Literature-based report on the use of Sodium Hypochlorite

Sodium hypochlorite (NaOCl) usually clear yellowish liquids with a characteristic odor of chlorine. It is an oxidizing agent and used domestically, as well as in the food industry, in healthcare and to treat potable water.

Working Mechanisms:

When sodium hypochlorite dissolves in water, hypochlorous acid (HOCl) and the less active hypochlorite ion (OCl^-) form, which play a role in oxidation and disinfection. The pH of the water determines how much hypochlorous acid is formed.

At typical ambient temperatures, sodium hypochlorite is more stable in dilute solutions that contain solvated Na^+ and OCl^- ions.

The following species and equilibria are present in solutions of NaOCl:
$OCl^- + H_2O \rightleftharpoons HOCl + OH^-$
$HOCl\ (aq) + Cl^- + H^+ \rightleftharpoons Cl_2\ (aq) + H_2O$
$Cl_2\ (aq) \rightleftharpoons Cl_2\ (g)$

The hypochlorous acid may also rapidly break down to hydrochloric acid and nascent oxygen, and consequently generates oxygen free radicals. $NaOCl + H_2O = NaOH + HOCl = NaCl + H_2O + O$

This oxygen and chlorine-based free radicals from sodium hypochlorite can disrupt cellular proteins and cause cytotoxic damage to the pathogenic cells providing significant disinfectant properties to NaOCl when applied on a solid surface or water medium.

Uses:

Sodium hypochlorite is used on a large scale in agriculture, chemical industries, paint and lime industries, food industries, glass industries, paper industries, pharmaceutical industries, and waste disposal industries. In the textile industry, sodium hypochlorite is used to bleach textiles. It is added to industrial wastewater to reduce odors. It neutralizes sulfur hydrogen gas (HS) and ammonia (NH_3). It is used to detoxify cyanide baths in metal industries. Hypochlorite is also used to prevent algae and shellfish growth in cooling towers.

In the water treatment process, sodium hypochlorite solution has been extensively used to improve the microbiological quality of water. The Centers for Disease Control and Prevention (CDC) and World Health Organization (WHO) both recommend a final chlorine dosage of ~2-4 mg/L (2-4 ppm) for water purification. Sodium hypochlorite can improve the microbiological quality of household water and reduce diarrheal disease. Sodium hypochlorite is also extensively used in swimming pools for water disinfection purpose.

Healthcare application

NaOCl was found extremely useful during World War-I. This chemical used to cure wounded soldiers often suffered from wound infections. Since then, NaOCl has made a significant impact on medicine and is used routinely in the treatment of burns, wounds, ulcers, and dentistry. Indeed, there is a report of using diluted sodium hypochlorite (0.006% NaOCl) solution as a cleansing body wash for the management of bacteriological disease in children. In another report by researchers at the Stanford University School of Medicine in November 2013, it was found that a very dilute (0.005%) solution of sodium hypochlorite in water became successful in treating skin damage with an inflammatory component caused by radiation therapy, excess sun exposure or aging.

However, prolonged or extensive exposure on NaOCl may create skin irritation and damage to the skin or dermal hypersensitivity. Such exposures can result in either immediate or delayed-type skin reactions. A little information is available on the effects of inhalation of hypochlorite mist or vapor. However, it would be expected to be irritating to the respiratory tract if a concentrated formulation (> 0.006%) was inhaled in sufficient quantity.

Therefore, it can be concluded that NaOCl is safe to use if the final concentration remains below ≤ 0.006%. However, if the NaOCl concentration becomes ≥ 0.006%, it may create significant toxicity to the human body.

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