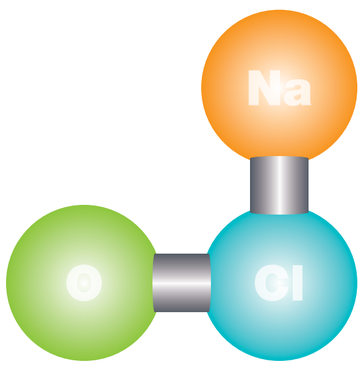
Chlorine Gas Alternative

Using sodium hypochlorite for wastewater disinfection

By John Rowe

In order to prevent the transmission of waterborne diseases, wastewater must be disinfected. The most common method of disinfection is carried out with chlorine. Chlorine is delivered in three forms: chlorine gas, calcium hypochlorite and sodium hypochlorite (NaClO).

NaClO is commonly known as liquid bleach, and it is frequently used as a wastewater disinfectant agent. The active ingredient in commercial bleach is NaClO. This compound is commonly available in 6%, 12% and 15% solutions. NaClO has a somewhat short shelf life dependent on sunlight, temperature, vibration and the beginning concentration. Increases in each of these parameters decrease the shelf life of the chemical. Ideally, NaClO should be stored in a cool room in an opaque container. As the chemical breaks down, its reaction in water slows down.



Uses & Applications

NaClO is an effective method of water disinfection. It is a clear, slightly yellowish solution with a characteristic odor. It is used on a large scale for surface purification, bleaching, odor removal, and wastewater and water disinfection. NaClO also is used in industrial applications, including chemicals, paint and lime, food, glass, paper, pharmaceuticals, synthetics and waste disposal. It is sometimes added to industrial wastewater in order to reduce odors. Hypochlorite neutralizes hydrogen sulfide gas and ammonia.

Concerns surrounding the safe transportation and handling of chlorine gas have directed public opinion toward the use of NaClO in place of chlorine gas for disinfection of water and wastewater.

NaClO solutions also have been used to treat and dilute cyanide wastewater, electroplating wastes and other industrial byproducts. In batch treatment operations, NaClO can be used to treat more concentrated cyanide wastes, such as silver cyanide plating solutions. It is commonly used as a biocide in industrial applications to control slime and bacteria in water systems used at power plants and in pulp and paper mills.

Instability. Chlorine evaporates at a rate of 0.75 grams active chlorine per day from the solution. When NaClO is heated, it disintegrates. The same reaction also happens when NaClO comes in contact with acids, sunlight, certain metals, and poisonous and corrosive gasses, including chlorine gas. It is a strong oxidant that reacts with flammable compounds and reducing agents but is not itself flammable.

These characteristics must be kept in mind during transportation, storage and usage. Due to the presence of caustic soda in NaClO the pH of the water is increased when the chemical is added. When NaClO dissolves in water, two substances are formed that play a role in oxidation and disinfection processes: hypochlorous acid and the less active hypochlorite ion. The pH of the water determines how much hypochlorous acid is formed. When NaClO is used, hydrochloric acid is used to lower the pH and increase the disinfection capability.

Production. NaClO can be produced in two ways. One is by dissolving salt in softened water, which results in a concentrated brine solution. The solution is electrolyzed and forms a NaClO solution in water that contains 150 grams of active chlorine per liter. During this reaction hydrogen gas also is formed. It also can be produced by adding chlorine gas to caustic soda. There are various ways to form NaClO through onsite salt electrolysis.

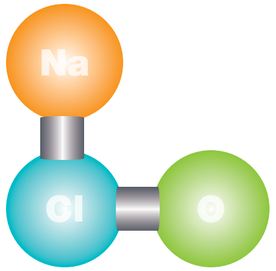
The advantage of the salt electrolysis system in the formation of NaClO is that no transport or storage is required. Another advantage of the onsite process is that chlorine lowers the pH, and no other acid is required to lower pH. The hydrogen gas that is produced is explosive, and as a result ventilation is required for explosion prevention.

Safety Precautions

Exposure. There is no threshold value for NaClO exposure. Various health effects occur after exposure to the chemical. In most cases, people are exposed to NaClO by inhalation of aerosols. If swallowed, its effects are stomachache, a burning sensation, coughing, diarrhea, sore throat and vomiting. It causes redness and pain when exposure to skin or eyes occurs and the skin can become sensitive after prolonged exposure. NaClO is poisonous to water organisms. It is mutagenic and very toxic when it comes in contact with ammonium salts.

While NaClO has many advantages—it can easily be stored and transported, or it can be produced on site; the dosage is simple; transport and storage of NaClO are safer than chlorine gas; and it is as effective as chlorine gas for disinfection—it is a dangerous and corrosive substance. Safety measures have to be taken to protect workers and the environment. NaClO should not come in contact with air, because that will cause it to disintegrate. Both NaClO and chlorine gas do not deactivate *Giardia Lambia* and *Cryptosporidium*.

Strong oxidizer. NaClO is a strong oxidizer. Oxidation reactions are corrosive and solutions burn the skin. The chemical can cause eye damage when used in concentrated forms. As recognized by the National Fire Protection Assn., however, only solutions containing more than 40% NaClO by weight are considered hazardous oxidizers. Solutions less than 40% are classified as a moderate oxidizing hazard. WWD



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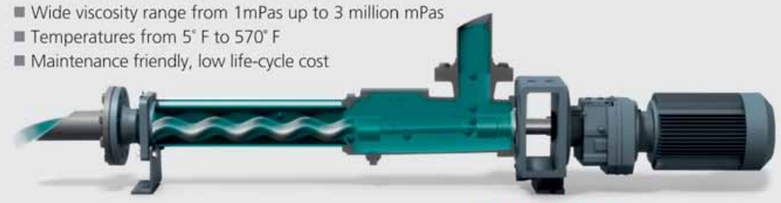

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