Choosing the Right Gas Analyser

Quantitech Director Dominic Duggan outlines the key factors affecting the choice of analyser for process, ambient and stack monitoring. In doing so, he claims that FTIR has become the dominant technology.

A potentially bewildering array of options present gas detection professionals with an opportunity to spend anything from a few hundred to tens of thousands of pounds on a single analyser. This choice is further complicated by the emergence of new technologies and new regulatory requirements, so whilst this article will provide an outline of some of the options, there is no substitute for expert advice.

Traditionally commonplace in occupational safety monitoring, multiparameter analysers enable operators to test for the gases of most concern in the workplace. However, in recent years, multiparameter gas analysers have become more prevalent in stack gas analysis as the technology has been proven and MCERTS approved instruments have become available.

Multiparameter analysers are generally more expensive than single parameter analysers. However, the cost comparison moves in favour of multiparameter as more gases are measured. Furthermore, many process operators have chosen multiparameter because it provides them with the option to add further gases at a later stage – 'future proofing' their monitoring capability.

As the leading proponent of FTIR in the UK, Quantitech has an obvious bias in favour of this technology. However, as time passes, FTIR is finding ever-increasing application in a wide variety of industries and applications. Whilst writing this article, for example, an engineer called for advice on the measurement of Benzene. A single parameter infrared analyser at a cost of about £10k was the obvious solution. Then the caller mentioned a further need to measure Sulphur Hexafluoride, which would incur a further £10k. So, at this point portable FTIR has to come into consideration because if the caller needs to measure three parameters, now or in the future, then the cost-effectiveness of multiparameter starts to outweigh single parameter analysers.

Applications – Stack Monitoring

More than thirty certified continuous emissions monitoring systems (CEMS) are available employing a variety of technologies. These include Ultraviolet (UV) and Infrared (IR) absorption, Fourier Transform Infrared (FTIR), Differential Optical Absorption Spectroscopy (DOAS), chemiluminescence and photoacoustic spectroscopy (PAS). Numerous techniques are also available for the measurement of particulates.

Many factors affect the choice of analyser, but the regulatory requirement is of course the most significant. A coal fired power station for example, may only be required to monitor SO_2, NOx and CO, whereas a municipal waste incineration plant will have to monitor other parameters such as organic compounds, HCl, HF and dioxins and heavy metals etc.

If a process operator is only required to monitor, say, three parameters, single gas analysers might be the most cost-effective alternative. However, if more gases are required (now or in the future) a multiparameter analyser would cost less.

Portable, MCERTS approved and relatively low cost, Horiba's PG250 multiparameter analyser has been very popular because it is a portable stack gas analyser that can simultaneously measure up to five separate gas components using the same standard reference measurement methods employed in permanently installed CEMS. These include NDIR for CO, SO_2, and CO_2, Chemiluminescence for NOx, and a Zirconium Oxide Cell for O_2 measurements.

Many of Quantitech's test house customers employ the Horiba PG250 to perform compliance monitoring on incinerator stacks for a broad range of parameters and to conduct QAL 2 calibration of CEMS, following the requirements of BS EN 14181.

In recent years there has also been an enormous growth in the popularity of FTIR based multiparameter monitoring systems – both portable and continuous. Quantitech has supplied over 100 Gasmet FTIR systems in the UK and almost 2000 systems have been installed worldwide.

An FTIR spectrometer obtains infrared spectra by first collecting an 'interferogram' of a sample signal with an interferometer, which measures all infrared frequencies simultaneously to produce a spectrum.

Sample identification is possible because chemical functional groups absorb light at specific frequencies. In addition, through calibration of the spectrometer, it is possible to determine the intensity of the absorption (relative to the component concentration). As a multicomponent gas analyser, the Gasmet FTIR is therefore ideal for process operators that need to:

1) Analyse multiple components, or
2) Analyse hot/wet gas
   (e.g., hot humid applications for HCN, NH_3 or HCl etc)
3) Analyse any gas in complicated gas mixtures

The Gasmet library of reference spectra consists of reference files of gas spectra measured to date with different Gasmet gas analysers. The library contains hundreds of spectra and each reference spectrum contains both quantitative and qualitative information about the component. This means that users are able to analyse samples retrospectively if a new parameter becomes of interest.

Whilst FTIR is able to analyse an enormous number of gases, the technique is not suitable for noble (or Inert) gases, homonuclear diatomic gases (e.g., N_2, Cl2, H2, F_2, etc) or H_2S (detection limit too high).

High levels of accuracy and low levels of maintenance are achieved as a result of continuous calibration with a He-Ne laser, which provides a stable wavenumber scale. In addition, high spectral signal to noise ratio and high wavenumber precision are characteristic of the FTIR method. This yields high analytical sensitivity, accuracy and precision.

The Gasmet FTIR analyser is MCERTS approved for nine of the most important parameters. However, with such a vast array of measurable parameters possible, existing users are able to take measurements that help improve process control and allay any concerns with potential additional monitoring requirements in the future.

FTIR is not currently certified for VOCs, however this is a subject that is currently being actively investigated.

The analysers outlined above monitor a sample stream that is extracted from the stack. However, in-situ multiparameter analysers are also available for measurement within the stack.

In addition to the regulatory requirement, a range of other factors affecting the choice of analyser include the gas mixture, temperature, flow rate, the external environment, stack accessibility and budget.

Applications – Process Monitoring

Similar factors affect the choice of analyser for monitoring manufacturing or production processes. However, gas concentrations tend to be higher and MCERTS approval is not essential. Nevertheless, manufactured products and processes tend to change so there is a

strong argument for flexibility in the monitoring strategy.

A further benefit of continuous process monitoring provides an opportunity for feedback control of the process and/or the creation of alarms.

Applications – Ambient Monitoring

Environmental monitoring of ambient gas levels is generally conducted at governmental and local authority level and also for research purposes. Such analysers employ similar methodologies and the same arguments exist for single and multiparameter instruments.

The portable ambient monitoring sector is more fragmented because the reasons for monitoring are more diverse.

Personal gas detectors employ low cost technologies that are mostly single parameter and capable of providing early warning of unsafe occupational exposure. Similar technologies, such as electrochemical sensors, are often employed for workplace surveys or leak detection.

Portable gas detectors are usually low in cost but it is important to be aware of the potential effects of interferences from other gases and of response factors to different organic vapours, for example.

Speciation of multiple gases within a mixture requires significantly more expensive technology. For example, individual volatile organic gases can be measured by photo ionisation detector in conjunction with a gas chromatograph and infra red analysers are able to measure multiple parameters by comparing sample wavelengths against a stored library.

The most recent development is the transfer of FTIR technology to the portable instrument sector. This has resulted in a portable analyser that is able to produce laboratory levels of accuracy for gas analysis in the field. Quantitech first launched the Gasmet DX4030 portable FTIR analyser in the UK during 2007 and in 2009 18 units were ordered by the Environment Agency for a new multi agency rapid response Air Quality Cell as part of a total instrumentation contract valued in excess of £1 million.

The Gasmet DX4030 can be configured for specific applications such as anaesthetic gases, fumigants, industrial chemicals etc. However, by generating a complete infrared spectrum of the sample air, it becomes possible to perform an analysis for almost any gas - substantially reducing the risk of failing to identify a significant compound.

Summary

Similar gas detection technologies are employed for ambient, stack and workplace monitoring. However, the choice of analyser is dictated by a wide range of factors that can have a substantial effect on the cost, so it is often helpful to obtain expert advice before making an investment in monitoring technology.

Whilst FTIR is fast becoming the answer to many of the questions; it is not the only answer. Separate samplers and analysers are necessary for Hydrogen Sulphide, Dioxins, heavy metals etc. However, the purpose of this article has been to highlight the fact that multiparameter FTIR has become the dominant technology.

AUTHOR DETAILS

Dominic Duggan
Quantitech Ltd
Unit 3, Old Wolverton Road
Milton Keynes MK12 5NP
Tel: 01908 227722
Fax: 01908 227733
Email:
sales@quantitech.co.uk
Web: www.quantitech.co.uk