Controlling Aeration with Ammonium Sensors
How one Arizona treatment plant optimized energy consumption and avoided an upgrade

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The City of Peoria’s Beardsley Water Reclamation Facility had a problem. The original ammonium sensors installed with their aeration upgrade weren’t working and would have to be sent back to Europe for repair. Also, running the aeration system using only a DO setpoint was using an excessive amount of power to maintain the system Nitrogen requirements. An upgrade of the facility was in the planning stages including adding an additional clarifier and filter to ensure water quality standards. Instead, staff decided to give another instrument manufacturer a try, replacing the original ammonium sensor with the Hach NH4Dsc ammonium probe. The NH4Dsc proved to be reliable, and became the first problem resolved at the Beardsley Plant.

With the sensor performing correctly, staff were able to begin automating the aeration system. The system is designed to control the inlet guide vanes on the blowers to meet a target ammonia value which was user-entered. The sensor is installed in the aeration tank, about a quarter of the length of the tank. After profiling the tank it was determined that at this point in the flow, nitrification was mostly complete, which allow the staff to use a dynamic setpoint of 1.5mg/L to 4.0 mg/l NH₄-N, dependent upon demand. The control algorithm used adjusts the blowers every 20 minutes, making the appropriate change to the inlet guide vanes to meet the ammonia setpoint. To ensure adequate mixing energy, 0.7mg/L of dissolved oxygen is used as the minimum operating condition; 2.4mg/L is the maximum, as measured with the Hach LDO probes installed.

Controlling aeration based upon ammonia numbers allows for further optimization of the aeration system, if the wastewater plant has to perform nitrification. In order to grow the proper groups of bacteria to perform nitrification, the sludge age has to be older than an average of four days (dependent upon temperature and the type of treatment system). At this age, the organisms which remove BOD are already well established, and therefore in an aeration basin environment, by the time ammonia begins to be removed, most of the BOD has already been removed. Thus, controlling aeration based upon the ammonia concentration means providing just enough air to get the job done—and not one bit more.

Operating under these parameters, staff found another area of the system which could optimize their energy consumption: the sequence of the blowers. The aeration system has five blowers, two 150hp and three 250hp blowers, and under the original sequence during times of low ammonia concentration a 250hp blower would provide the air and sometimes two 250 hp blowers would be needed during high winter seasonal weekend flows.
The staff reconfigured the sequence, beginning with a single 150hp blower, progressing to two 150hp, a 150hp and 250hp, and ending with both 250hp blowers during times of high ammonia concentration, leaving an additional 250 hp blower as a standby in cases of another blower failing.

The ammonium setpoint is confirmed daily, through plant effluent analysis using the Hach Simplified TKN procedure, where total nitrogen is measured in one vial, and nitrate/nitrite is measured in another. The DR/2800 spectrophotometer measures both vials and displays the total nitrogen, TKN, and nitrate/nitrite concentrations in one test.

With these improvements made to the aeration control system, the effects were easy to identify. First was the energy consumption: before the changes between 9,500 and 12,000 kwh/day were consumed; after the changes, between 8,000 and 9,000 kwh/day were consumed for an average savings of approximately 21%. Over the course of a year, this equates to a savings of $90,000. The cost of the sensors was $21,000, which equates to a return on investment of about three months.

After operating the system automatically for some time, another improvement became “clear”—settlevability improved and the clarifier effluent remained below 2.0 NTU. Due to the improvement in sludge quality, optimizing of the filter system and continuous measurement of the turbidity of the clarifier weir overflow and combined influent turbidity entering the filters it was clear that the $3,000,000 clarifier and filter additions became unnecessary. Recognizing these conditions, the project became an improvement project instead of an upgrade; including several turbidity, TSS, and chlorine analyzers and other control system improvements which continue to improve and optimize plant operations. Reliable and effective laboratory data, plant automation, and plant stability has helped to improve plant maintenance program efficiencies.

Recognizing the value of these improvements, the Arizona Water Association honored the Beardsley plant with the “Large Treatment Plant of the Year” award at the annual conference, and city managers asked staff to implement the same optimization system at the city’s Butler Advanced Wastewater Treatment Plant.