Process Control Features to Optimize Energy Efficiency and Process Stability

INTRODUCTION

Before online instrumentation, process adjustments to biological activated sludge processes were made based on delayed results from laboratory testing. The introduction of online instrumentation to the process tanks improved the response time and allowed operations staff to make process adjustments based on real-time data. The evolution continued when online instrumentation signals were fed to programmable logic controllers (PLCs) to automate the process adjustments based on real-time feedback. The current state of the practice uses online instrumentation and advanced process control logic to not only optimize the process stability and energy efficiency at the facility, but provide ease of use to the operations staff tasked with supporting the facility.

Figure 1 shows the key components of the secondary treatment stage, including blowers, aeration, mixing, pumping and instrumentation. A well-developed advanced process controller has a backbone that consists of both product and process expertise. Without understanding both the functionality of the products and the needs of the process, the controller will not be able to deliver meaningful and measureable improvements to both energy efficiency and process stability.

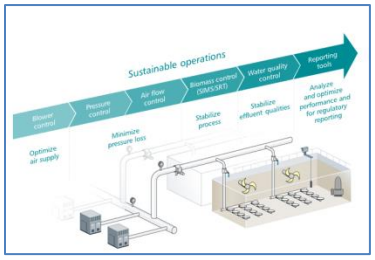

Figure 1: Secondary Treatment

DISCUSSION

A combination of control strategies can be used to optimize energy efficiency and process stability.

Blower and Aeration Control

The blowers are the largest energy consuming component at a wastewater treatment plant. A case study at the Sternö WWTP in Sweden identified 65% energy savings when combining upgraded blowers, aeration grids and an optimized aeration control system. The upgrades included the replacement of rotary lobe blowers with screw type, replacement of fine bubble tube diffusers with membrane low pressure diffusers and replacement of a simple dissolved oxygen (DO) control strategy with cascaded control and most open valve logic.

Dissolved Oxygen Sensor. The introduction of optical DO measurement technology has greatly increased acceptance of the technology as a basis for process control by increasing the reliability and simplifying the maintenance of DO sensors. Compared with electrochemical sensors, there are no membranes to replace and no electrodes to clean.

Biomass/Sludge Age Control

The solids retention time (SRT) or sludge age of the biological process is a key design and operating parameter for keeping a healthy biomass in the activated sludge basins. Too low of a sludge age and nitrification may suffer, too high of a sludge age may result in poor settling and wasted energy. The use of a SRT control algorithm automates the amount of solids that are wasted from the system in order to maintain an optimal sludge age. The most flexible controller will allow for multiple modes of operation, including manual control, target MLSS control, target SRT control, and complete automated control where the controller determines the required sludge age based on online and user entered parameters.

Total Suspended Solids Sensor. Optical instruments based on absorbance and reflectance have both been successfully utilized to measure total suspended solids, although reflectance instruments currently dominate the market. Optical solids sensors do not require reagents and are very stable. The biggest challenge is preventing fouling. As such, automatic cleaning using compressed air, water, or ultrasonic vibration is essential.

Water Quality Control

A plant can ensure the effluent quality from the facility by adding ammonia feedback to the aeration control strategy. The use of an ammonia sensor in the process provides feedback to the DO control strategy to select the necessary DO setpoint based on the treatment requirements at any given time. Maintaining an effluent ammonia concentration closer to the permitted effluent with ammonia feedback not only stabilizes the effluent to guarantee permit compliance, but also increase energy savings by preventing overtreatment.

Ammonium Sensor. Advances in ion selective electrode (ISE) have increased the options for online measurement of ammonium. Previously ISEs were known in the laboratory only, due to the complicated procedures required for matrix influences and drift effects. ISE instruments on the market today are solids state instruments that include multiple electrodes to measure nutrients and interfering ions simultaneously with signal processing in the sensor to perform dynamic compensation.

CONCLUSION

Using advanced process controllers developed by experts understanding both biological processes, and secondary treatment equipment, yields operational results that optimize the energy efficiency, process stability and ease of use for plant personnel.

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