

# Gas Safety in Wastewater Treatment

A Facility & Safety Manager's Guide  
to Gas Detection in 2024.



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## How to use this Guide.

Welcome to this comprehensive guide on understanding and detecting different gases in a wastewater treatment facility. If you're reading this, you likely have a stake in ensuring the safety and efficiency of wastewater treatment operations. We wrote this guide to help you understand and stay updated on gas detection in your facilities' operations.

This guide will leave you with:

- In-depth information on various gases you encounter daily.
- A breakdown of modern gas detection methods that can serve as your second set of eyes.
- Regulatory insights to ensure you're always on the right side of the law and where to look for more information.

Consider this guide your go-to resource, a toolbox, to help you navigate the often-complicated world of gas management in water treatment.

## Who is Interscan?

Established in 1975, Interscan Corporation is a leading global provider of specialized toxic gas detection instruments.

With a reputation for delivering top-notch customized engineering solutions, Interscan sets itself apart from the competition in a sea of generic products. The company's commitment to tailored products and quality craftsmanship has earned them worldwide recognition as the preferred choice for clients with specific requirements.

Interscan's unwavering dedication to providing personalized equipment underscores its position as a top-tier provider in the industry. With a long-standing history of excellence, Interscan continues to innovate and deliver unparalleled service to its valued clients.



# I. Importance of Safety Protocols in Wastewater Treatment Facilities

Safety managers in wastewater treatment facilities use safety protocols because of the various chemicals, equipment, and procedures used and the gases produced that pose a risk to staff, facility, and neighborhood, as discussed below.

## Role of Gas Detection in Ensuring Safety

Toxic and flammable gases produced in the various processes are a significant occupational risk in wastewater treatment plants. Gas detection plays a critical role in ensuring safety. It monitors the presence and concentration of potentially hazardous gases in the environment and provides early warnings or alarms when gas levels exceed safe limits. Here are some critical aspects of the role of gas detection in ensuring safety:

**Personnel Safety:** Wastewater treatment plants can produce or release harmful gases such as hydrogen sulfide (H<sub>2</sub>S), methane (CH<sub>4</sub>), and ammonia (NH<sub>3</sub>). Exposure to these gases can be life-threatening or cause serious health issues. Gas detectors help protect plant workers by providing early warning of gas leaks or elevated gas levels, allowing them to evacuate or take appropriate precautions.

**Process Control:** Gas detectors are integrated into the control systems of wastewater treatment plants to ensure that gas levels are within safe limits. When gas levels exceed predefined thresholds, alarms can be triggered, and automated systems can initiate safety measures, such as shutting down specific processes or activating ventilation systems.

**Environmental Protection:** Gas leaks or emissions from wastewater treatment plants can adversely affect the environment, nearby water bodies, and surrounding communities. Gas detectors help identify and prevent gas leaks, which can lead to environmental pollution and damage.





**Preventing Equipment Damage:** Some gases, such as hydrogen sulfide, can corrode equipment and infrastructure within wastewater treatment plants. Early detection of gas leaks can prevent costly damage to plant assets and infrastructure.

**Emergency Response:** In a gas-related emergency, gas detectors provide critical information to first responders and plant personnel. This information helps responders assess the situation, plan their response, and take appropriate actions to mitigate risks.



**Compliance with Regulations:** Gas detection systems assist in compliance with regulations by providing real-time data and documentation of gas levels and safety measures.

**Continuous Monitoring:** Gas detection systems often provide constant monitoring and can be integrated into control systems to automatically adjust ventilation or shut down processes when necessary, reducing the risk of accidents.

**Data Logging and Reporting:** Many gas detection systems record data over time, allowing for trend analysis, compliance reporting, and investigations into the causes of gas incidents.

**Community Relations:** Prioritizing safety builds trust with local communities.

Properly maintained and calibrated gas detection systems are crucial for minimizing risks associated with hazardous gases.

## II. Gas Detection Technologies and Methods

Gas detection identifies the presence and concentration of specific gases in the environment to ensure safety, monitor industrial processes, or detect leaks. Several principles and technologies are employed for gas detection, each with advantages and limitations. The sensors' principles could be catalytic combustion, electrochemical, infrared, photoionization, gas chromatography, ultrasonic, and ion mobility spectrometry.





## Types of Gas Detectors

Multiple sensors or detection principles may be combined to provide comprehensive gas monitoring solutions. There are three primary types of sensors used for gas detection.

### 1. Point Gas Detectors

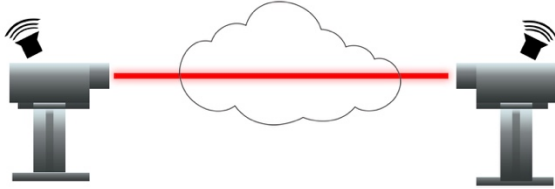
Point gas detectors are devices used to monitor specific gases in industrial environments. They employ various detection technologies like electrochemical, infrared, or catalytic bead sensors to identify gases within a defined concentration range. These detectors have preset alarm thresholds, triggering alerts when gas levels exceed safety limits. Regular calibration is essential for accuracy. They find applications in gas leak detection, safety monitoring, environmental compliance, and process control.

Point gas detectors can be portable or fixed, with some capable of detecting multiple gases. Maintenance, data logging, and connectivity for remote monitoring are essential features. They are crucial for preventing accidents and ensuring safety in workplaces with hazardous gases.



## 2. Open-path Detectors

Open-path detectors are instruments that remotely detect and measure specific substances or pollutants in the air over large distances. Open-path detectors use a source of light or another electromagnetic signal and a receiver to measure changes in the signal caused by a specific gas or particulate matter in the air. They rely on the principles of absorption spectroscopy, scattering, or other interactions between light and matter.



These detectors find applications in air quality monitoring, industrial safety, and environmental compliance. Their advantages include remote sensing capabilities, non-invasiveness, and quick response times. However, they may have limitations related to specificity, interference from environmental conditions, and the need for regular calibration. Open-path detectors use tunable diode laser absorption spectroscopy (TDLAS), differential optical absorption spectroscopy (DOAS), and LIDAR.

## 3. Portable Gas Detectors



Portable gas detectors are devices used to monitor and detect the presence of various gases in the air. They ensure safety in industries and applications where toxic, flammable, or explosive gases can be a threat. These detectors come in different types, such as catalytic bead sensors for flammable gases and electrochemical sensors for toxic gases. They have alarms to alert users when gas concentrations exceed safe levels and

often offer data logging capabilities for record-keeping.

Portable gas detectors are used in industrial settings, environmental monitoring, and emergency response and require regular calibration and user training for practical use. Compliance with regulations is also essential when using these devices.

In wastewater treatment plants, portable gas detectors can spot and measure,

- Toxic gases such as carbon dioxide, hydrogen sulfide, ammonia, chlorine, and
- Flammable gases like methane and oxygen.

Portable gas detectors play a vital role in ensuring the safety of workers and the prevention of accidents related to hazardous gases. They come in various sizes and configurations to meet the specific needs of different industries and applications. For



example, Interscan Instruments are portable devices that detect all the toxic gases in wastewater treatment plants. [GasD® 8000 Series](#) models use appropriate sensors, have audio and visual alarms, and have data logging possibilities. We offer sensing applications with concentration measurement ranges as low as parts per billion (ppb)

## Selection Criteria for Gas Detectors

Selecting the suitable gas detector involves considering several crucial factors:

- Identify the types of gases to be monitored.
- Determine the detection range needed for the application.
- Assess accuracy and sensitivity, especially for critical situations.
- Consider the detector's response time for rapid gas detection.
- Aim for a low false alarm rate to minimize disruptions.
- Account for environmental conditions and durability.
- Evaluate long-term maintenance requirements and costs.
- Ensure compliance with industry-specific safety standards.
- Check for clear displays and effective alarms.
- Decide on the power source, considering battery life and reliability.
- Consider data logging and connectivity options.
- Balance initial costs with potential savings from safety and downtime prevention.

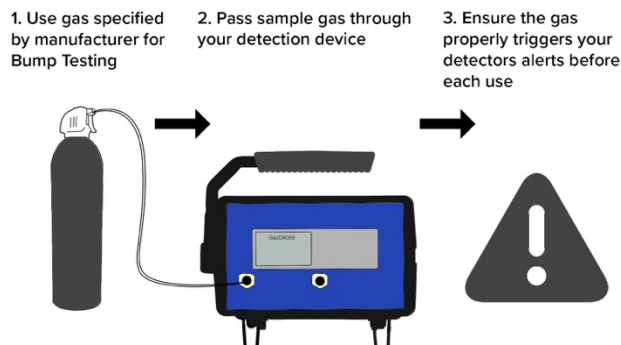
By addressing these criteria, safety managers can select a gas detector that best suits their monitoring needs and ensure safety in the plant.

## Calibration and Maintenance of Gas Detectors

Regular monitoring and maintenance of gas detection systems are essential for their reliable performance in safeguarding wastewater treatment plant operations.

**Maintenance and Calibration:** Gas detectors require regular maintenance, [bump testing](#), and calibration to ensure accuracy and reliability. Proper maintenance ensures that the sensors will perform effectively when needed.

**Training and Education:** Gas detection systems are most effective when plant personnel are trained in their use and understand the potential hazards associated with the gases being monitored. Training programs help ensure employees respond appropriately to gas alarms and emergencies.





## V. Gas Detection Challenges in Wastewater Treatment Environments

Gas detection in wastewater treatment environments presents several challenges due to these facilities' unique conditions and potential hazards. Here are some of the key challenges:

**Variability of Gas Types:** Wastewater treatment facilities can produce various gases. Detecting and monitoring multiple gas types simultaneously can be challenging.

**Harsh Environment:** Wastewater treatment plants are often characterized by damp, corrosive, and potentially explosive atmospheres. Standard gas detection equipment may not withstand these conditions and require specialized construction and materials.

**Interference:** Other chemicals and compounds in wastewater can interfere with gas detection. For example, hydrogen sulfide can be absorbed by organic matter in the water, reducing its concentration in the air and making accurate detection difficult.

**Maintenance Challenges:** The harsh environment of wastewater treatment plants can accelerate equipment wear and corrosion, increasing maintenance requirements.



**Explosive Atmospheres:** Methane and other flammable gases can accumulate in confined spaces within wastewater treatment facilities, creating potentially explosive atmospheres. Specialized explosion-proof or intrinsically safe gas detectors are often needed to ensure safety in these environments.

**Confined Spaces:** Wastewater treatment facilities often have confined spaces where gases can accumulate. These areas are difficult to access and pose additional safety risks to personnel. Proper training and equipment for confined space entry are essential.

**Detection Limits:** Some gases may be present in wastewater treatment environments at very low concentrations, making detection challenging. Gas detectors must have the sensitivity to detect gases even at trace levels to ensure the safety of workers and compliance with regulations.

**False Alarms:** Due to the variability in gas concentrations and interference factors, gas detectors in wastewater treatment plants may be prone to false alarms. It can lead to complacency among workers if false alarms occur frequently.



**Data Integration:** Modern wastewater treatment plants often use SCADA (Supervisory Control and Data Acquisition) systems for process control and monitoring. Integrating gas detection data into these systems for real-time monitoring and response can be complex.

**Regulatory Compliance:** Wastewater treatment facilities are subject to environmental and occupational safety regulations. Ensuring compliance with these regulations, which may include specific gas detection and alarm system requirements, is essential but complex.



To address these challenges, wastewater treatment facilities must have customized safety protocols and risk management.

## IV. Safety Protocols and Risk Management

Safety protocols and risk management are crucial in wastewater treatment plants to protect the environment and the health and safety of workers and the surrounding community. Here are key considerations and practices for ensuring safety in wastewater treatment plants:

### Comprehensive Risk Assessment:

- Identify and assess potential chemical, biological, and physical hazards.
- Evaluate the likelihood and consequences of accidents or incidents.
- Prioritize risks based on severity and probability.
- Consider factors such as the facility's design, location, processes, and historical data on gas emissions.

### Safety Training and Employee Involvement:

- Ensure all employees receive proper training on safety procedures, equipment operation, and emergency response.
- Conduct regular safety drills and training exercises.



- Keep workers informed about potential hazards and safe work practices.
- Enforce strict entry and exit procedures for confined spaces.



**Monitor Gas Levels:**

- Continuously monitor gas levels in critical facility areas, such as wastewater tanks, sewer lines, and pump stations.
- Install gas detectors and alarms that trigger warnings or shutdowns when gas levels exceed safe limits.

**Maintain Proper Ventilation:**

- Ensure that ventilation systems are well-maintained and regularly inspected.
- Implement redundancy in ventilation systems to prevent downtime in case of equipment failure.

**Personal Protective Equipment (PPE):**

- Provide appropriate PPE, such as gloves, goggles, respirators, and chemical-resistant suits, for employees working with hazardous substances.
- Ensure that PPE is regularly inspected, maintained, and replaced as needed.

**Chemical Handling and Storage:**

- Establish strict protocols for safely handling, storing, and disposing of chemicals used in treatment.
- Store chemicals in designated areas with proper labeling and containment measures.

**Equipment Maintenance and Inspection:**

- Implement a preventive maintenance program for all equipment to minimize the risk of breakdowns or accidents.
- Regularly inspect and test safety systems, alarms, and emergency shutdown mechanisms.
- Address any issues promptly to prevent gas leaks or equipment failures.

**Emergency Response Plan:**

- Develop a comprehensive emergency response plan outlining incidents' procedure, including spills, leaks, fires, and equipment failures.
- Train employees on emergency response protocols and conduct drills.



**Security Measures:**

- Implement security measures to protect the plant from unauthorized access and potential acts of sabotage or terrorism.
- Install surveillance cameras and access control systems.

**Environmental Monitoring:**

- Continuously monitor the quality of effluent discharges to ensure compliance with regulatory standards.
- Install sensors and alarms to detect leaks, spills, or unusual conditions.

**Hazard Communication:**

- Clearly label hazardous materials and provide Material Safety Data Sheets (MSDS) for all chemicals used in the plant.
- Ensure that employees understand the risks associated with each chemical and how to handle them safely.

**Regular Inspections and Audits:**

- Conduct regular safety inspections and audits to identify and address potential safety and compliance issues.
- Document the findings and corrective actions for benchmarking.

**Review and Update Safety Protocols:**

- Regularly review and update safety protocols based on changes in facility operations, regulations, or identifying new risks.

**Community Engagement:**

- Engage with the local community to address concerns, share information about safety measures, and provide contact information for reporting incidents or problems.

**Regulatory Compliance:**

- Stay current with all applicable environmental and safety regulations and ensure compliance.



- Work closely with local authorities and regulatory agencies and seek permits as required.

#### **Continuous Improvement:**

- Foster a culture of continuous improvement by encouraging employees to report near misses and safety concerns.
- Regularly review and update safety protocols and procedures based on lessons learned and emerging risks.

#### **Incident Investigation:**

- Investigate all incidents, accidents, and near misses to determine root causes and prevent future occurrences.
- Implement corrective actions based on investigation findings.

By implementing these safety protocols and risk management practices, wastewater treatment plants can minimize the likelihood of accidents and environmental harm while safeguarding the well-being of workers and the community. It's important to adapt these practices to a facility's specific needs and risks and seek expert advice. Also, adjust and update these measures as new technologies, regulations, and risks emerge.

## **V. Regulations and Standards**

Wastewater treatment plants often handle various gases as part of the treatment process, and it's essential to adhere to regulations and standards to ensure the safety of workers, protect the environment, operate within regulatory guidelines, and optimize the treatment process. The specific regulations and standards can vary by region and the type of wastewater treatment facility, but here are some general guidelines and considerations:

**Occupational Safety and Health Administration (OSHA) Regulations:** In the United States, OSHA provides regulations related to workplace safety, including those that apply to the plants. Facilities should follow OSHA standards for handling hazardous gases, such as confined space entry, respiratory protection, and hazard communication. OSHA standards for wastewater practices are derived from regulations for [general industries 29 CFR 1910](#), confined spaces 29 CFR 1926 Subpart A.A., and bloodborne pathogen standards 29 CFR 1910.1030.

**National Emission Standards for Hazardous Air Pollutants (NESHAPs):** NESHAPs are federal regulations in the U.S. that address emissions of hazardous air pollutants (HAPs) from various industrial sources, including wastewater treatment plants. Compliance with these standards may be required for specific gases emitted during wastewater treatment.



**Clean Air Act:** The Clean Air Act in the U.S. sets air quality standards and regulates emissions of various pollutants and other gases that may be released from wastewater treatment processes.

**Local Environmental Regulations:** Local and state environmental agencies may have specific regulations and standards that plant safety managers must adhere to regarding gas emissions and their impact on local air quality and the environment.

**National Fire Protection Association (NFPA) Standards:** NFPA provides fire safety standards and handles hazardous materials. NFPA 820 explicitly addresses fire and explosion hazards in treatment plants.

**European Union Directives:** In the European Union, various directives and regulations may apply to gases emitted from the plants, such as the Industrial Emissions Directive (IED), which sets emissions limits and requires permitting for certain facilities.

**International Standards:** ISO standards related to environmental management systems (e.g., ISO 14001) may apply to plants, helping ensure compliance with environmental regulations and standards.

Safety managers at wastewater treatment plants should work closely with regulatory agencies and environmental consultants to ensure compliance with relevant regulations and standards specific to their location and the gases they handle in wastewater treatment processes. Failure to comply with these regulations can lead to fines, penalties, and environmental harm.

## VI. Common Gases in Wastewater Treatment Facilities

The gases that a safety manager must track in a wastewater treatment facility are methane, hydrogen sulfide, ammonia, chlorine, carbon dioxide, and oxygen.

**A. Methane**

$\begin{array}{c} \text{H} \\ | \\ \text{H}-\text{C}-\text{H} \\ | \\ \text{H} \end{array}$  Methane is produced as a byproduct in substantial quantities in anaerobic digestion, where microorganisms break down organic compounds without oxygen. This methane can be collected and used as an energy source. Most advanced plants use aerobic processes, which do not produce much methane; however, large amounts of solids will release methane.

Methane (CH<sub>4</sub>) is a colorless, odorless, and flammable gas. It forms explosive mixtures with air within a specific concentration range (5-15% methane in the atmosphere).



Methane is a potent greenhouse gas, with a much higher global warming potential than carbon dioxide (CO<sub>2</sub>) over a short time frame.

## Health and Safety Risks

The occupational hazards of methane include health and safety risks.

**Health risks:** Methane poses several health safety risks when inhaled. It causes dizziness, headache, nausea, increased breathing rate, loss of coordination and judgment, and, in extreme cases, unconsciousness. At high concentrations, it reduces the amount of oxygen and, in confined spaces, can increase risks of asphyxiation.

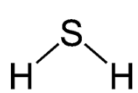
**Flammability:** Methane is highly flammable and can lead to fires or explosions if not handled properly.

## Regulatory Framework for Methane

In the USA, the Occupational Safety and Health Administration (OSHA), National Institute for Occupational Safety and Health (NIOSH), and the American Conference of Governmental Industrial Hygienists (ACGIH) have set the [following limits for methane](#):

- OSHA's legal airborne permissible exposure limit (PEL) averaged over an 8-hour work shift is 1000 ppm (0.1%)
- NIOSH airborne recommended exposure limit (REL) over a 10-hour work shift is 100 ppm.
- ACGIH airborne exposure limit averaged over an 8-hour work shift is 100 ppm.

Check workplace practices to keep staff safe [here](#).



## B. Hydrogen Sulfide

Anaerobic decomposition of plant and animal protein by bacterial processes in sewage can produce hydrogen sulfide (H<sub>2</sub>S). The direct reduction of sulfate also forms it and is common in wastewater treatment plants.

Hydrogen sulfide, also known as sewer gas, is a colorless, flammable gas with a distinct odor of rotten eggs. H<sub>2</sub>S is a gas at room temperature, standard atmospheric pressure, and heavier than air, accumulating at the bottom of confined spaces like storage tanks or sumps. Its odor is detectable at very low concentrations, making it a helpful warning sign for potential exposure. However, at higher concentrations of [150 ppb, it causes a loss of sense of smell](#).

H<sub>2</sub>S is soluble in water, which means it can dissolve into wastewater.

## Health and Safety Risks

Exposure to H<sub>2</sub>S can be highly hazardous to health and safety.

**Health risks:** H<sub>2</sub>S is highly toxic, with even low concentrations posing severe health risks.

- **Respiratory Effects:** Lower H<sub>2</sub>S concentrations (less than 10 ppm) ordinarily present in wastewater treatment plants can irritate the respiratory system, causing headaches and conjunctivitis.
- **Nervous System Effects:** Higher concentrations can affect the central nervous system, leading to headache, dizziness, nausea, and loss of consciousness.
- **Fatalities:** High concentrations can be lethal, causing rapid loss of consciousness and death. At 100 ppm, H<sub>2</sub>S is IDLH (immediately dangerous to life and health).
- **Irritation:** Contact with liquid H<sub>2</sub>S or its solutions can cause skin and eye irritation.

**Fire and Explosion:** H<sub>2</sub>S is flammable and can ignite, leading to fires and explosions in the presence of an ignition source. Lower Explosive Limit (LEL is 4.3%, and Upper Explosive Limit (UEL) is 45%.)

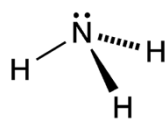
## Regulatory Framework for Hydrogen Sulfide

Regulatory agencies worldwide have established exposure limits for H<sub>2</sub>S to protect workers and the public.

[H<sub>2</sub>S Occupational Exposure Limits by OSHA and NIOSH](#) in the USA are as follows:

- OSHA has set an 8-hour time-weighted average (TWA) PEL of 10 parts per million (ppm) for H<sub>2</sub>S. The TWA in Norway is 10 ppm.
- OSHA set a short exposure limit (STEL) of 15 ppm over 15 minutes.
- NIOSH REL (10-min. ceiling) is 10 ppm.
- NIOSH IDLH is 100 ppm.

For more information on practices to safeguard people, [check this resource](#).



### C. Ammonia

Ammonia (NH<sub>3</sub>) is a natural byproduct of the breakdown of organic matter in human and animal waste. Also, rainwater can wash ammonia-containing substances from streets, lawns, and other surfaces into stormwater and, ultimately, wastewater treatment plants.





In wastewater treatment, ammonia removal is essential to prevent environmental pollution. Standard methods for removing ammonia from wastewater include nitrification and denitrification processes, ion exchange, and chemical precipitation.

Ammonia is a colorless gas at room temperature and pressure but can be liquefied under modest pressure. It has an intense, sharp, distinctive odor easily detectable even at low concentrations.

When dissolved, ammonia is highly soluble in water, forming ammonium hydroxide.  $\text{NH}_3$  is a highly reactive compound that can act as a base and a nucleophile in chemical reactions.



Figure 1 Ammonia. (2023, October 2). In Wikipedia.  
<https://en.wikipedia.org/wiki/Ammonia>

## Health and Safety Risks

The health and safety risks ammonia poses are listed below.

**Fire and Explosion Hazard:** Ammonia is Flammable from LEL of 15% to UEL of 28%

### Health effects:

- **Respiratory Irritation:** Inhalation of ammonia vapors can irritate the respiratory tract, leading to coughing, wheezing, and shortness of breath.
- **Eye and Skin Irritation:** Contact with ammonia can cause skin and eye irritation, including redness and burning.
- **Toxicity:** High ammonia concentrations in the air can be toxic and potentially fatal. Acute exposure can cause nausea, vomiting, and lung damage.

**Corrosion:** Ammonia is corrosive to some metals and materials.

## Regulatory Limits and Exposure Standards

Regulatory limits and exposure standards for ammonia vary by country and jurisdiction.

In [the United States](#), for example, OSHA has established permissible exposure limits for ammonia:

- TWA is 50 parts per million (ppm) over an 8-hour workday.

(NIOSH) limits for ammonia are as follows:

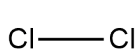
- The REL averaged over a 10-hour work shift is 25 ppm.
- The STEL is 35 ppm in any 15-minute work period.

Exposure standards for ammonia in ambient air, drinking water, and wastewater discharge are also established by environmental agencies to protect public health and the environment.

**Exposure and Safety Precautions:** To minimize exposure to ammonia, safety precautions include:

- Use of Personal Protective Equipment (PPE): This may include respiratory protection, safety goggles, gloves, and protective clothing.
- Ventilation: Ensure good ventilation in areas where ammonia is used or stored to prevent the buildup of vapors.
- Proper Storage: Store ammonia in well-ventilated areas away from incompatible substances.
- Emergency Response: Establish procedures and equipment, including eye wash stations and showers.
- Training: Train workers on the safe handling and storage of ammonia.

For more information on safety practices, [check here](#).



## D. Chlorine

Chlorine is not an off-gas of the treatment process but is commonly used for disinfection, especially in municipal wastewater treatment plants. Chlorine is added as gas or sodium hypochlorite (liquid bleach) to kill or inactivate harmful pathogens, such as bacteria and viruses, present in wastewater to ensure that the treated wastewater is safe to discharge into the environment or to reuse. However, any accident or incident during its shipping, storage, and handling poses a health and life risk to workers and neighborhoods.

Chlorine (Cl<sub>2</sub>) is a highly reactive, greenish-yellow gas with a distinctive bleach-like odor. Chlorine exists as a gas at room temperature and pressure. It is highly reactive and readily forms compounds with many other elements and chemicals. It is a potent oxidizing agent and can react violently with certain substances.

Chlorine gas dissolves in water to form hydrochloric acid (HCl) and hypochlorous acid (HOCl), essential in disinfection and water treatment.



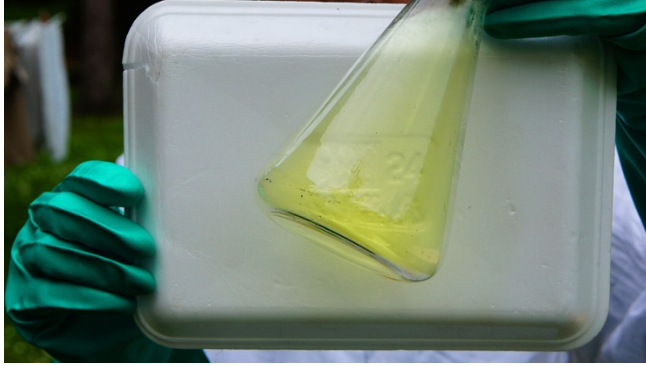


Figure 2: Antek123, CC BY-SA 3.0  
<<https://creativecommons.org/licenses/by-sa/3.0/>>, via Wikimedia Commons

## Health and Safety Risks

Chlorine poses several health and safety risks in its gaseous form and as compounds like sodium hypochlorite.

**Health effects:** It has health effects even after short exposure to low levels of the gas and liquid.

- **Toxicity:** Inhaling chlorine gas can cause respiratory irritation, coughing, chest tightness, and difficulty breathing. Severe exposure can lead to pulmonary edema (fluid accumulation in

the lungs), which can be life-threatening.

- **Skin and Eye Irritation:** Liquid chlorine compounds can cause skin and eye irritation on contact. Prolonged or severe exposure can result in burns and tissue damage.

**Fire and Explosion Hazard:** Chlorine is not flammable but is highly reactive. It can react violently with combustible materials, increasing the risk of fire or explosion. Cylinders can explode, leading to problems.

## Regulatory Limits and Exposure Standards

Various agencies have established chlorine regulatory limits and exposure standards to protect human health and the environment.

**Occupational Exposure Limits:** The limits set by various agencies in the USA for chlorine exposure are as follows:

- OSHA sets a PEL for chlorine gas of 1 ppm over an 8-hour workday.
- NIOSH recommends a REL during any 15-minute work period of 0.5 ppm.
- ACGIH's threshold limit value (TLV) averaged over an 8-hour work shift is 0.5 ppm, and STEL is 1 ppm.

**Environmental Regulations:** Regulatory agencies also set limits on the discharge of chlorine and its compounds into the environment to minimize harm to aquatic ecosystems.

**Safe Handling Guidelines:** Organizations and agencies provide guidelines for the secure handling and storage of chlorine and its compounds and emergency response procedures in case of accidental releases.

**Exposure Prevention:** To prevent exposure to chlorine and its associated risks, it is crucial to use proper protective equipment, follow safety protocols, and ensure



adequate ventilation in areas where chlorine is used or stored. For more details, consult [this document](#).

In recent years, there has been a shift toward using alternative disinfection methods in wastewater treatment to reduce the risks associated with chlorine use.

## $O=C=O$ E. Carbon Dioxide

Carbon dioxide ( $CO_2$ ) is naturally present in the atmosphere, meaning it can be found in wastewater due to air dissolution. During the biological treatment of wastewater, microorganisms consume organic matter and produce  $CO_2$  as a metabolic byproduct. In some industrial processes,  $CO_2$  may be intentionally added to wastewater for pH adjustment or chemical reactions. It can also be produced when carbonates or bicarbonates in wastewater react with acids.

Carbon dioxide is a colorless, odorless gas at average temperature and pressure. It is a solid (dry ice) at low temperatures and pressures and a liquid at higher pressures. Carbon dioxide gas is denser than air, accumulating in low-lying areas and becoming a health risk in confined spaces.

$CO_2$  is soluble in water, and when dissolved, it forms carbonic acid ( $H_2CO_3$ ), which can affect water pH. It is non-flammable and does not support combustion.

### Health and Safety Risks

Carbon dioxide is a health risk and a pollutant.

**Health effects:**  $CO_2$ 's effect on health depends on its concentrations and is as listed below:

- **Inhalation Hazard:** High concentrations of  $CO_2$  can displace oxygen in confined spaces, leading to asphyxiation.
- **Irritation:** Exposure to elevated levels of  $CO_2$  can cause respiratory and ocular irritation.

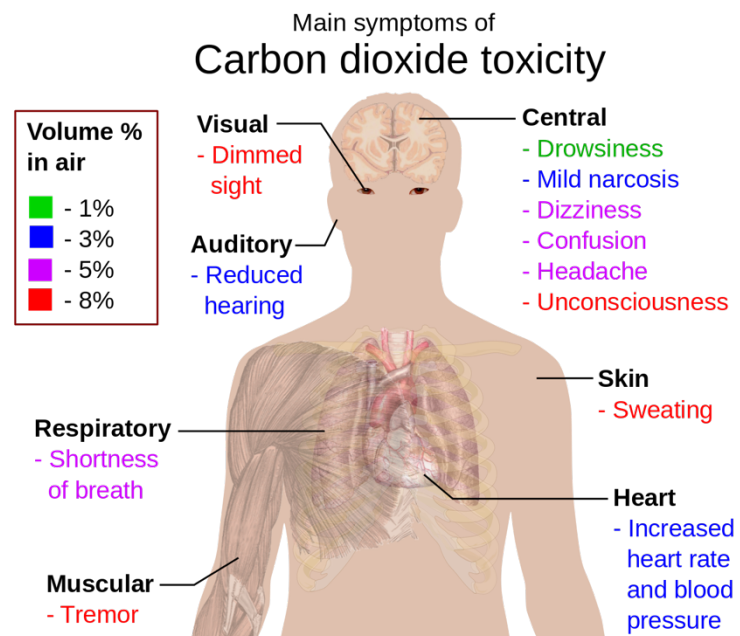


Figure 3 Haggström, Mikael (2014). "Medical gallery of Mikael Haggström 2014". WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.008. ISSN 2002-4436. Public Domain.orBy Mikael Haggström, used with permission., Public domain, via Wikimedia Commons





## Regulatory Limits and Exposure Standards

CO<sub>2</sub> in ambient air varies by region and country but typically ranges from 350 to 500 ppm.

- OSHA in the United States has established a PEL of 5,000 ppm over an 8-hour workday for CO<sub>2</sub>.
- NIOSH recommends an immediately dangerous to life or health (IDLH) [concentration of 40,000 ppm](#).

**Exposure Standards in Indoor Air:** The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommends indoor CO<sub>2</sub> levels below [1,000 ppm for comfort](#) and air quality. Elevated indoor CO<sub>2</sub> levels may indicate poor ventilation, impacting occupant health and well-being.

**Safety Precautions:** Adequate ventilation and monitoring of CO<sub>2</sub> levels are essential in areas where it may accumulate. Proper personal protective equipment (PPE) should be used when handling compressed CO<sub>2</sub>. For more safety instructions, check this [USDA document](#).

**Environmental Impact:** Increased levels of CO<sub>2</sub> in the atmosphere are a significant contributor to global warming and climate change. This is primarily due to its role as a greenhouse gas, trapping heat in the earth's atmosphere. Also, when CO<sub>2</sub> dissolves in water, it forms carbonic acid, which can lower the pH of water. Extremely low or high pH can be harmful to aquatic life.

## $O=O$ F. Oxygen

Oxygen (O<sub>2</sub>) is crucial in wastewater treatment, particularly aerobic treatment processes. Oxygen is supplied to wastewater in aeration tanks to support the growth of aerobic bacteria. These bacteria help break down organic matter in the wastewater through aerobic respiration, converting it into less harmful substances. Mechanical aerators or diffusers transfer oxygen from the air into the wastewater, ensuring the microbial population has an adequate oxygen supply for treatment.

Oxygen is one of the most abundant elements on Earth and is essential for life. It is a colorless, odorless, and tasteless gas at room temperature and standard pressure.



Figure 4 Staff Sgt. Nika Glover, U.S. Air Force, Public domain, via Wikimedia Commons



Oxygen is slightly soluble in water and more soluble in colder water. Oxygen is highly reactive, readily forms compounds with many other elements and molecules, and supports combustion.

### Health and Safety Risks

The safety risks of oxygen are more significant than health risks.

**Health Risks:** Oxygen is essential for human respiration. However, breathing pure oxygen at high pressures can lead to oxygen toxicity.

**Safety Risks:** Oxygen supports combustion, and elevated oxygen levels can increase the risk of fire and explosion in specific environments. Therefore, precautions are necessary when handling and storing oxygen.

### Regulatory Limits and Exposure Standards:

Workers are not typically exposed to dangerous oxygen levels in normal working conditions.

**Occupational Exposure Limits (OELs):** Occupational safety agencies may set OELs for oxygen in different countries. These limits are usually very high because oxygen is naturally present in the atmosphere.

Normal O<sub>2</sub> levels are 20.8 percent in the air. When concentrations rise over 21 percent by volume, the air is said to be oxygen-enriched and unstable. It increases the chances and severity of an explosion or flash fire. OSHA has set the oxygen enrichment alarm [level at 23 percent](#) by volume.

Check these [OSHA instructions](#) to prevent and avert accidents due to oxygen-enriched atmospheres.

## VII. Enhancing Safety in Wastewater Treatment Facilities

Wastewater plants have a unique combination of processes and equipment, producing or using hazardous gases with health or safety risks. Having to control all the gases in the complex environment presents challenges. Rigorous safety protocols, specialized equipment for gas detection, personnel training, and personal protection equipment are crucial to safeguard lives, health, and property.

By now, you should understand the different gases encountered in water treatment facilities, their permissible levels, and how to detect them effectively. This guide aims to serve as your cornerstone resource, simplifying complex topics without compromising on detail. Should you have any questions or need further clarification, please contact us at Interscan. Your safety and knowledge are our priority.



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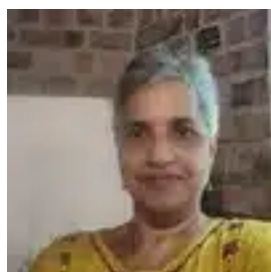
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*Please note: the contents of this E-book have been AI assisted and edited to ensure accuracy and clarity.*





# Contact Us

Thank you for taking the time to read this guide. We hope you found it informative and helpful in navigating the complexities of gas management in water treatment facilities. Your safety and knowledge are our priority.

## Get in Touch

For more information, further questions, or to discuss your specific needs, feel free to get in touch with us at:

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## Recommended Tools for Effective Gas Management

Having the right tools can make all the difference in managing your facility's gas levels efficiently and safely. Here are some products that can help:

### **GasD8000**

Type: Portable Gas Detector

Great for ensuring safety against toxic gases everywhere you go.

[More Info](#)

### **AccuSafe System**

Type: Fixed Point Detectors

Great for a facility that needs to detect gases in a single location or multiple locations at the same time.

[More Info](#)

For a complete list of products and custom solutions, visit our [Product Catalog](#).

