Gas alarm! The life-saving role of gas detectors in the refining sector

Refining risks are real, and can be mitigated

We do not have to go too far back in history to recall the fire at the ENI refinery in the Italian town of Sannazzaro dei Burgondi, north of Milan, which took place on the 1st of December 2016. The first of the month...it seems to be an ominous date, so best to check that everything is in order now, before the next month rolls around. The good news is that great strides can, and are, being taken to improve the safety of refinery assets and personnel all around the world. For example, improvements in gas detection have been extremely important.

One aspect of improved gas monitoring is simply a better understanding of the risks of exposure to hazardous chemicals. Take the example of benzene which is now a listed carcinogen: in 1960 the 8-hour Occupational Exposure Limit (OEL) in Finland was 25ppm; in the 1970s the limit was reduced to 10ppm. Through the 80s and 90s the OEL_{8h} was down to 5ppm and since the year 2000 the limit has been only 1ppm. A second aspect has been the rapid evolution of high sensitivity, accuracy, reliability and selectivity of gas sensors that are built into the most modern portable and fixed gas detection equipment.

The safety issues referred to here are not simply theoretical; they are very real. As an

example of the hazards involved, consider that on the 5th of November in 2005 at the Delaware City Refinery in the USA two maintenance contractors died by suffocation. They were raising a pipe onto a reactor which was inerted with nitrogen to protect the catalyst contained within. One of the technicians fainted and fell into the reactor; the second victim was also asphyxiated in trying to save his colleague. One might wonder if these fatalities could have been avoided if the maintenance workers had been better informed of the risks and had been issued with personal gas detectors that could have been sniffing for oxygen and making an audible alarm in the case of oxygen deficiency.

Ageing assets, product pipeline and geographic shift

From what we read in the popular press about oil reserves running low and the drive towards clean air, we might imagine that the emergence of electrically powered vehicles or the use of hydrogen as an alternative fuel might, over time, eliminate the risks posed on refineries as they are no longer required. Not so!

According to the "Market Analytics: Refined Products – 2018" report, written by Nexant in December of 2018, the market for refined products will continue to grow worldwide at approximately 1% per year through to 2035. Within this global view, it is anticipated that the mature markets in Europe and the United States will maintain their current production levels and, in the future, form a reduced share of the global pie, as the markets in Asia continue to grow at a faster pace. To satisfy that demand, the projected growth in refining capacity in Asia is anticipated to grow at nine million barrels per day (BPD), while the Middle East is expected to add about 4 million BPD. These two regions will therefore represent 75% of projected capacity additions through to 2035. The report also projects that refining capacity in most other parts of the world is expected to remain in operation at levels close to the 2018 baseline.

So, whilst electricity, renewables and alternative fuels will play an increasingly important role in the energy mix in future decades, we must continue to focus on operational safety improvements in the installed base and make similar investments in process safety as new capacity comes on stream.

Toxic and flammable gases present a risk on the refinery

To avoid the physical hazards of explosion, the risks associated with oxygen deficiency and the health hazards of toxic gases, refinery workers wear gas detectors when working in confined spaces or close to high risk leak points. An array of fixed detectors, often strategically located at flanges, pumps, valves and other potential leak points will also generally be in place.

One of the most common refinery toxic gas hazards is H_2S. The potency of its danger may be understood when reviewing the case of Dan Gunraj who lost his life at the Marathon

Robinson refinery in Illinois in on the 20th of January 2007. He was working in the alkylation unit decanting liquors to the neutralisation pits when he was overcome by high levels of H_2S. He was, in fact, wearing his portable H_2S gas detector when he was overcome by the fumes. The gas detector was audibly alarming and was found to be reading 95ppm when his body was recovered from the scene by co-workers wearing breathing apparatus.

In the petrochemical industry, H_2S, CO, O_2 and hydrocarbon gas detectors are perhaps the most common. Various sensor technologies are used in these portable gas detectors. For example, the hydrocarbons will be detected with a lower explosive limit (LEL) sensor when testing for explosion risk or with a photo ionisation detector (PID) sensor when sniffing for toxic hydrocarbons such as the BTEX group. Beyond this core range of gases, many more chemicals may need to be detected, depending on the unit operations present at any particular site.

Portable gas detectors save lives and refinery assets

Gas detectors are often worn by refinery staff and count as one of their most important pieces of personal protective equipment (PPE). Their use is so important that the industry has been pulling for highly visible colours such as red, yellow and orange to be used in their construction so that workers can quickly see that their colleagues have remembered to wear their gas detector.

So, if these gas detectors are so critical, how can personnel be sure they are working when needed? According to the guidelines from most manufacturers and many local operating standards and regulations, gas detectors should to be 'bump tested' daily. This means that a small amount of test gas will be applied to the gas detector to check if the sensor and the acoustic and visual alarms are operational. Beyond that, usually every 6 months, most gas detectors need to be calibrated.

The daily functional test is good enough to say that the detector functions and produces an alarm, but it is not a precisely controlled calibration event. Whilst the functional test generally occurs on the refinery, the calibration generally takes place at an off-site service laboratory. Alternatively, the detector can be returned to the manufacturer's service facility for a general overhaul which may also involve replacement of some of the sensors contained in the gas detector. The calibration frequency can range from once per month to once per year depending on local regulation, how adverse the operating conditions are, and the sensor technology used.

The availability of 'bump test' gas mixtures is generally high. Many specialty gas suppliers around the world can produce cylinder gases for this purpose because the certification and accreditation requirements are relatively straight forward. The availability of calibration gas mixtures is also good, but the costs of these gas mixtures are higher and the number of suppliers able to offer the required quality standards is narrower.

Whilst the comments here represent the high standard of best practice that is prevalent in the industry, it should be noted that some statistics indicate that the average frequency of these functional tests is sometimes stretched to weeks or months. And that cannot be described as best practice under any circumstances. So, the technology is there: we simply need to use it in a disciplined way to its full potential to keep our refining assets and people safe.

Contact the author, Stephen B. Harrison, for further information on this topic and other consulting engagements in the energy sector in the DACH region or beyond.

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