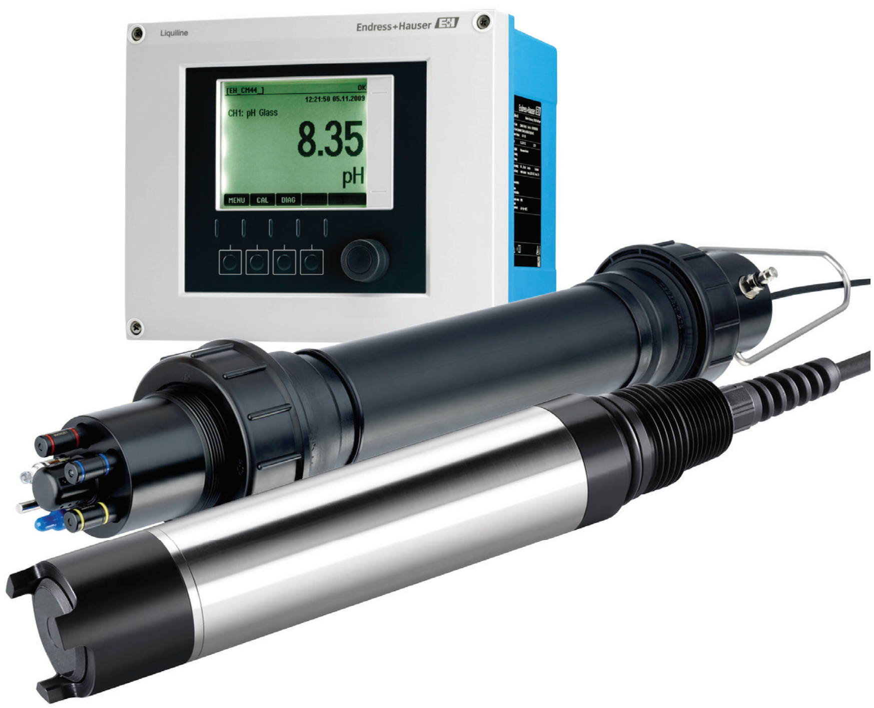
How To Slash Energy Costs With Optimized Aeration Control



Utilities are under constant pressure to reduce costs, meet regulatory requirements, and improve sustainability. Finding the best way to meet these goals is a constant challenge.

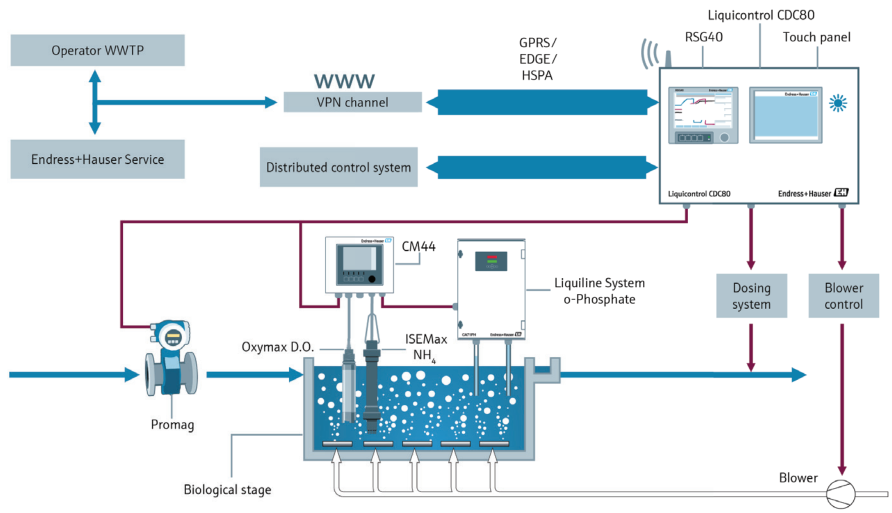
Endress+Hauser has been helping water and wastewater utilities achieve their objectives for many years. They are a global leader in process automation and measurement. Endress+Hauser spoke with Water Online to discuss how to save energy in today's wastewater treatment facilities.

Wastewater utilities are tasked with meeting stringent effluent limits, yet pressured to reduce costs. How can aeration control help to meet those goals?

Control of the aeration process is critical to efficient operation of wastewater treatment plants. The impact of control is twofold, as both over and under aeration have detrimental effects. The energy wasted on over-aeration mounts quickly. The energy expended increases exponentially with increasing dissolved oxygen (DO) concentrations and the impact on the biology can negatively impact the final effluent quality. Automated control of the aeration process is an important energy conservation measure that greatly reduces energy usage by quickly adjusting to variable conditions within the basin. The oxygen required for biological processes within the aeration basin is proportional to organic and ammonia loading in the influent wastewater. The most efficient control results in optimum removal of nutrients, carbon, and solids from the final product.

What variables affect oxygen demand in wastewater treatment facilities?

Plant designers try to maximize the oxygen transfer efficiency (OTE) under most operating conditions so that the plant will operate efficiently. OTE depends on a number of external factors including flow



rate, water temperature, and site elevation. It decreases with increasing concentration of solids and surfactants. Within the basin itself, it increases from the inlet to the outlet as organic material is biodegraded.

At many wastewater treatment plants, the operators manage aeration levels manually by running lab tests and turning the blowers on and off as needed. Is this the most cost-effective method of aeration control?

In some facilities, wastewater treatment operators take field measurements to determine the DO concentration in the aeration basins. Based on the results, operational modifications are made (e.g., to blowers or aeration system valves) to adjust the oxygen being delivered to the basins based on target set points. This is typically done only a few times (or once) per day and does not closely reflect diurnal variations in DO demand. In addition, a high safety factor is often applied to ensure that DO does not decrease below the target concentration, should the influent wastewater characteristics change quickly.

In order to more closely match the air delivered to the biological process oxygen demand, utilities commonly install automated control systems. Because the energy required increases exponentially with DO concentration, energy savings from automated DO control can be significant. Automated control systems measure real-time DO or ammonium (or both) using probes located within the aeration basins. These measurements are used as inputs to a process controller that controls the blowers, resulting in a cost reduction.

Can the problem of excessive blower operation be solved by installing variable frequency drives (VFDs) and DO meters in the system?

It is common to find aeration control strategies based on a proportional, integral, derivative (PID) control loop. This traditional measurement loop uses a DO probe and transmitter combination to measure the amount of oxygen existing in the basin. This value is compared to the DO set point (between 2.0 to 4.5 mg/L). The required output is calculated and applied to the flow control valve to regulate the amount of air flowing into the tank, which changes the DO concentration in the basin.

While this application is capable of maintaining the DO within acceptable limits, the practice does not provide a solution to the low energy consumption requirements of today's modern plants. This suggests that VFDs offer an efficient alternative for aeration control over traditional flow control valves.

When implementing a VFD strategy, flow control valves are removed from the system. The VFD, which is usually an integral part of the plant's motor control center, receives the output signal of the DO controller and in turn changes the speed of the air blower. The reduction in energy has been reported to be as much as 50 percent at 20 percent reduction of flow[1].

Which parameters should be measured and controlled in order to obtain the most energy reduction while meeting permit requirements?

Measured parameters at a minimum should be DO and flow, with the control determined by DO requirements.

However, the most effective strategy is to measure flow and DO and control with the ammonium measurement(s).

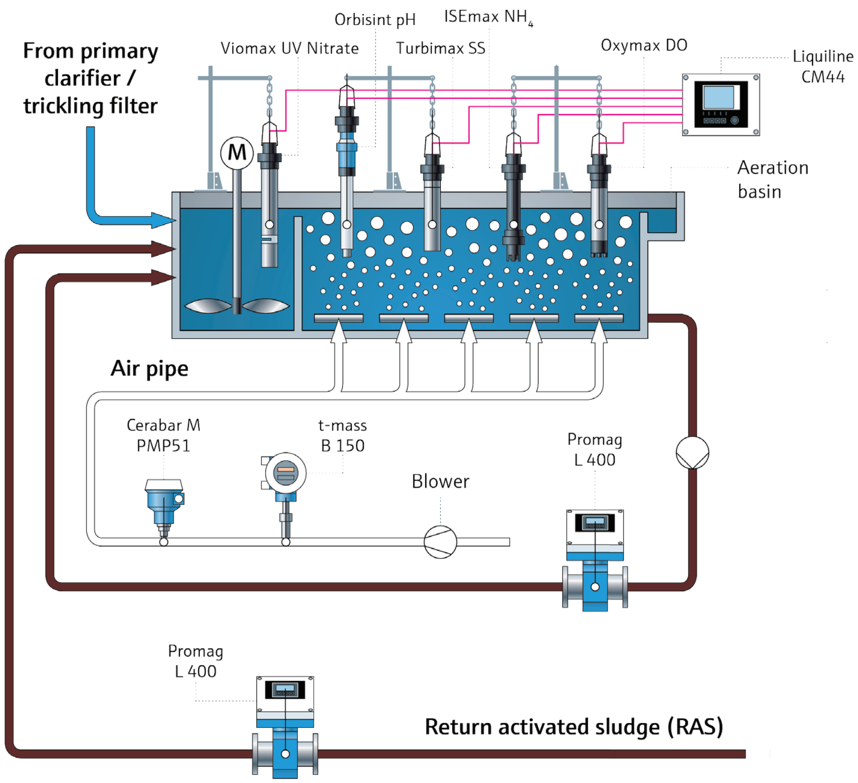
How can aeration control help to meet nutrient limits?

As discharge permit requirements become stricter throughout the U.S., biological nutrient removal will become a necessity for most, if not all, plants. In order to operate the plant efficiently to meet regulatory compliance requirements, the removal of nitrogen, phosphorus, carbon, and solids can be attained most effectively by using continuous online analytical measurements and an optimized control strategy.

Can aeration optimization help control the activated sludge process to reduce plant upsets?

In addition to wasting energy, over-aeration can cause poor sludge settling, increased foam, and have negative impacts on the anoxic zone of a biological nutrient removal (BNR) plant. Under- aeration can lead to underperformance of the activated sludge process and bulking issues. In some cases, under-aeration causes issues with struvite formation in sludge due to unwanted biological phosphorus removal. The best strategy to implement is one that provides good control over DO levels so that the aeration system supplies only what is needed[2].

[1]VFD application in wastewater treatment aeration control, Yehia, S, Control Engineering 2015.
[2]Evaluation of Energy Conservation Measures, US EPA 832-R-10-005, 2010.



Do the operators still have control over the process when aeration optimization is automated?

They can override the system if needed, but in reality, once the process is optimized during operation, they only need to monitor rather than interact with the control system on a daily basis.

Does Endress+Hauser provide training and service for aeration control systems?

For our Liquicontrol System, Endress+Hauser offers commissioning, training, and optimization services for the aeration control platform. Customers who purchase field instrumentation only can have Endress+Hauser commission the devices and provide training. They will have the option of working with Rockwell Automation, our strategic business partner for control systems, to complete the aeration control system themselves.

Can the aeration instrumentation be integrated with the plant's equipment and supervisory control and data acquisition (SCADA) system, and how long does it take to get everything working?

It depends on the plant, but an automated control system can be as simple as a feedback control loop that is manipulated in response to changes in DO. The system can use an on-off control strategy based on DO or ammonium. Automated control can also be a more complex system with multiple measurement technologies and proprietary algorithms, such as the Liquicontrol System by Endress+Hauser.

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