

Online gas analysis

gas-lab Q1 with turbo

Growing energy needs, globalisation and the liberalisation of the gas trade are driving demand for efficient and innovative gas measuring equipment, particularly equipment for analysing gas quality. One aspect of this trend is the global distribution of gases from various sources and in various qualities. A large number of processes relating to the use of gas, such as gas turbines, are very sensitive to varying gas parameters and must be adjusted or regulated accordingly. Alternatively the range of gas parameters can be limited by mixing gas in the transport network. Both cases require efficient process measuring equipment for gas quality. Online measuring equipment, which measures the target parameters continuously and quickly, provides the perfect solution to this problem. The correlative gas quality analyser gas-lab Q1 from Elster-Instromet is therefore used globally for these applications with great success. The already high measuring dynamics of the device has now been further increased by some new developments.

The use of gas turbine power plants is growing all over the world. They can generate electricity and heat with a high efficiency level, offer a great deal of flexibility in output and produce relatively low emissions of pollutants and CO₂. The perfect operation of gas turbines, however, is heavily dependent on the parameters of the combustion gas and therefore this process requires the appropriate measuring, control and regulating equipment. The aim of this is to improve the energy efficiency of the turbine while at the same time reducing emissions of pollutants from it and also minimising the mechanical stresses on the turbine imposed by the dynamics of the combustion process. The online gas quality analyser gas-lab Q1 (Fig. 1) from Elster-Instromet supplies the main gas parameters such as calorific value, density, Wobbe index and methane number on a continuous basis using a measuring rate of approx. 1 Hz; it is therefore frequently used for controlling turbines.

To illustrate the measuring dynamics of the gas-lab Q1 achieved to date, Figure 2 shows the results of an extensive large field test using a real gas power plant. The composition of the combustion gas was varied quickly and sharply by adding liquid petroleum gas (LPG) to study the reaction of the gas turbine. The calorific value of the gas mixture was recorded continuously and in real time by the gas-lab Q1 (blue curve in Figure 2). In addition to the measuring dynamics, the measuring accuracy was also verified with a gas chromatograph. The yellow dots in Fig. 2 indicate the moment at which the samples were taken while the green dots are the end of measuring by the gas chromatograph.



Fig. 1: Measuring unit of the gas-lab Q1 in an EEx d housing on a mounting plate with low pressure regulators for sample and calibration gas as well as a bypass



graph. The red dots show that the measuring deviations (right-hand scale) are within a range of 0.2% and that the measurement process of the gas-lab Q1 does not deviate from the comparison measurement by the gas chromatograph by more than 0.25%. It should be noted in this respect that both devices were calibrated independently with different reference gases (from different continents).

The combination of a high measuring dynamics and accuracy for the calorific value over a wide range of natural gas types is unique. This means that the device also complies with the high requirements both for measuring, control and regulating equipment and also for fiscal measurements. Nevertheless users always want to increase the measuring dynamics even

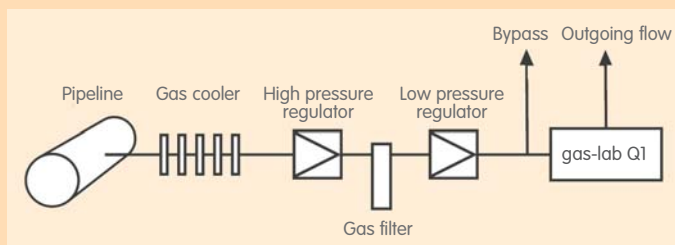


Fig. 3: Gas sampling for a typical measurement application for controlling gas turbines. The flow mechanics parameters of the sample taking and preparation processes as well as those in the measuring unit itself were enhanced to improve the measuring dynamics of the gas-lab Q1. In addition, the parameters of the adaptive digital signal processing filters underwent further development.

further so as to give them even more design freedom when planning the pipelines for power plants and gas mixing systems. For gas turbine power plants, faster measurements mean that the feed system to a gas turbine can be designed

in more compact form. Continuous gas analysis units such as calorimeters or residual oxygen meters have long been in use in large gas mixing stations, for example for regulating the Wobbe index of transport gas. These stations will also benefit from an increase in the measuring dynamics since the mixing loops can therefore be designed to be smaller.

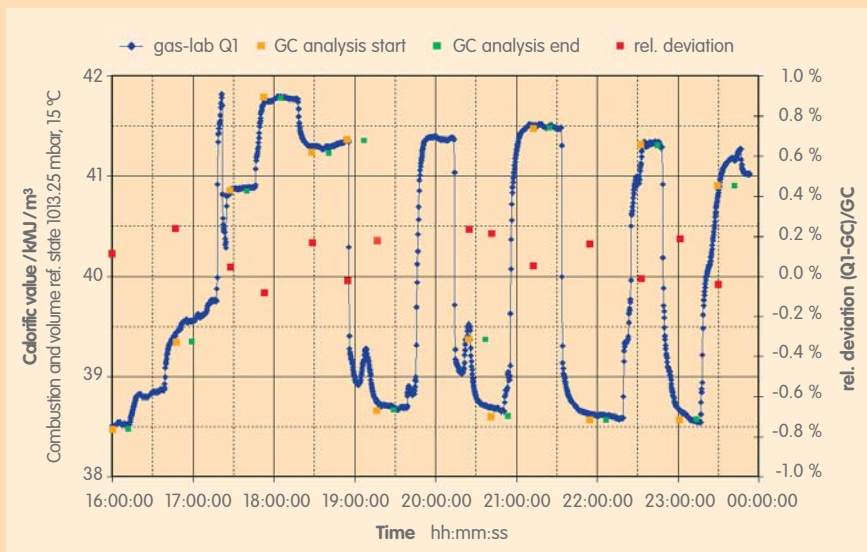


Fig. 2: Measurement results from a large field test: Variation of the combustion gas for a gas power plant by adding liquid petroleum gas. Measurement of the calorific value with the gas-lab Q1 (with its previous measuring dynamics) compared to a gas chromatograph.

So how has it been possible to make a further increase in the measuring dynamics of the gas-lab Q1?

First of all the various timings from taking the sample to entering it in the measuring unit were analysed. The following typical structure for a gas turbine measurement was considered for this purpose (Fig. 3). The gas is taken from a pipeline which has a pressure level of 30 bar, passes through a gas cooler and its pressure is then reduced to 0.5 bar in a high pressure reduction system. The gas is filtered from droplets and particulates by a coalescence filter and its pressure reduced further to a pressure of 80 mbar when it enters the measuring unit by means of a low pres-

sure regulator. This process requires the time t_{sample} . Finally the gas flows into the measuring unit where the gas change must take place in the internal volumes, while the raw signal is measured and the signal then also processed. The duration of this process is characterised by a so-called t_{90} time; this is the time from the start of the gas change to the point at which 90% of the signal change that corresponds to the gas change has been reached. We define an internal t_{90} time $t_{90_{\text{int}}}$ for the duration of the jump in the measuring unit and an external t_{90} time $t_{90_{\text{ext}}}$ which also includes the time for taking the sample and is dependent on the external gas flow. Figure 4 shows the times described above in the typical signal curve for a calorific value measurement during a fast gas change.

In this latest further development, the flow mechanics parameters and bypasses for taking the sample were adjusted in such a way that the time required for taking the sample t_{sample} was reduced from 8 seconds to 4 seconds. To reduce the jump duration $t_{90_{\text{int}}}$ for the gas change in the measuring unit, the flow mechanics parameters in the sensor bank were also improved. In addition the adaptive digital signal processing filters underwent further development and were tuned up. This resulted in the internal jump duration $t_{90_{\text{int}}}$ being reduced from approx. 15 – 20 seconds in the past to the current approx. 5 – 8 seconds.

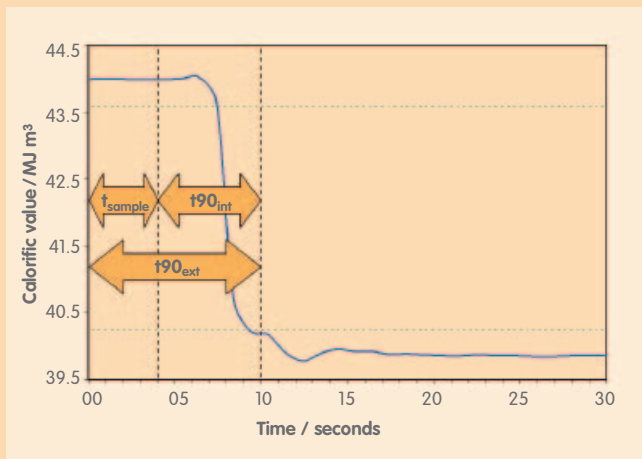


Fig. 4: Schematic diagram of the jump response of the calorific value measurement after an abrupt gas change at time 0. Illustration of the time for taking the sample t_{sample} , the internal jump duration $t_{90_{\text{int}}}$ and the total jump duration $t_{90_{\text{ext}}}$.

Overall the improvements result in a total jump duration $t_{90_{\text{ext}}}$ of approx. 12 seconds for a typical application for controlling gas turbines with a 30 bar pipeline.

This development meant that Elster-Instromet follows the wishes of users: Increasing the measuring dynamics of the gas-lab Q1 now gives them even greater freedom in the design of the pipelines for measuring and control applications.

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