Chlorine

Product Overview

- Chlorine is a greenish-yellow gas, with a strong, irritating odor. It is often transported as a liquid under pressure. Chlorine is one of the Earth’s most abundant chemical elements. For further details, see Product Description.
- Chlorine is well-known for its use as an industrial disinfectant for water treatment, but it is also an essential raw material for making plastics and organic chemicals for building materials, electronics, fiber optics, pharmaceuticals, medical plastics, and much more. For further details, see Product Uses.
- Those working with chlorine in manufacturing operations could be exposed during maintenance, sampling, testing, or other procedures. Consumers are unlikely to contact chlorine, but may come into contact with products into which chlorine has been incorporated, including chlorine-based bleach and pool chemicals. Consumers should read and follow the instructions that are provided with these products. For further details, see Exposure Potential.
- Eye or skin contact may cause severe irritation with burns. Brief inhalation of easily attainable concentrations may cause serious adverse effects, even death, as well as severe irritation of the upper respiratory tract or severe pulmonary edema and damage to the lungs. For further details, see Health Information.
- Chlorine gas is so reactive that it not usually detected by itself in the environment. If released as a liquid, it evaporates quickly. Chlorine gas in the atmosphere is broken down by sunlight in minutes. Chlorine dissolves in water and reacts with a variety of chemicals in soil. This material is not likely to accumulate in the food chain. Chlorine is highly toxic to aquatic organisms on an acute basis. For further details, see Environmental Information.
- Chlorine will react with many inorganic and organic compounds. For further details, see Physical Hazard Information.

Manufacture of Product

- Capacity - In 2008, global consumption of chloride was estimated to be 55,000 metric kilotonnes (121 million pounds). The Dow Chemical Company operates production facilities in Freeport, Texas, and Plaquemine, Louisiana, USA, and through its foreign affiliates in Stade and Schkopau, Germany; and Aratu, Brazil.
Product Safety Assessment: Chlorine

- **Process**\(^{12,13}\) – Most chlorine is produced using the chlor-alkali process. In this process, electricity is applied to a solution of salt water, or brine. The electricity separates sodium from chloride. Chlorine gas, hydrogen gas, and caustic soda are the coproducts of the chlor-alkali process. Chlorine is produced at the positive electrode (anode) and sodium hydroxide and hydrogen at the negative electrode (cathode). The electrolysis reaction is shown below.

\[
2 \text{NaCl (aq)} + 2 \text{H}_2\text{O} \xrightarrow{\text{Electrical energy}} \text{Cl}_2(\text{gas}) + \text{H}_2(\text{gas}) + 2\text{NaOH (aq)}
\]

The anode and cathode chambers are separated by a barrier to prevent the sodium hydroxide and hydrogen from reacting with the chlorine. This barrier is either an ion-selective membrane or porous diaphragm. The membrane is selective, meaning that sodium chloride cannot readily pass through the membrane, resulting in less salt in the final caustic. Dow uses both diaphragm cells and membrane cells to produce caustic soda and chlorine.

**Product Description**\(^{14,15,16}\)
Chlorine is a greenish-yellow, gas, with a strong, irritating odor. It is often transported as a liquid under pressure. It belongs to a group of elemental chemicals called “halogens.” Chlorine is one of the Earth’s most abundant chemical elements and is usually found in nature bonded to other elements like sodium, potassium, and calcium. The best known chlorine compound is sodium chloride, or common table salt.

**Product Uses**\(^{17}\)
Chlorine chemistry is used in over half of all industrial chemical processes, including 90% of pharmaceuticals and over 96% of crop-protection chemicals. The greatest volume of chlorine is used in the production of vinyl chloride monomer to produce polyvinyl chloride (PVC). PVC is a low-cost, versatile plastic used in building materials, medical equipment, appliance parts, and water pipes.

**Exposure Potential**\(^{18,19}\)
Chlorine is used in the production of industrial and consumer products. Based on the uses for chlorine, the public could be exposed through:

- **Workplace exposure** – Exposure can occur either in a chlorine manufacturing facility or in the various industrial or manufacturing facilities that use chlorine. It is produced, distributed, stored, and consumed in closed systems. Those working with chlorine in manufacturing operations could be exposed during maintenance, sampling, testing, or other procedures. Since chlorine can be irritating or corrosive depending on concentrations, exposure should be limited and protective equipment for eyes and skin, as well as an approved full-face respirator or self-contained breathing apparatus, should be kept accessible and ready to use and worn during these procedures. All facilities with chlorine on site should have a thorough training program for employees and appropriate work processes and safety equipment in place to limit chlorine exposure. See Health Information.

- **Consumer exposure to products containing chlorine** – Dow does not sell chlorine for direct consumer use. However, chlorine is a raw material used to produce a wide range of products used by consumers. Consumer exposure to chlorine can occur when misusing chlorine-based bleach. Always refer to instructions that are provided with these products to protect against exposure. See Health Information.

- **Environmental releases** – In the event of a release, the focus is on containing the release to prevent contamination of soil and surface or ground water. Chlorine is not persistent. If released to water, it dissolves quickly and is converted into chloride and hypochlorous acid. If released to soil, it reacts quickly with other matter and is converted to other compounds. Chlorine will not bioconcentrate, but is highly toxic to aquatic organisms on an acute basis. Ventilate the area of the leak or spill and isolate the area.
until vapors have dispersed. Respiratory protection is required for cleaning up spills and leaks. See Environmental, Health, and Physical Hazard Information.

- **Large release** – Industrial spills or releases are infrequent and generally contained. If a large spill does occur, the material should be captured, collected, and reprocessed or disposed of according to applicable governmental requirements. Evacuate and ventilate the area. Only trained and properly protected personnel must be involved in clean-up operations. Approved positive pressure, self-contained breathing apparatus (SCBA) with a full-face mask is recommended for emergency work. Keep personnel out of low areas and upwind of the spill. Spills of the liquefied gas may form ice, which can plug drains and make valves inoperable. If liquefied chlorine comes into contact with water, it can result in boiling, frothing, and rapid generation of vapor. Use appropriate safety equipment. See Environmental, Health, and Physical Hazard Information.

- **In case of fire** – Deny any unnecessary entry into the area and consider the use of unmanned hose holders. Chlorine is not flammable. Use extinguishment techniques appropriate for the surrounding material, although use of a direct water stream is not recommended. Firefighters should wear positive-pressure, self-contained breathing apparatus (SCBA) and protective firefighting clothing. Vapors are heavier than air and may travel a long distance and accumulate in low-lying areas. Immediately withdraw all personnel from the area in case of rising sounds from venting safety device or discolorations of the container. Keep fire water out of waterways and sewers to minimize the potential for environmental damage. Follow emergency procedures carefully. See Environmental, Health, and Physical Hazard Information.

For more information, request the relevant Safety Data Sheet from the Dow Customer Information Group.

**Health Information**

- **Eye contact** – Contact may cause severe irritation with corneal injury, which may result in permanent impairment of vision, even blindness. Chemical burns may occur. Vapor may cause severe irritation and corneal injury.

- **Skin contact** – Brief contact may cause severe burns. Symptoms may include pain, severe local redness, and tissue damage.

- **Inhalation** – Brief exposure (minutes) to easily attainable concentrations may cause serious adverse effects, even death. Gas may cause severe irritation of the upper respiratory tract (nose and throat). May cause severe pulmonary edema (fluid in the lungs). Excessive exposure may cause lung injury. Symptoms may include dizziness, shortness of breath, headache, fever, drowsiness, and anesthetic or narcotic effects.

- **Ingestion** – Because chlorine is a gas at room temperature and pressure, swallowing is unlikely.

- **Repeated exposure** – Symptoms may include respiratory effects. Based on animal testing, effects have been reported on the kidney, liver, lung, and teeth.

For more information, request the relevant Safety Data Sheet from the Dow Customer Information Group.

**Environmental Information**

Chlorine gas is very reactive, so it does not remain in the environment for long periods of time. Chlorine gas in the atmosphere is broken down by sunlight within minutes. In water, chlorine dissolves quickly and is converted into hydrochloric acid and hypochlorous acid. In soil, chlorine reacts quickly with other matter and is converted to other compounds. Biodegradation is not applicable with chlorine because of its reactivity and tendency to bond with other elements.

Chlorine is highly toxic (EC50 <0.1 mg/L) to aquatic organisms on an acute basis. Chlorine is too reactive to bioaccumulate in the food chain.

For more information, request the relevant Safety Data Sheet from the Dow Customer Information Group.
Physical Hazard Information

Chlorine is stable, with no known dangerous reactions under normal storage and use conditions. Avoid proximity to chemicals and flammable materials, as well as contact with moisture. Contact with combustible material can cause a fire. May react explosively with some organic compounds under confinement.

Avoid contact with ammonia, acetylene, combustible materials, hydrogen, organic compounds, phosphorous compounds, and reducing agents. This material can be corrosive when wet. Water contamination of chlorine may cause corrosion of metals due to formation of hydrochloric acid. Avoid contact with metals.

For more information, request the relevant Safety Data Sheet from the Dow Customer Information Group.

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Regulatory Information

Regulations may exist that govern the manufacture, sale, transportation, use, and/or disposal of chlorine. These regulations may vary by city, state, country, or geographic region. Information may be found by consulting the relevant Safety Data Sheet or Contact Us.

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Additional Information

- Request the relevant Safety Data Sheet from the Dow Customer Information Group (www.dow.com/assistance/dowcig.htm)
- Contact Us (www.dow.com/causticsoda/contact/)
- American Chemistry Council Chlorine website (http://chlorine.americanchemistry.com/)
- World Chlorine Council web site (http://www.worldchlorine.org)
- “Chlorine (CAS No. 7782-50-5),” Screening Information Data Set (SIDS) Initial Assessment Profile (SIAP), Organisation for Economic Co-operation and Development (OECD), United Nations Environment Programme (UNEP), SIAM 16, 27–30 May 2003 (http://webnet.oecd.org/HPV/UI/handler.axd?id=866c1bcc-86c4-408d-8316-cc8c717af421)

For more business information about chlorine, visit the Dow Caustic Soda Business web site at www.dow.com/causticsoda/index.htm.

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References

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