Gas detection

Specialty gases and cylinder filling facilities in focus

By Stephen B. Harrison

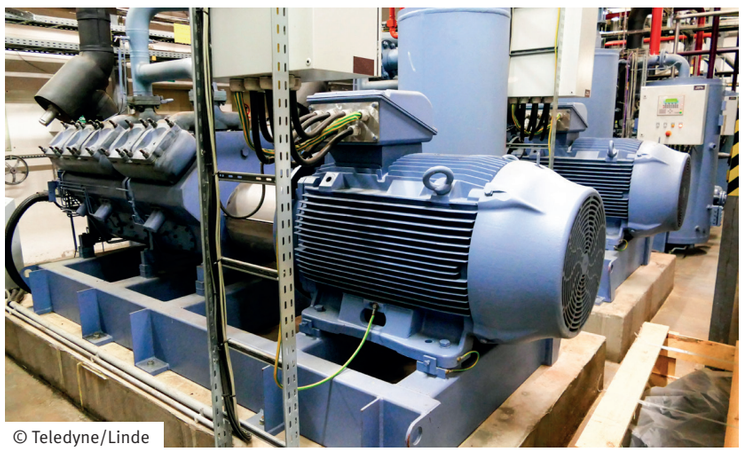
Whilst ASUs and SMRs are high value assets, they are also highly automated and relatively few people are in contact with the process equipment during normal operation.

Many of the people employed in the industrial gases sector work on cylinder filling plants. These are often highly manual operations where the workforce spends much of their day in proximity to potentially hazardous gases. The hazards are similar to ASU and SMR operations: oxygen is core to medical cylinder gases; hydrogen and nitrogen are used in industrial cylinder gases; and carbon monoxide is commonly used on specialty gas cylinder filling sites, where a plethora of other exotic toxic, flammable and pyrophoric gases might be processed.

Hazard management at the plant

Jorge Duarte Guimarães, an industrial and specialty gases consultant in São Paolo, Brazil, who has spent more than 30 years in the sector with most of that time with AGA and Linde, says that, ”When implementing a gas detection system in a specialty gases plant, the critical points are those related to the toxicological characteristics and the risks associated with any leakage of the products that will be produced and handled on the site.”

“Oxygen and inert gases such as nitrogen, helium and argon, despite being almost 99.9% of the air around us, when pure, have high risks. For example: the release of oxygen can enhance combustion or even lead to loss of consciousness for personnel. Therefore, fixed oxygen detectors are requirements



© Teledyne/Linde

> “The use of a cause and effect matrix is really powerful”

in specialty gases and medical cylinder filling plants.”

He continues to say that, “Flammable gases such as hydrogen and methane demand specific attention due to the danger of fire and explosion.”

“Explosimeters and flame detection systems should be considered in areas where these products are handled. Special consideration should be paid to gas mixing rooms where different gas lines cylinders are handled involving a range of products with a mix of risks such as: oxidising, inert, toxic and flammable. In these cases, a system with multi-gas detectors is necessary.”

“The use of portable detectors is also common in special gas plants, as many areas of the plant, such as: laboratories, filling stations, compressor rooms and warehouses are confined spaces.”

Cylinder filling process design

“The use of a cause and effect matrix is really powerful,” says Robert Lee, Managing Director at iGAS Technology Solutions in the UK.

“When we design industrial, specialty and medical gases cylinder filling plants for operating companies, they want us to deliver a fully engineered solution. So, we bring in specialist gas detection

© Teledyne/Linde

companies to select the right technology to sense for the gases that are being used in the process. We work together to identify the hazards and scope the most cost-effective gas detection system.”

“Beyond the hardware design and construction, what my team can offer is the engineering expertise and operational insight to devise safety management systems that link the gas detection alarms with likely causes of the leak and appropriate mitigation.”

“For some gas alarms a simple intervention like shutting a flow control valve may be all that is required to eliminate the hazard. In the other extreme, an emergency shutdown of the entire process and evacuation of the plant building would be required. This is where the process of working through the ‘cause and effect matrix’ comes into play.”

Customer personnel and site safety

As an example of a customer application, food freezing factories using cryogens such as liquid nitrogen or liquid carbon dioxide will also require gas detection equipment. A combination of wall-mounted sniffers close to the processing equipment and wearable devices is often used.

Beyond these cryogens, gases for use in mechanical refrigeration systems are also supplied by many industrial gas companies. The use of hydrocarbon refrigerants in this area is becoming increasingly popular due to their low environmental impact and excellent thermodynamic performance. Their application stretches from food processing factories to small domestic refrigerators, super-market food display cabinets and world-scale natural gas liquefaction systems.

The main risk introduced with hydrocarbon refrigerants such as isobutane, propane, propylene and ethylene, compared with alternative fluorine-based refrigerants, is flammability. Speaking on this topic from his role as Global Product Manager of Specialty Gases & Equipment at The Linde Group in Germany, Roberto Parola says, “Flammable and explosion hazards should be properly assessed – both for new systems and when hydrocarbons are used as retrofit gases in existing refrigeration equipment.”

> “Flammable and explosion hazards should be properly assessed – both for new systems and when hydrocarbons are used as retrofit gases”

“The implementation of adequate measures, including a proper gas detection system, ventilation, safety signage and the designation of Ex-proof areas should be considered as actionable outcomes of the risk assessment.”

Natural refrigerants such as carbon dioxide (CO_2) and ammonia must also be used with appropriate precautions. Parola adds that, “Ammonia is used extensively in large-scale commercial and industrial refrigeration equipment. It has zero global warming potential, which is a major reason for its selection.”

“Despite these eco-benefits, ammonia is both toxic and flammable. An ammonia leak might be detected through our sense of smell, but we should not

rely exclusively on our nose as a warning system: gas detection equipment should also be considered."

Gas detection – aligning to the hazards

François Ampe, Product Line Manager EMEA at Teledyne Gas and Flame Detection in France, is an expert in gas detection systems for toxic, flammable, oxidising and inert gases.

He says that, "Cylinder and bulk liquid gas storage areas at customer sites, for example specialty gas cylinder stores at universities, toxic gas cabinets at semiconductor producers or the medical cylinder gases stores at a hospital, may also require gas detection equipment."

With a focus on the people, he says, "Industrial gas field service personnel, such as customer engineering services teams working on tank maintenance or drivers making bulk liquid deliveries will also need gas detection equipment."

"But there is no 'one-size fits all' gas detection solution," he says. "Bulk carbon dioxide deliveries to a brewery or beverage bottling plant may warrant the use of a CO_2 detector. Liquid oxygen deliveries to local hospital bulk storage tanks may call for the use of an oxygen gas detector. And, applications specialists visiting from the industrial gases provider for process optimisation will most probably have an appropriate wearable gas detector as part of their PPE kit. Every situation is different and will need a solution appropriate to the application."

Ampe adds that, "The range of solutions starts with PPE stock-items such as an oxygen gas detector to test for enrichment or deficiency. It then becomes more complex with fixed gas detectors up to fully integrated gas and flame detection systems which are integrated into automated safety control systems and emergency management procedures."

He continues with some examples, "The gas detector sensor used to measure oxygen enrichment and deficiency will be an electrochemical fuel cell sensor. For infrared active gases such as methane, which is flammable or carbon monoxide, which is both toxic and flammable, we can employ infrared techniques in the sensor. But, for gases such as hydrogen we must revert to a specialised catalytic bead detection principle. Picking the right product for the job is not always obvious, that's why we have a technical support team at Teledyne Gas and Flame Detection – to guide end-users to the safest solution for their situation.

Gas detection certification and testing

During the manufacture, maintenance, recertification and in-situ bump testing of gas detectors, specialty gas mixtures are used. These simulate the gas leak conditions to check that the sensor and electronics built into the gas detection system are functioning properly.

Parola says that "When portable and fixed gas detectors are manufactured or calibrated in a laboratory environment, large and medium sized high-pressure gas cylinders are often used to leverage economies of scale. For in-situ bump tests, gas cylinder portability is the priority."

Fixed gas detectors for gases which are lighter than air, such as hydrogen and methane, are often located in the ceiling of a building. Detectors for other gases may also be in locations that are difficult to access. So, a portable cylinder means a maximum of only a few kilograms total weight, meaning it can readily be carried up ladders or down-stairs. Parola says, "Compact design is important in addition to light weight. That's where our ECOCYL range scores well. The cylinders are fitted with a non-removable carry-handle which doubles-up as a protective guard for the VIPR that is attached to the top of the cylinder to regulate the gas pressure and control the flow rate."

In 2019, Linde added the ECOCYL 201 and 202 models to its range of portable specialty gases packages. These new models have 30% higher filling pressure than the previous ECOCYLs and the 202 variant uses a two litre cylinder – representing twice the capacity of the original model. gw

ABOUT THE AUTHOR

Stephen B. Harrison is celebrating 30 years involvement in industrial gases. He was previously global head of Specialty Gases & Equipment at Linde Gas, and spent more than 15 years with BOC Gases. He is now a consultant and Managing Director at sbh4 GmbH. If you are interested in a white paper covering gas detection on a range of facilities, contact the author.