Sodium Hypochlorite

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I. IDENTIFICATION[1,2]

Chemical Name: Sodium Hypochlorite
Synonyms: Hypochlorous acid, sodium salt, sodium oxychloride
CAS Number: 7681-52-9
Molecular Weight: 75.45
Structural Formula: Cl-O-Na(H_2O)

II. CHEMICAL AND PHYSICAL PROPERTIES[1,2]

Physical State: Greenish-yellow liquid with a moderate chlorine odor. May be present as a white crystal as well.
Melting Point: 18°C (64°F)
Decomposition Temperature: 175°C (350°F)
Vapor Pressure: Not available
Odor Threshold: The odor threshold is likely to be similar to that of chlorine—approximately 0.3 ppm.
Flammability Limits: Not flammable
Specific Gravity: 1.08–1.26 at 20°C (68°F)
Solubility: 29.3 g/100 mL water at 0°C (32°F)
pH: 10–11 (5% aqueous solution); 11.2 (15% aqueous solution)
Conversion Factor: 1 ppm (v/v) = 1.45 mg/m^3 (for chlorine)
Stability: Aqueous solutions are stable when kept away from light. Crystalline sodium hypochlorite is very unstable and will decompose on contact with carbon dioxide in air.
Reactivity: Will rapidly decompose on contact with many ammonium compounds, including acetates, nitrates, oxalates, and phosphates, to release chlorine or nitrogen trichloride. $NC1_3$ is explosive at low concentrations.
Incompatibility: Organics, ammonia compounds, reducing agents, acids, metal ions, and heat.

III. USES[3]

Sodium hypochlorite is used as a general purpose germicidal agent, disinfectant, sterilizer, and bleach. It may also be used for water treatment and for treatment of cyanide wastes.

IV. ANIMAL TOXICITY DATA

A. Acute Toxicity

1. Oral Toxicity

Rat[2] LD_{50} 8.9 g/kg (as solution)

LD_{50} (solid) 890mg/kg

Rat[4] LD_{50} (solution, 15%) 5.8–6.8 g/kg

2. Eye Toxicity

Rabbit: A 5% solution of sodium hypochlorite instilled in rabbit eyes caused immediate pain but with rapid flushing left only transient corneal epithelial haze and conjunctival edema. With no treatment, injury was more severe with small hemorrhages in the conjunctiva.[5]

One drop of a 159% solution of sodium hypochlorite instilled in rabbit eyes caused severe pain, hemorrhages of the conjunctiva, opaque appearance of the corneal epithelium, and edema of the cornea. This effect was reversible after 21 days.[50]

3. Skin Toxicity

a. Absorption

Rabbit[6]) LD_{50} >10g/kg

b. Irritation

Rabbit: Not corrosive when applied as an 11% solution with 2% NaOH to the occluded skin of rabbits. When 0.5 mL was applied for 4 hr, 3/6 showed slight brown areas, and 4/6 showed light eschar at 48 hr.[7]

Slightly irritating when applied as a 5.25% solution to the occluded and nonoccluded skin of rabbits and guinea pigs.[8]

4. Inhalation Toxicity

Rat[2] 1-hr LC_{50} >10.5 mg/L

B. Mutagenicity/Cytogenicity

1. Sodium hypochlorite induced base-substitution mutations in *Salmonella typhimurium* strains TA 1530 and TA 1535 at doses of 1.4×10^{-4} to 1.4×10^{-7} µmoles per plate. The number of revertants per plate was variable and riot dose-dependent because of the suspected toxicity of sodium hypochlorite.[9]

2. At a maximum dose of 5 mg/plate, sodium hypochlorite was positive in the Ames assay for *S. typhimurium* strain TA 100 with S9 activation.[10]

3. Sodium hypochlorite was weakly mutagenic in the Chinese hamster ovary chromosomal aberration test at a maximum dose of 0.5 mg/mL. Of the cells observed, 21% had structural aberrations.[10]

C. Metabolism and Pharmacokinetics

1. Hypochlorous acid administered to rats in drinking water at 1, 10, and 100 mg/L for 12 months caused changes in blood glutathione concentrations because of the effect of HOCl on the oxidation-reduction cycle of glutathione serum hemolysis (GSH). The highest dose level caused a decrease in red blood cell count and an increase in incorporation of 3H-thymidirie, related to DNA synthesis, in the testes and kidneys. The effect on DNA synthesis is not understood.[11]

2. No chlorination reaction products were observed in urinary extracts of rats after ingesting 8 and 16 mg/day sodium hypochlorite solution for 8 days.[12]

D. Reproductive/Developmental Toxicity

1. Seven successive generations of BD II rats were dosed with 100 mg free HOCI/L of drinking water. There was no evidence of toxic effects on growth, fertility, histology, or hematology.[13]

2. Female rats were administered 0.1,10, and 100 mg/L free HOC1 in drinking water for 10 weeks prior to and through Day 20 of gestation. There were no significant increases in fetal resorptions or changes in fetal weight gain. The highest doses appear to have a slight embryo-toxic effect. A slight increase in skeletal variations (ossified or missing vertebrae) was seen at the 10 and 100 mg/L doses. Some soft-tissue defects- (improper orientation of the heart or adrenal agenesis) were also observed at the 100 mg/L dose.[14]

E. Subacute Toxicity

1. For 9 to 42 days, 100 rats and 20 guinea pigs were administered 0, 80,400, and 2000 mg/L HOCI in drinking water and milk. This was equivalent to a dose of 8, 40, and 200 mg/kg available chlorine. No effects were observed.[15]

2. Rats were administered 0.5%, 1%, 2%, and 4% sodium hypochlorite in drinking water ad lib for 14 days and 0.05%, 0.1%, 0.2%, and 0.4% sodium hypochlorite in drinking water ad lib for 92 days. In both tests, at all levels, the rats showed evidence of dehydration. No macroscopic or histopathologic changes were observed.[16]

F. Subchronic Toxicity

For 92 days, 120 male and female rats were administered sodium hypochlorite in drinking water at concentrations of 0.025%, 0.05%, 0.1%, 0.2%, and 0.4%. Weight gain was reduced in all groups with a significant change in weight gain observed at 0.2% for males and 0.4% for females. No macroscopic or histologic changes were observed, however. Slight effects on the liver for both genders were indicated by changes in the serum enzyme levels at the 0.2% and 0.4% doses. A maximum tolerated dose (MTD) of 0.1 % to 0.2% for males, and 0.2% to 0.4% for females was estimated on the basis of these data.[17]

G. Chronic Toxicity and Carcinogenicity

1. Groups of 50 male and 50 female F-344 rats and B6C3F1 mice were administered sodium hypochlorite in drinking water at levels of 0.1% and 0.05% for male rats, 0.2% and 0.1% for female rats, and 0.1 % and 0.05% for both sexes of mice for a period of 2 years. A reduction in overall weight gain, as well as organ weight gain, was observed at all levels. No significant macroscopic or histopathologic changes were observed. No significant increase in the incidence of tumors was observed over the control group. The reduction in weight gain may be suggestive of chronic toxicity at elevated doses.[17,18]

2. A small number of fibrosarcomas and squamous cell carcinomas were observed in mice treated dermally with repeated subcarcinogenic

doses of 4-nitroquinoline-l-oxide, followed by a dermal treatment with sodium hypochlorite. Mice treated with only 4-nitroquinoline-l-oxide at submanifestational dose or with only sodium hypochlorite showed no evidence of skin tumors.[19]

3. Sodium hypochlorite was inactive as a promoter or cocarcinogen in female Sencarmice when applied dermally twice per week, for 51 weeks, alone or following initiation with dimethyl benzanthracene.[20]

V. HUMAN USE AND EXPERIENCE

A. A 5.25% solution of sodium hypochlorite applied to intact human skin for 4 hr and observed at 4, 24, and 48 hr resulted in exudation and slight sloughing of the skin on 4 of 7 subjects.[8]

B. Accidental eye contact with 5% sodium hypochlorite solution caused temporary burning discomfort and slight irritation of the corneal epithelium with no lasting injury.[5]

C. Two patients were reported with chronic allergic dermatitis of the hand related to sensitization to sodium hypochlorite as the active component in a commercial bleach product.[21]

D. There is very little workplace experience with sodium hypochlorite since exposure is usually to the weak aqueous form.

VI. RATIONALE

Acute, subacute, subchronic, and chronic toxicity studies have indicated no significant treatment-related effects. Sodium hypochlorite is moderately irritating by skin contact in humans. High concentrations may cause moderate to severe eye irritation but not permanent injury. Sodium hypochlorite is not carcinogenic or teratogenic. Higher doses appear to have a slight embryotoxic effect.

Since nearly all sodium hypochlorite is handled as an aqueous solution, airborne exposure is likely to be to an aerosol or mist. Sodium hypochlorite dissociates in water to form free hypochlorous acid in equilibrium. The toxic effects from inhalation are likely to be similar to those from chlorine or sodium hydroxide. The American Conference of Governmental Industrial Hygienists (ACGIH®)[22] Threshold Limit Value (TLV®) for chlorine is 1 ppm (3 mg/nr) ceiling, and the TLV® for sodium hydroxide is 2 mg/m^3 ceiling.

VII. RECOMMENDED WEEL™ GUIDE

15-min time-weighted average (TWA): 2 mg/m^3

VIII. REFERENCES

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NOTE: The following databases were searched for this 2009 WEEL Revision:

MEDLINE (1989 – 2008)
IPA (1970 – 2008)
CURRENT CONTENTS (1990 – 2008)
CAB (Global Health)(1973 – 2008)
CINAHL (1982 – 2008)