GAS DETECTION SYSTEMS - PROTECTING PEOPLE, ASSETS AND FACILITIES

The price tag of a medium-sized, medium-complexity refinery in Europe is around 2 billion Euros. That's the typical total replacement and rebuild value of the capital assets. Such a site will also be the workplace for several hundred permanent employees and many additional contract staff. With such a rich concentration of people and assets, it is essential to consider the right mix of gas detection systems for safety.

Fire and explosions rocked the Philadelphia Energy Solutions refinery on the US east coast on the 21st of June 2019. Soon after, the incident led to the announcement that the refinery complex would cease operations after more than 150 years of oil storage and refining on the site. At 335 thousand barrels per day of refining capacity it ranked as tenth largest refinery in the US and was the largest on the eastern seaboard. The risks posed by flammable gases are more than theoretical: they present a real and present danger that must be monitored using an array of suitable gas detection techniques to protect people, assets and entire facilities.

Violent explosions, invisible killers and environmental pollutants

It is a miracle that the dramatic refinery blaze at Philadelphia resulted in no deaths. It is equally fortunate that violent explosions and raging fires at refineries in Vohburg in Germany in 2018 and Sannazzaro de'Burgondi in Italy in 2016 also resulted in no fatalities. But toxic and inert gases present hazards which are equally as dangerous, but much subtler that these sensational events.

Underground miners work in a confined space for most of their shift, on the other hand entry into confined spaces generally takes place on refineries during maintenance and turn-around events. Whether we consider refineries or sub-surface mining, where gas detection systems are also common, hydrogen sulphide is one of the most feared toxic gases and will often be incorporated into the range of gases monitored by fixed toxic gas detection systems.

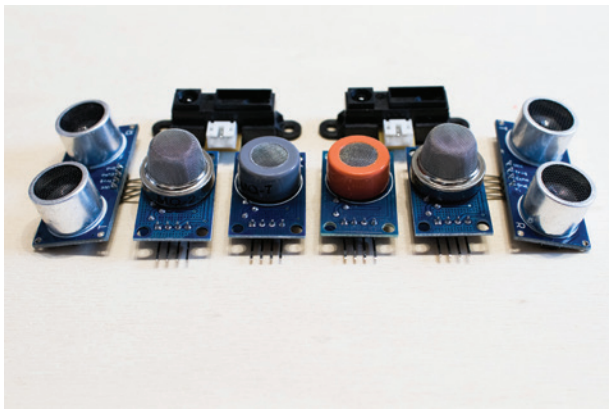
Toxic gas leaks can present a dire health hazard, as can the accumulation of an inert gas, such as nitrogen, to displace life-giving oxygen. A toxic gas cloud is likely to be invisible. Some toxic gases are detectable by their odour, but many are not. And, nitrogen accumulation resulting in oxygen deficiency is completely invisible and odourless – but extremely dangerous. Gas detection systems have a vital role to play in protecting people in such situations.

Hydrocarbon gas-leaks on the refinery present a flammability risk on the one hand and an environmental concern on the other. The monitoring of hydrocarbon gas-leaks on refineries is regulated by the US EPA according to Method 21 – 'determination of volatile organic compound leaks'. It prescribes suitable distances between the potential leak point and the gas detector and proposes suitable gas detection technologies such as photoionization, infrared absorption or catalytic oxidation. All these sensor types are common in various modern chemical-based fixed gas detection systems.

Vast spaces and high-risk point sources

Portable gas detection systems which are worn by operators as they move around between locations can be effective to warn personnel to avoid areas where toxic, flammable or inert gases have accumulated. Fixed systems, on the other hand are designed to detect gas leaks as they happen or soon after. However, whether they are fixed or portable, gas detection systems based on chemical sensor technologies are limited to monitoring gases close to the location where they are situated. Open path gas detection systems, on the other hand, can detect flammable gases in the line of sight where they are installed and can cover a vast range.

For expansive areas, such as a tank farm or the route of a gas pipeline oven flat terrain an open path gas detection system might be ideal to cover the long distances involved. On the other hand, in a complex refinery process field where distillation



columns, scrubbers, reaction vessels and piping are obstructing the line of sight the open path system is unlikely to have the ideal surroundings to operate to its full potential. For a location that has been assessed as a high-risk leak area during a HAZOP study, such as a gas compressor or volatile liquid pump, a fixed location gas detector may be more suitable.

Given the differences that exist, is there a right or wrong gas detection system? Or is it the case that each has its purpose and a combination of strategies is the most effective solution? To investigate the consensus on the most suitable applications for fixed gas detection systems, portable gas detection systems and open path gas detection systems several leading equipment suppliers and systems integrators in the sector were invited to participate in a short questionnaire. Six companies chose to participate and the average their responses is presented here.

Digital innovation potential

All these gas detection systems lend themselves to the increased use of wireless communications technology allowing easer installation and more effective communications. Units can be set up to act as one large mesh network and some may be selected as communications gateways. Additionally, for portable gas detectors, peer notification of alarms combined with remote monitoring allows for shortened response time, plus accountability of users. They also enable voice communications or "man-down" communication from the user to a base location.

Digital innovations also have the potential to minimise the short-comings of some of the systems. For example, increased diagnostics and intelligence can minimise the frequency of false-alarms caused by rogue readings on chemical sensors or physical obstructions such as birds or trucks passing through an open path gas detector beam.

A cocktail of solutions

In summary, each system has its strengths. For example, a portable gas detector is just right for short term entry into a confined space such as a reactor vessel that requires inspection. It is also ideal for use in areas that will be temporarily occupied such as gas exploration drilling rigs or construction sites. On the other hand, a fixed gas detector, for example sniffing for hydrogen sulphide close to a flanged joint on a Claus desulphurisation reactor would be ideal for integration into the site alarm network. And, an open path system is a great option for monitoring the perimeter of the process field to detect a hydrocarbon gas cloud that may be moving towards the administration building or control room.

It is also the case that each system has its limitations. Fixed and portable chemical-based gas detection systems require frequent bump testing and periodic calibration – and that incurs some ongoing maintenance effort and cost. Portable systems are not easily integrated into site alarm systems and the battery will require periodic re-charging, making them unsuitable for long term use away from a charging station. Open path systems can have comparatively high one-time installation costs and are limited in the number of toxic gases that they can detect. Despite their comparatively high cost per system, due to their large range a single pair of open path optical gas detectors may be able to do the job of many fixed chemical detectors and the maths can quickly add up to cost savings.

Rather than pick a single system, most refinery and hydrocarbon processing sites will find it optimal to employ a cocktail of solutions. Portable devices for site-walks and the release of confined spaces to issue a permit to work for maintenance. Fixed systems for leak detection around high risk equipment and integration to the site alarm system. Open path systems for large zone coverage and to validate the alarm signals generated by other fixed gas detection systems. As with many aspects of health, safety and environmental management it's not a black and white question of either / or but a more colourful rainbow of solutions that will lead to the optimal protection of people, assets and sites.

	Fixed gas detection system	Hand-held portable gas detector	Open path gas detection system
Suitability for employee protection	1.8	3.0	1.3
Suitability for asset protection	3.0	1.0	2.7
Suitability for overall site protection	2.7	1.3	3.0
Affordability per device	1.8	2.8	1.2
Range of toxic components detectable	1.8	1.8	1.8
Range of environmental pollutants detectable	2.7	2.2	2.3
Range of flammable components detectable	3.0	3.0	2.0
Average score less than 1.5		Weak	
Average score between 1.5 and 2.5		Good	
Average score more than 2.5		Excellent	

With thanks to: Almont do Brasil, Clean Environment Brasil, DCT-Multitech Consultoria Treinamentos e Serviços, Gastech Australia, JDuarteG Consultoria, R2 Safety, United Electric Controls

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