Three steps to accurate gas metering heaven......

Combined cycle gas turbine (CCGT) power stations, combined heat and power (CHP) plants, gas storage sites and intensive energy using industries burn or handle very large quantities of gas per annum. This gas usually represents one of the greatest input costs (and hence risks) to their business, a cost which is mainly determined by the accuracy of their gas metering and the price paid for the gas. Companies often go to great lengths to make sure the commercial arrangements for gas purchase are as favourable as possible, but overlook the obvious question: Actually, how accurate is our gas metering?

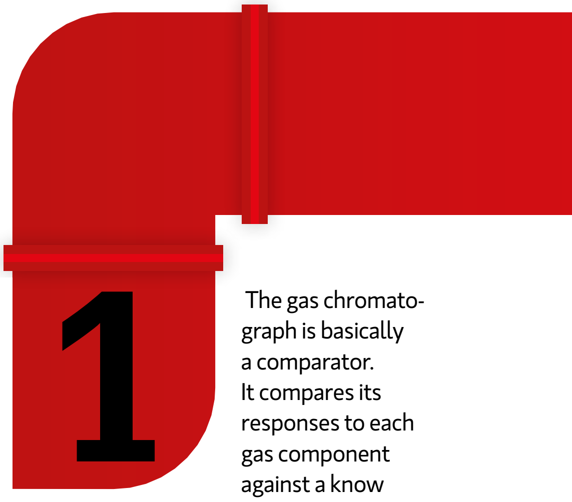
Modern high pressure/high volume gas metering systems are far more complex than many people realise, far more so than your domestic meter at home, but ultimately doing the same job – generating a bill. Unlike your meter at home these are not "it and forget" systems, they are made up of multiple components, all of which are susceptible to drift, faults, incorrect set up, or botched maintenance. This is a very specialised area, where experience really counts and expertise is mainly concentrated in the upstream oil and gas sector – offshore and at the gas terminals around our coasts.

Very few companies offer such expertise to the downstream sector, the gas users onshore. One such company that does is EffecTech Ltd., who are unique in being able to facilitate all three of the steps that must be taken to reduce the uncertainty of gas metering systems to the lowest possible percentage of gas volume and energy. For readers who are less familiar with gas metering for billing or custody transfer, sometimes known as "fiscal metering" here is an overview of the key steps to consider.

The distinction between volume and energy in relation to natural gas measurement is a very important one. Gas is usually traded in terms of energy units, but most meters primarily measure volume. Therefore, one of the tasks of the metering system as a whole is to convert from volume (or mass) to energy for billing purposes. However, the instrument that measures the energy content of the gas also plays a vital role in determining the volume. As many readers will be aware, this instrument is the process gas chromatograph. Typical North Sea natural gas is made up of many components, of which Methane, Ethane, Propane, Nitrogen, and Carbon dioxide comprise the largest fractions. The chromatograph separates these components, measures and reports the percentage of each component in the mix by mole fraction, and often calculates the energy content of the gas – or calorific value (CV); expressed as megajoules per standard cubic metre. But the gas composition reported by the chromatograph is used for much more than just this.

In the UK a standard cubic metre of gas is defined as a being at 15°c and 1.01325 BarA, a standard atmosphere in fact. However, most flow meters such as turbine and ultrasonic meters, measure the volume of gas flowing through them at whatever pressure and temperature exists in the pipe line. This uncorrected (gross, or observed) volume, has to be converted into standard volume before it can be further converted into units of energy. The composition data from the gas chromatograph is used by the flow computer (or volume corrector) to calculate the density and standard density of the gas in order to do this. The calculations for this are quite complex, and should conform to the international standards ISO 6976 and AGA8. To calculate gas density at line conditions, the pressure and temperature of the gas flowing through the meter must also be accurately measured.

So what are the three steps the gas user should take to ensure that this complex set of interactions all operate within the lowest possible uncertainty? Two relate to the gas chromatograph, and the other to the rest of the metering system.



The gas chromatograph is basically a comparator. It compares its responses to each gas component against a know proportion of each component contained in a calibration gas. Usually the gas chromatograph performs a self calibration daily using this calibration gas. However, the most important point to understand from this is that the accuracy of the gas chromatograph is primarily dependent on the quality of this calibration gas. In the recent past these gases were made up and certified gravimetrically by weight, however the best calibration gases available today are made gravimetrically, and then calibrated and certified by analysis by an ISO17025 accredited calibration laboratory. The certification is therefore for what comes out of the cylinder and not what was put into the cylinder.

2

Whilst chromatograph calibration using a calibration gas is essential, each gas component is only calibrated at one value (that contained in the calibration gas). To ensure that the chromatograph is both linear over the full possible concentration range for each component, and repeatable in its measurements, the ISO10723 performance evaluation was developed. This involves repeated analysis of seven very different certified gas mixtures, and a considerable amount of statistical data analysis of the results from this. Annual ISO10723 evaluations are compulsory in the UK to comply with the requirements of the Carbon Emission Trading Scheme (Tier 1). However, they are advisable even for sites where this is not a requirement. When combined with an audit of the instrument and its gas sample let down system, the ISO10723 evaluation is the only way to ensure that the gas chromatograph is generating quality data, and producing the lowest possible measurement uncertainty.

3

Many people think that validation of the gas flow metering system ends with having the meter itself calibrated. Whilst this is a vital part of the process, it is usually only done every 3 to 5 years, because in the case of turbine, ultrasonic, and Coriolis meters, calibration must be performed at an ISO17025-accredited facility, and on natural gas at typical operating pressure, temperature, and over the full range of flow rates. Normally the meter and associated upstream pipe spools are sent away together, making the process quite costly. In the case of orifice meters, just the orifice plate is usually sent away for calibration annually. However, whatever meter technology is employed, on-site validation of the entire metering system is absolutely vital to ensure that costly mis-measurements of gas volume do not occur. This involves in-situ calibration of pressure, temperature; and in the case of orifice type flow meters, differential pressure transmitters. Ideally, this should be carried out by an ISO17025-accredited organisation. The flow computer must be validated to ensure that the calculated values for density, standard density, CV, as well as standard volume and energy flow rates and totals, are correct against third party off-line calculations. The configuration and fixed factors used in the flow computer for these calculations must also be verified as part of this process. Finally, all the data – particularly for gas composition – moving around the system should be correctly transferred to the correct locations.

There are within the gas industry recognised procedures for carrying out all these validations, in the case of National Grid Gas these are often referred to as ME2. Where the metering system is owned and operated by the plant owner or buyer of the gas National Grid will insist that the metering system is validated annually as a minimum. However, in order to reduce the financial risk from possible large monetary adjustments should an error come to light, more frequent validations are strongly recommended.

In cases where the end user of the gas does not own and maintain the metering system, there is one further step to take. They should definitely consider having an experienced third party carry out an audit of the metering system, its maintenance, and validation. This is usually best done by having the third party witness a full validation of the metering system carried out by the normal personnel. Even just doing this as a one off exercise will provide valuable assurance, but regular witnessing will ensure that those performing the maintenance and validation are not cutting any corners, and highlight if they lack in the required experience and knowledge.

Finally, it should always be remembered that the cost of taking all of the steps to best gas measurement practice outlined above, is actually very small in relation to both the total annual value of the gas metering, and the potential financial risks from not doing so. It should therefore be viewed in rather the same way as insurance. ■

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