Technical Publication

Thermal Mass Flow Meter Helps Mud Logging Contractor Meet U.S. EPA Flare Gas Emissions Monitoring Requirements

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Figure 3: ST100 Series display close-up view

Upstream oil/gas production companies around the globe depend on mud logging service companies to analyze mud samples that help them maintain the correct direction for their drilling field operations. In mud logging, samples of rock cuttings from bore holes are brought to the surface by recirculating drilling media (mud) for analysis by a mobile laboratory to determine the lithology and fluid content of the sample.

The surface logging process helps oil/gas engineers determine the correct drilling direction and depth when first commissioning a new well. The drilling operation including mud logging and data analysis can take from three to four weeks. Drilling mud is pumped down the hole to help keep the bit from overheating and to bring rock cuttings to the surface for analysis.

Engineers from the logging service company and the production company generate the logged mud data. The careful analysis of this data helps the engineers confirm the presence of oil and gas to maintain drilling efficiency.

Problem

As the mud is returned to the surface from down the hole, it also contains natural gas. This mud must be run through a gas buster to separate out the gas from the mud. The mud is then recycled back to the drilling (logging) system, and the natural gas is vented to a flare stack and burned off at low flow rates typically from 15 fps to 20 fps.

U.S. Environmental Protection Agency (EPA) Directive 40 CFR Part 98 requires measurement and reporting of these flare gas emissions from mud logging operations *(Figure 1)*. To provide the required flare gas data, mud logging service companies need an accurate, reliable gas flow meter able to measure gas flow at relatively low flow rates with the added benefit of low pressure drop.

In a north central U.S. oil/gas field employing hydraulic fracturing technology, a major mud logging service company recently began looking for a flare gas flow measurement solution that supported these difficult operational requirements and that would help it meet the environmental regulations. The company needed to measure flare gas accurately and reliably at the well head and then find a convenient way to gather the data for EPA compliance flare gas reporting. Environmental regulations normally require flare gas monitoring and reporting that stipulates flow meter accuracy of ±5% of reading throughout the entire measuring range.

Accurate surface logging flare gas measurement presents a challenging environment for any flow meter. It must be able to accurately measure the extremely low flow rates within the 5% of reading requirement. Changes in gas production can also result in a wide turndown requirement that makes it difficult to achieve this accuracy level.

Solution

The mud logging service company engineers contacted Fluid Components International (FCI) for a possible solution. After analyzing the process requirements, the applications team at FCI recommended the company's ST100 Series thermal mass gas flow meter *(Figure 2)*, which provides acceptable accuracy at low flow rates combined with a turndown far in excess of 100:1. The meter also includes integral data logging, and the meter's insertion style probe offered low pressure drop.

Figure 2: ST100 Series thermal mass gas flow meter

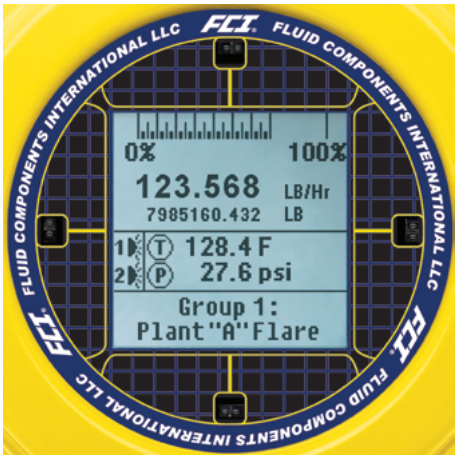

Figure 3: ST100 Series display close-up view

The ST100's unique hot-tap design allows the insertion type probe to be inserted directly into the surface logging gas monitoring system without the need to shut the process down. The ST100 meter includes a display totalizer *(Figure 3)* which can be read every 24 hours together with an internal data logger SD card to log flow data up to 90-days. This flow data is captured, stored, and easily exported to a Microsoft Excel® spreadsheet via USB cable connection or by removal of the SD card.

The flow meter process connection in this case is a 1-inch 300# flange. Pressure conditions at the well head can range from 10 psig to 250 psig (0.07 KPA(g) to 1.7 KPA(g)) at temperatures from 50 °F to 500 °F (10 °C to 260 °C). The gas flow rate was 23 SCFM to 1200 SCFM (0.65 NCMM to 34 NCMM), and the media was a seven component mixed gas. A remote transmitter was located over 50 feet away in a heated location because of extreme cold weather conditions, which allows the LCD display to show mass flow rate and totalized mass flow.

FCI's thermal dispersion constant power technology provides direct mass flow measurement without the need for additional pressure and temperature transmitters, which are required by volumetric type flow instruments such as differential pressure (dP) orifice plate meters, vortex shedding, ultrasonic and other meter technologies. The meter chosen by the mud logging company includes this built-in temperature compensation technology, which automatically compensates for changes in gas properties based on varying process temperatures.

FCI's advanced constant power design for thermal dispersion mass flow measurement allows the reference RTD temperature measurement to be used as an additional output *(Figure 4)*. This constant power technology has proven to be highly reliable and is preferred in moist gas applications where the naturally damped constant power design helps prevent the output "pegging" to 20 mA with the presence of moisture. The heated sensor provides a drying effect, which results in a stable and repeatable reading.

FCI's flow meters feature an advanced thermal mass sensing element comprised of two all-welded 316L stainless steel thermowells, with two precision matched platinum resistance temperature detectors (RTDs). This highly reliable no-moving parts design uses a heated RTD relative to the reference RTD, which creates a temperature differential relative to the gas flow rate.

The ST100 meter can be factory calibrated to measure virtually any process gas, including wet gas, mixed gases and dirty gases. The basic insertion style air/gas meter features a thermal flow sensing element that measures flow from 0.25 SFPS to 1000 SFPS (0.07 NMPS to 305 NMPS) with accuracy of ±0.75 percent of reading, ±0.5 percent of full scale.

This meter is agency approved for hazardous environments, including the entire instrument, the transmitter and the rugged, NEMA 4X/IP67 rated enclosure. Instrument approvals include ATEX, IECEx, FM and FMc.

Conclusion

The mud logging service company is pleased with the performance of the ST100 flow meter, which made it easier to meet the EPA's flare gas monitoring requirements. The benefits of this flow meter in this application included low flow sensitivity to 0.25 fps, multiple calibration groups, low pressure drop and easy, low cost installation. The company plans to expand use of this meter as it receives new contracts to commission additional oil/gas wells in the future. ■

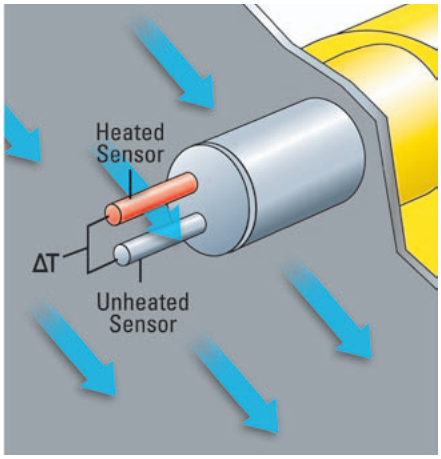

Figure 4: Thermal dispersion mass flow sensing theory of operation