WHITE PAPER

The Importance of Gas Detection in Water Treatment

Reducing gas risk during water treatment and sewage processes

Water utility companies help provide clean water for drinking, bathing, and industrial and commercial uses. Wastewater treatment plants and sewage systems help keep our waterways clean and sanitary.

Throughout the water industry, the risk of gas exposure and gas-associated hazards are considerable. Harmful gases can be found in water tanks, service reservoirs, pumping wells, treatment units, chemical storage and handling areas, sumps, sewers, overflows, boreholes, and manholes.

In this whitepaper, we will look at gas hazards in the main water processing areas and how the risk of accidental exposure or damage can be reduced.

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Detecting Gas Saving Lives

Description of the main water process areas

Water Treatment

To make water clean and potable, it needs to undergo a treatment process that includes the following steps:

1. **Rain collection** – Rainwater flows into rivers and streams, or filters down into the earth to generate groundwater. Water utility companies pump this water to reservoirs or their water treatment works where it undergoes various stages of treatment.
2. **Storage** – Untreated water is usually stored in reservoirs, which allows heavier particles and larger sediment to settle to the bottom.
3. **Screening** – Before filtering the water with sand, it is put through a screen to remove any large floating objects such as leaves and branches.
4. **Particle removal** – In some treatment plants, a solution is added to increase the particle size, making them easier to remove in a process known as flocculation. Next, the water is filtered through rapid gravity filters (which use coarse sand) and slow sand filters (which use fine sand).
5. **Chemical treatment** – The final treatment stage is to add a small amount of chlorine to the water to kill off bacteria and organisms, making it safe to drink.
6. **Storage and pumping** – The treated water is stored in covered reservoirs and pumped to consumers as required.

Sewage Treatment

The treatment of sewage varies depending on the type of treatment plant. The typical process looks like this:

1. **Wastewater and sewage collection** – The sewer system is a network of drains, pipes, and larger sewer pipes, which collects and pumps wastewater to the sewage treatment works.
2. **Screening** – The first step is to put the wastewater through screens to remove larger items such as wet wipes, nappies, other sanitary items, bricks, bottles, and rags. Finer screens are also used to remove grit.
3. **Primary treatment** – Organic human waste or effluent is then removed by using large settlement tanks, which allow solids to separate and sink to the base, forming sludge. Large mechanical arms push the sludge to the centre of the base of the tank where it is pumped away and treated again.
4. **Secondary treatment** – The secondary stage involves removal of smaller particles and organisms in another settlement tank. Some sewage treatment works use ‘aeration lanes’ which involve pumping air into the wastewater.
5. **Final treatment** – The wastewater is put into one more settlement tank, then filtered through a bed of sand
6. **Returning the water** – The treated water is returned to rivers and streams. Some of the sludge is collected to generate power or recycled as fertiliser for agriculture.

In the next section, we discuss the gas hazards that occur at the various stages listed above and the risks to health and safety that they present.

Gas hazards in the water treatment industry

Ammonia (NH_3)

Ammonia gas can be released during wastewater treatment in settlement tanks or lagoons. The ammonia is commonly used in industrial and agricultural processes, which makes it prevalent in wastewater. Ammonia can be oxidised biologically in a bacterial process called nitrification which produces first nitrites and then nitrates.

Ammonia gas is potentially harmful to health and the environment. It can cause swelling and burning sensation in the airways, lung damage, and fatalities in high concentrations. It can also adversely affect the digestive system.

The safe working limits for ammonia, as set out in EH40/2005 Workplace Exposure Limits, are: Long-term exposure limit (8-hr reference period) of 25 ppm and Short-term exposure limit (15 minute reference period) of 35 ppm

Hydrogen sulphide (H_2S)

Hydrogen sulphide is a foul smelling and toxic gas that can occur during wastewater treatment. Sulphur is present in both human and livestock waste, as well as rainfall in urban areas and domestic wastewater. Contaminants that contain sulphides can chemically form hydrogen sulphide during anaerobic processes in wastewater treatment plants.

Hydrogen sulphide presents a risk to humans as it affects the nervous system, leading to nausea and headaches. It can also irritate the skin, eyes, and respiratory system, or cause a temporary loss of the sense of smell. At high concentrations, it can be fatal.

EH40/2005 Workplace Exposure Limits exposure limits for H_2S over the long-term (8 hour) exposure limit is 5 ppm and short-term (15 minutes) is 10 ppm.

Chlorine (Cl)

Chlorine is often added at wastewater treatment plants as a disinfectant. It helps to remove dangerous pathogens from the water.

Exposure to chlorine in the atmosphere can lead to irritation of skin, eyes, and the respiratory system. At higher concentrations, chlorine can cause serious throat and lung damage.EH40/2005 Workplace Exposure Limits exposure limits for Cl over the short-term (15 minutes) is 0.5 ppm and there are no safe long-term limits, therefore long-term exposure should be avoided altogether.

Ozone (O_3)

Ozone is used in some water treatment plants. Ozone is dissolved in the wastewater, which produces a biocide that neutralises up to 99% of viruses and bacteria.

Ozone is highly reactive and toxic. Uncontrolled exposure can cause respiratory problems such as irritation and damage of the upper airways.

EH40/2005 Workplace Exposure Limits exposure limits for O_3 over the short-term (15 minutes) is 0.2 ppm and there are no safe long-term limits, therefore long-term exposure should be avoided altogether.

Methane (CH_2)

Methane, also known as natural gas, can accumulate in sewers and drains. Too much methane in an enclosed or partially enclosed atmosphere can present the risk of explosion. Methane is also a by-product during sludge digestion and some other processes or can leak into sewers from adjacent gas distribution infrastructure or nearby refuse sites.

There is no guidance on workplace exposure limits for methane in the EH40/2005 Workplace Exposure Limits document. But the fact that methane gas is highly explosive means working where concentrations are below 20%LEL is advisable.

Carbon dioxide (CO_2)

CO_2 is sometimes used as a wastewater treatment solution. When CO_2 is added to water it forms carbonic acid that naturally adjusts acidity or pH levels to a normal value.

Exposure to significant concentrations of CO_2 risks medical symptoms including headache, respiratory problems, dizziness, confusion, and tremors. At high concentrations, exposure can lead to unconsciousness.

EH40/2005 Workplace Exposure Limits exposure limits for CO_2 over the long-term (8 hour) exposure limit is 5000 ppm and short-term (15 minutes) is 15000 ppm.

Biogas

Biogas is a mixture of methane and carbon dioxide and can be formed during the anaerobic digestion of sewage sludge during wastewater treatment. Due to its commercial value, biogas is often collected, stored, and sold as a fuel source.

Biogas is flammable and explosive. Exposure risks include respiratory problems (including asphyxiation), headaches, eye irritation, memory loss, and dizziness.

There is no guidance on workplace exposure limits for biogas in the EH40/2005 Workplace Exposure Limits document, though guidelines on both methane and carbon dioxide should be followed.

Nitrogen Oxides (NO, NO_2, N_2O)

Nitrogen oxides occur naturally in the environment, or as products of combustion. They can easily get into standing water. Most wastewater treatment plants apply some form of nitrogen removal to denitrify the water and sludge before releasing it.

Nitrogen oxides exposure can lead to dizziness, confusion, balance loss, impaired cognitive processing, and muscle weakness.

EH40/2005 Workplace Exposure Limits exposure limits for NO over the long-term (8 hour) exposure limit is 2 ppm, for NO_2 over the long-term (8 hour) exposure limit is 0.5 ppm and short-term (15 minutes) is 1 ppm, and for N_2O over the long-term (8 hour) exposure limit is 100 ppm.

Certification in safe confined space working can be gained from City & Guilds and RoSPA (Royal Society for the Prevention of Accidents).

Confined Space Hazards

The water treatment process involves confined space working for some employees. Engineers who are tasked with the inspection, maintenance, and repair of water tanks and sewage systems are at particular risk of gas exposure when working in confined spaces.

The build-up of hazardous gases presents a high risk to human health. Therefore, suitable breathing apparatus and personal gas detection monitors should be worn. The Health and Safety Executive (HSE) issues guidance on safe working practices in confined spaces.

Training is available on confined space working practices, supervision, and management. Certification in safe confined space working can be gained from City & Guilds and RoSPA (Royal Society for the Prevention of Accidents).

Responsible Parties for Gas and Confined Space Hazards

Plant owners and contractors

The main responsibility for the management of gas and confined space risks lies on the shoulders of the plant owners and main contractors working within the treatment plant. The plant owners may employ people directly or through contractor firms to work in areas that present a risk of gas exposure. Therefore, they have a duty of care to mitigate the risk of accidental exposure and harm.

Consultants

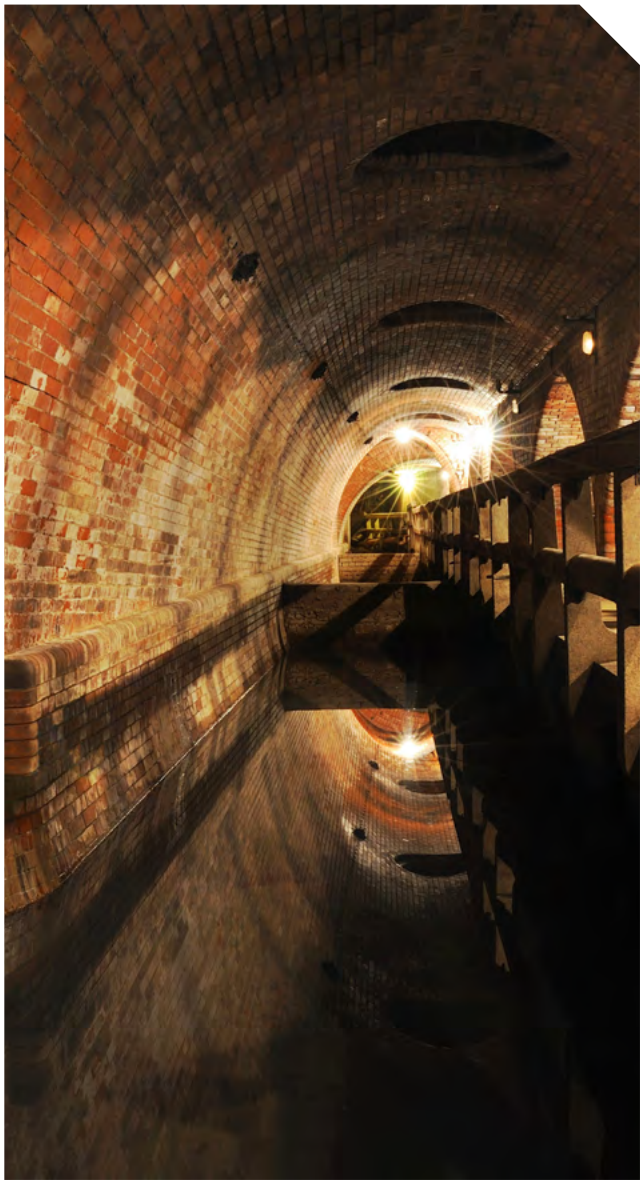
Consultants who provide operational support for water treatment plants may also share some of the responsibility for hazard control. The consultant may flag up areas for improvement throughout the treatment process, including the implementation of gas detection technology.

OEM suppliers

Providers of water tanks, pumps, and other equipment used during wastewater treatment are duty bound to ensure that the equipment contains toxic gases adequately.

Safety inspectors

The main role of a safety inspector is to ensure that health and safety guidance and legislation is being followed. If they notice any safety breaches or lack of regulatory compliance, then they will take the necessary action to rectify the situation. This may include the implementation of gas detection technology.



Crowcon's products monitor the surroundings and help to warn of and thereby help prevent health issues.

Crowcon Gas Detection Products

Crowcon has a wide range of gas detection products to help you meet the demands of the water treatment industry.

Fixed Gas Detectors

Fixed gas detectors are ideal to monitor and alert water treatment plant managers and workers to the presence of all the major gas hazards. The fixed gas detectors can be permanently positioned inside water tanks, sewage systems, and any other areas that present a high risk of gas exposure.

Portable Gas Detectors

Portable gas detectors are lightweight and robust wearable gas detection devices that are particularly useful for confined space workers, but that are generally useful in the determination and mitigation of personal gas risks. The portable gas detectors sound and signal an alert to workers when gas levels are reaching dangerous concentrations, allowing action to be taken.

Control panel

A control panel can be applied to coordinate numerous fixed gas detection devices and provide a trigger for alarm systems.

For more information about gas detection within water and water treatment, or to explore more of Crowcon's gas detection range, please get in touch with our friendly team.