

Existing Chemicals Information Sheet

SULFURIC ACID

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General

Sulfuric acid is used predominantly as a basic chemical ingredient in a variety of industrial processes.

Background

In 2002 the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) published a list of High Volume Industrial Chemicals (HVIC) that are manufactured in and/or imported into Australia in volumes of 1000 tonnes/year or greater based on information supplied by industry (NICNAS, 2002). To address the increasing public demand for concise and easily accessible information on chemicals, NICNAS has undertaken a program to provide information, in the most suitable format, on those chemicals on the HVIC list deemed appropriate (e.g. excluding mixtures) for which a full independent hazard assessment has not been conducted by NICNAS. Sulfuric acid is identified as one such chemical on the HVIC list.

A literature search by NICNAS indicated sulfuric acid had been reviewed in an international review program. Thus, an information sheet was considered the most suitable format to report data on the human health effects of sulfuric acid. The data presented here are from a secondary source and though a credible publication, original publications have not been obtained and it has therefore not been possible to determine the robustness of the reported studies.

Data Sources

Data were obtained from the following source:

1. OECD (Organisation for Economic Co-operation and Development) (2001), SIDS Initial Assessment Report (SIAR)

Identity and Physico-Chemical Properties

Information on identity and use was obtained from the OECD SIAR (2001), Merck Index (1996), United States Agency for Toxic Substances and Disease Registry (ATSDR, 1998) and Worksafe Australia (now known as National Occupational Health and Safety Commission - NOHSC) study (1996): "Sulphuric acid mist: Exposures, Controls and Respiratory Symptoms". There are a large number of synonyms for sulfuric acid available in the literature. Those most frequently cited are provided in Table 1.

Table 1 Synonyms for Sulfuric Acid

	Sulfuric acid
Synonyms	Sulphuric acid Dihydrogen sulphate Oil of vitriol Vitriol oleum Diothionic acid
Structural Formula	$\begin{array}{c} \text{O} \\ \\ \text{H}-\text{S}-\text{H} \\ \\ \text{O} \end{array}$

Sulfuric acid is a colourless and odourless viscous liquid (nonflammable) that is heavier than water. It is a strong mineral acid that readily dissolves in water to form hydrogen and sulfate ion. The acid strength of a sulfuric acid solution is determined by the amount (or percentage) of sulfuric acid it contains - the higher the amount of the chemical, the stronger the acid strength. 100% sulfuric acid has a melting point of 10.4°C-10.5°C and boiling point of 290°C.

Sulfuric acid is a powerful acidic oxidizer. It can cause ignition or explosion in contact with many materials. It has a strong affinity for water, abstracting water from air and organic materials. A great deal of heat is generated when the acid is mixed with water. This may cause splashing of the acid.

Import, Manufacture and Use

Sulfuric acid is listed on the NICNAS HVIC List, with industrial use in the range of greater than 1 000 000 tonnes/year. The HVIC List also contains information on industry and use categories for sulfuric acid. Industry categories identified for sulfuric acid are the chemical industry (chemicals used in manufacture, supply and synthesis), electrical/electronic engineering, mining and metal extraction, and domestic/cleaners. Sulfuric acid uses reported within the HVIC use categories are process regulators, pH-regulating agents, conductive agents, anti-condensation agents and others (unspecified uses).

In 1996, Worksafe Australia undertook an exposure study for sulfuric acid mist in industries using sulfuric acid, including lead battery manufacture, metal refining, fertilizer manufacture, electroplating and wool carbonising (Worksafe Australia, 1996). Sulfuric acid has also been known for uses in soap and margarine manufacture, tanning and catalytic alkylation of hydrocarbons (Worksafe Australia, 1996).

The OECD SIAR (2001) reports that sulfuric acid uses are non-dispersive industrial uses. The worldwide uses include phosphoric acid and fertilizer production (32%); basic chemical synthesis, pigments, oil industries (58%); metal extraction, refining and processing of metals (2%); batteries (0.8%), and other industrial uses such as pulp and paper (7%).

The reporting of sulfuric acid in the domestic/cleaners industry category of the HVIC List

and use in lead-acid batteries means that there is potential for consumer exposure to sulfuric acid. Some home cleaners (especially toilet bowl cleaners) reportedly contain compounds that release sulfuric acid when they come into contact with water (ASTDR, 1998).

Current Regulatory Status Australia

Sulfuric acid is listed in:

- the National Occupational Health and Safety Commission (NOHSC, 1995) *Exposure Standards for Atmospheric Contaminants in the Occupational Environment*, with an 8-hour time weighted average of 1 mg/m³;
- the NOHSC (1999) *List of Designated Hazardous Substances* as Corrosive and labelled with the risk phrase R35; 'Causes severe burns'. Labelling requirements are also determined by the concentration of the acid in the aqueous solutions.
- the National Drugs and Poisons Schedule Committee (May 2003) *Standard for the Uniform Scheduling of Drugs and Poisons* in Schedule 6 as a Poison (except in fire extinguishers or in preparations containing 0.5% or less of sulfuric acid); with the warning statement 'Corrosive' and general safety directions 'Avoid contact with eye' and 'Avoid contact with skin'.
- the FORS (1998) *Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code)* 6th edition; with UN Number 1830 (with more than 51% acid); UN Number 2796 (with not more than 51% acid or BATTERY FLUID, ACID); UN Number 18331 (SULFURIC ACID, FUMING); and UN Number 1832 (SULFURIC ACID, SPENT: sulfuric acid usually of high concentration which has been used for chemical processes).

It is the responsibility of manufacturers and importers who supply sulfuric acid for use at work to determine whether it is a hazardous substance in accordance with the National Occupational Health and Safety Commission's *Approved Criteria for Classifying Hazardous Substances (1999)*. If hazardous, the manufacturer or importer has a responsibility to classify and label the substance appropriately

Data Sources for Human Health Effects

Information on sulfuric acid was sourced from the OECD SIAR (2001). The OECD SIAR is based upon the Screening Information Data Set (SIDS) program, which is a voluntary cooperative international testing program that began in 1989, operating under the auspices of the chemicals program within the Environment Health and Safety Division of the OECD. The program focuses on developing base level test information on approximately 600 poorly characterised international High Production Volume (HPV) chemicals. Data are used to "screen" the chemicals and set priorities for further testing or risk assessment/management activities. The OECD list of HPV chemicals serves as the overall priority list from which chemicals are selected for the SIDS program. These HPV chemicals include all chemicals reported to be produced or imported at levels greater than 1 000 tonnes per year in at least one Member country or in the European Union region, and are compiled by the OECD Secretariat on the basis of regular submissions by Member states.

Health and Safety Information

Sulfuric acid per se is not expected to be absorbed or distributed throughout the body. The acid will rapidly dissociate into H⁺ and SO₄²⁻ in the body electrolyte pool.

Animal Data

Acute Toxicity

Sulfuric acid is a direct acting toxicant. Toxic signs of oral exposure are irritation/corrosion of the gastrointestinal tract, whose effects are the result of the hydrogen ion rather than the effects of the sulfate ion. Only one acute oral toxicity study is reported, with an LD50 value in the rat of 2140 mg/kg. No data are available on the acute dermal toxicity or on acute toxicity by other routes to the chemical. Inhalation LC50 values in the rat, mouse and rabbit are 0.375 – 0.425 mg/L, 0.600 – 0.850 mg/L and 1.470 – 1.610 mg/L, respectively, depending on the exposure time (2.75- to 8-hour) and the source of the mist (unspecified/10-60% sulfuric acid). Guinea pigs, particularly younger animals, appear to be the most sensitive to the acute inhalation effects of sulfuric acid, with 8-hour inhalation LC50 values of 0.018 – 0.05 mg/L (unspecified concentration).

Irritation

Solutions of 10% sulfuric acid do not appear to be irritating to the skin of different species (rabbits, guinea pigs and humans). Conflicting results (not irritating or severely irritating) are reported in eye irritation studies using 10% sulfuric acid. The diluting and buffering effects of tears may explain this observation.

Sensitisation

Based on the available information, sulfuric acid is not considered an allergen by contact with skin.

Effects from Repeated Exposure

Despite some deficiencies in the test protocols, the repeat dose inhalation toxicity studies in several animal species (rat, guinea pig, rabbit, monkey, hamster and dog) show consistent type of effects though highly variable degrees of toxicity. Adverse effects include altered respiratory function and histopathology of the larynx and changes in the clearance of particles from the tracheobronchial/respiratory system. The extent of these effects depends on the concentration of the acid, type of animal tested and endpoint measured. No data on repeat dose toxicity for sulfuric acid by oral or dermal routes are available.

Genotoxicity

No in vivo mutagenicity studies of the chemical are available. A non-bacterial (chromosomal aberration) and bacterial (gene mutation) in vitro genetic toxicity study shows chromosomal aberration (which is known to occur as a result of exposure to high concentrations of hydrogen ions) but no mutation, respectively.

Carcinogenicity

No carcinogenic effects have been observed in the rat, mouse, hamster and guinea pig carcinogenicity studies of sulfuric acid mist. However, the studies are unreliable due to significant protocol deficiencies.

Reproductive toxicity

Available data show no reproductive toxicity in animals after oral, dermal or inhalation exposure to sulfuric acid. It is unlikely, however, that the chemical reaches reproductive

organs because the chemical is not expected to be absorbed or distributed in the body. This proposal is supported by the observations that no major changes in reproductive organs are noted in chronic inhalation studies (rat and guinea pig). Based on studies in the mouse and rabbit, sulfuric acid is not considered a developmental toxicant.

Human Data

Irritation

Sulfuric acid has been used in industrial processes for many decades and skin burns due to concentrated sulfuric acid are well documented, with repeated contact with diluted (unspecified) sulfuric acid causing skin ulceration and inflammation.

Sensitisation

Long-term industrial use of 10% sulfuric acid in the rayon industry has not resulted in reports of sensitisation to sulfuric acid.

Acute Toxicity

Acute inhalation exposure to sulfuric acid aerosols causes a range of effects in the respiratory system including decreases in particle clearance rates at low concentrations (<1.0 mg/m³) to changes in lung function (>1.0 mg/m³). Acute inhalation exposure of sulfuric acid at lower concentrations (<1.0 mg/m³) reportedly decreases the ability of the respiratory tract to remove other small particles which may be inhaled. Asthmatics and those with hyperactive airways appear more sensitive to the broncho-constrictive effects of inhaled sulfuric acid.

Effects of repeated Exposure

Repeated exposure to aerosol concentrations of sulfuric acid greater than 3.0 mg/m³ damages teeth.

Carcinogenicity

Several epidemiology studies on potential exposure to sulfuric acid aerosol from a range of industries (such as the manufacture of sulfuric acid, isopropanol, fertilisers and soaps and detergents, lead battery manufacture, metal pickling and the steel industry) show increases in lung cancer incidence or cancer of the respiratory tract, and in some cases, laryngeal cancer. Other studies in similar populations have shown no such increase. Co-exposures to a range of other chemicals, some of which are known to be carcinogenic, and inadequate control for confounding factors such as smoking, are features of the studies. A case-controlled study in stomach cancer notes an association with exposure to sulfuric acid mists. The SIAR notes "there is inadequate information for drawing any meaningful conclusion about an association between occupational exposure to sulfuric acid mist and nasal and other respiratory tract cancers". However, the International Agency for Research in Cancer (IARC) review in 1992 reports "there is sufficient evidence that occupational exposure to strong inorganic mists containing sulfuric acid is carcinogenic to human". The IARC notes, "occupational exposure to strong inorganic acid mists is carcinogenic to humans" as a Group 1 carcinogenic activity (IARC, 1992).

Outcome of the SIDS OECD Initial Assessment (2001)

The OECD SIAR (2001) concluded *"[sulfuric acid] is a candidate for further work: ...the collection of information about exposure during agricultural use... [and] ...about occupational exposure to sulfuric acid mist should be considered"*.

The Worksafe Australia study concluded that the highest exposure was in the lead-acid battery manufacture, and control of exposure could be effective with the use of enclosure and ventilation. Exposures in electrolytic refining of metals were also relatively high, and could be reduced by mist suppression agents, enclosure and ventilation. However, respiratory protection may be required in situations where these measures are not feasible. Exposures for other uses were considered low.

Overall, the primary health effects of the chemical are due to the corrosive and irritating nature of the acid. This causes direct local effects on the skin, eyes, respiratory and gastrointestinal tract when there is exposure to sufficient concentrations. The extent of the direct toxicity of the chemical depends on the length of exposure, humidity (both in the environment and respiratory tract) and presence of other chemicals (such as bases) that may neutralise the acid.

References

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