing element so that oxygen can interact freely with that fluorescence layer behind the sensor cap. But really, at the end of the day, the reliability is going to depend on how well the owner takes care of the instrumentation. So a sensor that's neglected no matter how well designed is eventually going to give poor data. So no matter what, manual cleaning is going to be an important part of reliability and to prevent large data drifts.

Question: How does excessive sludge age increase energy cost?

Dr. Smith: This starts to get into a bit of a philosophical discussion as well but I'm going to start when you've got bacteria in the system. They're living, they're dying. And so you have an oxygen demand from the living part. They're consuming organic matter, they're consuming ammonium. But you have to consider the dying part as well. So when these bacteria die, their parts become available for the other bacteria to then cannibalize. So it's been referred to as cryptic growth because it's happening in the system but it's kind of hidden from the observer. However, you know I think there are arguments out there to be said for maintaining higher SRTs than lower. But I think from our point of view today, it should be to optimize that solids retention time for your system.

Question: How often should SRT be controlled?

Dr. Smith: Good follow on question. And that is also difficult to answer easily but I will say from our experiences with our customers, a lot of utilities are very reluctant, for example, to automate their SRT control. And the concern is that they'll waste too much or waste too fast. And that

is a concern. But generally, if you are automating SRT control, you want it to be very slow. And so, for example, you want to take an average of many measurement points, maybe even days worth of data in order to track your SRT. However, I do know there are utilities that update their SRT set points on 15-minute intervals. And they have success with it. I think the important part regardless is having transparency in the system so you can see when there are problems and act on them when needed. And of course, keeping the sensors clean.

Question: How does SRT control improve TSS?

Dr. Smith: I was waiting for somebody to ask that question. And so, really, it's a matter of controlling the sludge quality. And, you know again, this can depend on a lot of factors as well. But here is my understanding and you may disagree or comment. But the sludge quality is really what affects the settleability of the sludge. And by say, for example, not controlling SRT, that sludge quality, the properties of the biomass can vary. For example, the settleability, flocculation rate, compaction rate, by maintaining an SRT, you can find an SRT that works and you keep your system at that SRT to keep it functioning properly.

Question: Do you know what the target should be if our average temperature is ten degrees Celsius or less?

Dr. Smith: Yes, thanks for the question. Well, it's kind of dependent on what you have to do. So if you have to do nitrification, for example, going back to the chart we showed earlier, the target SRT wouldn't be more than 12 days. And I think that's pretty much in line with a lot of utilities. If you do not have to do nitrification, though, much lower SRT could help you to achieve your goals and reduce your energy consumption and maybe even the number of reactors you have online. Good question, thank you.

Question: How frequently do wastewater treatment plants recalibrate their TSS online sensor? Since calibration depending on sludge, readings will change, and then will the TSS need recalibration?

Dr. Smith: Well, there's a lot of different approaches to this. As I've mentioned, an online TSS sensor can be factory calibrated. So if your particular properties are similar to what's in the factory calibration, plug it in and in you go. Recalibration intervals then would have to do with one, whether your sludge changes and that may happen seasonally. So, for instance, you might need a recalibration for winter and summer conditions. But also, of course, with age the sensor optics are going to age a little bit. And of course, that's going to be a much slower process. But you'll know when you're drifting apart by measuring and keeping a good record of verification measurements with, for example, a calibrated handheld or good grab samples measured with good laboratory practice in the lab.

And, you know, that's how you'll know when it's time to calibrate your TSS sensor. And one other important thing I guess is your tolerance for inaccuracy. I think 100 mg/L will be important to some and not so important to others. So really, your expectations also define what that interval needs to be. Thanks for the question.

Question: We have DO probes installed at the beginning of the aeration basins. Should they be moved to the end of the aeration basin?

Dr. Smith: Another terrific question and one that, again, will have different responses. So I think it depends again on your control system. It would be my desire to have the sensor located where you can make adjustments. So, for example, if you're controlling based on a drop leg at the front end of the aeration basin, you know, monitoring that at the front end is probably appropriate. On the other hand, if you're monitoring at the back end of the aeration basin, the influent loadings can change. And when they change the DO concentration, DO can be consumed at the front end and you wouldn't notice that at the backend until several hours later when the water makes it to the end of the basin. So that's kind of my two cents but the others, there's a lot of things to think about when you're controlling dissolved oxygen.

Question: With phosphorus removal becoming more and more important to our area, how does DO concentration affect phosphorus removal?

Dr. Smith: Yes, so I think early on I had a chart there that showed that...well, first of all, let's talk about phosphorus (P) removal. Let's talk about biological phosphorus removal. It requires P release and it requires P uptake. So from that chart we showed early on, we showed that the

P release occurs from the anaerobic region. And so by controlling DO you would want DO to be zero or near zero in that region in order to have a proper phosphorus release. At the other side of that then is phosphorus uptake and that occurs under oxic conditions. And this may violate the 2 mg/L set point that I mentioned earlier but it may be an exception. At the front end of that aeration tank, the general consensus is that you want the DO concentration to be not limiting so that you get the maximum phosphate uptake.

And in that case, it may be desirable to have a higher DO than 2 mg/L.

When it comes to the chemical phosphorus removal which we haven't talked about much today, I think that DO concentration is a little harder to establish a relationship. You know, it's probably going to be that DO concentration is going to be controlled by other processes.

Question: Which measurements can be applied to phosphorus removal?

Dr. Smith: A number of utilities have used ORP very effectively, especially in batch-type processes. But the real gold standard would be orthophosphate measurement. The orthophosphate gives you an indication of phosphate release and also phosphate uptake. Of course, total phosphate, or TP is usually the compliance parameter. But that parameter is really a function of how well your separation device is working, for example, your final clarifier or your filter. And for controlling those you would want to use sludge blanket level and TSS to make sure that that particular phosphorus is captured and doesn't escape into the effluent. Those are really the main measurements that are applicable to key removal.

Question: Should RAS flow always be increased to offset a rising blanket?

Dr. Smith: I love it when people are looking at the charts and saying, "Wait a minute, that doesn't make sense to me all the time. What if this happens?" And so the question is, in general, yes. But you also have to consider that your sludge blankets may be increasing because your SRT is too high. So a response to the rising sludge blanket may also include increasing wasting rate. And so for example, if you recall I mentioned that centrifuge spin control test. One of the neat things about that, although it's a batch test and we don't sell centrifuges, if that's what you have, it can give you the information you need so you know whether you need RAS control or waste control.

Question: How is nitrate monitoring related to carbon?

Dr. Smith: I guess I kind of skipped over that a little bit in the interest of time. I want to say at this point if I didn't already that we're going to have separate webinars on each of these topics where we'll get into each of these in more depth. But to answer your question with denitrification, and really, there's two conditions. One is you could either be nitrate limited, in which case there's not enough nitrate or carbon limited, in which case there's not enough carbon. And so measuring that nitrate tells you in which condition you're under. If you're nitrate limited, for instance in the anoxic zone, the response is to increase the recirculation rate. On the other hand, if you're carbon limited, increasing your circulation rate may not improve performance. So you need to know what that nitrate concentration is through testing.

Question: Should you calibrate a TSS probe closer to your measurement range?

Dr. Smith: That kind of depends on your instrument. So, for instance, I know with the handheld I showed earlier that that's one of the methods of calibrating is a zero calibration. But for the continuous measurement we showed in the slide, I think the zero really not that important unless you happen to be measuring the effluent. You really would probably benefit by calibrating within your normal operating range. So if zero is near your normal operating range then yes. But otherwise, I would say probably not.

Question: This goes back to the graph that you showed the flux curve on. Can you explain briefly again the flux curve represents when this contains mixed liquor suspended solid and RAS rate?

Dr. Smith: Terrific question. So that curve really represents the quality of the sludge. It's actually very easy to generate and I would encourage you to do so. Really all you need is a settling column and take some measurements over time. And it's defined very well in a WERF protocol. So that flux curve then defines how well the sludge settles,

so what is the quality of the sludge. And so it gives you a region over where you know, basically, it gives you a mass balance. It gives you a way to instantaneously calculate your mass balance. Because within that curve, by plotting the flow rates for any condition, you can know under what condition you're operating. So for example, the example I gave was thickening failure where that RAS flow rate curve is outside of the flux curve.

Let's take the extreme example. If we had plotted those two lines and that point, the intersection had fallen above the curve, so outside the curve, that is a very serious condition. That's a clarification failure and basically, all your clarifier should become a wide spot in the line. It's a complicated topic. I hope I've helped to answer that a little bit but I'd be happy to re-address it offline with anybody that's interested. (Robert.Smith@xyleminc.com)

achieve. So for denitrification, I think it's not uncommon for that anoxic zone volume to be up to 40% of the overall aeration tank volume. It could be less. And a lot of it depends on how you're operating the system. So for example, let's take a case where you're operating your oxic zone at 6 mg/L and when it leaves the clarifier, you're still at 4 mg/L. So that return activated sludge is going back to the anoxic zone with four parts per million of dissolved oxygen. That is going to eat up your anoxic zone volume if you will. So you're essentially losing anoxic zone volume by putting that high DO RAS back into the anoxic zone. So to minimize the volume you want to have minimized the dissolved oxygen concentration, minimize the nitrates, and minimize oxygen from other sources.

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Question: What is the desired retention time in an anoxic zone?

Dr. Smith: Again, that depends on what you're trying to