Many oil fields, especially mature ones, can produce high levels of Hydrogen Sulfide (H₂S), which is deadly at even low concentrations. As drilling is often in remote locations, getting to the nearest hospital in time to respond to an exposure event could be impossible. It is always crucial to be able to detect the gas as soon as possible when a leak occurs, in even the most challenging conditions.

It is important to remember that detection coverage for H₂S in facilities where it is known to be present is an ongoing program that needs to be constantly evaluated and updated. Many facilities have constantly changing conditions with connections that are affected by the highly corrosive properties of H₂S. Some facilities simply do not have adequate coverage or don’t completely understand the options available to protect their plant and the people who work there.

The toxicity of H₂S gas is extremely high. Its flammability level is actually...
much lower than its toxic level for humans. Fortunately, having the distinct odor of rotten eggs allows plant workers to detect H2S gas in the relatively safe range of parts per billion.

The primary goal of any fixed point H2S detection system is to safeguard workers by warning them of the presence of hazardous toxic levels of H2S in their workplace. As manufacturers continue to improve toxic gas detection technology, it is important to understand how these may be applicable in your installation.

Electrochemical and metal oxide semiconductor (MOS) cells have for many years been the only field-proven toxic sensing technologies, but more advanced optical sensing technologies are now emerging and have widened the scope. The use of personal gas detectors, or hand-held portable gas detectors, in combination with a comprehensive fixed gas detection system is excellent practice for complete site safety. In many countries standards exist that require every worker in a potentially hazardous area to be equipped with a personal gas detector.

It is important to note that H2S being heavier than air, sinks to the lowest lying area. Sensing elements must be positioned accordingly to optimize performance.

**MOS Sensors**

The typical construction of an MOS (metal oxide semiconductor) sensing element includes a platinum heater element, an insulation medium and the sensing element itself, which is a gas-sensitive resistive film. This film will employ traditional materials or materials that are enhanced at the nano-level to improve performance. When H2S comes into contact with this film there are measurable changes in the electrical conductivity. These changes are typically amplified in a transmitter device.

MOS detectors have a long life compared to electrochemical sensors and continue to operate in wide ranging temperatures, particularly high temperatures, as well as in extremely dry conditions. However, similar to electrochemical detectors, MOS detectors are not fail-safe and a change in oxygen levels may affect their output.

Recently, advances in nano-enhanced material construction have been able to effectively deal with the above challenges. While the appearance and operating principle of an NE-MOS sensor is identical to that of a traditional MOS sensor, NE-MOS benefits from a mechanically conformed array of sensing components known as “nanotubes” being applied to the resistive film in a manner in which they are perfectly aligned, symmetric, and extremely concentrated during the manufacturing process.

Traditional materials are produced using a process that leaves gaps and creates irregularities, resulting in the performance challenges outlined above. Nano-enhanced materials equate to increased overall sensing capability, faster response, and much higher stability.

**Electrochemical Detectors**

In an electrochemical sensor the cells combine enclosed electrodes and electrolyte. H2S diffuses through a permeable membrane, the volume of H2S increases in the air, an oxidation or reduction reaction occurs at one of the electrodes, and as a result, a linear current change occurs. This enables a display or an amplifier device to generate an indication of the H2S level. These detectors also have high sensitivity and repeatability, which has established this as the toxic detection technology of choice in a wide variety of applications.

The use of electrochemical sensors in desert and arctic regions is not the ideal solution though. The detector’s lack of resilience in high and low temperatures and the effect of humidity on the detector’s performance are serious considerations. Normally one can expect a T90 response in around about 30 seconds in temperate conditions.

When you start to approach -20°C the detector’s speed of response reduces significantly, as temperatures continue to lower the output will decrease even further.

Other considerations with electrochemical sensors are that they do require routine calibration; every six months is typically recommended. It may be required more frequently depending on the site conditions. The sensors are not inherently fail-safe but some manufacturers have employed electronic sensor health monitoring which will generate a fault output. And electrochemical detectors are all cross sensitive to other specific types of gases which need to be considered during installation to avoid exposure to these contaminants.

**Optical Sensing Technology**

Optical hydrocarbon detectors are a field-proven detection solution in many industrial applications and optical H2S detectors use the same basic operating principle. In an optical H2S sensor, the signal is absorbed by the H2S gas as it passes through the detector’s optical path. The sensor will record the signal reduction and a microprocessor will calculate a corresponding gas value.

Because the sensor uses positive feedback at its zero gas level, this technology is inherently fail safe. Any internal damage to the detector results in an impact on processing so they must continuously perform valuable fault diagnostics to ensure optimum performance, which also compensates effectively for temperature and humidity.

Optical sensors are deployed as either a fixed point-type detectors or an open path installation. Fixed point-type gas detectors must be strategically located to effectively provide coverage for a targeted area. Regular routine inspections are good practice but full calibrations are typically only required every 12 months.

Open path or line-of-sight (LOS) detectors use employ an optical transmitter and a paired receiver located at a maximum specified distance apart to monitor the space between them. Any volume of the H2S gas passing through the beam of light will provide a reading. But it is not currently possible to accurately determine the ppm level with this technology. They also cannot have any obstructions to their path, which makes their effective application somewhat limited in areas where workers are constantly present. They are well suited for monitoring gas migration into perimeter areas of an installation.

Manufacturers of H2S sensing solutions face several unique challenges in a wide variety of applications. As the current oil and gas fields located in hospitable regions are completing their life cycle, there is going to be a fundamental shift to the more extreme operating locations of the world. In this context, it is critical that the safety devices perform at a high level in these conditions in order to protect plant and personnel as well as maximize uptime in these locations that require more capital to operate.

Operators need to consider specific application and environmental conditions to be able to select the best available technology that will provide the highest degree of safety and performance. As new technologies emerge it may become possible to combine the point type devices, open-path optical detectors, with new and emerging technologies like ultrasonic gas leak detection and laser-based sensing for providing enhanced safety to support even higher standards. **FSM**

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