Technical Publication

Solar Powered Thermal Mass Flow Meters For Oil Field Flare Gas Monitoring System

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How do you operate new gas flow meters at an oil field without utility power service in the remote southern Bakken formation region of North Dakota? That was the challenge facing Legacy Reserves LP at remote sites in the Williston Basin, North Dakota.

In an era of increasing environmental concern and regulation, the team at this isolated oil field needed to upgrade its waste gas reporting capabilities for the North Dakota Industrial Commission (NDIC) and the U.S. Bureau of Land Management (BLM). They realized that new state and federal regulations would require monthly testing and reporting, requiring a more sophisticated flow measurement solution.

"We are now required by the NDIC to monitor waste gas resulting from each of our 14 production wells. We wanted to add new flow meters to each well for this purpose in advance of the deadline. The state has set new limits for gas emissions, and we must stay within those limits or cutback well production," said Bernie Schillo, Production Foreman, for Legacy Reserves.

The Problem

Without any utility power service at the field's location in the Golden Valley of North Dakota, Schillo's team decided to explore powering the new meters with solar energy. The 14 wells are laid out on single well pads connected to a 3-phase heater/treater tank that separates the crude oil into three process streams: oil, natural gas and water.

Waste gas from the separation process that is unsuitable for commercial use is then sent to a tank with a flare unit and burned off as necessary. This flammable gas is a combination including: methane, ethane, carbon dioxide, and additional trace hydrocarbons plus water vapor.

Each of the 14 well heads would require two new gas flow meters to support the process. The variable and sometimes low flow volume at the wells meant that differential pressure technologies such as orifice plates could not be used in this application. Legacy Reserves also wanted to use existing gas lines as much as possible.

The Legacy Reserves team completed an assessment for the NDIC prior to starting the project to prove that production could continue while meeting environmental standards. In years past, previous regulations required only an annual 24-hour test of the flare gas monitoring system with the results extrapolated for annual results. Today, more stringent regulations are driving the need for continuous flow measurement.

"We had to convince the state that it was more cost-effective to install flow meters on the wells than to install multiple new gas lines. The supervisory control and data acquisition (SCADA) system that we use is also installed on each well. Our gas streams are on the low volume side and the other approach just wasn't practical," Schillo said.

The Solution

Schillo's team contacted Mike Smith, Technical Sales, at Jasper Engineering in Williston, ND, for help with the solar powered flow meter system. Smith agreed with the feasibility of the team's decision to use solar power for the flow meters, and asked the applications team at Fluid Components International (FCI) for a flow meter solution capable of handling the variable low flow wet gas measurement while being solar powered.

Jasper Engineering then helped the Legacy Reserves site team design their new solar powered system for the flow meters and additional components. The system utilizes two 50 Watt panels to provide 24 hour power, even during the cold Dakota winters on cloudy or snowy days. The team chose two large 12 Volt, 40 Amp hour backup batteries that are housed in a rugged 16 x 16 x 10 inch enclosure *(Figure 1)*.

Figure 1: Solar power system at well site

FCI recommended the ST75V thermal mass flow meter for the 14 wells because of the smaller line size and its constant power thermal dispersion sensing technology that accurately measures mass flow in wet gas applications *(Figure 2)*.

The Legacy Reserves team appreciated knowing their new flow meters *(Figure 3)* were accurate to ±1% of reading over a broad flow range, with repeatability of ±0.5 percent of reading in this wet gas application. This meter is suitable for line sizes from 0.25 inches to 2 inches (6 mm to 51 mm) diameters. For larger diameter pipes of 2.5 inches to 200 inches [63 mm to 5000 mm], FCI provides insertion-style flow thermal flow meters such as models ST98 and ST100.

This meter's robust thermal dispersion mass flow sensing element has no moving parts and no orifices to clog or foul for minimal maintenance in wet, dirty gas applications. FCI's thermal dispersion sensing technology provides direct mass flow measurement. It places two thermowell protected platinum RTD temperature sensors in the process stream *(Figure 4)*. One RTD is heated while the other senses the actual process temperature. The temperature difference between these sensors generates an analog output, which is proportional to the media cooling affect and compensates for changes in pressure and temperature to give a direct mass flow output without additional instrumentation.

This meter's flow element is constructed with a 316L stainless steel body and its Hastelloy C-22 thermowell sensors resist corrosion. Real-time temperature compensation is standard across the whole operating temperature range for accurate, repeatable measurement year-round.

Figure 2: FCI Model ST75V flow meter

Figure 3: FCI Model ST75V flow meter installed at well head

The ST75V meter's transmitter outputs include dual 4-20 mA analog outputs, which are user assignable to flow rate and/or temperature, a 0-500 Hz pulse output for totalized flow and a serial RS-232C I/O port. The optional digital display/readout is a two-line LCD displaying flow rate and totalized flow or flow rate and temperature. In applications with difficult access or display readability, the ST75V's transmitter is also available to be remote mounted up to 50 feet (15 m) away from the flow element inserted in the pipe.

The Legacy Reserves team needed a flow meter with agency approvals for this demanding oil/gas hazardous environment application, and the ST75V meter approvals include: FM/CSA, Class 1, Div 1, Groups B, C, D; Class 1, Div II, Groups A-D, ATEX/IECEx Zone 1, II 2 G Ex d IIC T6 …T3, II 2 D Ex tD A21 IP67 T90°C…T300°C.

The new meters were easy to install at the Legacy Reserves site. It only took the crew 1.5 days to complete the installation after a short training presentation. The meters were installed at a 45-degree angle to avoid wet gas accumulation on the sensor head that could affect measurement accuracy.

Conclusions

Schillo said at the conclusion of the project, "What we're seeing with the new meters is extremely positive. They've proven themselves already during our reviews with the NDIC and BLM staff. There have been no problems to report." In addition, Schillo added that he is already thinking about using the FCI ST75V flow meters at other company production sites. He also was pleased with the support that he received from Jasper Engineering and FCI throughout the process of selecting and installing the new meters. ■

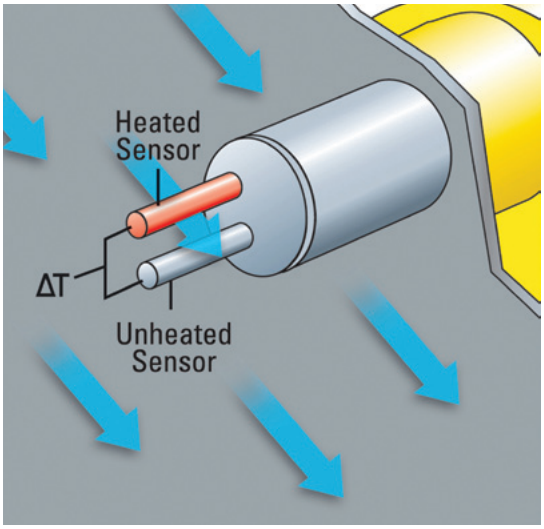

Figure 4: Thermal dispersion technology principle of operation