New Demands for Gas Sensing - Yes we can.

Customer perception of electronics is changing rapidly. Smaller, more intuitive and intelligent handheld devices are becoming the norm. Integrated GPS and GPRS technologies are now expected, but add chemical sensors and the profile changes.

User needs for gas detectors are changing: tightening specifications, new regulatory requirements and the public awareness of "at risk" persons are pushing gas detector performance to levels not previously required.

We consider four gas detection applications where customer expectations are changing:

- Toxic gas safety
- combustion and flue gas monitoring
- Indoor, cabin and urban air quality monitoring
- domestic carbon monoxide detection

Toxic gas safety

Until recently, measuring carbon monoxide and hydrogen sulphide was adequate for most applications. But the bar has been set lower: first responders are now concerned about other toxic gases:

- Hydrogen cyanide is generated from burning plastics such as SAN, which is used to bottle many liquids; this was not a concern for fire fighters, but is now a serious risk.
- NO and NO_2 are health risks that have previously been ignored, but are now becoming centre stage. Nitrogen oxide affects blood flow and nitrogen dioxide causes pulmonary oedema- NO is less of a problem, but the latter is dangerous- the red colour and smell of nitrogen dioxide at least warn us of its presence, unlike CO, which is the silent killer.

Help is at hand: HCN, NO and NO_2 gas sensors are now available from gas sensor manufacturers, with response sensitivity that matches the needs.

Safety officers have monitored the presence of inorganic gases, but must now confront the newer challenge of volatile organic compounds (VOCs). This is more difficult because we can not measure specific VOCs without a laboratory, we do not know the risk they pose, and we do not know where they are present in certain workplaces. This is a tough problem that needs to be tackled. Quick "sniffers" are now available- photo-ionisation detectors (PIDs) measure VOCs to the parts-per-billion (PPB) concentration level, but do not tell you whether the detected VOC is dangerous, unfortunately. The gas sensor industry is researching new technologies to help users determine the risk of VOCs and this will take years. Controlled working environments can be sampled using Tedlar bags and laboratory procedures such as GC-MS and GC-GC with thermal desorption to pre-concentrate the low concentrations of VOCs, so repetitive operations in a known environment can be assessed, but VOC risk assessment in the field can only be guessed with a PID. A correct profile of VOC risk is many years away.

A commonly asked question is the lifetime of toxic gas sensors, but there is no simple answer. Most toxic gas sensors (CO, H_2S, NO_x) should work correctly for many years, so long as the humidity/ temperature environment is within the specification: typically 15 to 90% rh and -30 to +50°C. Quoted lifetimes are mostly arbitrary, and are marketing driven, not long term testing derived. Most sensors will recover when exposed to temperature/humidity extremes by simply exposing them to normal conditions for one/ two weeks, but some "exotic" sensors will not recover. Ask your gas sensor supplier for advice.

And let's not forget combustible gases, which continue to be the greatest hazard to workers in mines and other confined spaces. The biggest problem is poisoning of the detector, termed "pellistor". This pellistor needs to have a large surface area so that it can respond to combustible gases, but any presence of silicones glassifies the pellistor, ruining its response to combustible gases - not a good idea. Manufacturers of pellistors are striving constantly to increase poison resistance, while also reducing power requirement to extend battery life - two requirements that contradict.

Combustion and Flue Gas Monitoring

New boiler designs and the regulatory requirements for increased monitoring of the flue are demanding more checks by both boiler installers and boiler maintenance contractors.

New condensing boilers are energy efficient, but also cause problems by concentrating acid gases in the exhaust. This problem is only now being understood, and this problem can lead to early failure of the carbon monoxide, oxygen and nitrogen oxides sensors. Gas sensor manufacturers are responding to this problem, so contact your sensor supplier. Another issue with condensing boilers is that they contain a gas/air ratio valve which must be accurately adjusted for continued stochiometric operation. Recent HSE research has led CORGI (and more latterly the Gas Safe Register) to strongly recommend checking the combustion performance by an analysis of the gases in the flue.

Carbon dioxide concentration is currently calculated by dilution of the oxygen concentration. However, this is now being reviewed and direct measurement of carbon dioxide concentration using non-dispersive infrared (NDIR) technology is the preferred technology. NDIR increases the cost, but gives a secure measurement.

Flue gas analysers (FGAs) have traditionally measured CO and oxygen to calculate boiler efficiency, but newer, more expensive FGAs now measure nitrogen oxides and "spillage" of CO and CO_2. Measuring NO_x allows the engineer to better tune the boiler for minimum emissions and best efficiency, while checking for CO and CO_2 spillage ensures that the family is safe from leakages, which may cause long term health problems. CoGDEM, as a trade association, is lobbying the heating industry to check for leakages of combustion products to ensure safe usage of gas boilers.

When measuring carbon monoxide, flue gas analysers will also respond to hydrogen. This problem is well known and regulations in some European countries insist that CO sensors have low response to

hydrogen; this legislation has not yet been enacted in the UK, but will most likely come into force here as well. Carbon monoxide sensors that have low hydrogen sensitivity must be designed into the FGA, not just fit-and-forget.

Please note: Domestic gas safety in Great Britain has changed. CORGI gas registration ended in GB on 31 March and no longer applies to gas safety law. From 1 April 2009, all gas engineers must be on the new Gas Safe Register™ to do gas work lawfully. Always ask for a Gas Safe registered engineer. And always ask to see their ID card. Be gas safe. For more information go to www.GasSafeRegister.co.uk or call 0800 408 5500.

Urban air quality

We are all living in a more densely populated environment, with increased risks from pollutants. Historically, these risks have been monitored from a few cabins located in large cities, but this is not adequate. Research in the UK (MESSAGE) had shown that we can map in real time the pollutant concentrations in cities that have previously been ignored. For example, Cambridge is being monitored in real time with thirty wireless boxes, thanks to the combined efforts of the Chemistry, Engineering and Applied Mathematics departments.

VOCs are starting to raise their profile. For example, BTEX (benzene toluene ethyl benzene and xylenes) are regulated, specifically benzene. However, there is no current sensor that measures specifically benzene, ignoring toluene and the xylenes. Work is underway, but this is one of the toughest problems to solve.

Very low concentrations of ozone and the hydroxyl radical dominate our atmospheric chemistry, affecting especially the health of at-risk persons, where asthma and allergies can ruin their quality of life. The gas detection industry needs to confront these problems and provide gas sensors and detectors that meet urban air requirements, keeping people healthy.

Wireless networks are required to monitor gas pollution around sensitive areas such as airports, sewage works and bus terminals. The technology exists, we just need to pursue the goal.

Atmospheric chemists need more data to test their global warming models. They are counting on the gas detection industry to provide them with affordable, accurate detectors for carbon dioxide, methane and trace gases. A tough problem, but necessary for advancing scientific understanding of global warming.

Particulates damage health. Most of the particulates are emitted by diesel cars, buses, lorries and taxis. Particulates are classified as either PM10 (10 micrometer diameter or smaller) or PM 2.5 (2.5 micrometer or smaller). This mass measurement uses diode laser scattering in field measurements because the more expensive technologies are too bulky and expensive. Referencing of DL technology with government calibration is necessary.

Indoor and cabin air quality

Air quality in offices has been a priority for many years, and continues. More recently, air quality in planes and now air quality in cars and lorries have gained importance. Cabin air quality in planes is focussing on hydraulic fluid by-products, while car air quality is concentrating on plasticisers in PVC and other cabin plastics.

Both of these problem gases are best measured using photoionisation detectors (PIDs), which can measure to the part-per-billion level.

Domestic CO alarms

We all know the benefits of smoke alarms and now carbon monoxide detectors are joining smoke alarms as a requisite for safe houses. Recent studies have shown that over 80% of UK homes have a smoke alarm, whereas the population of CO alarms is only around 24%. Previously, long term reliability was a problem with carbon monoxide detectors, but the industry has proven that the CO alarms are reliable and are capable of meeting the tough requirements of the performance standard EN 50291. Spot detectors have been shown to be poor substitutes, but their low cost was tempting; now that electrochemical CO detectors have come down in price, costing as little as £10, the cost barrier has disappeared. Congratulations to the alarm manufacturers who have reduced customer cost, and the sensor manufacturers who have enabled them to do it!.

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