Gas Application Note

Ammonia

Ammonia is a compound with the formula NH_3. It is normally encountered as a gas with a characteristic pungent odor. Although Ammonia contributes significantly to the nutritional needs of Earth, the gas itself is caustic and can cause serious health damage.

Ammonia used commercially is usually named Anhydrous Ammonia. This term emphasizes the absence of water. Because NH_3 boils at -33°C, the liquid must be stored under pressure or at low temperature. Its heat of vaporisation is, however, sufficiently high that NH_3 can be readily handled in ordinary beakers in a fume hood.

Industrial Applications

The main uses of Ammonia are in the production of fertilizers, explosives, and synthesis of organonitrogen compounds.

Because of its many uses, Ammonia is one of the most highly produced inorganic chemicals. Dozens of chemical plants Worldwide produce Ammonia. The Worldwide Ammonia production in 2004 was 109 million metric tons. The People's Republic of China produced 28.4% of the Worldwide production followed by India with 8.6%, Russia with 8.4%, and the United States with 8.2%. About 80% or more of the Ammonia produced is used for fertilizing agricultural crops.

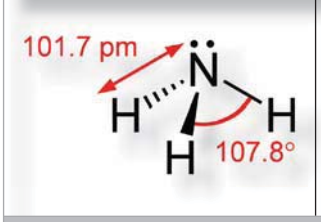
Ammonia is used in the manufacture of Nitric Acid; certain alkalies such as soda ash; dyes; pharmaceuticals such as sulfa drugs, vitamins and cosmetics; synthetic textile fibres such as nylon, rayon and acrylics; and for the manufacture of certain plastics such as phenolics and polyurethanes.

The pulp and paper industry uses Ammonia for pulping wood and as a casein dispersant in the coating of paper. Ammonia is used in several areas of water and wastewater treatment, such as pH control, in solution form to regenerate weak anion exchange resins, in conjunction with Chlorine to produce potable water and as an Oxygen scavenger in boiler water treatment.

The largest NH_3 market is Industrial Refrigeration. Ammonia is utilized in Food & Beverage production and Cold Storage as the refrigerant of choice due to its high efficiency and low cost when compared to major R-gasses like R-22, R404a and R407. Additionally, while Ammonia is both toxic to humans and combustible at high levels, it naturally absorbs into the atmosphere making it the "natural" refrigerant versus ozone depleting CFCs and HCFCs

Potential industries and applications for gas detection products

- Chemical Industry
- Fertiliser manufacturing
- Explosives / fireworks production
- Pulp and paper
- Water and wastewater treatment
- Industrial refrigeration

Ammonia	
	
General	
Systematic Name	Ammonia Azane
Other Names	Hydrogen Nitride Spirit of Hartshorn Nitrosil Vaporole
Molecular Formula	NH_3
Appearance	Colorless Gas with strong pungent odor
CAS Number	7664-41-7
Properties	
Vapor Density	0.59
Melting Point	-77.73°C (195.42K)
Boiling Point	-33.34°C (239.81K)
Toxic Exposure Limits	
OSHA Permissible Exposure Limit (PEL)	
Long-term exposure limit (8-hour TWA reference period)	
ppm	mg.m-3
50	035
ACGIH Threshold Limit Value	
8-hour TWA workday and a 40-hour workweek	25ppm

Gas Application Note

Chlorine

Chlorine is the chemical element with atomic number 17 and symbol Cl. In its common elemental form (Cl_2 or "Dichlorine") under standard conditions, it is a pale green gas about 2.5 times as dense as air. It has a disagreeable, suffocating odor that is detectable in concentrations as low as 3.5ppm and is poisonous. Chlorine is a powerful oxidant and is used in bleaching and disinfectants. As a common disinfectant, it is used in swimming pools to keep them clean. In the upper atmosphere, Chlorine atoms have been implicated in destruction of the Ozone layer.

Industrial Applications

Chlorine's principal applications are in the production of a wide range of industrial and consumer products. For example, it is used in making plastics, solvents for dry cleaning and metal degreasing, textiles, agrochemicals and pharmaceuticals, insecticides, dyestuffs, etc.

Chlorine is an important chemical for water purification, in disinfectants, and in bleach. It is used (in the form of hypochlorous acid) to kill bacteria and other microbes in drinking water supplies and public swimming pools. However, in most private swimming pools Chlorine itself is not used, but rather Sodium Hypochlorite (household bleach), formed from Chlorine and Sodium Hydroxide, or solid tablets of Chlorinated Isocyanurates. Even small water supplies are now routinely chlorinated.

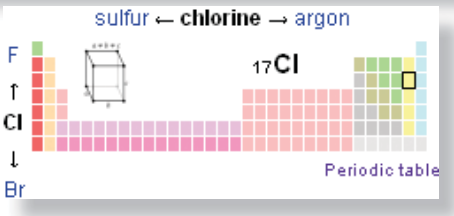
Chlorine is used extensively in organic and inorganic chemistry as an oxidizing agent and in substitution reactions because Chlorine often imparts many desired properties to an organic compound, due to its electronegativity.

Chlorine compounds are used as intermediates in the production of a number of important commercial products that do not contain Chlorine. Examples are: Polycarbonates, Polyurethanes, Silicones, Polytetrafluoroethylene, Carboxymethyl Cellulose and Propylene Oxide.

Chlorine is used in the manufacture of numerous organic Chlorine compounds, the most significant of which in terms of production volume are 1,2-Dichloroethane and Vinyl Chloride, intermediates in the production of PVC. Other particularly important organochlorines are Methyl Chloride, Methylene Chloride, Chloroform, Vinylidene Chloride, Trichloroethylene, Perchloroethylene, Allyl Chloride, Epichlorohydrin, Chlorobenzene, Dichlorobenzenes and Trichlorobenzenes. Chlorine is also used in the production of Chlorates and in Bromine extraction.

Potential industries and applications for gas detection products

- Water and wastewater treatment
- Swimming pools
- Chemical plants
- Industrial manufacturing plants
- Pharmaceutical manufacturing

Chlorine	
	
General	
Systematic Name	Chlorine
Molecular Formula	Cl_2
Appearance	Yellowish Green Gas
CAS Number	7782-50-5
Properties	
Vapor Density	2.5
Melting Point	-101.5°C (171.6K, 150.7°F)
Boiling Point	-34.04°C (239.11K, 29.27°F)
Toxic Exposure Limits	
OSHA Permissible Exposure Limit (PEL)	
Long-term exposure limit (8-hour TWA reference period)	
ppm	mg.m-3
1 (ceiling)	2.9 (ceiling)
ACGIH Threshold Limit Value	
8-hour TWA workday and a 40-hour workweek	0.5ppm

Honeywell

Gas Application Note

Chlorine Dioxide

Chlorine Dioxide is a chemical compound with the formula ClO_2. This red-yellow gas crystallizes as orange crystals at –59°C. As one of several oxides of Chlorine, it is a potent and useful oxidizing agent used in water treatment and in bleaching.

In many countries Chlorine Dioxide gas may not be transported at any concentration and is almost always produced at the application site using a Chlorine Dioxide generator. In some countries, Chlorine Dioxide solution below 3 grams per liter in concentration may be transported by land, but is relatively unstable and deteriorates quickly.

Industrial Applications

Chlorine Dioxide is used primarily (>95%) for bleaching of wood pulp, but is also used for the bleaching of flour and for the disinfection of water. The Niagara Falls, New York water treatment plant first used Chlorine Dioxide for drinking water treatment in 1944 for Phenol destruction.

Chlorine Dioxide was introduced as a drinking water disinfectant on a large scale in 1956, when Brussels, Belgium, changed from Chlorine to Chlorine Dioxide. Its most common use in water treatment is as a pre-oxidant prior to chlorination of drinking water to reduce trihalomethanes which are a carcinogenic disinfection by-product associated with chlorination of naturally occurring organics in the raw water. Chlorine Dioxide is also used in conjunction with Ozone disinfection of water to reduce the formation of bromates which are regulated carcinogens. Chlorine Dioxide is also superior to Chlorine when operating above neutral pH, when Ammonia is present and for the control of biofilms.

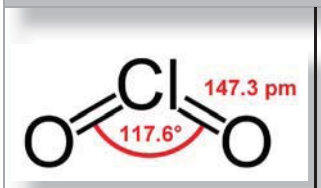
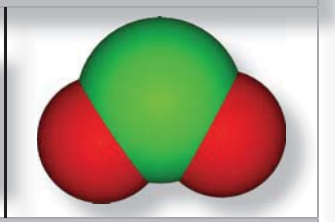
Chlorine Dioxide is used in many industrial water treatment applications as a biocide including cooling towers, process water and food processing. Chlorine Dioxide is less corrosive than Chlorine and superior for the control of Legionella bacteria.

It can also be used for air disinfection, and was the principal agent used in the decontamination of buildings in the United States after the 2001 anthrax attacks. Recently, after the disaster of Hurricane Katrina in New Orleans, Louisiana and the surrounding Gulf Coast, Chlorine Dioxide has been used to eradicate dangerous mold from houses inundated by water from massive flooding.

Chlorine Dioxide is used as an oxidant for Phenol destruction in waste water streams, control of zebra mussels in water intakes and for odor control in the air scrubbers of animal by-product (rendering) plants.

Potential industries and applications for gas detection products

- Municipal water treatment plants
- Industrial water treatment plants
- Pulp and paper manufacture
- Flour bleaching
- Building decontamination / disinfection

Chlorine Dioxide	
	
General	
Systematic Name	Chlorine Dioxide
Other Names	Chlorine Oxide Chlorine Peroxide Chlorine(IV) Oxide
Molecular Formula	ClO_2
Appearance	Red-Yellow Gas with strong pungent odor
CAS Number	10049-04-4
Properties	
Vapor Density	2.3
Melting Point	-59°C
Boiling Point	10°C
Toxic Exposure Limits	
OSHA Permissible Exposure Limit (PEL)	
Long-term exposure limit (8-hour TWA reference period)	
ppm	mg.m-3
0.1	0.3
ACGIH Threshold Limit Value	
8-hour TWA workday and a 40-hour workweek	0.1ppm

Gas Application Note

Hydrogen Chloride

The compound Hydrogen Chloride has the formula HCl. At room temperature, it is a colorless gas, which forms white fumes of Hydrochloric Acid upon contact with atmospheric humidity. Hydrogen Chloride gas, as well as Hydrochloric Acid, are important in technology and industry. The formula HCl is often used to refer, somewhat misleadingly, to Hydrochloric Acid, an aqueous solution derived from Hydrogen Chloride.

Hydrogen Chloride forms corrosive Hydrochloric Acid on contact with water found in body tissue. Inhalation of the fumes can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory system failure, and death. Skin contact can cause redness, pain, and severe skin burns. Hydrogen Chloride may cause severe burns to the eye and permanent eye damage.

Industrial Applications

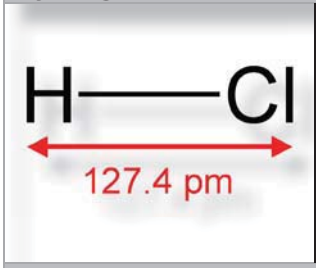
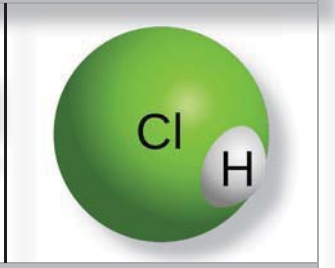
Historical uses of Hydrogen Chloride in the 20th century include hydrochlorinations of alkynes in producing the chlorinated monomers Chloroprene and Vinyl Chloride, which are subsequently polymerized to make Polychloroprene (Neoprene) and Polyvinyl Chloride (PVC), respectively. In the production of Vinyl Chloride, Acetylene (C_2H_2) is Hydrochlorinated by adding the HCl across the triple bond of the C_2H_2 molecule, turning the triple into a double bond, yielding Vinyl Chloride.

- Most Hydrogen Chloride is used in the production of Hydrochloric Acid.
- Hydrochlorination of rubber
- Production of Vinyl and Alkyl Chlorides
- Chemical intermediate in other chemical production
- Use as babbitting flux
- Treatment of cotton (delinting and separation from wool)
- Used in semiconductor industry (in pure grade)
  - » - Etching semiconductor crystals
  - » - Converting Silicon to $SiHCl_3$ for purification of Silicon

Hydrogen Chloride usually comes in compressed gas cylinders that are either red and brown or grey with a yellow band.

Potential industries and applications for gas detection products

- Hydrogen Chloride production
- Chemical manufacturing
- Rubber treatment
- Metal treatment plants
- Cotton treatment
- Semiconductor manufacturing

Hydrogen Chloride	
	
General	
Systematic Name	Hydrogen Chloride Chlorane
Other Names	Chlorohydric Acid Hydrochloride Hydrochloric Acid Hydrochloric Acid gas
Molecular Formula	HCL
Appearance	Colorless Gas hygroscopic
CAS Number	7647-01-0
Properties	
Vapor Density	1.3
Melting Point	-114.2°C (158.8K)
Boiling Point	-85.1°C (187.9K)
Toxic Exposure Limits	
OSHA Permissible Exposure Limit (PEL)	
Long-term exposure limit (8-hour TWA reference period)	
ppm	mg.m-3
5 (ceiling)	7 (ceiling)
ACGIH Threshold Limit Value	
8-hour TWA workday and a 40-hour workweek	2ppm (ceiling)

Gas Application Note

Hydrogen Cyanide

Hydrogen Cyanide is a chemical compound with chemical formula HCN. A solution of Hydrogen Cyanide in water is called Hydrocyanic Acid. Hydrogen Cyanide is a colorless, very poisonous, and highly volatile liquid that boils slightly above room temperature at 26°C (78.8°F). HCN has a faint, bitter, almond-like odor that some people are unable to detect due to a genetic trait. Hydrogen Cyanide is weakly acidic and partly ionizes in solution to give the Cyanide Anion, CN-. The salts of Hydrogen Cyanide are known as Cyanides. HCN is a highly valuable precursor to many chemical compounds ranging from polymers to pharmaceuticals.

Industrial Applications

Hydrogen Cyanide is an important chemical with over a million tons produced globally each year. Hydrogen Cyanide is manufactured industrially by reacting Methane and Ammonia in air at high temperatures over a platinum catalyst. The resultant product is then used to make a wide range of chemicals for use in paints, plastics and synthetic fibres such as nylon.

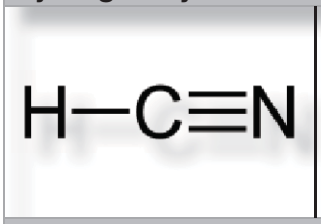
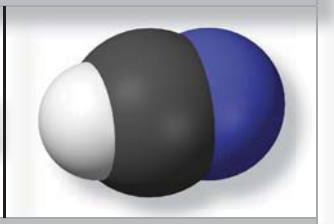
Sodium and Potassium Cyanide and other Cyanide salts may be made from Hydrogen Cyanide and these are widely used in metal processing including electroplating and hardening. Large amounts of Sodium Cyanide are used around the World in the extraction of gold and silver from ores.

Hydrogen Cyanide and other Cyanide compounds have also been used as a fumigant to control pests in grain stores.

Hydrogen Cyanide is produced and found throughout the environment at low levels from combustion of organic matter, volcanoes and from the natural processes of some plants, bacteria, algae and fungi.

Potential industries and applications for gas detection products

- Chemical manufacture
- Grain stores
- Metal processing factories

Hydrogen Cyanide	
	
General	
Systematic Name	Hydrogen Cyanide
Other Names	Hydrocyanic Acid Prussic Acid Formonitrile Formic Anammonide Carbon Hydride Nitride Cyclon
Molecular Formula	HCN
Appearance	Colorless Gas or pale blue highly volatile liquid
CAS Number	74-90-8
Properties	
Vapor Density	0.94
Melting Point	-13.4°C (259.75K, 7.88°F)
Boiling Point	26°C (299.15 K, 78.8°F)
Toxic Exposure Limits	
OSHA Permissible Exposure Limit (PEL)	
Long-term exposure limit (8-hour TWA reference period)	
ppm	mg.m-3
10	11
ACGIH Threshold Limit Value	
8-hour TWA workday and a 40-hour workweek	4.7ppm (ceiling)

Honeywell

Gas Application Note

Hydrogen Fluoride

Hydrogen Fluoride is a chemical compound with the formula HF. Together with Hydrofluoric Acid, it is the principal industrial source of Fluorine and hence the precursor to many important compounds including pharmaceuticals and polymers (e.g. Teflon). HF is widely used in the petrochemical industry and a component of many superacids. HF boils just below room temperature whereas the other Hydrogen halides condense at much lower temperatures. Aqueous solutions of HF, called Hydrofluoric Acid, are strongly corrosive.

Industrial Applications

HF is used for fluorinating polymers giving Fluorocarbons, petroleum refining, glassmaking, aluminium manufacturing, titanium pickling, quartz purification, and metal finishing. It is also used to synthesise UF6, which is key to separating uranium isotopes.

Hydrogen Fluoride is used in:

- The glass etching, electronic, and chemical industries
- The production of aluminium
- The production of Chlorofluorocarbons (CFCs)
- Quartz purification
- Separating uranium isotopes, as a catalyst in the petroleum industry
- Titanium and stainless steel pickling

Hydrogen Fluoride is typically marketed in three common forms:

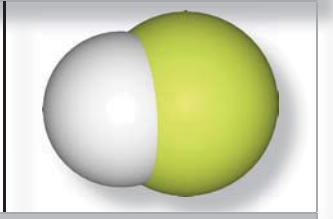
- Anhydrous HF,
- Aqueous 70% HF
- Aqueous 49% HF.

HF is manufactured by the reaction of Calcium Fluoride (fluorspar) and Sulfuric Acid.

HF immediately converts to Hydrofluoric Acid upon contact with moisture, including tissue. Hydrofluoric Acid is highly corrosive and toxic.

Potential industries and applications for gas detection products

- Petroleum refining
- Glassmaking
- Aluminium manufacturing
- Metal finishing

Hydrogen Fluoride	
	
General	
Systematic Name	Hydrogen Fluoride
Other Names	Fluoric Acid Hydrofluoride Hydrofluoric Acid Fluorine Monohydride
Molecular Formula	HF
Appearance	Colorless Gas
CAS Number	7664-39-3
Properties	
Vapor Density	0.7
Melting Point	-84°C (190K, 118°F)
Boiling Point	19.54°C (293K, 67.2°F)
Toxic Exposure Limits	
OSHA Permissible Exposure Limit (PEL)	
Long-term exposure limit (8-hour TWA reference period)	
ppm	mg.m-3
3	-
ACGIH Threshold Limit Value	
8-hour TWA workday and a 40-hour workweek	3ppm (ceiling)

Gas Application Note

Hydrogen Sulfide

Hydrogen Sulfide is the chemical compound with the formula H_2S. This colorless, toxic and flammable gas is responsible for the foul odor of rotten eggs and flatulence. It often results from the bacterial break down of organic matter in the absence of Oxygen, such as in swamps, landfill sites and sewers (anaerobic digestion).

It also occurs in volcanic gases, natural gas and some well waters. The odor of H_2S is commonly misattributed to elemental Sulphur, which is in fact odorless.

Hydrogen Sulfide has numerous names, some of which are archaic (see Table).

Hydrogen Sulfide is a highly toxic and flammable gas. Being heavier than air, it tends to accumulate at the bottom of poorly ventilated spaces. Although very pungent at first, it quickly deadens the sense of smell, so potential victims may be unaware of its presence until it is too late.

Hydrogen Sulfide is corrosive and renders some steels brittle, leading to Sulfide stress cracking — a concern especially for handling sour gas and sour crude oil in the oil industry. Generally small amounts of Hydrogen Sulfide (>1%) occur in crude petroleum but natural gas can contain up to 28%.

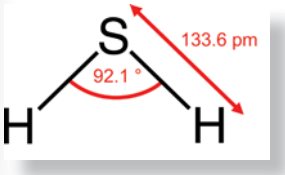
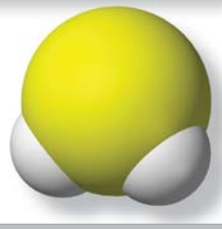
Industrial Applications

In the nuclear industry, Hydrogen Sulfide is also used in the separation of Deuterium Oxide, i.e. heavy water, from normal water via the Girdler Sulfide process.

For spark ignition engines, the most commonly used catalytic converter is the three-way converter. Unwanted reactions, such as the formation of Hydrogen Sulfide can occur in the three-way catalyst.

Potential industries and applications for gas detection products

- Drilling rigs and platforms
- Production platforms
- Refineries
- Gas storage and distribution
- Chemical plants
- Wastewater treatment
- Landfill gas
- Nuclear industry (heavy water)
- Engine test facilities
- Confined space entry
- Utilities

Hydrogen Sulfide	
	
General	
Systematic Name	Hydrogen Sulfide Sulfane
Other Names	Sulfuretted Hydrogen Sulfane Sulfur Hydride Sour Gas Sulfurated Hydrogen Hydrosulfuric Acid Sewer Gas Stink Damp
Molecular Formula	H_2S
Appearance	Colorless Gas
CAS Number	7783-06-4
Properties	
Vapor Density	1.19
Melting Point	-82.30°C (190.85K)
Boiling Point	-60.28°C (212.87K)
Toxic Exposure Limits	
OSHA Permissible Exposure Limit (PEL)	
Long-term exposure limit (8-hour TWA reference period)	
ppm	mg.m-3
20 (ceiling)	-
ACGIH Threshold Limit Value	
8-hour TWA workday and a 40-hour workweek	10ppm

Gas Application Note

Nitrogen Dioxide

Nitrogen Dioxide is the chemical compound NO_2. It is one of the several Nitrogen Oxides. This reddish-brown gas has a characteristic sharp, biting odor. NO_2 is one of the most prominent air pollutants and a poison by inhalation.

Nitrogen Dioxide is toxic by inhalation. Symptoms of poisoning (lung edema) tend to appear several hours after one has inhaled a low but potentially fatal dose. Also, low concentrations (4ppm) will anesthetize the nose, thus creating a potential for overexposure.

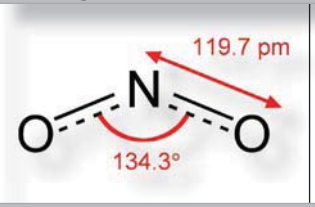
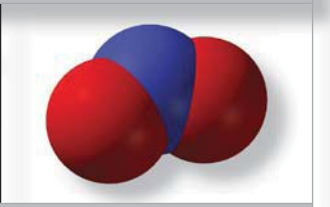
Long-term exposure to NO_2 at concentrations above 40-100µg/m³ causes adverse health effects.

Industrial Applications

The most important source of NO_2 is internal combustion engines, which emit Nitrogen Oxides near people. A major industrial source is pulp mills.

Potential industries and applications for gas detection products

- Pulp and paper mills
- Engine test facilities
- Truck loading bays
- Tunnels
- Parking Garages

Nitrogen Dioxide	
	
General	
Systematic Name	Nitrogen Dioxide
Molecular Formula	NO_2
Appearance	Brown Gas
CAS Number	10102-44-0
Properties	
Vapor Density	1.58
Melting Point	-11.2°C (261.95K)
Boiling Point	21.1°C (293.25K)
Toxic Exposure Limits	
OSHA Permissible Exposure Limit (PEL)	
Long-term exposure limit (8-hour TWA reference period)	
ppm	mg.m-3
5 (ceiling)	9 (ceiling)
ACGIH Threshold Limit Value	
8-hour TWA workday and a 40-hour workweek	3ppm

Honeywell

Gas Application Note

Nitric Oxide

Nitric Oxide is a chemical compound with chemical formula NO. This gas is an important signaling molecule in the body of mammals including humans and is an extremely important intermediate in the chemical industry. It is also a toxic air pollutant produced by automobile engines and power plants.

Nitric Oxide (NO) should not be confused with Nitrous Oxide (N_2O), a general anaesthetic, or with Nitrogen Dioxide (NO_2) which is another poisonous air pollutant.

The Nitric Oxide molecule is a free radical, which is relevant to understanding its high reactivity. It reacts with the Oxygen in air to form Nitrogen Dioxide, signalled by the appearance of the reddish-brown color.

Nitric Oxide in the air may convert to Nitric Acid, which has been implicated in acid rain. Furthermore, both NO and NO_2 participate in Ozone layer depletion.

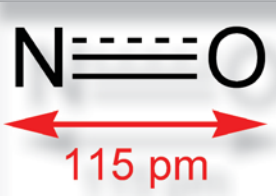
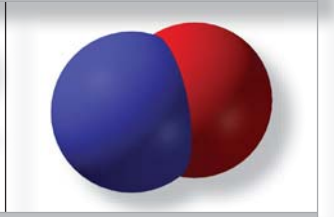
Industrial Applications

Although Nitric Oxide has relatively few direct uses, it is produced on a massive scale as an intermediate in the Ostwald process for the synthesis of Nitric Acid from Ammonia.

In 2005, the US alone produced 6 million metric tons of Nitric Acid. It finds use in the semiconductor industry for various processes. In one of its applications it is used along with Nitrous Oxide to form Oxynitride gates in CMOS devices.

Potential industries and applications for gas detection products

- Nitric Acid production
- Semiconductor manufacture

Nitric Oxide	
	
General	
Systematic Name	Nitric Oxide
Molecular Formula	NO
Appearance	Colorless Gas
CAS Number	10102-43-9
Properties	
Vapor Density	1.04
Melting Point	-163.6°C (109.6K)
Boiling Point	-151.7°C (121.4K)
Toxic Exposure Limits	
OSHA Permissible Exposure Limit (PEL)	
Long-term exposure limit (8-hour TWA reference period)	
ppm	mg.m-3
25	30
ACGIH Threshold Limit Value	
8-hour TWA workday and a 40-hour workweek	25ppm

Gas Application Note

Ozone

Ozone (O_3) is a triatomic molecule, consisting of three Oxygen atoms. It is an allotrope of Oxygen that is much less stable than the diatomic species O_2. Ground-level Ozone is an air pollutant with harmful effects on the respiratory systems of animals. Ozone in the upper atmosphere filters potentially damaging ultraviolet light from reaching the Earth's surface. It is present in low concentrations throughout the Earth's atmosphere. It has many industrial and consumer applications.

Industrial Applications

Many hospitals use large Ozone generators to decontaminate operating rooms between surgeries. The rooms are cleaned and then sealed airtight before being filled with Ozone which effectively kills or neutralizes all remaining bacteria.

Ozone can be used for bleaching substances and for killing microorganisms in air and water sources. Many municipal drinking water systems kill bacteria with Ozone instead of the more common Chlorine. Ozone has a very high oxidation potential. Ozone does not form Organochlorine compounds, but it also does not remain in the water after treatment, so some systems introduce a small amount of Chlorine to prevent bacterial growth in the pipes, or may use Chlorine intermittently, based on results of periodic testing.

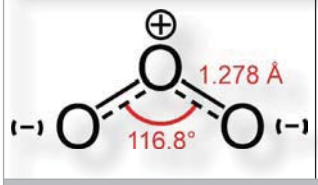
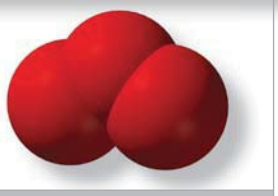
Where electrical power is abundant, Ozone is a cost-effective method of treating water, as it is produced on demand and does not require transportation and storage of hazardous chemicals. Once it has decayed, it leaves no taste or odor in drinking water.

Industrially, Ozone or Ozonated water is used to:

- Disinfect laundry in hospitals, food factories, care homes etc
- Disinfect water before it is bottled
- Deodorize air and objects, such as after a fire - extensively used in fabric restoration
- Kill bacteria on food or contact surfaces
- Sanitize swimming pools and spas
- Scrub yeast and mold spores from the air in food processing plants
- Wash fresh fruits and vegetables to kill yeast, mold and bacteria
- Chemically attack contaminants in water: Iron, Arsenic, Hydrogen Sulfide, Nitrites, and complex organics lumped together as "color"
- Manufacture chemical compounds via chemical synthesis
- Assist in processing plastics to allow adhesion of inks
- Clean hospital operating rooms where air needs to be sterile
- Eradicate waterborne parasites such as Giardia and Cryptosporidium in surface water treatment plants. This process is known as Ozonation.

Potential industries and applications for gas detection products

- Hospital sterilization
- Water disinfection / cleaning
- Deodorization of fabrics
- Sanitizing swimming pools
- Cleaning air in food processing plants
- Chemical manufacture

Ozone	
	
General	
Systematic Name	Trioxygen
Molecular Formula	O_3
Appearance	Bluish colored Gas
CAS Number	10028-15-6
Properties	
Vapor Density	1.6
Melting Point	-526.5°C
Boiling Point	-111.9°C
Toxic Exposure Limits	
OSHA Permissible Exposure Limit (PEL)	
Long-term exposure limit (8-hour TWA reference period)	
ppm	mg.m-3
0.1	0.2
ACGIH Threshold Limit Value	
8-hour TWA workday and a 40-hour workweek	100ppb

Honeywell

Gas Application Note

Phosphine

Phosphine is the common name for Phosphorus Hydride (PH_3), also known by the IUPAC name Phosphane and, occasionally, Phosphamine. It is a colorless, flammable gas with a boiling point of -88°C at standard pressure. Pure Phosphine is odorless, but "technical grade" Phosphine has a highly unpleasant odor like garlic or rotting fish, due to the presence of substituted Phosphine and Diphosphine (P_2H_4). Phosphines are also a group of substituted Phosphines, with the structure R3P, where other functional groups replace Hydrogens. They are important in catalysts where they complex to various metal ions; a chiral metal Phosphine complex can catalyse a reaction to give chiral products.

Industrial Applications

Phosphine is highly toxic; it can easily kill in relatively low concentrations. Because of this, the gas is used for pest control by fumigation. For farm use, it is often sold in the form of Aluminium Phosphide, Calcium Phosphide, or Zinc Phosphide pellets, which yield Phosphine on contact with atmospheric water or rodents' stomach acid. These pellets also contain other chemicals which evolve Ammonia which helps to reduce the potential for spontaneous ignition or explosion of the Phosphine gas. They may also contain other agents, such as Methanethiol, to give the gas a detectable garlic smell to help warn against its presence in the atmosphere.

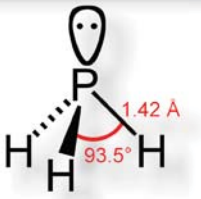
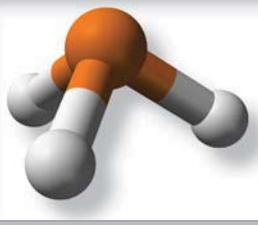
Phosphine is also used as a dopant in the semiconductor industry, and a precursor for the deposition of compound semiconductors. Recently high purity Tertiary Butyl Phosphine (TBP) has been developed as a less hazardous liquid alternative to highly toxic Phosphine gas, for application in Metalorganic Vapor Phase Epitaxy (MOVPE) of III-V compound semiconductors.

Phosphine is highly toxic to organisms undergoing oxidative respiration, but is non toxic to organisms kept under low Oxygen (<1%) or that can anaerobically respire (i.e. ferment). Because of these characteristics, Phosphine is widely used as a fumigant of metabolically dormant stored products such as grain. The toxicity of Phosphine kills insect pests that might infest the grain, but does not affect the viability of the dormant grain.

Because continued use of the previously widely used fumigant Methyl Bromide has been banned under the Montreal Protocol, Phosphine is the only widely used, cost effective, rapidly acting fumigant that does not leave residues on the stored product.

Potential industries and applications for gas detection products

- Semiconductor manufacturing
- Fumigation for pest control
- Production of pest control pellets
- Fumigation of metabolically stored products (e.g. grain)

Phosphine	
	
General	
Systematic Name	Phosphane
Other Names	Phosphine Phosphamine Phosphorus Hydride Phosphorated Hydrogen
Molecular Formula	PH_3
Appearance	Colorless Gas
CAS Number	7803-51-2
Properties	
Vapor Density	1.17
Melting Point	-134°C
Boiling Point	-87.8°C
Toxic Exposure Limits	
OSHA Permissible Exposure Limit (PEL)	
Long-term exposure limit (8-hour TWA reference period)	
ppm	mg.m-3
0.3	0.4
ACGIH Threshold Limit Value	
8-hour TWA workday and a 40-hour workweek	300ppb

Honeywell

Gas Application Note

Sulfur Dioxide

Sulfur Dioxide is the chemical compound with the formula SO_2. This important gas is the main product from the combustion of Sulfur compounds and is of significant environmental concern. SO_2 is often described as the "smell of burning Sulfur" but is not responsible for the smell of rotten eggs.

SO_2 is produced by volcanoes and in various industrial processes. Since coal and petroleum contain various amounts of Sulfur compounds, their combustion generates Sulfur Dioxide. Further oxidation of SO_2, usually in the presence of a catalyst such as NO_2, forms H_2SO_4, and thus acid rain.

Industrial Applications

Sulfur Dioxide is sometimes used as a preservative (E number: E220) in alcoholic drinks, or dried apricots and other dried fruits due to its antimicrobial properties. The preservative is used to maintain the appearance of the fruit rather than prevent rotting. This can give fruit a distinctive chemical taste.

Sulfur Dioxide is also a good reductant. In the presence of water, Sulfur Dioxide is able to decolorize substances that can be reduced by it; thus making it a useful reducing bleach for papers and delicate materials such as clothes.

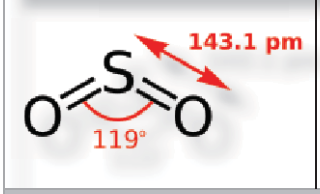
Approximately 300,000 tons are used each year to manufacture Hydrosulphites and other Sulfur-containing chemicals. Sulfur Dioxide is also used to make Sulfuric Acid, being converted to Sulfur Trioxide, and then to Oleum, which is made into Sulfuric Acid.

Sulfur Dioxide is a very important element in winemaking, and is designated as parts per million in wine. It acts as an antibiotic and antioxidant, protecting wine from spoilage organisms, bacteria, and oxidation, and also helps to keep volatile acidity at desirable levels. Sulfur Dioxide is responsible for the words "contains Sulfates" found on wine labels. Wines with SO_2 concentrations below 10ppm do not require "contains Sulfites" on the label by US and EU laws. The upper limit of SO_2 allowed in wine is 350ppm in US, in the EU is 160ppm for red wines and 210ppm for white and rosé wines. In low concentrations SO_2 is mostly undetected in wine, but at over 50ppm, SO_2 becomes evident in the nose and taste of wine.

SO_2 is also a very important element in winery sanitation. Wineries and equipment must be kept very clean, and because bleach cannot be used in a winery, a mixture of SO_2, water, and citric acid is commonly used to clean hoses, tanks, and other equipment to keep it clean and free of bacteria.

Potential industries and applications for gas detection products

- Chemical manufacture
- Water and wastewater treatment
- Dried food / alcohol preservative
- Pulp and paper bleaching
- Textile bleaching
- Winemaking
- Production of Sulfuric Acid

Sulfur Dioxide	
	
General	
Systematic Name	Sulfur Dioxide
Other Names	Sulfur Dioxide Sulfur(IV) Oxide Sulfurous Anhydride
Molecular Formula	SO_2
Appearance	Colorless Gas
CAS Number	7446-09-5
Properties	
Vapor Density	2.26
Melting Point	-72.4°C (200.75K)
Boiling Point	-10°C (263K)
Toxic Exposure Limits	
OSHA Permissible Exposure Limit (PEL)	
Long-term exposure limit (8-hour TWA reference period)	
ppm	mg.m-3
5	13
ACGIH Threshold Limit Value	
8-hour TWA workday and a 40-hour workweek	2ppm

Honeywell Product Offering

Sensepoint XCD

XNX Universal Transmitter

Series 3000 XPIS

FD Series Flame Detector

SPM

CM4

VertexM

Vertex

Find out more
www.honeywellanalytics.com

Contact Honeywell Analytics:

Americas
Honeywell Analytics Inc.
405 Barclay Blvd.
Lincolnshire, IL 60069
USA
Tel: +1 847 955 8200
Toll free: +1 800 538 0363
Fax: +1 847 955 8210
detectgas@honeywell.com

Technical Services
ha.us.service@honeywell.com

www.honeywell.com

Europe, Middle East, Africa
Life Safety Distribution AG
Wilstrasse 11-U31
CH-8610 Uster
Switzerland
Tel: +41 (0)44 943 4300
Fax: +41 (0)44 943 4398
gasdetection@honeywell.com

Asia Pacific
Honeywell Analytics Asia Pacific
#508, Kolon Science Valley (I)
187-10 Guro-Dong, Guro-Gu
Seoul, 152-050
Korea
Tel: +82 (0)2 2025 0307
Fax: +82 (0)2 2025 0329
analytics.ap@honeywell.com

H2S_AppNote_V1_Americas
02/10

Honeywell