White Paper-

RAISING POWER PLANT EFFICIENCY VIA ACCURATE FUEL MEASUREMENT

Introduction

The energy picture in the U.S. and around the world is undergoing radical change. Renewable generation is flooding onto the grid, displacing traditional generation sources. Existing economics and regulatory demands mean that coal and nuclear are in decline. The last few years has witnessed a steady stream of announcements about coal plant retirements and the cancellations of proposed nuclear facilities.

While renewable sources like wind and solar are favored at a governmental level to pick up the slack, the reality is that natural gas-fired generation plays a vital role in supporting renewables. Wind, for example, tends to peak during the night and in the early hours of the morning. As demand picks up in the morning, wind available typically drops off sharply. Similarly, solar output fades as the evening peak demand surges.

What is emerging is a power grid where renewables are favored but natural gas is required to fill in the gaps in supply. Expect, therefore, more and more fast-ramp gas turbine plants to appear on the grid in tandem with the built out of more renewables. However, gas quality is more variable than ever and this can endanger machinery unless proper monitoring is carried out. The answer is accurate fuel flow monitoring. The right fuel flow meter provides very precise tuning to match flow rate and pressure drop requirements. There are several different types of flow meters on the market. It is important that natural gas facilities select the right one for their needs.

The Emerging Grid and Fuel Monitoring

The demand for natural gas has been rising in many areas, particularly in the USA. Yet that has come with a decline in the quality of the gas supply. Those power plants receiving gas from shale gas deposits, for example, have to deal with lower gas quality due to the presence of various impurities. In other parts of the world, and greater reliance on unconventional gas has brought about a gas supply which includes greater concentrations of H_2S and other hazardous components.

These newer sources of natural gas typically contain an overabundance of heavier hydrocarbon components. One simple cycle plant in the Marcellus shale field in the U.S., for example, was receiving gas that contained more than 20% ethane and oil sludge. As a result, the gas supply fell outside the quality specified for operation of its fuel nozzles. If the plant burned that fuel, the nozzles and the combustion system could become badly damaged.

Another aspect of the problem is the makeup of the gas, which can vary over time. Even within one day, shifts in shale gas dew point mean that gas received from the pipeline that met quality standards in the morning, may no longer qualify. This comes about as changes in the dew point impact the temperature at which the gas stream undergoes a phase transition to liquid at a given pressure. It is vital, therefore, that power plants closely monitor their gas before allowing it to enter their turbines.

During hot weather, for example, the temperature inside a pipeline can rise dramatically which affects the hydrocarbon dew point. How? Heavier hydrocarbon elements that are in a gaseous state during the day may condense at night to form more liquids inside the pipeline. Such liquids can sometimes cause damage to combustors and other turbomachinery components.

An unfortunate side effect of the North American shale boom bears mention as regards fuel quality: there are more gas supplies available than ever before. The consequence of this is that many pipeline networks now have gas inputs from multiple suppliers and each one has a different gas makeup. Gas that is compliant to machinery specifications can suddenly become hazardous due to its point of origin shifting. These days more than ever, then, plant managers have to closely monitor gas quality rather than relying on the measurement data of others.

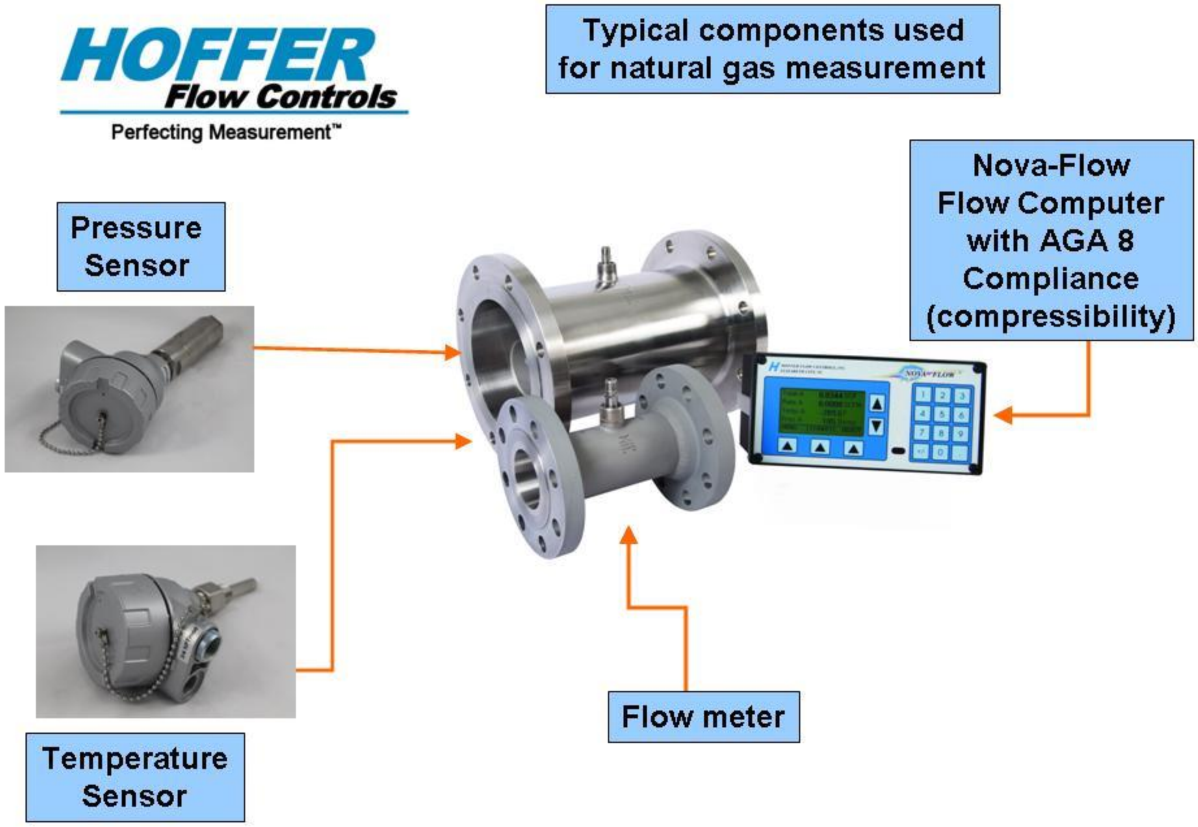
Flow Meter Options

Monitoring of natural gas is accomplished via a fuel flow meter that is installed before the gas is fed into the combustor. There are several types of flow meter options available. For gas-fired turbines, the main choices are mass Coriolis, multipath ultrasonic and turbine flow meters.

Mass Coriolis instruments make use of the Coriolis effect. A vibration is induced in the flow tube and sensors monitor changes in frequency, phase shift and amplitude which help determine the mass flow rate. These meters are accurate, meet many industry standards and are widely used. However, they require a large independent foundation, under EPA rules require regular calibration to maintain accuracy levels, and they are expensive.

Multipath ultrasonic devices are also commonly employed in fuel flow measurement. They use ultrasonic pulses to calculate the amount of gas passing through the meter. As they don't depend on kinetic energy, low rates of flow can be measured. These meters provide a very low pressure drop but also come with a higher price tag. As they have no moving parts, maintenance costs are relatively low.

Turbine flow meters were first developed for fuel measurement on aircraft. To this day, they remain in use in modern planes including the very latest stealth jets. These devices measure the velocity of a moving fluid. Turbine flow meters offer high accuracy that can be maintained over a wide turndown range. Calibration is easiest on this type of meter. The pricing for a turbine flow meter will be more attractive and the turbine flow meter will attain an accuracy of ±.25% of reading or better. For gas turbines, turbine flow meters are generally the best option.



Specifying of Turbine Fuel Flow Meters
Those specifying them should look for those characteristics which matter most:

Approvals: Particularly for small gas turbines, approvals play a vital role. As gas turbines are shipped all over the world, those manufacturers that provide the widest range of approvals are a wise choice as requirements vary widely from continent to continent and country to country. Relevant approvals include ATEX, PED 97/23/EC, NACE, Hand Book 44 USA, OIML, R-81-World, CSA-Canada, NIST-USA, CE Standard –Europe, Dantest – Denmark, NORSOK, ISO-IEC 17025, ASME B31.3, AGA Report 9, ISO CD17089 and ISO 9001.

For larger gas turbines, accuracy and high performance are probably the most important elements of the selection process. On the performance front, response times should be in the millisecond range for best results. The industry's general accuracy standard is 1.5%, however some demanding power plants require measurement accuracy down to 0.25% to assist in their emissions monitoring efforts. Pay attention, as well, to repeatability, which deals with how well a measuring device is able to display the same value of a measured variable under identical conditions. Look for a repeatability factor of .1% or better for best results with large gas turbines.

CFR compliance is another area to consider. The Clean Air Act has requirements for fuel flow meters as covered under 40 CFR 75. This gives an elaborate description of the calibration and accuracy standards for these meters. Vendors have to provide meter calibrations that demonstrate they comply with this standard.

When it comes to calibration, the process should be simple, straightforward and should not have to be repeated endlessly. Users want an accurate fuel meter that provides reliable readings without rocket science or the continual need for verification.

Some plants continue to use orifice and differential pressure meters in gas fuel flow measurement. However, these instruments have a limited turndown range that can be an issue in some natural gas applications. Stick to meters that provide an adequate turndown range.

Price, too, plays a part. For gas turbine fuel flow, there is no need to specify the most expensive type of meter as that may not provide the best return on investment. But it is wise to avoid those priced very low as they will not provide the performance required for gas-fired plants. Some manufacturers make components from plastic or aluminum, but these aren't robust enough for the heavy duty nature of gas-fired facilities. Similarly, corners can be cut with rotors. Cast iron rotors inside turbine fuel meters, for example, are heavy and this translates into slower dynamic response to changes in flow rate. Rotors that are precision machined from bar stock are lighter and provide faster response.

In terms of maintenance, turbine operators have enough to worry about without having to babysit a fuel flow meter. Opt for models with relatively low maintenance needs.

Pressure drop can also vary from one turbine flow meter to another and this has to be balanced against other factors. Curved blades, for example, are known to extract the greatest amount of energy from a fluid stream which makes them attractive for power plant applications. However, curved blades also produce a higher pressure drop. Flat blades, on the other hand, often provide the best mix of performance and pressure drop.

Thermal efficiency

Correct flow measurement of natural gas is vital in determining the plant's thermal efficiency in converting fuel BTU's to kWh's and balancing output with the correct degree of control over plant stack emissions. Contracts between the turbine OEM and the utility, for example, often guarantee certain levels of thermal efficiency. For a specific amount of fuel, a definite amount of electricity output is expected. If the conversion from BTUs to kWHs is not what it should be, contractual penalties can come into play. Utility billing meters provided by gas pipeline companies, after all, are far less accurate and cannot be relied upon. It takes a reliable turbine fuel meter to ensure gas quality and flow accuracy.

About Hoffer Flow Controls

Hoffer Flow Controls has a long and successful history in a variety of measurement applications associated with gas turbine systems. Its meters are used by every major manufacturer of gas turbines for applications that include fuel measurement (gas and liquid), wet NOx emission reduction spray systems, critical cooling water flow, fuel conditioning flows and condensate flows to name but a few.

The Hoffer Flow "Premier" Series of custody transfer gas meters continue to set the standard for high performance measurement. These gas turbine flow meters and flow computers have been selected by many domestic power utilities as the meter of choice for their natural gas flow applications. Hoffer supplies complete flow systems to these customers that include meters, meter runs (upstream and downstream piping and flow straightening sections compliant with AGA 3) and flow computers that are AGA 7 and 8 compliant. In addition to meeting these American Gas Association standards these systems are used to verify compliance with the continuous emission monitoring rule "Appendix D of CFR (Code of Federal Regulations) 40.

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