NEW TRENDS IN MEASURING NATURAL GAS FLOW RATES

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HISTORICAL PERSPECTIVE

Traditionally, the flow of natural gas has been measured by a combination of pressure transducers, smart transmitters, and flow computers. In the earliest types of natural gas flow measurement, transducers and transmitters were connected to flow computers to calculate natural gas flow rates. In terms of the real measurements, these transducers and transmitters served as the heart of flow computers. They still do in newer, smarter forms.

The pressure transducer is basically a sensor that converts one form of energy, pressure or mechanical, to an electrical form of energy. These early transducers provided a low-level analog input, which limited the amount of information available to the flow computer or control system.

INTRODUCTION OF NEW DEVICES

Once smart transmitters were introduced to the process industry, they became the instruments of choice. A bonus for the natural gas industry is that smart transmitters are able to accommodate the longer geographic distances required for accurate measurement of natural gas.

A smart transmitter accepts a signal from an internal transducer, digitizes it, compensates for temperature and pressure changes and generates a scaled signal strong enough for transmission over long distances.

Initially and in most transmitters available today, piezoresistive and capacitance technology was used. A true smart transmitter using piezoresistive technology is microprocessor-based, provides remote, digital, bi-directional communication, employs enhanced self-diagnostics, and is characterized for pressure and temperature compensation.

Smart transmitters enable the accurate measurement of differential pressure (DP) across an orifice for example, from which the flow rate is then inferred.

Unfortunately, this measurement is often flawed unless pressure and temperature transmitters are also used.

While smart transmitters could always measure absolute pressure (AP), they were only sensitive and accurate enough to be used to compensate the DP measurement for static pressure changes. In the same way, a temperature sensor on the same silicon (dye) is used to measure temperature and compensate the DP measurement for ambient temperature changes.

With the advent of the new SMV 3000 multivariable transmitter, a revolutionary new sensor was employed. This increased sensitivity sensor provides a highly accurate static pressure measurement also; a 0 - 400 inch DP measurement with 0.075% of span accuracy and 0 - 1500 psia AP measurement with 0.075% of span accuracy. Dynamic flow compensation is supplied by calculating in real time the discharge coefficient, gas expansion factor and thermal expansion factor. Figure 1 below shows a multivariable transmitter sensor.

A multivariable sensor measures differential pressure, gauge or absolute pressure, and meter body temperature. The absolute pressure and meter body temperature measurements are also used in a process call characterization.

Characterization involves measuring the DP at different static pressures and temperatures as well as measuring the static pressure at different temperatures. The data collected from this characterization process is stored in the transmitter. When a DP or AP measurement is made...
in the field, this characterization process ensures an accurate measurement under changing pressure and ambient temperature conditions.

For reverse flow applications, this type of characterization is important because it will allow negative DP ranges (0 - negative 400’’ H₂O). This capability for measuring reverse flows can be an important advantage in the natural gas industry.

In addition, new applications with these instruments allow the meter body to connect up with almost any electronics used by flow computer manufacturers for a straightforward, uncomplicated mass flow rate solution.

ACCURATE MASS FLOW CALCULATIONS

Many flow measurement applications are inaccurate, as there are no compensation calculations for density changes. The historically common use of a single variable DP transmitter to calculate volumetric flow, without compensating for temperature and other effects, can provide a highly inaccurate flow measurement.

The new trend is towards multivariable transmitters that not only measure DP, but temperature and pressure as well. Using all these variables, the multivariable transmitter is able to accurately compensate for any changes in temperature and pressure to provide a much more accurate flow rate reading. Because these variables can fluctuate considerably, the flow rates, either in mass or volume, are considerably more accurate.

BENEFITS TO THE NATURAL GAS INDUSTRY

What does the increased capability of multivariable transmitters and transducers mean for the natural gas industry? It means that a complete mass flow measurement is readily available and much less costly than ever before.

These costs savings are included in the purchase price, installation, reduced number of instruments needed, less maintenance due to less instruments, and the often incalculable benefits of having accurate flow rates available for custody transfer billings, accurate process control, and the like. These types of benefits can be obtained in applications such as shown in Figure 2 below.