Technical Publication

Flow Meter Enhances Chlorination System Performance for Municipal Water Department

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Figure 1: Water treatment plant chlorine tanks

The water municipality at a mid-size city in the Western region of the U.S. serving a population of about 180,000 people needed to address a chlorine disinfection system problem at one of its water treatment plants. The city's engineers take great pride in providing their community with a safe source of drinking water and gave this issue the highest priority.

In order to provide a reliable, safe source of clean drinking water, all municipal system operators rely on a disinfection system to kill germs. There are several different methods of disinfection treatment, such as chlorine (Cl_2), UV, and ozone. Chlorine remains a popular disinfectant around the world. Where chlorine is in use, accurate measurement of the gas is essential for successful disinfection and for safety purposes.

Problem

At one of the city's water treatment plants, the chlorinator system's flow measurement lacked suitable turndown capability (measuring range) and was not repeatable at lower flow rates and monthly totalized chlorine usage were not consistent *(Figure 1)*. This poor control over the amount of chlorine being dispensed resulted in either excessive, wasteful chlorine use, or potentially hazardous and expensive re-treatment. Adding too much chlorine affects water taste (swimming pool), wastes expensive chlorine gas and adds the cost of extra residual chlorine removal. With too little chlorine added, the disinfection treatment process is incomplete, and the water requires costly additional alternative treatment or re-treatment.

The city's system had been initially designed with simple site-gauge rotameters. Later, for automated control purposes, differential pressure (dP) type orifice plate flow meters were added into the system. The city's engineers soon discovered the orifice plate dP meters could not be relied upon to measure accurately under flow conditions where little pressure differential was available, and the limited flow range could not support the changing dose rates with changes in water demand.

The treatment plant needed a better gas flow meter solution that would be appropriate for service in a 1-inch diameter pipe at a flow rate of 150 lb/day to 2,000 lb/day [68 kg/day to 907 kg/day]. The operating temperature was 60 °F to 100 °F [16 °C to 38 °C] at a pressure of 0 psig to 10 psig [0 bar(g) to 0.7 bar(g)]. The flow meter would be used to measure chlorine and no other gases and would be installed in a location where inadequate straight-pipe run was present and added to the accuracy challenge for any velocity based instrument. The flow velocities also resulted in measurement required in the transitional zone where the gas flow profile was transitioning from laminar to turbulent. Mass flow provided an additional advantage of allowing a simple, direct means of reconciling monthly throughput compared against the change in weight of the chlorine gas containers that were installed on load cell technology scales.

Figure 2: Installed ST100L Flow Meter with Vortab Flow Conditioner

Solution

After consulting with the application engineering team at Fluid Components International (FCI), the engineers at the water department selected the Model ST100L thermal dispersion gas mass flow meter with built-in Vortab® flow conditioner *(Figure 2)*. The Model ST100L is an in-line, spool piece flow meter that combines best-in-class transmitter/electronics and superior sensor design to provide a truly state-of-the-art gas flow meter for industrial process and plant applications in line sizes up to 2 inches [50 mm].

FCI's model ST100L constant power technology thermal flow meter *(Figure 3)* was installed in the water system's chlorine gas inlet line to the chlorinator panel. To ensure maximum corrosion resistance and longest service life in the highly corrosive chlorine gas environment, the ST100L's entire sensor assembly, including flow elements, flow body and Vortab flow conditioner elements, are fabricated entirely of Hastelloy C-276.

FCI's gas flow meters are typically calibrated in FCI's NIST traceable flow laboratory using the actual gas to be measured and at the installation's actual temperature and pressure conditions. However, chlorine gas presents safety concerns during the calibration process which renders that process unfeasible. It has also been thoroughly established that air equivalency calibrations for chlorine gas are inaccurate, unrepeatable and simply, inadequate. FCI solves this problem by combining a lab-based equivalency basic calibration with an on-site, in-situ calibration adjustment against the site's rotameters, all performed by an FCI field service technician. This achieved the highly accurate and repeatable measurement needed by the client. The on-site calibration matching proved to be the best solution because the totalized flow readings from the FCI Model ST100L and the weigh scale comparison were now consistently aligned.

The in-line configuration ST100L meter measures air/gas flow from 0.25 SFPS to 1000 SFPS (0,07 NMPS to 305 NMPS), with turndowns of 100:1 and with accuracy of ±0.75 percent of reading, ±0.5 percent of full scale. To match present and future DCS, PLC or SCADA needs, users can select from multiple output options including triple 4-20 mA analog, frequency/pulse, or certified digital bus communications of HART®, FOUNDATION™ Fieldbus, PROFIBUS PA and Modbus RS485.

The ST100L flow meter also features a best-in-class graphical, multivariable, backlit LCD readout, which provides operators with a continuous display of all process measurements, alarm status and service diagnostics. Its four-button user keyboard is activated through the glass, which means the user never needs to remove lids or open up the unit at the installation site. The instrument also includes a USB port for PC interface and an ethernet port for service needs.

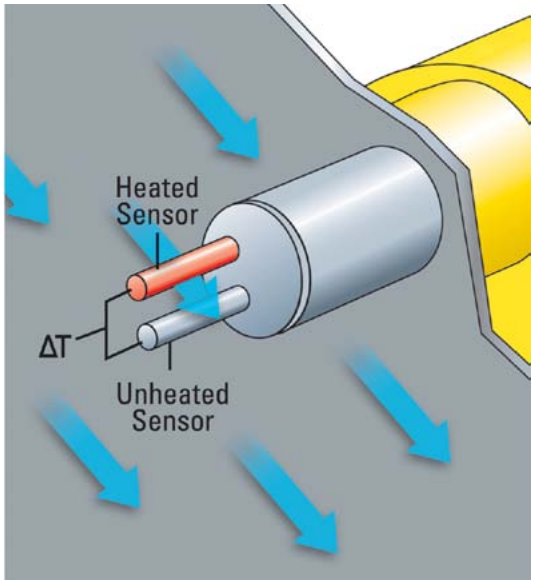

Figure 3: Thermal dispersion constant power principle of operation

The ST100L meter is designed to ensure the longest service life in even the most rugged industrial applications and installations. The enclosure is NEMA4X/IP67 rated and features four separate conduit ports to isolate all wiring. Additional pedigrees include global agency approval for hazardous environments (ATEX, IECEx, FM, FMc, Inmetro, NEPSI and EAC/TR CU) and SIL compliance. The electronics/transmitter is available for installation as either integral with the flow element or remotable (up to 1000 feet [300 meters]).

The integral Vortab flow conditioner ensured optimal installation performance by overcoming the limited piping straight run and the flow range occurring in the transitional flow region. Vortab uniquely eliminates both swirl and velocity profile distortions produced by process equipment obstructions and/or inadequate straight run of pipe and

ducting, as well as temperature and media stratification that can be present at the low flow rates where FCI meters perform and with the lowest pressure drop of all flow conditioner alternatives.

Conclusion

The ST100L flow meters have been installed in the chlorine gas inlet lines and achieving consistent accurate and repeatable flow measurement results. The site is achieving the desired disinfection results with proper chlorine dosing at significant cost savings due to reduced chlorine use, avoiding re-treatment and lessened residual chlorine removal processes. ■

ST100L Flow Meter with Vortab Flow Conditioner