From: Environmental Science & Engineering - www.esemag.com - May 1996

Why life's a bleach.

(The Sodium Hypochlorite Story)

By Dr. John Fletcher and Don Ciancone*

*Colgate-Palmolive Canada Inc.

Sodium hypochlorite, the active ingredient in household bleach, was discovered by the French chemist Berthollet, in Javel on the outskirts of Paris, in 1787. Its ability to effectively whiten textiles was quickly discovered and put to commercial use with great success. By the end of the nineteenth century, after Louis Pasteur had discovered sodium hypochlorite's potent effectiveness against disease-causing bacteria, it became widely used as a disinfectant. Studies by numerous independent research institutes have supported the high level of disinfection effectiveness of sodium hypochlorite. It is recognized as having an unsurpassed disinfection spectrum.

Sodium hypochlorite, NaOCl, is manufactured by the reaction of molecular chlorine with sodium hydroxide and water. A small excess of sodium hydroxide is required to maintain the pH between 11 and 13 to minimize decomposition. Household bleaches usually contain 3% to 6% NaOCl whereas bleaches for Industrial & Institutional (I&I) applications are typically 10% - 12% active.

Sodium hypochlorite disproportionates spontaneously to chloride and chlorate. This disproportionation is accelerated by ionic strength, temperature and concentration of the bleach. Metals such as copper, nickel and cobalt catalyze the decomposition of sodium hypochlorite.

Every day, millions of households throughout the world rely on sodium hypochlorite bleach for their disinfection, deodorizing and cleaning needs. The world market for sodium hypochlorite bleach, marketed to the consumer, is in excess of 4,000,000 tons. This does not include the large quantities used, particularly in North America, for industrial uses such as waste water treatment and drinking water disinfection.

Sodium hypochlorite solutions are often mistakenly referred to as "chlorine bleach". This arises because of the use of chlorine in its manufacture. However, this is truly a misnomer as "chlorine" gas is not present in the product nor is it involved in the product's mode of action.

Its Many Uses and Benefits

Sodium hypochlorite has long been recognized as having outstanding disinfection properties. It has been proven by the Institute Pasteur in Paris to be the most effective disinfectant against all known pathogenic bacteria, fungi and viruses.

In recent years, the incidence of infection among certain populations has increased, in part because of less attention to basic hygiene, wider social interaction and increasing resistance of bacteria to antibiotics. When used as part of a daily hygiene regimen, sodium hypochlorite bleach can be effective in preventing infections by eliminating surface germs, bacteria and viruses that cause them.

It is widely used in homes, schools, hospitals, swimming pools, drinking water supplies, and for disinfecting hard surfaces and surgical instruments. Its low cost and ready availability makes it

an invaluable weapon for the maintenance of human health and proper preventative hygiene, throughout the world. This is particularly so in the developing world where it is a major contributor in the efforts to stem the debilitating consequences of cholera, dysentery, typhoid and other waterborne biotic diseases. In recent outbreaks of cholera in Latin America and the Caribbean Islands, sodium hypochlorite was an effective deterrent that minimized morbidity and mortality, as was reported at a symposium on tropical diseases conducted under the aegis of the Pasteur Institute.

Sodium hypochlorite also has an important public health role in the developed world. There is increasing consumer awareness and concern that the home can be a haven for disease-causing organisms, such as salmonella and E. Coli. Following good hygiene practices and using hypochlorite bleach has been shown to be the most effective means of minimizing these dangers. It is also very efficacious for the removal of mold and mildew.

In hospitals and other health care facilities bleach is used to disinfect surfaces against HIV, the virus responsible for the transmission of AIDS, and Hepatitis B. In fact, many authorities, such as the Ontario Ministry of Health, specifically advocate such practices.

It has been used by NASA in the United States during the Apollo program to assure destruction of any potentially harmful organisms introduced from space missions.

Throughout the world sodium hypochlorite is used as a laundry whitener, stain remover and sanitizer both for consumer, as well as institutional laundry. It can be safely used on many washable, colourfast fabrics including cotton, polyester, nylon, acetate, linen, rayon and permanent press. It is highly effective at removing a wide range of stains and soils not totally removed by laundry detergents alone, e.g. blood, body soil, coffee, grass, mustard, red wine, etc. It provides a significant boost to the whitening and cleaning power of laundry detergents even in cold or hard water and its unique disinfecting properties assures sanitization, which is of particular importance in hospital linens for example, to reduce the possible transmission of disease.

For industrial and institutional applications the versatility and usefulness of sodium hypochlorite include:

- It is used extensively in the area of water treatment to disinfect municipal drinking water and by those taking drinking water from wells.
- It controls algae in open reservoirs.
- It remains as one of the most effective, and certainly the most cost-effective means of contolling the zebra mussel population, the presence of which is causing serious problems for industry and the ecosystem throughout North America.
- It is widely used for swimming pool water disinfection, both as a daily regimen and as a shock treatment.
- It is used to treat sewage to reduce odours and increase digesting efficiency.
- Chemical toilets, industrial wastes for odour control.
- Cyanide waste treatment in metal finishing.
- Treatment for cyanide effluent in gold mining.
- Air scrubbing.
- Food processing: dairy equipment sanitizing, fruit and vegetable processing, mushroom production, hog, beef and poultry production, maple syrup production, fish processing.

- Precious metal recovery.
- Cooling water and boiler water treatment to prevent fouling.

Human and Environmental Safety

During the last few years there has been a concerted effort to investigate and assess the human and environmental safety aspects of sodium hypochlorite. An extensive review of the literature has been undertaken by many investigators and the conclusions drawn are that sodium hypochlorite is safe for humans and the environment.

Depending on the concentration involved, hypochlorite solutions can be classified as either irritant or corrosive and appropriate precautions should be taken when using the product, carefully reading the label, adhering to cautionary warnings and following usage directions. Particular attention must be paid to not mixing with other products, such as toilet bowl cleaners, rust removers, ammonia or acids.

Although skin and mucous membrane irritation can occur when the exposure concentration is greater than 5%, these effects are reversible. The overall safety of sodium hypochlorite is further documented by reports from poison control centres in North America and Europe which show no major health effects after unintentional ingestion or skin contact. The unpleasant taste of the product prevents unintentional ingestion of significant quantities and thereby limits the extent of injuries.

It is documented that sodium hypochlorite is not a mutagen, carcinogen, teratogen or skin sensitizer. Indeed, in the context of its use in drinking water, IARC (the International Agency for Research on Cancer) has concluded that chlorinated drinking water is not a "classifiable" human carcinogen.

Under normal household use, sodium hypochlorite is broken down in the environment into table salt, oxygen and water. Other substances may be formed, to a small extent. These by-products are most often referred to as AOX (adsorbable organic halides). A great many studies have been made to provide a risk assessment of household bleach in terms of its formation of AOX.

The conclusions drawn were:

- the amount of AOX is very small both in absolute terms and relative to other human activities and natural sources,
- the majority of these AOX are easily degradable,
- the AOXs formed are primarily water soluble and not bio-accumulative.
- highly chlorinated species, such as dioxins, are not formed.

The conclusion of the Swedish Environmental Research Institute was that sodium hypochlorite "does most probably not create environmental problems when used in the right manner and in recommended quantities".

Conclusion

Sodium hypochlorite has a long history of safe use in homes, hospitals and schools, and it is widely available at low cost to consumers. It is highly beneficial to basic hygiene and good health due to its disinfecting and sanitizing qualities. It kills all known germs and a wider range of bacteria than other disinfectants, and it helps to prevent the spread of diseases through water and surfaces.