REFINERY BOILER REPLACEMENT PROJECT'S AIR & FUEL GAS MEASUREMENT CHALLENGES SOLVED WITH PRECISION MULTIPOINT THERMAL FLOW METER

Figure 1: End-Customer Refinery

When the process and plant engineers at a major oil sands refinery in the province of Alberta, Canada, needed to replace their boiler system to upgrade its efficiency and thereby reduce its fuel costs and carbon footprint, they faced several technical challenges. Among them was the optimisation of the forced air flow to fuel gas ratio that would optimise the boiler flame burn rate for the most consistent, lowest cost heating under all operational and weather conditions.

As the price of natural gas for industrial heating processes and plant electric power continues to rise due to limited supply access, clean air emissions controls are also growing more stringent too. For these reasons, there is a need for petrochemical and other industrial process companies to more tightly control heating processes involving burners, boilers, furnaces, ovens, kilns, dryers, oxidisers and flare stacks (as well as reduce their electric power costs).

Many process and plant engineers will be familiar with some form of the old adage, "You can't control what you don't measure accurately." Fortunately, there are many process heating best practices that can be incorporated into industrial process plant operations. The one thing all of these enhancements depend on, however, is accurate, consistent air/gas flow measurement to control the burn and assure highly efficient heating.

The refinery's boiler replacement project plant team engaged a major engineering, production and construction (EPC) firm. To operate the boiler at optimum efficiency and maintain safe operating conditions (Figure 1), three critical air/gas flow measurements were identified early as critical to project success: (1) forced draft air, (2) combustion air and (3) fuel/flue gas recirculation.

The Problem

The original specifications developed for the boiler project identified averaging pitot tube flow measurement technology for the air flow measurements, but the EPC quickly realised that the technology was limited in its flow range capability and would require much more effort to maintain for the refinery team. For these reasons, the engineers decided to review other flow measurement technology options that might be a better fit for the project.

Large boiler applications always come with challenges. Properly evaluating the measurement is relatively easy. Determining the ideal meter location gets challenging when existing plant equipment layout access and clearances are considered in addition to the measurement accuracy objectives. A lot of work went in to selecting locations that not only could be measured accurately, but also didn't pose an issue when it came to installation and maintenance of the instruments. The following meter location requirements were identified:

Forced Draft Air Inlet (Figure 2)

- 120x33-inch [3,048 x 838 mm] cross section of duct
- Two ducts, each with two 4-point air flow meter systems for redundant measurement
  - Four air sensor points per meter for optimal performance
- Air flow rate: 1,901 to 190,100 lbm/hr flow range [862 to 86,277 kg/hr]
- Accuracy: Less than 5% of reading

Combustion Air

- 63x50-inch [1,600 x 1,270 mm] cross section of duct
- One duct with three 2-point air flow meters systems for redundant measurement
  - Two air sensor points per meter for optimal performance
- Air flow rate: 4,710 to 471,000 lbm/hr [2,136 to 213,642 kg/hr]
- Accuracy: Less than 5% of reading

Flue Gas Recirculation Line (Figure 3)

- 41.25-inch [1,048 mm] pipe (inner diameter)
- One gas flow meter 3-point system
- Gas flow rate: 626.7 to 62,670 lbm/hr [284.3 to 28,427 kg/hr]
  - Two calibration groups: natural gas or refinery fuel gas
- Accuracy: Less than 3% of reading

Figure 2: Forced Air (Aleksandrs Kenenkovs | Adobe Stock Images)

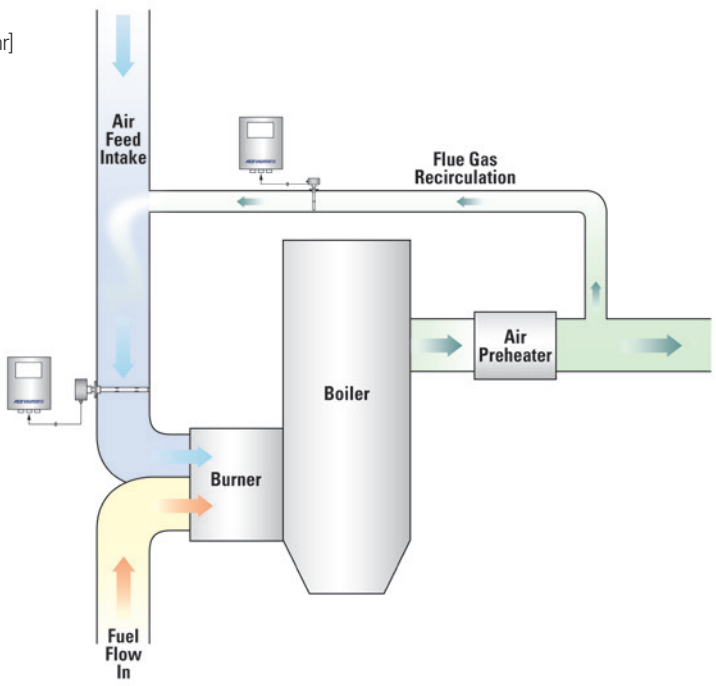

Figure 3: Fuel Gas / Flue Gas Recirculation

The Solution

The EPC team then requested assistance to find the proper flow meter technology solution from a local instrumentation manufacturers' representative. The multi-line manufacturers' rep firm then in turn contacted Fluid Components International (FCI), a leading manufacturer of thermal mass flow meters to evaluate the two air flow measurement applications and propose a solution.

Impressed with how well the FCI recommended MT100 Series Multipoint Thermal Flow Meters would perform in the two air measurement applications, the EPC firm then requested that the rep firm and FCI evaluate the fuel gas application to further take advantage of the multipoint gas sensing technology performance capabilities of the FCI MT100 Series Thermal Flow Meter. After further consultation and evaluation, the plant engineers, the EPC and the manufacturers' rep engineers all generally agreed that the FCI multipoint thermal flow meters provided the best solution based on their accuracy, repeatability and virtually no maintenance required sensors.

In addition to providing the instrumentation hardware, the rep firm and manufacturer recommended to the EPC that they perform in-situ traverses of each duct at several boiler loadings (flow rates) to ensure the meters on the air inlet and combustion air ducts were measuring within an acceptable tolerance. This step was viewed by all as critical because the redundant meters would not all be installed in the ideal position for equal area measurement of the duct. This service also would ensure that the measurements were not being negatively influenced by any field conditions that might have been unknown during the design phase of the project.

Being responsive to requests, taking the time to ask questions, providing STEP files for 3D modeling, and educating the design engineering team along the way all led to the final decision by the refinery and EPC teams to select the FCI MT100 Series Multipoint Thermal Flow Meters. In addition, the plant team noted that it previously had favorable experience with other FCI thermal meters in different applications when the proposed various flow measurement instrumentation alternatives to the original design.

FCI's versatile MT100 Series Flow Meters (Figure 4) feature proven precision, repeatable and compact thermal dispersion flow sensor technology. They accurately monitor and report the flow rate and/or the totalised flow of air and fuel gases in order to achieve the precise combustion ratio necessary for optimum boiler performance that produces the steam for cracking and other high-heat refinery and other petrochemical production processes.

MT100 Flow Meters combine state-of-the-art electronics technology with application-specific precision multipoint flow sensors in a rugged package designed for demanding operating environments. These meters provide temperature-compensated direct mass flow measurement of air and fuel gases. They come with one to eight flow rate sensing points. The sensors are inserted at multiple locations along the boiler burner piping assembly and their outputs are multiplexed and averaged to measure the air and gas flow rates and totalised flows.

The MT100 meter's sensors also can be installed at multiple points in other air or gas process lines in a single plane or across a large mast for stack gas waste measurement. These rugged, long-life, nearly-zero maintenance instruments excel in dirty, hot or humid environments because there are no moving parts, orifices or glass windows to foul or clog.

Figure 4: FCI MT100 Series Multipoint Flow Meter

The rugged MT100 Multipoint Flow Meters with their temperature-compensated sensors measure air, natural gas, process gases or flue waste gasses operating at up to 454°C (850°F). They measure flow rates over a wide range from 0,07 to 305 NMPS (0.25 to 1000 SFPS) with 100:1 turndown and with excellent accuracy of ± 1.75% of reading, ± 0.5% of full scale.

In demanding industries, such as oil/gas refineries, chemical, electric power generation and others, various sized diameter pipes and ducts present unique challenges to achieve successful flow meter installation and performance. Hot, moist and/or dirty gases along with a lack of pipe straight-run, distorted flow profiles, low flow rates and wide turndowns rates are common issues.

The MT100's transmitter is both full-featured and rugged to meet these operating challenges. It's all stainless steel enclosure is NEMA4X/IP66 rated to ensure long service life in outdoor installations. Its electronics comes with an extensive choice of output options to interface with virtually any DCS, PLC, SCADA, or recorder. High resolution, 16 bit, dual 4-20mA analog outputs with NAMUR 43 compliance, HART I/O, and Modbus RS485 RTU/ ASCII are all standard. Optionally available are Profibus-PA or Foundation Fieldbus communications

The MT100's large colour touch-screen LCD readout provides comprehensive process information to users with both analog and digital displays of flow rate, temperature and totalised flow, a user time-base selectable strip-chart of flow rate and sensor status diagnostics. MT100 electronics also include a user programmable data logger to which flow rate, temperature and totalized flow as well as fault codes can be recorded on a removable, 8 GB microSD card.

All MT100 Meters have been independently tested and verified to meet and comply with IEC safety directives for EMC and LVD, and carry the CE marking. Optionally available for process installations with hazardous, potentially explosive gases and/ or dust, MT100 meters can be ordered with ATEX or IECEx or FM/FMc agency approvals for Division II/Zone 2. The highly repeatable and reliable MT100 Series Multipoint Mass Flow Meter are also TÜV-certified as AMS compliant with EN15267-3 with QAL1 and EN14181 (2015).

Conclusions

Selecting the proper flow meter technology for refinery process boilers can be challenging. Attention must be given to the details to ensure expectations are met and installation and start-up takes place without any last-minute rework. Collaboration with an experienced and knowledgeable instrument manufacturer is critical in the success of any project of this nature.

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