Technical Publication

Ozone Gas Flow Monitoring for Water Treatment Systems

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Figure 1: Ozone Treatment System

Many municipal water treatment plants utilize Ozone Treatment Systems to produce clean water for residential and industrial users. While all the various types of water treatment systems have their advantages and disadvantages, Ozone (O3) systems provide excellent disinfection and avoid some of the chemical byproduct problems experienced with the use of chlorination. Ozone treatment systems also produce no odors or after-taste, which makes the finished water more palatable.

Ozone is an unstable molecule that can easily be converted to Oxygen. As an oxidizer, it becomes a strong disinfectant that kills dangerous organisms within raw water supplies to make the water safe for human consumption.

As Ozone is highly reactive and unstable, it cannot be stored and must be generated as needed for water treatment. Ozone is generally produced in large quantities from gases containing Oxygen, using silent electrical discharge (corona discharge), and applied to the raw water via bubble contact for disinfection purposes.

The Problem

Ozone production is an expensive process. Therefore, accurately and reliably measuring Ozone as it is produced and applied within the water treatment plant is essential to control water quality and costs. While analyzers are able to show plant operators the percentage, by volume, of Ozone in Oxygen, the plant operators also need to know the total mass flow of Ozone to achieve maximum operational efficiency.

The selection of a precision gas mass flow meter for this purpose ensures the disinfection process operates more effectively and more economically. In a typical plant, Ozone is first generated and then introduced into the filtration process at three different points where a flow meter is required.

Ozone is first used as a coagulant prior to primary filtration. Then it is injected in low doses as the oxidizing agent. Finally, it is applied in high doses as a disinfectant to breakdown pollutants, such as pesticides. In Europe, there is a directive from the European Community (EC) that requires the removal of soluble herbicides and pesticides from drinking water. Ozone is an excellent solution to meet this directive.

The Solution

At each point in the water treatment process, the Ozone dosing flow rate is different, which makes sizing the correct flow meter a challenge, plus a typical Ozone treatment system can flow gas media as a combination of Oxygen and Ozone typically as 98% and 2% respectively. While there are many different flow measurement technologies and types of flow meters, the need for direct mass flow measurement significantly narrows the choices. Thermal Dispersion is an excellent choice for this application.

Thermal dispersion mass flow meters are frequently selected for Ozone treatment systems *(Figure 1)* and other municipal water treatment plant applications because of their accuracy, wide turndown ratio of up to 100:1, low pressure drop, no-moving parts design (low maintenance), rugged construction and economy. They are available from a number of manufacturers, including Fluid Components International (FCI).

A thermal mass flow meter, such as FCI's Model ST98 *(Figure 2)* employs a no-moving parts design flow sensor inserted

Figure 2: ST98 Flow Meter

directly into the Ozone process flow. The ST98 thermal flow meter measures gas flow over a wide range from 0.75 to 600 SFPS (0.2 to 172 NMPS), with accuracy of +1 percent of reading, +0.5 percent of full scale. The repeatability of such a flow meter is +0.5 percent of reading—again supporting the need for reliability in a critical process with potentially hazardous operations. The turndown ratio is generally factory preset and field adjustable from 2:1 to 100:1.

Thermal sensing is one of only a few technologies that measure mass flow rate; it is also one of the few technologies that can be used for measuring gas mass flow in small lines, large pipes, ducts, or stacks.

A thermal mass flow-sensing element contains two thermowell-protected platinum resistance temperature detectors *(Figure 3)*. One resistance temperature detector (RTD) is heated and the other RTD senses the process temperature. When placed in the process gas stream, the differential temperature between the two RTDs is directly related to the process gas flow rate and the specific properties of the process gas. Higher flow rates due to higher velocities or more dense media cause greater cooling of the heated RTD and a reduction in the RTD temperature differential, making possible the precise measurement of the gas flow rate over a wide flow range.

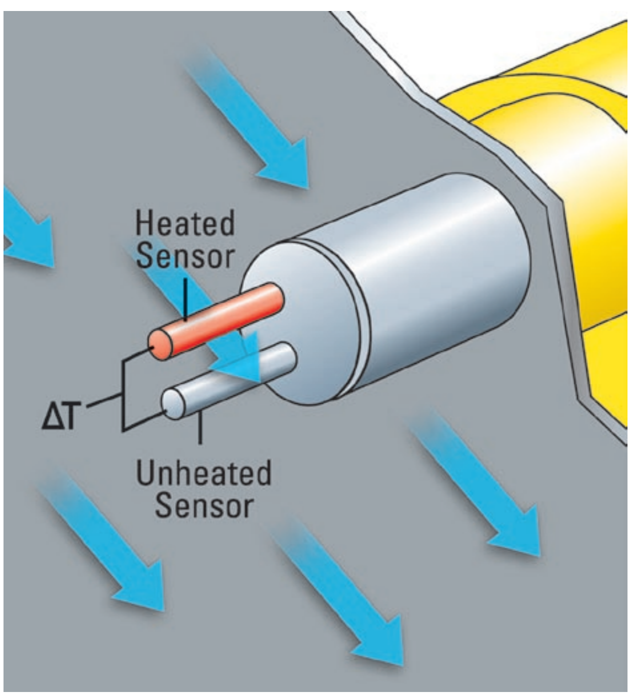

Figure 3: Thermal Mass Flow Sensing Theory of Operation

The flow element is manufactured out of a material compatible with the gas. In most cases, Stainless Steel or Hasteloy C is adequate, however, other exotic metals are also available. In addition, the typical insertion flow element results in a negligible pressure drop in most applications. This benefit can translate into significant reductions in energy usage and thereby result in a more cost effective process.

Many flow meters feature a local LCD display. A typical display includes four lines of 20 characters that generally indicate flow rate, total flow, temperature, relay status, current calibration mode and sample rate. Meters with a microprocessor-based transmitter can provide a 4-20mA output with an RS-232C serial port for communications. A variety of communication buses are available for flow meters of all types, including Profibus and HART. FCI has a broad range of thermal mass flow switches, media interface switches, point level sensors, and mass flow meters.

Conclusions

In a typical Ozone treatment system, one thermal mass flow meter will be installed on each Ozone generator to calculate the total mass flow of the Ozone gas as it is produced and then sent on its way to the various treatment areas. Flow meters are then also installed at each treatment location, which in our example plant is included as the coagulant treatment prior to filtration, the primary oxidizing treatment for disinfection purposes, and lastly for the removal of herbicides and pesticides as disinfectant treatment. ■