Sensing invisible hazards

There is a new state-of-the-art in toxic and flammable gas sensor technologies that changes the art of what's possible. Dr Tom Shelley reports

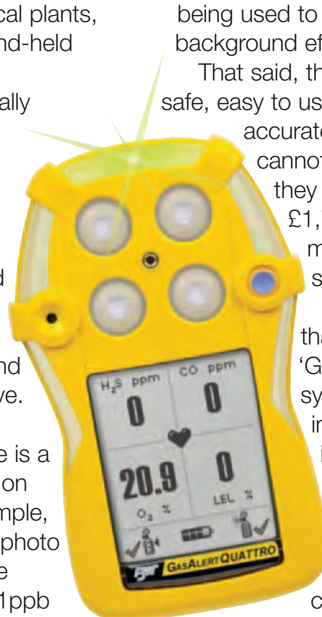
Pointers

- The vast majority of flammable and toxic gases can now be detected reliably and inexpensively
- Volatile organic compounds, for example, can be seen down to ppb
- Technologies used vary from ionisation, using ultra short wavelength ultraviolet light, to electrochemical, infared and catalytic bead
- A full explanation of technologies is available from Honeywell Analytics, with its 'Gas Book'

Research and development into gas sniffing technologies is yielding sensors capable of detecting hazards down to parts per billion, where required. And that's for use in fixed equipment installed on process or chemical plants, as well as for mobile equipment, both hand-held and worn on clothing.

Most substances of concern – essentially flammable or toxic – can now be detected reliably and fairly inexpensively. The exceptions are some chemical and biological agents that might be used by terrorists, where there are so many possibilities that gas chromatographs and spectrometers are among the few effective methods of detection. While such products can be vehicle or even hand portable, they are still somewhat expensive.

However, for the industrial user, where hazards are known and understood, there is a plethora of new and improved products. Ion Science, based near Cambridge, for example, has brought out its 'ProCheck Tiger PID (photo ionisation detector) that can detect volatile organic compounds (VOCs) in the range 1ppb (parts per billion) to 20,000ppm (parts per million), and is pre-programmed to sense more than 450 gases, including some that are classified as military and/or terrorist threats.



Marketing manager Sam Holson says that applications include clean rooms and clinical locations, where very low levels of VOCs are of interest, as they "help qualify control of those environments". As he says, changes in ppb detected can often also assist in locating the source of fugitive emissions. Other applications requiring ppb gas detection include protecting workers in confined spaces and, perhaps surprisingly, in fruit ripening plants.

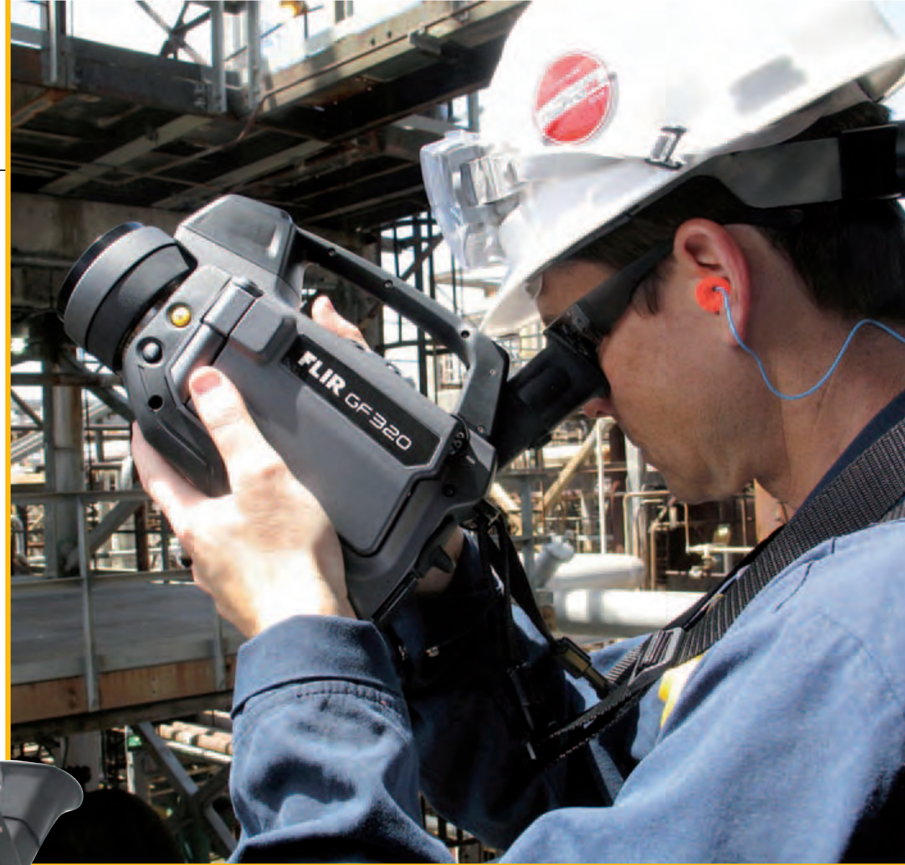
PID type devices work by using short wavelength ultraviolet light to ionise the molecules of interest, enabling current to be carried between electrodes. Choice of lamp output wavelength ensures that, while VOCs are ionised, molecules of the required process gases are not. Interestingly, Ion Science's instrument has three, instead of the usual two, electrodes – the third, patented, 'fence' electrode being used to remove contamination and background effects, especially in wet conditions.

That said, these instruments are also intrinsically safe, easy to use, extremely sensitive and very accurate. The only downside is that they cannot identify precisely what substances they are detecting. They cost from £1,700 and are available from the manufacturer or from distributors, such as Shawcity.

Technical advisor Alex Graft reports that Ion Science has also developed a 'GasClam' in-borehole monitoring system for landfill, coal mine and industrial gas monitoring. This instrument can be left in the ground for up to three months to measure carbon dioxide, methane and oxygen, as well as barometric pressure and temperature – with carbon monoxide or VOC measurement as optional extras.

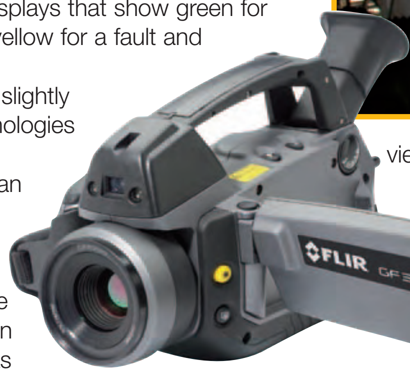
Meanwhile, other gas sensing technologies include electrochemical, infrared and catalytic bead – and instrument manufacturers are enabling some interchange, by making equipment modular. Honeywell, for example, recently introduced BW Technologies' GasAlertMicro 5 personal multi-gas detectors (above), as well as Sensepoint XCD.

The former, as its name suggests, can simultaneously monitor and display up to five atmospheric hazards. This is available in three formats: electrochemical for toxic gases; PID for VOCs; and infrared for carbon dioxide. PID sensors cannot be used in an infrared unit and vice versa, but all three models support plug-in electrochemical cells, as well as conventional catalytic bead gas sensors. These can detect and measure: hydrogen sulphide, carbon monoxide, sulphur dioxide,



phosphine, ammonia, nitrogen dioxide, hydrogen cyanide, chlorine, chlorine dioxide, combustibles, ozone and oxygen. Oxygen is of concern here, simply because too little can lead to suffocation and too much to spontaneous combustion.

As for the Sensepoint XCD, this unit is designed to detect flammable, toxic or oxygen gases in a three wire, 4—20mA format with relay outputs. Detectable gases include: flammable (catalytic), methane and carbon dioxide (infrared) and oxygen, hydrogen sulphide, carbon monoxide and hydrogen (electrochemical cells). The company says that future additions will cover: ammonia, chlorine, nitric oxide, nitrogen dioxide and sulphur dioxide. The sensors all come with displays that show green for normal operation, flash yellow for a fault and flash red for an alarm.



Incidentally, for those slightly mystified by all the technologies and options, Honeywell Analytics has produced an excellent 80 page ‘Gas Book’, free from distributors. Equally, for those who find the whole business of gas detection off-putting – because gas detectors not only have to be purchased, but maintained and recalibrated at intervals – Gavin O’Driscoll, director of Eolas Technology, based in Dublin, makes the point that it is now possible to rent detectors supplied by firms such as Industrial Scientific, which provide them as part of a managed service, monitoring for conditions such as detectors that have been turned off in an alarm condition.

Open-path sensing

So much for the general sensing purpose technologies. There are, however, times when a point sensor may not be ideal – say, to cover a large petrochemical site or an offshore rig. Too many sensors might be needed and coverage would only be localised to each. For these situations, gas detector manufacturers offer solutions such as ‘line of sight’ equipment. Draeger, for example, has its Polytron Pulsar Open Path gas detector that harnesses infrared light absorption to detect hydrocarbon leaks within a line of sight of up to 200m. This unit can be calibrated with one common gas, such as propane, and then, during normal operation, several target gases can be selected from an internal gas library, without recalibration.

Then again, leaks can be detected at a distance, using a suitable infrared camera. Flir’s GF (gas finder) cameras can now detect a wide range of hydrocarbons and VOCs, as well as carbon monoxide and sulphur hexafluoride. Thermal sensitivity of less than 25mK makes leaks clearly visible as plumes of ‘smoke’ in the camera’s viewfinder or LCD screen.

An alternative approach to wide area gas leak detection is a spectrometer, typically transported on an all terrain vehicle. Apogee Scientific in Colorado, USA, has developed such a system, designed to be placed in a toolbox with a 50mm diameter hose running to the front – providing an air inlet. Power comes from the vehicle’s battery and the instrument measures methane, total hydrocarbons and carbon dioxide simultaneously at sub ppm concentrations. Monitoring is at 50 samples per second and detected leaks can be correlated with spatial positions, as determined by GPS.

Finally, what about the situation where a source of industrial pollution is unknown? Smith Detection has developed a lightweight chemical detector for just such an eventuality. Its LCD 3.3, which is primarily for the military market, relies on ion mobility spectrometry, in which an air sample is drawn into the sampling line, which then passes two pinhole inlets, one for each of two spectrometers. Corona discharge is used to ionise the air samples.

Typically, air ions travel faster than ions of other chemicals. All ions are swept towards a gating grid by an electric field. The grid opens momentarily to allow clusters of ions to enter the two drift regions. One collects positively charged ions, while the other saves negative ions. As well as chemical warfare agents, the units can cover hydrogen sulphide, hydrogen chloride, hydrogen fluoride, hydrogen bromide, chlorine, sulphur dioxide and phosgene.

Several other chemicals can also be programmed in for recognition – the list including: ethylene oxide, fluorine, propylene oxide, methanol, trichlorethane, acetic acid, dimethylamine and styrene. Its makers, however, suggest restricting coverage to fewer than 10 substances to reduce the possibility of false alarms. PE

Above and left: Flir’s GF (gas finder) cameras can now detect a wide range of hydrocarbons and VOCs, as well as carbon monoxide and sulphur hexafluoride