Technical Publication

Thermal Flow Meter Helps Semiconductor Manufacturer Solve Boiler Fuel Gas Mystery for Multi-Building Campus

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When the plant team at a large semiconductor manufacturer in the northwestern region of the U.S. found its boilers were consuming an unusually large quantity of natural gas, the numbers simply didn't add up. Something mysterious was going on with the boilers, which incorrectly showed gas consumption above plant permit levels, and this situation would eventually cause regulatory reporting problems later on.

The company is a global leader in advanced memory and semiconductor technologies. Its products are found in a wide range of applications from personal electronic devices to automobiles to mobile communications to enterprise data storage to medical devices and industrial equipment.

The large campus includes multiple buildings for engineering, manufacturing and administrative functions. The plant's operations are supported by two central utility plants (CUPs) with multiple natural gas fueled boilers, which provide hot water for the heating, ventilation and air conditioning (HVAC) systems in the buildings and for the manufacturing processes.

The Problem

When the plant team's engineers investigated the high level of natural gas consumption, they soon discovered that the cause was not over-consumption by the boilers. After further system tests, the team quickly focused on the flow meters that were installed on the three-inch gas lines that fueled each of the burners.

Even with the gas completely shut-off to the boilers, the flow meters were still registering a significant amount of gas flow to the boilers. These flow meters were vortex shedding technology instruments, using the vortices of a gas or liquid passing by a bluff body placed in the pipe's flow stream to measure flow. The changing frequency of these vortices is converted to flow velocity, which is used to calculate the volumetric flow rate.

Unfortunately, piping in the CUP building was exposed to vibration from other industrial equipment installed in close proximity. The vibrating pipes connected to the flow meters interfered significantly with the vortex shedding sensors, leading them to record measurements erratically and register flowing gas when none was present. The plant team considered its options to resolve the issue and determined that it would be easier, less costly and more reliable to replace the meters with another flow technology immune to vibration rather than trying to stabilize the surrounding equipment and pipes.

The Solution

The plant team then contacted the applications group at Fluid Components International (FCI) to discuss the problem with its inaccurate flow measurement caused by the vibrating pipes. Requirements for the new flow meters, included the 3-inch pipe (Schedule 40 [DN 75]) with a 0.75-inch NPT process connection and subject to continuous vibration.

The natural gas flow to be measured ranged from 3,000 to 30,000 SCFH (85 to 850 m3/hr) at a process temperature ranging from 40 to 80°F (4 to 27°C). The pressure range was 7 to 12 psig [0,5 to 0,8 bar(g)]. With the surrounding equipment already in place, there also was limited straight run of pipe available, which could create irregular fluid flow dynamics (swirl) within the piping where the new flow meters were to be installed.

After learning the flow meter performance and installation requirements, the FCI applications group recommended the ST98 Air/Gas Thermal Mass Flow Meter (Figure 1) with remote electronics. The plant team agreed, and the vortex meters were removed from the two CUP buildings.

FCI then installed 16 new thermal flow meters on the 16 gas lines (8 in each building supporting 16 boilers total). A 3-inch [75 mm] Vortab® VIS flow conditioner was also installed on each line to ensure optimum flow measurement under the limited straight-run conditions and to avoid the high cost of relocating any equipment or piping.

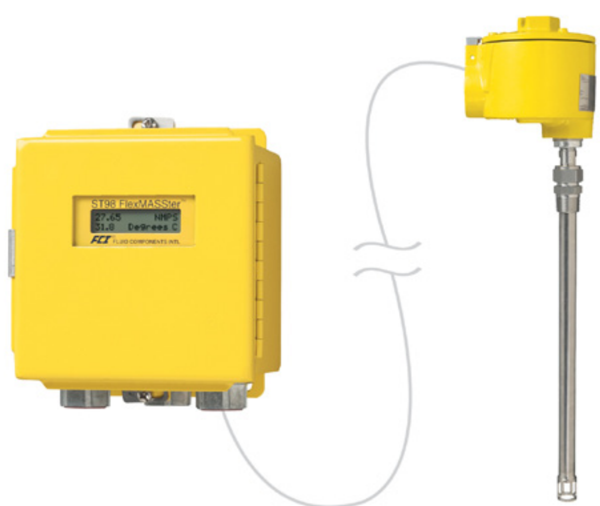

Figure 1: FCI Model ST98 thermal mass flow meter, remote configuration

Each thermal meter's insertion probe was inserted directly in the natural gas line downstream from the flow conditioner (Figure 2). The team appreciated the meter's simple insertion probe type design for its low cost of installation.

With their no-moving parts design, the thermal mass flow sensors are unaffected by the continuous vibration within the pipes and require virtually no maintenance. Each meter's electronics/transmitter was installed about 15 feet [3 meters] away from the probe where the local displays would be easy to view by the plant team and further isolated from vibration.

The plant team appreciated the simplicity of this constant current thermal dispersion sensing technology, which provides accurate mass flow measurement under difficult mechanical conditions. Other volumetric based air/gas flow sensor technologies generally would have required additional separate temperature and pressure sensors for the same mass flow measurement with increased installed cost, maintenance requirements and lifecycle costs.

The FCI thermal dispersion sensing technology provides direct mass flow measurement, using two thermowell-protected platinum RTD temperature sensors inserted directly in the process stream (Figure 3). One RTD is heated while the other RTD senses the actual process temperature. The temperature differential between these two sensors generates a voltage output signal, which is proportional to the media cooling effect and is used to indicate the mass flow rate.

The FCI thermal dispersion technology meter also includes built-in temperature compensation to ensure repeatable and reliable measurement even with large changes in process temperatures. The FCI constant current temperature compensation technology, adjusts automatically for accurate flow measurement with changes in process temperatures including effects from seasonal changes, such as cold winters, hot summers.

The plant team was satisfied with the meter's accuracy of ±1% of reading, ±0.5% of full scale, with repeatability of ±0.5% of reading. The meter includes a rugged, NEMA 4X/IP66-rated enclosure and is agency approved for installation in hazardous gas (Ex) locations including combustible natural gas or biogases.

Figure 2: Installed FCI Model ST98 flow meter with Vortab flow conditioner

Conclusions

With the installation of the 16 new thermal dispersion meters on the gas lines feeding each boiler at the two CUP's on campus, the plant team was able to confirm the actual natural gas flow rates were within its permitted usage levels. There would be no discrepancy in reporting to the various governmental agencies that monitor the plant's energy consumption and environmental impact.

The plant team found the thermal dispersion meters provided accurate and reliable measurement within the industrial environment where high vibration was present inside the CUP's. The insertion style configuration combined with the VORTAB flow conditioners made them easy to install on the existing piping and required no retrofitting of equipment, while also avoiding any accuracy problems that might have been caused by the limited pipe straight runs in the CUP's.

After more than a year, the plant team reports that the thermal dispersion meters continue to operate without any issues. The plant team is considering thermal dispersion meters for future air and special gas applications based on its experience with the meter's direct mass flow technology. ■

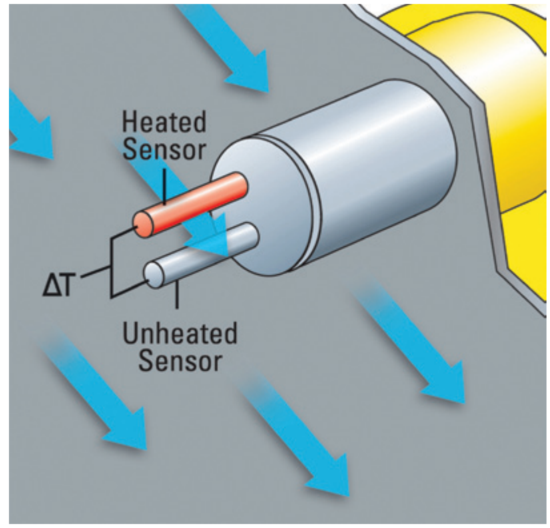

Figure 3: Thermal dispersion technology principle of operation