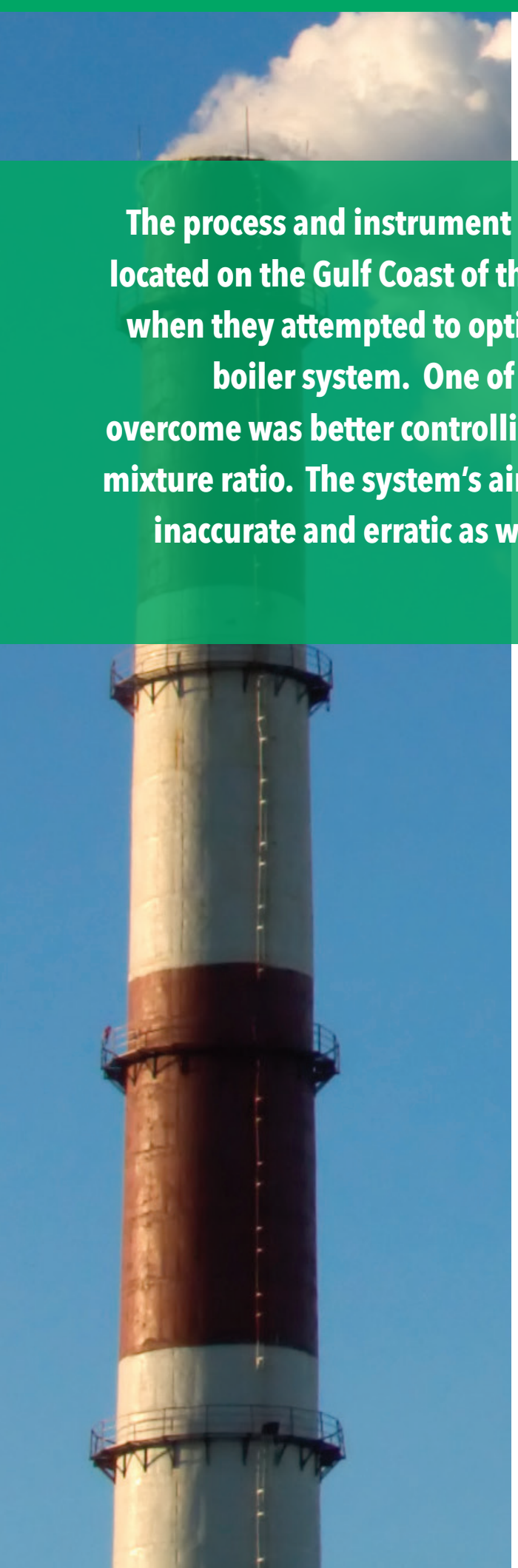
MULTIPOINT THERMAL MASS FLOW METER OPTIMIZES REFINERY'S BOILER AIR-TO-FUEL MIXTURE RATIO FOR HIGHER OPERATING EFFICIENCY



The process and instrument engineers at a major oil refinery located on the Gulf Coast of the U.S. ran into several problems when they attempted to optimize their plant's large primary boiler system. One of the major issues they needed to overcome was better controlling the boiler's burner air-to-fuel mixture ratio. The system's air flow measurements were often inaccurate and erratic as well, which frustrated attempts to optimize the boiler's efficiency.

Like most boiler system designs, this one included a large, high capacity, air feed intake duct providing air to the boiler's burner. The accurate measuring of the intake air flow rate is important to achieving the most efficient mixture of air and natural gas at the burner in any boiler system. The more efficient the air-to-fuel combustion ratio control, the less gas is consumed and with the least amount of off-gas, which reduces operational costs and the plant's environmental footprint.

The Problem

The size and scale of this large boiler system's primary duct limited the available flow meter technologies that the plant engineers could consider and the installation location itself was less than ideal. The air flow rate at startup also was substantially less than the flow rate during normal operation, which required an air flow meter with a high turndown ratio.

Additionally, the large air intake duct was only partially covered, which allows rain and dust into the duct. Furthermore, there are dense arrays of noise silencer tubes in the duct that restrict the installation of flow sensors to narrow passages between the tubes.

The refinery had originally installed a multipoint differential pressure (DP) averaging flow meter. The DP meter's reading, however, proved to be unreliable. The DP-bar had only a narrow turndown and the small orifices in the device were constantly fouling and clogging with dust particles, which resulted in excessive downtime and frequent unplanned maintenance.

Due to the size and scale of the ducting, its open to the elements construction and cramped layout, the choices of air/gas flow measurement sensing technologies was limited. In general the larger the diameter of a duct, pipe or stack, the more difficult it is to measure the air flow. Of the many technologies that measure air/gas flow, very few of them can operate accurately and reliably under these difficult conditions.

The energy cost of inefficient boiler burner air-to-fuel mixtures can be significant. Inefficient operation of boilers in large refineries can slow product throughput, affect product quality and increase costs. The process team at the refinery needed to find a better solution to its boiler problem, which eventually required looking at alternative flow meter technologies.

The Solution

The process and instrumentation engineering team at the refinery contacted Fluid Components International (FCI) to consider an alternative solution. FCI's local sales representative and applications engineering team recommended trying the MT100S Multipoint Thermal Mass Flow Meter (Fig 1).

The MT100 series is an insertion type multipoint flow meter specifically designed for large diameter pipes and large rectangular ducts, such as these air feed intakes (Fig 2), as well as stacks, flues, scrubbers and HVAC systems. These large pipe/duct applications

Fig 1. FCI MT100 Multipoint Flow Meter Refinery Montage

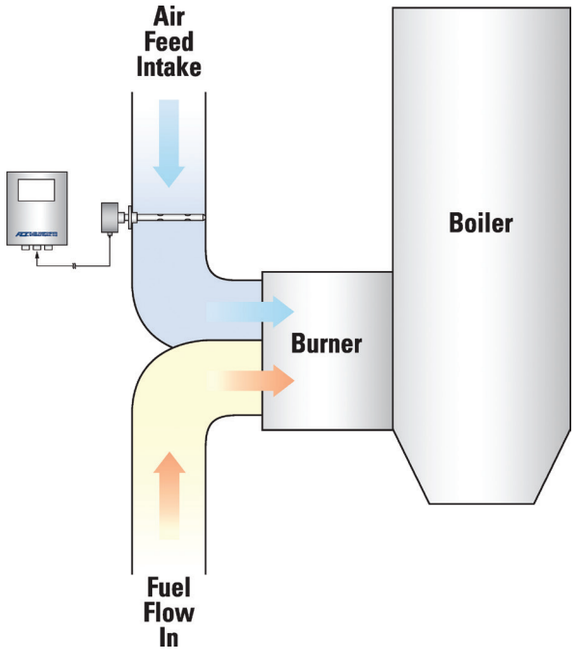


Fig 2. Combustion Pre-Heater Air for Boilers

are difficult for ordinary flow meters because of distorted flow profiles and lack of straight-run that result in inaccurate and non-repeatable flow measurements.

The diameter of the MT100's meter's multiple flow elements was small enough to fit between the silencers and their adjustable insertion length allowed their measuring point to be set on site to optimize the repeatability and reliability of the air measurement. Furthermore, because the MT100's thermal flow elements have no orifices or moving parts to clog or foul, the cost and time of routine maintenance could be significantly reduced.

To ensure accuracy in large diameter ducts, stacks and pipes, the MT100 flow meters can be supplied with up to eight flow rate sensors. The multiple sensors are inserted at various depths within a duct, pipe or stack and their outputs are multiplexed and averaged to calculate the flow rate with high accuracy in the process line. They can be installed at multiple points around the process line as an array of single tap points or mounted across a mast.

The engineering staff at the refinery also was pleased to learn that the standard MT100 meter offers: a large 100:1 turndown within a wide 0.25 to 1000 SFPS [0,07 to 305 NMPS] flow range This meter further provided ±1.75% of reading, ±0.5% full scale accuracy, with 0.5% of reading repeatability, which collectively met or exceeded all of their measurement performance objectives.

The MT100 transmitter's local readout provided the refinery plant team with a state-of-the-art, color LCD display. It continuously shows the flow rate in actual engineering units, as a percentage of its range and in a trend graph whose time base is user selectable. The comprehensive readout also continuously displays totalized flow, intake air temperature and the operational status of each flow sensor in the system.

The MT100 transmitter's standard analog outputs include dual (2), high resolution, 16 bit 4-20mA, compliant with NAMUR NE43, and a 0-1kHz frequency/pulse. Standard digital bus communications include HART (Fieldcomm Group™ certified) and Modbus 485. A USB port for interface to PC's is also included. Optional bus communications available are Foundation Fieldbus and Profibus-PA.

The meter's electronics include a user programmable data logger feature to which flow rate, temperature and totalized flow, as well as fault codes, can be recorded on a removable, 8GB microSD card. The instrument also features a 3-point precision calibration drift check, which can be initiated on user demand or programmed to run automatically.

For stack and flue gas environmental monitoring applications, the MT100 multipoint meters are available with an optional Continuous Emissions Monitoring System (CEMS/CERMS) package which adds special calibration checking routines compliant with U.S. Environmental Protection Agency's (EPA) requirements.

Thermal Dispersion Flow Sensing

The MT100 flow meter is designed with thermal dispersion sensing technology, which provides direct mass flow measurement. This technology places two thermowell protected platinum RTD temperature sensors in the process stream. One RTD is heated while the other senses the actual process temperature. The temperature difference between these sensors generates a voltage output, which is proportional to the media cooling affect and can be used to measure the gas mass flow rate (Fig 3) without the need for additional pressure or temperature transmitters.

With this direct mass flow sensor technology, the multipoint thermal meter selected by the refinery plant team also includes

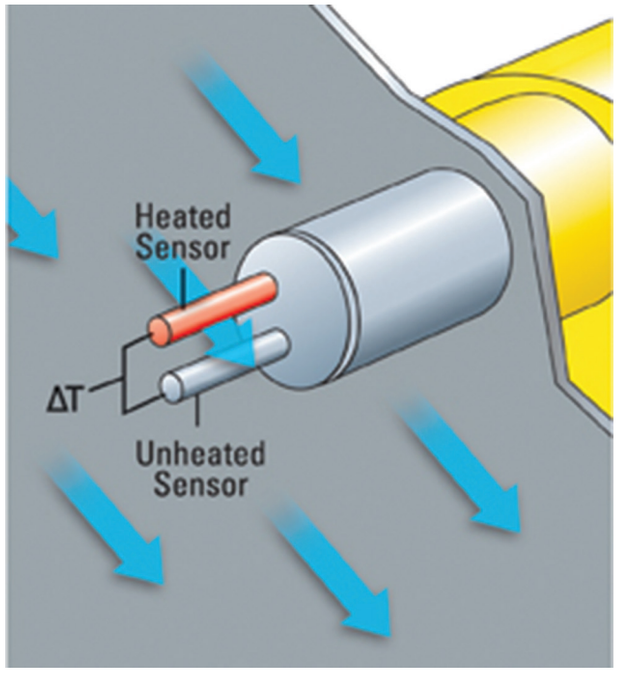


Fig 3.Thermal DIspersion Mass Flow Sensing Theory of Operation

built-in real-time temperature compensation. This capability ensures repeatable and reliable measurement even in applications where wide process temperature variations are present, such as large refineries in continuous operation throughout the year.

With no moving parts or orifices to plug or foul, the multipoint thermal mass flow meter was immune to dust and dirt, resulting in virtually maintenance free, continuous operation and lower installed cost.

Conclusions

The refinery team was pleased to report that the newly installed MT100 multipoint flow meters have been in continuous, successful operation for nearly a year. The plant team has improved the efficiency of its boiler system, lowered its operational cost and reduced its environmental footprint by using FCI's MT100 Multipoint Flow Meter to better optimize the boiler's fuel-to-air mixture ratio with more accurate, dependable air flow measurement and by eliminating un-planned maintenance.

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