Air-Gas Mass Flow Meter Improves Wastewater Processing Efficiency

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A fast growing city in the arid desert regions of the Western U.S. recently addressed the need to expand its municipal service for new residents and subdivisions. In recent years, the city's residential demand for wastewater treatment tripled from less than 1 million gallons to more than 1.5 million gallons per day. In planning for the wastewater treatment plant's expanded capabilities, the city's water engineers identified minimizing aeration basin compressed air energy costs as a goal.

Wastewater Treatment

In wastewater treatment plants, a variety of processes are employed to eliminate organic pollutants from water to ensure it meets sanitary requirements for future use. One of the most common processes is the activated sludge method, which biologically treats the wastewater through the use of large aeration basins. This process requires the pumping of compressed air into the aeration basins where a diffuser system ensures the air is distributed evenly for optimum treatment. The energy needed to provide compressed air is a significant cost in the operation of a wastewater treatment plant.

Tiny micro-organisms in the aeration basins decompose biologically degradable organic solids in the wastewater. These micro-organisms depend on the aeration system to provide the right amount of air necessary for them to thrive and consume the suspended solids in the wastewater. These solids are eventually removed downstream of the aeration basin and can be digested to create energy at the plant.

Large amounts of air are required to ensure the aeration process operates effectively to treat the wastewater adequately before it can be moved along to clarifying basins, filtering, disinfection, and other treatment processes. Controlling the proper amount of air that is released into the aeration basins is essential since the air flow controls the growth of micro-organisms that treat the wastewater. Flow meters are typically installed in the aeration system piping to measure the amount of air flow, with their analog or digital output connected to the facility's control system.

In most plants, each of several aeration basins is configured with numerous diffuser systems, and individual air flow monitoring with independent control is generally required for each diffuser system. The compressor system must run at all times to maintain the optimum amount of air to the diffuser systems and the aeration basins, with flow rates changing throughout the day based on demand.

Air/Gas Flow Meters

The engineers at the city plant needed to place air flow meters in a rugged area of the facility with an underground vault, which required remote access (Figure 1). The installation site was further challenged with straight pipe run limitations, hazardous gases present, a wet/dirty environment and with fluctuating wastewater levels.

The flow meters needed to be installed in a 24-inch line for blower air flow into the aeration basins. Accurate measurement of the air flow was necessary for the control system to maintain the correct level of dissolved oxygen in the aeration basins and proper treatment of the wastewater. The meters also needed to provide accuracy over a wide flow range because the facility requires flow rates to increase from 0.5 to 3.0 MGD with future growth.

After reviewing various flow meter technologies, the city's plant engineers selected the ST98 Flow Meter from Fluid Components International (FCI) (Figure 2) because of its accurate performance over a wide flow range, ease of installation and low maintenance requirements. This flow meter is designed with a thermal dispersion mass flow sensing element that provides excellent measurement accuracy and reliability in harsh

environments. To compensate for flow disturbances resulting from limited piping upstream, Vortab Flow Conditioners (Model VIP) were installed to ensure flow meter accuracy. The flow conditioners remove both swirl and distorted velocity flow profiles to support accurate flow measurement by the meter at all velocities under these challenging conditions.

The ST98 flow meter also includes an integral 2-way HART protocol interface for direct communication with the plants distributed control system. The HART interface allowed the plant engineers to receive multiple process variables and configure the flow meter remotely from the safety of the control room.

HART's field-proven communications protocol provides reliable two-way communication as part of the existing 4-20mA wiring.

Using integral two-way HART communications, the city's process engineers have simplified control and access to important flow meter flow data including diagnostics, calibration and configuration information.

The highly stable constant power flow sensor design allows the meter to be used in applications where upset flow conditions such as sudden changes in flow, temperature, or moisture are present.

With its highly reliable thermal mass sensing element, the flow meter delivers precision mass flow rate, totalized flow and temperature measurement to the city's engineers. It is ideal for air/gas flow measurement in wastewater treatment applications and offers high accuracy to ±1% of reading, 0.5% of full scale. Repeatability is ±0.5% of reading.

This insertion style flow meter can be installed cost effectively without shutting down the process by using a simple NPT fitting. The flow meter operates over a wide flow range from 0.75 to 600 SFPS (0.21 to 172 NMPS), and the turndown ratio is factory preset from 10:1 up to 100:1. The flow meter operates at pressures up to 250 psig [17 bar (g)].

The flow meter's thermal mass sensing element is comprised of two all-welded 316L stainless steel thermowells that protect two matched platinum precision resistance temperature detectors (RTDs) (Figure 3). With a highly reliable no-moving parts solid-state design, one RTD is slightly heated relative to the reference RTD, and the temperature difference between the two is proportional to changes in the gas flow rate.

The flow meter's transmitter features robust, microprocessor-based electronics and can be integral with the sensor, or remote mounted up to 1000 feet [350m] away. NEMA Type 4X (IP66) rated and explosion-proof, Division 1 [Zone1] rated enclosures are available for the toughest environments.

The city engineers also installed Vortab VIP Flow Conditioners to provide repeatable and symmetric velocity flow profiles at the metering location to reduce pipe straight-run requirements (Figure 4). The flow conditioner was installed 3 pipe diameters downstream from the flow disturbance to provide symmetrical and swirl-free repeatable laminar flow, which ensures the flow meter meets the city's accuracy and repeatability specifications.

The standard flow conditioner is manufactured with 316L stainless steel in sizes for installation in pipes from 2 to 40 inch diameters (5 to 1,000c). Other materials and larger line sizes are also available.

Conclusion

In wastewater treatment facilities, as well as industrial plants, the cost of air flow can easily be one of the facility's largest energy expenses. The cost of energy to produce compressed air continues to rise along with fuel costs. Optimizing the aeration process by measuring and controlling the aeration system's air flow with an accurate, reliable flow meter reduces energy costs and overall plant operational costs. In addition, the flow conditioner can reduce piping costs and the low pressure drop characteristics minimize compressor/pump power requirements.

Outfitting wastewater treatment aeration systems such as this city's plant with a mass flow meter will result in improved process effectiveness and reduced energy consumption. Looking carefully at measuring accuracy and range needs, installation conditions and maintenance requirements will assist in selecting the most cost effective flow metering solution.