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Gas Analysis Application

Using the QGA for Syngas measurement and process control

Hiden QGA gas analysis system

Introduction

Synthesis gas (syngas) is a mixture of gases made from a variety of gasification processes, such as coal gasification. The gas mixture is then used to synthesise commercially useful products, such as methanol and ammonia, or used as a source of energy for power generation. The main advantage is transport – gas is easier and cheaper to pump and transport than coal.
For process control it is important to know the composition of the gases produced by gasification. This allows the chemical rate of a reaction to be optimised, or the energy value of the combustion gas to be adjusted for fuel efficiency. A convenient, non-destructive way to do this is to use mass spectrometry, which can identify the gases and measure the compositions in real-time. Hiden offers gas analysis systems, based on quadrupole mass spectrometers, such as the QGA gas analysis system (pictured to left). A flowing gas stream can be measured with the QGA taking a small sample and giving an output of gas composition in real time. Small changes in composition are detected and can be used for process monitoring and control.

Syngas Applications

The Hiden QGA has several advantages for this application. The Hiden QIC (quartz inert capillary) flexible 2 metre inlet provides fast response times less than 300 milliseconds for most common gases and vapours, including water and organic vapours. Sampling from the syngas at pressures between 100 mbar to 2 bar gauge, the instrument takes a representative sample of the main gas flow. The consumption of

sample can be varied, up to 20 sccm (standard cubic centimetres per minute), depending on the configuration and settings.

The Hiden QMS (quadrupole mass spectrometer) is the heart of the analysis system and is stable and sensitive down to ppm levels.

QGA Professional is a custom software package supplied with all QGA systems and allows for quantitative gas analysis in real-time. It is designed to be simple to use and has straightforward setup screens. The species of interest are added to the analysis and an overall mass spectrum is generated, as see in Figure 1. This shows the overlapping mass peaks, and the anticipated contribution from each different species.

The QGA Professional software is intuitive and easy to setup, with automatic calibration and a library of gases included. The experiment files gather data which is quantitative and can be easily exported or sent to a DCS or PLC, in real time.

The system is reliable with low maintenance requirements, using a dry scroll pump and no moving parts in the mass spectrometer, enabling very high uptime. This makes it well suited for measurement of syngas processes.

Figure 1: QGA Professional screenshot showing gas components cracking pattern for syngas mixture

Example Data

Some typical syngas compositions are seen in Table 1.

Gas	Gas 1	Gas 2	Gas 3
	Typical Value / %		
Carbon Monoxide, CO	45 – 55	50	5
Nitrogen, N_2	8	10	80
Carbon Dioxide, CO_2	10-15	20	5
Methane, CH_4	2	-	5
Hydrogen, H_2	25 – 30	20	5

Table 1: Example typical compositional ranges for syngas components

Measurements

A gas panel was used to create a typical syngas composition. This also allowed variation of the composition, so the QGA could be evaluated for this application. The QGA professional software features were used. For calibration, gas flushing through the system is important, before calibration is started. This allows the system to stabilise, giving better calibration data and improved quantitative measurement data when the syngas sampling is commenced. The software also has the relative sensitivity factors, and other information in the library, allowing easy setup, whatever the syngas mixture of interest. Mass spectrometry are also very flexible and can be used to detect and interpret any unknown that are seen in the sample.

For this testing the software was setup to measure the key peaks of the mass spectra for the 5 components of H_2, CH_4, CO, CO_2, N_2. There are some overlaps, which QGA Professional automatically calculates, based on the calibration performed. The standard method for this mixture is given by:

- CO at mass 12,
- N_2 at mass 14,
- CO_2 at mass 44,
- CH_4 at mass 15

Essentially this is the method to de-convolute the spectra, which uses the strongest peaks in the spectra.

Using the gas panel enabled a wide range of compositions to be investigated.

Gas	Composition Range 1:	Composition Range 2:
	Typical Value / %	
Carbon Monoxide	> 30 %	> 30 %
Nitrogen	10% < > 30 %	1% < > 30 %
Carbon Dioxide	0%	< 10%
Methane	0%	< 10%
Hydrogen	> 100 ppm	> 100 ppm

Table 2: Example typical compositional ranges for measured syngas components

Composition range 1 can be analyzed by the QGA using the QGA Professional software and the standard method a). Composition range 2 shows typical values for a coal gasification application. Due to the low level of nitrogen and the presence of carbon dioxide, this composition range is more easily measured using a custom method.

The various results were collated from the sample gas tests. This allowed a correlation between the gas concentration expected and actual to be plotted. Expected was calculated using the mass flow controller, whereas actual was the measured by the QGA instrument.

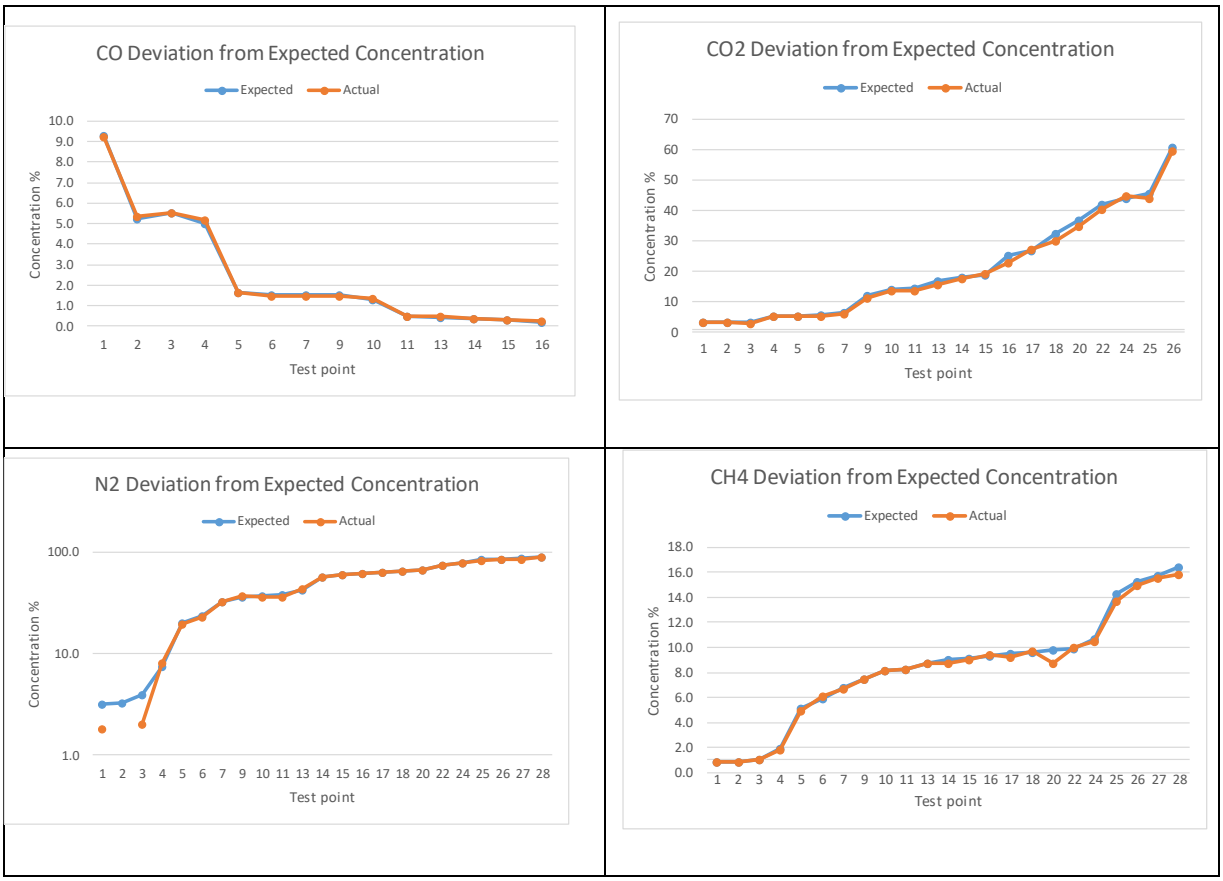

Figure 2: Comparison of composition for CO, CO_2, N_2, CH_4 for syngas components

Conclusions

Generally, there is a good correlation between the expected and measured data, with only small deviations. So mass spectrometry is an accurate method for measuring the changing syngas composition. The largest deviation was for low levels of N_2. Where there are deviations, the method can be adjusted to take into account the different mass peaks available for the gases.
Hiden is able to provide guidance and templates if the Syngas typical composition is known, and with the QGA provides much more rapid analysis than traditional sampling and submission to laboratory measurements. The real time analysis enables the end user to optimise their process gas flow with regard to the composition, an important aspect of many Syngas processes.
The experience built up can provide insight into other syngas compositions which are atypical. The method development can be adapted to perform these potentially more difficult measurements.

References

Using quadrupole mass spectrometry for on-line gas analysis – Gasification of biomass and refuse derived fuel
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