GAS DETECTION WITH NETWORKED COMMUNICATIONS FOR SAFETY AND PROCESS AUTOMATION IN REFINERY WASTEWATER TREATMENT APPLICATIONS

Gas detection in refinery wastewater treatment

A refinery wastewater treatment facility will involve asphyxiant, oxidant, flammable and toxic gas hazards. Methane can be produced by anaerobic microbes in the sewage pipes feeding wastewater to the treatment process. The toxic gas hydrogen sulphide (H_2S) can also be generated by bacterial action on the polluted water. Depending on the type of aerobic processes used, oxygen enrichment and the presence of ozone may also present safety risks. Some wastewater treatment plants rely on carbon dioxide for pH control. An accumulation of this gas can be toxic. And, the utility-gas nitrogen will be used for maintenance and purging applications. It's a heady cocktail of risks that calls for an armoury of gas detection equipment.

One part in a million: ultra-sensitive gas detection is required

One vital aspect of gas detection is to mitigate the risks of exposure to hazardous chemicals. In recent decades, scientific and toxicological research has improved our understanding of these risks to the point of realising that many chemicals are toxic to humans at levels as low as one part per million. 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 OEL8h was down to 5ppm and since the year 2000 the limit has been only 1ppm.

Benzene and other volatile organic compounds (VOCs) are often present in refinery wastewater. Through the agitation of the water and the sparging of air or oxygen into the aerobic section of the water-treatment basins, benzene and other VOCs may be released to the atmosphere. There are often also environmental restrictions on VOC emissions and the careful selection and location of highly sensitive gas detection equipment around the refinery wastewater treatment plant can both improve safety for employees and ensure that environmental emission consent levels are continuously met.

Confined space entry: the case for portable gas detection

The water treatment plant on the refinery and the associated pipe work to and from the facility will have many confined spaces. Each sump, phase separator and holding tank is potentially an accumulation point for toxic or flammable gases. Nitrogen, which is often used for purging toxic or flammable gases from process equipment prior to maintenance, is an asphyxiant gas – so it also presents a significant risk.

To underline the severity, 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 vessel which was inerted with nitrogen. 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.

According to modern best practices, non-standard events such as construction, start-up, decommissioning, purging and maintenance should be subject to case-specific risk assessments. Gas detection is likely to be specified under an appropriate 'permit-to-work'. This permit may specify the use of portable or wearable gas detection equipment. Kevin O'Donnell, EMEA Business Development Manager at Teledyne Gas and Flame detection explains: "gas detection is about protecting people in addition to plant assets. Maintenance can take place in just about any location on the wastewater treatment plant and will generally involve people – and their safety must be protected".

Area gas detectors, such as the BM 25 from Teledyne Gas & Flame detection can be carried to the maintenance location to provide localised monitoring of hazardous gases. Going one step further, the BM 25 Wireless area gas monitor can communicate with the X40 controller to enact various safety mitigations, such as the automated closure of an actuated valve.

Pumped sample collection using PS200 hand-held gas detector
Credit: Teledyne Gas & Flame Detection

BM25 Gas Detection Unit Credit: Teledyne Gas and Flame Detection

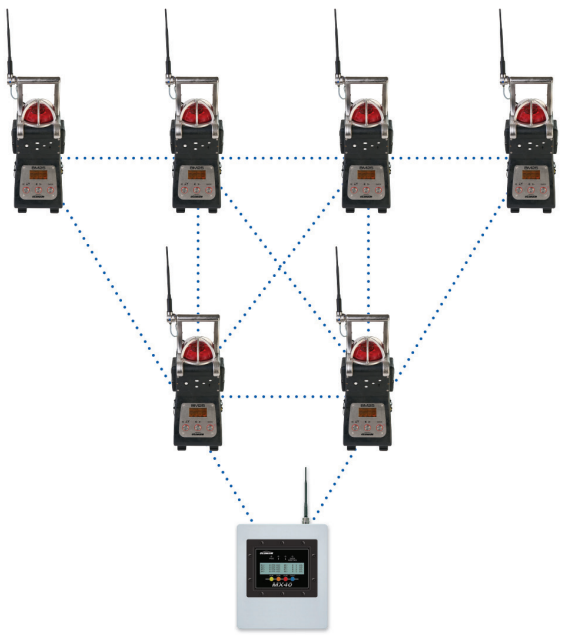
Entry into confined spaces presents an additional risk due to reduced ventilation and the potential for hazardous gas accumulation. Kevin O'Donnell says that "wearing a portable gas detector as part of their PPE is routine for many maintenance teams on refinery wastewater treatment plants. One of the benefits of our PS200 is that it can be configured to include an internal sample pump. That means that gas can be drawn from up to 30 metres away using flexible tubing. This eliminates the need to lower the detector into a pit or empty tank prior to entry and it's a much better way to monitor the atmosphere inside the tank". If the tank has been purged with nitrogen, it will be essential to ventilate the tank with air prior to entry. The PS200 can validate that a safe oxygen concentration has been achieved in the tank to avoid asphyxiation of the maintenance team.

BM25_and MX40 Credit: Teledyne Gas and Flame Detection

Networked systems work best

With such a broad range of gases to be detected, an integrated gas detection network is ideal for a water treatment plant. "For new-build water treatment facility projects a hard-wired gas detection and alarm network can be planned into the construction phase" says François Ampe - Product Line Manager EMEA at Teledyne Gas and Flame Detection. "On the other hand, when a site wishes to upgrade their gas detection network to comply with modern safety standards, a wireless network can be more cost effective to retrofit. It avoids the risk, cost and change management process of digging new trenches and laying additional cable racks".

As an example of a wireless compatible gas detection network management system, Teledyne's Model X40 Integrated Alarm & Control System is designed to monitor multiple gas detection sensors as a Modbus™ Master. It is field programmable and offers intuitive, embedded intelligence. The control system displays real time readings and field device status on a backlit LCD screen. During normal operation the alarm status, gas type and concentration for up to eight gas detector sensors are displayed sequentially.



BM25 Wireless MX40 Pattern Credit: Teledyne Gas and Flame Detection

Planning ahead

Wastewater treatment plants are often unmanned sites in remote locations of the refinery complex and maintenance can therefore be time consuming. Careful product selection can minimise the lifetime ownership cost of the gas detection system.

François Ampe explains that "the air at a refinery water treatment facility will most likely contain traces of H_2S gas. In addition to presenting a toxic hazard to the operators, H_2S is corrosive to metals such as steel, copper and brass. The use of stainless-steel gas detection sensors is therefore recommended to ensure the longevity of the system and minimise maintenance costs". Stainless steel gas detection sensor housings are slightly more expensive than alternative materials of construction on day one, but they will pay for themselves within a short period because they last longer: reducing the materials and labour costs of servicing and maintenance.

Selecting the right sensor

The range of gases that needs to be detected in a refinery wastewater treatment facility calls for a wide range of gas detection sensor technologies. Electrochemical sensors are used to monitor oxygen deficiency or enrichment. They are also suitable to detect the presence of low levels of toxic gases such as H_2S.

PS200 Credit: Teledyne Gas and Flame Detection

Semi-conductor sensors are used where higher concentrations of H_2S may be present or where the ambient temperature is high – they have a longer operating life under these harsh conditions. Catalytic sensors are used for the detection of explosive gases such as methane, which can be produced in the sewer feeding the wastewater treatment facility. Alternatively, infrared (IR) sensors can be used for the detection of explosive gases (such as methane) or a build-up of carbon dioxide, which is often used for pH control.

Yellow-N Credit: Teledyne Gas and Flame Detection

Infrared sensors are recommended for corrosive atmospheres or where high levels of H_2S are present because continued exposure to a concentration of H_2S above 3 ppm risks saturation of standard catalytic sensors. On this point, Francois Ampe says that "our IR sensor cells are not sensitive to poisons such as H_2S, so they last longer and can be guaranteed for 5 years: maintenance is reduced to only one annual test". He continues to say that "on the other hand, the power consumption for the catalytic sensors is much less than for IR, only 150mA compared to 250mA. Where solar power is used in remote locations to power the gas detection sensor network, this low power consumption is attractive. This kind of product selection advice helps our downstream oil and gas sector customers choose a gas detection system that best fits their needs".

Refineries are often located close to sensitive natural resources such as rivers and oceans

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