Using Air Flow Meters on Aeration Diffusers Improves Wastewater Treatment Efficiency

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Wastewater treatment plants (Fig 1 and 2) use different treatment processes to eliminate organic pollutants in the wastewater. 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 activated sludge method introduces microorganisms into the aeration basins that biologically decompose the organics in the wastewater. These microorganisms require air to survive and depend on the aeration system to provide the right amount of air necessary for them to thrive and consume the organics in the wastewater. Eventually, over a period of time, they flocculate into a mass and settle to the bottom of the basin along with the non-biodegradable solids.

Compressed air is typically used to provide the air to the aeration basins. Controlling the proper amount of air that is released into the aeration basins is essential because it controls the growth of microorganisms that treat the wastewater. Flow meters are typically installed in the aeration system piping to measure the amount of air flow and the meters' analog or digital outputs run to the control system.

Operators of both industrial plants and wastewater facilities find that compressed air is one of the highest energy expenses. The cost of energy to produce compressed air continues to rise along with fuel costs. So, optimising the aeration process by measuring and controlling the aeration system's air flow with a suitable flow meter reduces energy costs.

In plants with multiple aeration basins, each one is configured with several diffuser systems. Typically a wastewater treatment plant has multiple aeration basins and each is configured with several diffuser systems. Individual air flow monitoring and independent control is generally required for each diffuser system. The compressor system must run 24-x-7 to maintain the optimum amount of air flowing to the diffuser systems, but demand for air changes throughout the day to accommodate a variety of variables that affect the efficiency of the microorganisms.

Best practices for evaluating and selecting flow meters for both aeration processes and wastewater treatment applications include five key considerations:

- Flow Sensor Technology
- Accuracy and Flow Range
- Operating Environment
- Ease of Installation
- Maintenance and Life

Flow Sensor Technology

There are three primary flow sensor technologies that are generally used by wastewater treatment plant operators for monitoring air flow in aeration applications:

- Differential pressure (orifice plates)
- Vortex shedding technologies
- Thermal dispersion (mass flow)

Differential pressure (orifice plates) and, to a limited degree, vortex shedding technologies have an installed base. While, orifice plates have been in use for many decades in water treatment plants and vortex shedding is recognised for its high accuracy, thermal dispersion flow measurement now has the largest installed base for this application for several important reasons. Thermal dispersion has grown in popularity because it offers direct mass flow measurement, offers a wider turndown ratio, has no holes or moving parts to foul or clog, is an insertion style meter that installs in a single tap and is the most cost effective technology applied for the pipe lines sizes commonly found in the aeration distribution system.

Accuracy and Flow Range

A common specification in major municipal wastewater treatment plants is for the aeration flow meter to measure over a wide flow range from 1.5 to 150 SFPS (0.46 to 46 NMPS) with an accuracy of +2% of reading, +0.5% of full scale, with a repeatability of +0.5% of reading. Most aeration systems will operate with excellent efficiency at this level of accuracy. Flow meter manufacturers can provide products for higher accuracy specifications, however these products typically include extra features and functions that are unused in aeration application and they carry a price premium. It is also critically important to look at a flow meter's repeatability specification, which tells the user how reliably the device will maintain its specified accuracy level.

Operating Environment

Environmental conditions change throughout the day, which in turn affect the mass of the air and the required amount of compressed air flow into the aeration basins. Flow meters for such applications must be able to tolerate significant drops in pressure throughout the system from 0.8 to 17.6 psig [0.6 to 1.2 bar (g)], which means the flow meter must be have a wide turn-down range and this can be a problem for mechanical devices with moving parts that wear over time. Temperatures can vary widely from -4 to 150F (-20 to 65C). This is also a rugged, dirty environment that can be a maintenance issue with devices with holes that may plug or foul, and the device may require an approval rating matched for installation location.

Ease of Installation

Flow meter installation requirements vary significantly depending on the technology and manufacturer design. Some flow meter installation requirements are easier than others. Be sure to ask if the flow meter that you are considering can be inserted directly into the process pipe or if it requires an inline configuration that will require you to cut and splice your pipes in multiple places. To accurately measure flow, meters require some length of unobstructed pipe straight-run upstream and downstream from the meter to achieve their specified accuracy.

If your facility has space constraints, or the layout requires the placement a valve or an elbow near your flow meter, consider adding a flow conditioner. By adding a flow conditioner to your configuration, you will reduce the straight-run needed to ensure accurate flow measurement. Tabbed type flow conditioners, such as those provided by the Vortab Company, have proved successful in these applications. Other flow conditioning technology choices including tube bundles, honeycombs, and perforated plates, may also be considered depending upon the specifics of the application and obstructions.

Maintenance and Life

It's important to understand the maintenance requirements for the flow meter you are considering. Some flow meters need more frequent recalibration, and/or cleaning which can be time-consuming or, worse, require you to remove the meter from service. For wastewater aeration applications, the ideal flow meter will have no moving parts to wear out and no routine cleaning requirements to minimise maintenance cost and provide many years of service. When calculating the cost of a new flow meter, be sure to look beyond the purchase price to determine what it will cost to maintain and how long it will provide service before you make a final decision.

Realising Energy Savings

There are several factors that contribute to the cost of compressed air. These include the plant's physical climate, the layout, the amount of waste, the equipment in use (including the diffuser, compressor and control system), the piping configuration, the flow instrumentation and the energy supplier.

If you could design the perfect system, all of these factors would work together to promote the optimum microorganism growth rate needed to treat the water in the shortest amount of time by using the least amount of compressed air. While perfection is beyond most of us, improvement is possible and valuable. If your energy costs seem high, be sure to consider all the variables, including the type of the flow meters, where they are placed in the pipeline and their calibration for your application.

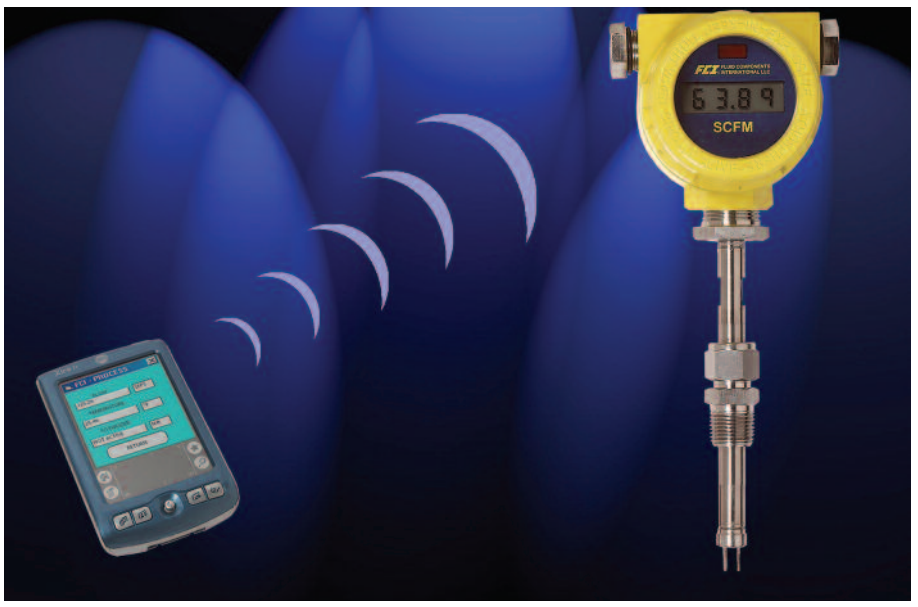
You can optimise compressor efficiency and minimise energy costs by selecting the best flow meter technology for your application. To determine the potential savings, consider the amount of compressed air consumed daily and then look at what a small percentage improvement in compressor efficiency is worth. Then ask your flow meter supplier to help you review the performance of the instrument in the actual application.

Conclusions

Improved process effectiveness and reduced energy consumption are two of the main benefits of choosing the best flow meter for your wastewater treatment aeration system. Looking carefully at measuring accuracy and range needs, installation conditions and complexity, and maintenance requirements will result in selecting the most cost effective flow metering solution.

In recent years, manufacturers have developed flow meter technologies that do a better job of meeting the measurement needs of air flow, digester gases and other gases. Wastewater treatment facility operators now have more options to improve their processes and manage costs. At Fluid Components International, for example, we have designed a broad range of new and enhanced flow meters for aeration flow measurement and other wastewater treatment applications.

We designed the ST50 model Flow Meter (Fig 3) specifically for optimising the aeration and compressed air applications used in wastewater treatment facilities like yours. The ST50 incorporates thermal mass flow sensor technology for a no-moving parts insertion style element with optional wireless IR communication, which is easy to install and requires virtually no maintenance. Its



transmitter electronics include dual analog outputs and optional digital readout all housed in a small, rugged, metal enclosure for long service life regardless of installation of environment.

Accuracy is an important factor when you are evaluating flow meters for an application. However, focusing on accuracy alone can be misleading since it's the flow meter repeatability that ultimately optimises the aeration system. Add overall performance, reliability, installation requirements and lifecycle costs to your flow meter checklist. You can also avoid headaches if you ask about how well the flow meter will operate within your specific environment. Don't forget to consider the ease of installation and think ahead about maintenance. To evaluate your true total investment cost, compare the initial cash outlay to the total cost of operating your next flow meter over its lifecycle.