SIDS INITIAL ASSESSMENT PROFILE

CAS No.	7778-54-3
Chemical Name	Calcium hypochlorite
Structural Formula	$Ca(OCl)_2$

SUMMARY CONCLUSIONS OF THE SIAR

Human Health

Calcium hypochlorite is a white or grayish-white powder. This substance is dissociated into calcium ion (Ca^{++}) and hypochlorite ion (ClO^-) in water. Human health effect may be caused by contact with the solid powder, the aqueous solution, or accidentally generated chlorine gas. The calcium ion can generate a strong alkaline condition at the application site. Concerning hypochlorite ion toxicity, the exposure scenarios to calcium hypochlorite are common to sodium hypochlorite (liquid) or chlorine gas which is utilized as a source of hypochlorite ions, and they are thoroughly assessed in competent/pertinent international risk assessment programmes of organizations like WHO or the EU. Substantial parts of the description on hypochlorite-ion-related effects are common to those in the assessment documents for chlorine (CAS No 7782-50-5) which is also assessed in the OECD HPV Chemicals Programme.

Most of the data for toxicity of this substance by the oral route are from studies performed with sodium hypochlorite or chlorine gas. In biological systems, characterized by pH values in the range of 6-8, the most abundant active chemical species is HOCl, in equilibrium with ClO^-. Such available chlorine is readily absorbed via the oral route and distributed into plasma, bone marrow, testis, skin, kidney and lung. Only ca. 50% is excreted mainly with the urine followed by excretion with feces. HOCl is not enzymatically metabolized.

The acute oral LD_{50} of calcium hypochlorite was 790 mg/kg in male rats. Inhalation exposures to concentrations of greater than about 500 ppm (10 min or more) may be fatal for rats. Based on human experience and control studies in volunteers, it can be concluded that the acute NOAEL for humans was considered to be 0.5 ppm (1.5 mg/m^3). In a 13-week study, male and female F-344 rats (10/sex/group) received NaClO in drinking water at level of 0.025, 0.05, 0.1, 0.2, or 0.4 %. A weight gain was significantly decreased in male rats at 0.2 and 0.4 % and in females at 0.4 %. These effects were dose related and obviously correlated with reduced water consumption. No histopathological changes attributable to the treatment were found. But an increase of AAT in the blood gave evidence of the adverse effects on the liver. Based on significant body-weight reduction at the top dose, a subchronic NOAEL of 59.5 mg/kg bw/day as free available chlorine (FAC*) (at 0.1% NaClO level in the drinking water) can be calculated for male rats. For female rats a subchronic NOAEL of 215.7 mg/kg bw/day as FAC (at 0.2 % NaClO level in the drinking water) can be calculated. A NOAEL of 950 ppm available chlorine (59.5 mg/kg bw/day) can be derived from a 13-week rat study with sodium hypochlorite in drinking water.

In a life-time guideline NTP-study, 70 male and female F344 rats and B6C3F1 mice were administered chlorine via drinking water at dose levels of 0, 70, 140 and 275 mg (equivalent to FAC)/L in buffered water. These concentrations were equivalent to 0, 4.8, 7.5 and 13.9 mg/kg bw/day for male rats and 0, 3.8, 6.9 and 13.2 mg/kg bw/day for female rats. Mean body weights of male and female rats were similar among treated and control groups at both 14-week and 66-week interim evaluations. Those of male mice were significantly lower at week 66. Dose-related decrease in water consumption was observed throughout the study in both species and sexes. Food consumption was comparable among chlorine-treated and control groups. There were no clinical findings, alterations in haematological parameters and biologically significant differences in relative organ weights attributable to the treatment at 14/15-week and 66-week interim evaluations. Survival rate in chlorine-treated groups of rats and mice were similar to those of the controls after two groups. There was no evidence for non-neoplastic lesions to be associated with the consumption of chlorinated drinking water [NTP, 1992]. Based on these findings, a NOAEL (chronic) can be calculated to be approximately 14 mg available chlorine /kg bw/day for rats and 22.5 mg available chlorine /kg bw/day for mice.

Calcium hypochlorite is reported to be corrosive to the skin and has severe effects that can be expected from exposure to the eyes, which is ascribable to the alkalinity of calcium cation (pH=12.0 at 1 % FAC*). Moderate to severe lesions in the respiratory tract were reported after exposure to chlorine that may emerge in case of accidental misuse of hypochlorite salts. Exposure to chlorine at 9 ppm (27 mg/m^3) for 6 h/day during 1, 3 and 5 days was reported to cause epithelial necrosis, cellular exfoliation, erosion, ulceration and squamous metaplasia in the nasal passage of rats and mice. For either of Ca or Na salt, reliable skin sensitization studies are not available and case reports are available but no reliable case report could be found showing a sensitization potential in humans.

There are data from *in vitro* studies to suggest that solutions of chlorine/hypochlorite have some mutagenic potential, but it can be concluded that they are not mutagenic *in vivo*.

No carcinogenicity was observed in mice or rats exposed by inhalation to chlorine and orally to sodium hypochlorite, except some equivocal results were reported for female rats by oral route. For human carcinogenicity, no causal relationship between hypochlorite exposure and tumor incidence was observed. The observation is applicable to calcium hypochlorite.

No reproductive toxic effects were shown up to 5 mg/kg (highest dose tested) of sodium salt (equivalent to 4.8 mg/kg of Calcium salt) in a one generation oral study in rats. No evidence of adverse developmental effects were reported in animals. Moreover, epidemiological studies in humans did not show any evidence of toxic effects on reproduction and development.

{*Hypochlorite ion is predominant at alkaline pH values, while Cl_2 is mainly present at pH below 4. Therefore the concentration of chlorine in an aqueous solution is generally expressed as free available chlorine (FAC) which is the sum of Cl_2 + HOCl + ClO^-, regardless whether these species stem from dissolved gaseous chlorine or from dissolved sodium/calcium hypochlorite.}

Environment

Calcium hypochlorite is a white or grayish-white powder with chlorine like odor at ambient temperatures and pressures. Density is 2.35 g/cm^3 and vapour pressure is not applicable. This substance is a strong oxidizer. It is highly soluble in water (214 g/L). The anion of this substance dissolved in water is brought to equilibrium between active chlorine species like chlorine (Cl_2), hypochloric acid (HOCl) or hypochlorite ClO^-. The relative amounts of the components are dependent on ionic strength and pH. At the pH in the natural environment (6-8), HOCl or ClO^- is dominating (HClO: pKa = 7.53). A diluted aqueous solution of HOCl will decompose very slowly in the dark, but more rapidly in the presence of light, particularly rapidly in full sun light, by producing hydrogen chloride and oxygen. Some chlorine and chloric acid ($HClO_3$) may also develop. The physico-chemical properties indicate that chlorine released into the environment as HClO or Cl_2 is distributed into water and air. Consequently, the effects that may manifest in the natural environment are considered common to those assessed for the other source of hypochlorite.

In the natural water, in the presence of organic or inorganic compounds, the free available chlorine immediately reacts forming various chlorinated and/or oxidized by-products e.g. chloramines or chloromethanes. They are mainly distributed to the hydrosphere, but are also able to transfer to some extent to the atmosphere depending on their intrinsic properties. A potential for bioaccumulation or bioconcentration of active chlorine species can be disregarded, because of their water solubility and their high reactivity.
Valid freshwater short-term toxicity data are available only for invertebrates: the LC50 for *Ceriodaphnia dubia* is 5 µg FAC/l (FAC=Free available chlorine). Adequate standard acute tests in fish are not available, but from many reliable studies performed under intermittent exposure conditions a 96h LC50 of 60 µg TRC/L and a 168h LC50 of 330 µg TRC/L can be derived (TRC = total residual chlorine = the sum of combined and free residual available chlorine). Due to the intermittent regime (three 45 minutes pulses per day) a 96h LC50 << 60 µg TRC/l can be expected for fish in a standard test. Most lowest result for algae is reported for *Thalassiosira pseudonana* with a IC_{50} of 75 µg/L (20°C).

Regarding long-term toxicity to freshwater organisms, the lowest NOEC was 5 µg/L (*Ictalurus punctatus*, 133d, growth). In microcosm and field studies the most sensitive parameter was the density of zooplankton with a NOEC of 1.5 µg TRC/L, and zooplankton is more sensitive to chlorine than algae.
For salt water, valid short-term toxicity data are available for mollusks and for fish (*Oncorhynchus kisutch* 96 h LC50 = 32 µg TRO/L) (TRO = Total Residual Oxidant) showing comparable sensitivity. For long term toxicity the molluscs are more sensitive than fish showing a 15d NOEC of 6.2 µg TRO/L. It is impossible to delineate representative toxicity indicator figures because of the unique feature of the chemical to be tested in standard methods. However, the accumulated scientific information covering a wide range of species, temperature, application regime or field studies can be used for the hazard assessment.

Exposure

Calcium hypochlorite is a basic chemical, and used as algicide, bactericide, deodorant, disinfectant, fungicide, oxidizing agent, bleaching agent and so on. Chlorine (gas) or sodium hypochlorite (liquid) is used in far higher amounts for the same purpose. The production volume of calcium hypochlorite was estimated to be 16,940 tonnes/year in Japan in 2001, and the total nameplate capacity worldwide including the PRC was approximately 230,000 t/year in 2002.

Exposure to this substance can occur through accidental events in industry (e.g. during filling operations of chlorine gas, using procedure as bleaching agents), during transport and storage, during professional water purification and disinfection measures for swimming-pools.
There is no available official recommendation and regulation for an occupational exposure limit. However, there are some recommendations and regulations for chlorine. This product is a solid and direct contact to the powder can be irritating or corrosive. The product is therefore usually pelletted with water to avoid dust generation and to control exposure during handling or transportation.

For consumers exposure to chlorine gas can occur through accidental events during the use of this chemical for disinfection of swimming-pools and the use of hypochlorite-containing cleaning products. For example, mixing of household cleaning agents, hypochlorite and acids eventually causes chlorine release and inhalation.

RECOMMENDATION

Human Health: The chemical is currently of low priority for further work.

Environment: The chemical is a candidate for further work

RATIONALE FOR THE RECOMMENDATION AND NATURE OF FURTHER WORK RECOMMENDED

Human Health:

The chemical possesses properties (corrosive effects and acute respiratory toxicity) indicating a hazard for human health. Although there are some open uses, consumer exposure is sufficiently regulated under the drinking and other water acts and occupational exposure is adequately controlled in the Sponsor country to ensure safe handling, and therefore this chemical is currently of low priority for further work. Countries may desire to investigate any exposure scenarios that were not presented by Sponsor countries.

Environment:

The substance has hazardous properties for the environments. As there are some open uses of the substance an exposure assessment and if necessary risk assessment should be performed for these uses. The formation of chlorinated by products should be taken into account. Work to that effect is being or has been performed for sodium hypochlorite in many countries and also within the framework of the EU existing substance regulation. The action that may be taken should be common to that for sodium hypochlorite.