

## **MLSS measurements- a comparison of manual and online readings**

The mixed liquor in aeration basins has historically been monitored and controlled by taking periodic “grab samples” of the mixed liquor, running the sample through a filter, drying the residue left on the filter, and then weighing. In the 1970’s, online instrumentation was introduced to constantly monitor, and theoretically control, the MLSS concentration in aeration basins. The idea was that by knowing the MLSS concentration on a continuous basis, the return activated sludge flows could be optimized to maintain a constant load even during variations in influent flow and load.

The Standard Methods for the Examination of Water and Wastewater lists six different methods for determining solids concentration. All of the methods require that a sample be dried at a specific temperature for a period of time that will ensure that the water in the sample has evaporated. This time period is determined by weighing the sample numerous times and comparing the readings until there is no change in the weight of the sample. At that point the sample is weighed and the calculation for solids is made using a formula that takes into account the total volume of the sample.

For example, a 100 ml sample is pulled and then filtered through a glass-fiber filter disk. The filter disk is then placed in an oven and dried. After the sample has completely dried the filter disk is removed from the oven and weighed. The weight of the filter disk is subtracted from the total weight. If the calculated weight of the sample is 200 mg, after subtracting the weight of the filter disk, then the total suspended solids would equal 2000 mg/l. This number is reached by simply multiplying the calculated weight by the same factor used to bring the sample volume up to one liter ( $100 \text{ ml} \times 10 = 1 \text{ liter}$ ) ( $200 \text{ mg} \times 10 = 2000 \text{ mg}$ ).

This manual, grab sample method of determining solids concentration has a couple of drawbacks when viewed with an eye towards controlling the MLSS in the aeration basin. The first issue is the fact that the result is determined hours after the sample was taken, in some cases the results are not known until the next day. To control the process using this data the assumption has to be made that the solids concentration is either unchanged from the time of measurement or that the facility knows the relationship of solids concentration over time. In a closed, municipal treatment plant it is

possible to roughly control the MLSS concentration by making either of the above two assumptions. The influent flow and loading to a closed, municipal treatment system would not be affected by a rain event or industrial discharge thereby eliminating the two most common upset conditions.

Unfortunately, most treatment systems are combined and do have an industrial component mixed with the municipal waste. A combined treatment system simply means that rain run-off is treated the same as wastewater. It is not uncommon for the flow to a plant to double during a rain event. As the flow into the plant increases the solids concentration in the influent will typically decrease due to dilution. This in turn will dilute the MLSS concentration if the flow of return activated sludge is not adjusted. How much dilution occurs can be difficult to predict thereby making adjustments to the RAS during such an event an educated guess at best.

A second consideration in taking grab samples for lab analysis is that the whole process is very time consuming for the operations staff and the lab staff. For example, the labor cost of 12 sample analyses per day will equate to about \$46,980.00 a year. This is based on samples being analyzed 5 days a week with the time per sample being one hour. This example also assumes a reduction factor of 25% to cover the times that samples are not taken as scheduled due to whatever reasons. The labor rate used for this example is \$20.00 an hour. There are plants that have installed online instrumentation to monitor and control the MLSS concentration. There have been reports of an 80% reduction in the number of samples sent to the lab for analysis. Using the above example, the savings to the plant would be \$37,584.00 per year minus the cost of the instrumentation for the first year.

A third consideration in taking grab samples for lab analysis is accuracy and repeatability. While absolute accuracy is less important than repeatability, the accuracy of the measurement is still a vital component in controlling the MLSS concentration. According to the Standard Methods for the Examination of Water and Wastewater the accuracy will vary depending on the method used along with the actual concentration. These inherent inaccuracies range from about 1% too as high as 33%.

Another factor that affects absolute accuracy is that an aeration basin is the container of a dynamic process. There are variations in solids

concentrations throughout the basin. It is not uncommon for two samples that were pulled for the same location, at the same time to have a difference of as much as 300mg/l. To a large degree the variations are dictated by the mixing in the basin. A basin with a mechanical aerator will have large differences, while a fine bubble diffuser system will tend to be more homogenous.

As mentioned earlier, there are continuous, online analyzers that measure the MLSS concentration in aeration basins. These analyzers have been marketed for well over twenty years. The obvious question at this point would be “Why do treatment plants still take manual grab samples when the cost savings of going to a continuous, online measuring system seem to be more than justified?”. The answer to this mystery can be stated in two words; MAINTENANCE and CALIBRATION.

Almost all analyzers that measure MLSS use optical sensors of some sort. This means that for any sensor to work correctly the lens must be free of fouling. In the past this issue was addressed most often with a mechanical cleaning system, usually some type of wiper. While this did address the issue of keeping the lens free of fouling, submerging a mechanical moving part in the mixed liquor introduced a different kind of problem; the wiper would fail after a short period of time due to the harsh environment. This fact made the correct operation of the sensor very spotty unless the sensor was on a very frequent maintenance schedule. The need for constant maintenance erased the cost savings and also causes the MLSS concentration reported by the online instrument to not be trusted by the operations staff. While self-cleaning is vital to the proper operation of the sensor, the mechanical wiper method should be avoided.

The other issue that has caused the industry to tread slowly in going to online, continuous MLSS analyzers is the calibration of the sensor. The most common method of calibration involves using formazine or Fullers Earth mixed to a known concentration with water. While this method will give a calibration that is somewhat repeatable there are a couple of drawbacks to this method. The first is that the particle size, particle color, and particle density of the standards (either formazine or Fullers Earth) have no relationship to the size, color, or density of the MLSS. This will introduce an error to the measurement made by the sensor. A second drawback to this method is that it is at least a two man job that is time consuming and difficult to do correctly. The calibration medium must be

vigorously agitated so that the solids do not settle. This is most often accomplished by stirring the calibration medium with the sensor itself. Keep in mind that the sensor is always attached to a metal pipe ten to fifteen feet long used for mounting. It is almost impossible to use this long pipe as the agitator and get a homogenous mix of the calibration medium, again causing another offset in the calibration value. The mixing issue also negates any repeatability advantages that would appear to be gained by this approach.

Another method of calibrating on-line MLSS analyzers is to pull a large enough sample to do a lab analysis on part of the sample and also calibrate the sensor with the remainder. The biggest advantage to this method is that the analyzer is calibrated to the actual process ensuring that particle size, density, and color is consistent with what the analyzer will actually be measuring. The two drawbacks to this method are the mixing issue mentioned above and preserving the sample during the time it takes to get the lab analysis results. This time period, as mentioned previously, can easily be 24 hours. The problem here is that the solids characteristics of the sample will change over time. The sample was taken from an aerated, mixed reactor and basically put into a very small settling basin. The longer the sample stays in the small settling basin, the more the change in the characteristics of the solids. Again, this will cause an error in the calibration.

A third method is to pull a sample for lab analysis while at the same time instructing the analyzer to “remember” the value that the analyzer was reading at the time the sample was taken. This allows the operator to calibrate the analyzer at any time after the lab analysis is complete. The two big advantages to this method are that the analyzer is calibrated to the actual process and that the sensor does not need to be removed for calibration. The benefits of calibrating to the actual process are discussed above. The benefit of doing the calibration insitu is that the sample does not have to be preserved and calibration becomes a quick, one man job. The only drawback to this method is the inaccuracies that occur during the lab analysis that were discussed above. This can be overcome to a large degree by pulling two or three samples at the same time, doing a separate lab analysis on each sample, then averaging the results and using the result to calibrate the online analyzer. The more samples pulled and averaged, the more accurate the result.

## **Conclusion**

There is sufficient justification from both a process and cost consideration for treatment plants to install continuous, online MLSS analyzers. Care must be taken in choosing a suitable sensor and analyzer design. A self-cleaning sensor is vital for long term accuracy and repeatability. The method used to clean the sensor should be one that does not require moving parts to be submerged in the process as this is a maintenance headache. The analyzer should have the ability to be calibrated in the actual process, preferably without having to remove the sensor to do so. When samples are pulled for calibration, it is important that more than one sample be pulled and the results of the individual analyses averaged together.