STEP-BY-STEP REDUCTION OF TOTAL

The orthophosphate analyzer can work alone or in conjunction with other sensors in a continuous monitoring and control system.

Achieving low effluent total phosphorus in treated municipal wastewater

By Laura St. Pierre & Rob Smith

Wastewater treatment facilities undergo continuous monitoring of multiple parameters and compounds throughout the treatment process on a daily basis; the monitoring and subsequent control of those parameters and compounds during the process is essential to optimizing the efficiencies of the plant on a daily, weekly and annual basis.

One of the compounds that is critical for treatment plants to measure at many stages during the process—from primary settling to the aeration tanks and to the effluent—is orthophosphate (also known as soluble reactive phosphorus and commonly referred to as phosphate).

Because phosphorus is a nutrient in short supply in most freshwater, even a modest increase in the element can, under the right conditions, set off a chain of undesirable events, including accelerated plant growth, algae blooms, low dissolved oxygen and the death of certain fish, invertebrates and other aquatic animals.

Monitoring phosphate during the wastewater treatment process allows for fine tuning and optimizing chemical dosing for removal of phosphate, which provides significant cost savings to the plant while protecting the aquatic environment downstream of the facility.

YSI, a Xylem brand, recently introduced the P 700 IQ orthophosphate analyzer—to be used as a standalone analyzer or in conjunction with other sensors in an IQ SensorNet 2020 XT continuous monitoring and control system—to address the needs of the wastewater treatment industry. It measures the amount of orthophosphate throughout the wastewater treatment process and can help determine whether or not it has been eliminated.

Instructions for Achieving Low Effluent Total Phosphorus

The following provides step-by-step instructions for achieving low effluent total phosphorus (TP) in treated municipal wastewater, facilitating the control of chemical dosing based on data from online analyzers throughout the process.

The primary objectives for the treatment process as it pertains to total phosphorus are:

- To achieve less than 1 mg/L TP;
- To minimize total chemical usage; and
- To realize lower operating costs.

The chemical treatment mechanism is a reaction between iron or aluminum salts and soluble phosphate, which forms an insoluble compound that is removed by sedimentation or filtration.

Within the wastewater treatment process, there are several control alternatives that a facility can consider:

Flow-proportional feed-forward control. Chemical dosing is adjusted proportionally to the measured wastewater flow.

Load-proportional feed-forward control. Chemical dosing is adjusted proportionally to the load calculated from wastewater flow and the upstream online phosphate measurement.

Feedback control. Chemical dosage is adjusted based on the downstream online phosphate measurement.

Chemical dosing options that a wastewater treatment plant can pursue are:

Pre-precipitation. When identifying a chemical dosing point before the biological process, phosphorus is removed in the primary settling tanks. In conjunction, the online phosphate measurement should be taken between the primary settling and aeration tanks to be used as part of a system based on feedback control.

Post-precipitation. When chemical dosing is done after the biological process, phosphorus is removed in the final clarifiers or effluent filters. The online phosphate measurement should be taken between the aeration tanks and the final clarifier, or after the final clarifiers with feedback control.

Simultaneous (pre- and post-precipitation). This option utilizes chemical dosing before and after the biological process, which facilitates low effluent phosphorus limits.

The P 700 IQ online colorimetric phosphate analyzer can be the primary component of a

wastewater treatment plant control system. It comes with a built-in sample transport pump and a filtration mechanism. It provides automatic calibration and facilitates low reagent consumption. It can be used as a standalone analyzer, or with the YSI IQ SensorNet 2020XT controller with built-in proportional output to control variable-speed chemical metering pumps.

6 Steps to Control System Implementation

Control system implementation can be achieved in the following six steps:

1. ***Benchtop jar testing.*** This critical first step will provide a benchmark for the execution of phosphorous measurement and treatment for the wastewater facility. It is essential at the outset to evaluate pre- and post-precipitation, and jar testing provides a quick analysis to help determine the most effective chemical needed for your process (e.g., alum or ferric chloride).
2. ***Determine appropriate chemical dosage.*** Once it is determined which chemical should be used, the jar testing also will help to estimate the chemical dosage required to achieve the total phosphorous effluent target.
3. ***Determine chemical storage requirements.*** Based on the estimated chemical dosage—and, as a result, the long-term chemical usage—it then is necessary to determine the chemical delivery and storage requirements. There are numerous options for supply and delivery of treatment chemicals: 55-gal drums, 330-gal totes, or in bulk tanks installed on site and refilled as needed by a local distributor.
4. ***Locate measurement system and chemical feed and storage facilities.*** Establishing the location of the actual measurement within the treatment process is an important step, as the location should not be too far downstream from the dosing location to minimize lag time. The feed location should be chosen in an area that is well mixed, so that the chemical is well dispersed throughout the solution. One ideal place for the feed location is in the flow distribution chamber.
5. ***Install and commission measurement system.*** Once the location of the measurement system has been determined, the next step is to install and commission the system accordingly. As part of this process, it is important to select a response time, and to identify measurement, cleaning and calibration intervals for long-term optimization of the system.
6. ***Tune control system.*** As the control system is commissioned and begins to provide online measurements, it is important to adjust set-point and gain setting, so as to achieve desired phosphorus removal at the lowest optimal chemical consumption. WWD

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