

## Existing Chemicals Information Sheet

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#### General

Copper is a naturally occurring metal that possesses high electrical and thermal conductivity and resists corrosion. It is also essential for human health.

#### 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. 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. Copper is identified as one such chemical on the HVIC List.

A literature search by NICNAS indicated copper 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 copper. The data presented here are from a secondary source and though a creditable 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 was obtained from the following source:

1. IPCS (International Programme on Chemical Safety) (1998) Environmental Health Criteria 200.

#### Identity and Physico-Chemical Properties

As well as the metallic form, copper also displays three further oxidative states with which it can form copper compounds. The oxidative states of copper are provided in Table 1.

Table 1 Oxidative States for Copper

Oxidative state	Copper
Cu <sup>0</sup>	metallic copper
Cu <sup>+</sup>	cuprous ion
Cu <sup>2+</sup>	cupric ion
Cu <sup>3+</sup>	trivalent copper ion
Structural Formula	Cu

Copper metal is sparingly soluble in water, salt or mildly acidic solutions, but can be dissolved in nitric and sulfuric acids as well as basic solutions of ammonium hydroxide or carbonate. It possesses high electrical and thermal conductivity and resists corrosion.

### **Import, Manufacture and Use**

As stated, copper is listed on the NICNAS HVIC List, a list compiled with industry of industrial chemicals that are manufactured and/or imported into Australia in large quantities. The industrial use of copper in Australia is in the range of 100 000 to 999 999 tonnes/year. Additionally, the HVIC List contains information on the use and broad industry categories for copper. The specified use categories applicable to copper are as a conductive agent, and other uses outside the specified categories. The industry categories identified as using copper are the engineering industry (civil), and mining and metal extraction industry.

The IPCS review reports copper metal is mainly manufactured by smelting of copper sulfide ore followed by electrolytic refining. Another main source of copper is through recycling processes (about one-third). Globally the largest use of copper is in electrical wire and cable and other electronic applications (65% of total annual copper consumption). Copper is also used extensively in building and construction, including plumbing, architectural applications such as roofing, guttering and flashing, and in fixtures and fittings (15%). The remaining is used in transport equipment, air-conditioning and refrigeration as well as general and light engineering uses such as machine parts, and process equipment, coinage, ordnance and consumer goods, such as domestic appliances as well as production of bronze and brass alloys (20%). Copper is also reported to be used in the manufacture of copper salts and other inorganic and organometallic compounds, to prepare intrauterine devices, as well as being a major constituent of metallic amalgams used in dentistry.

### **Current Regulatory Status in Australia**

Copper **is** listed in:

- the National Occupational Health and Safety Commission (NOHSC) (1995) *Exposure Standards for Atmospheric Contaminants in the Occupational Environment*, with separate exposure standards set for copper dust/mists and fumes.
  - Copper (dusts and mists) have an 8-hour time weighted average (TWA) of 1 mg/m<sup>3</sup>
  - Copper (fumes) have an 8-hour TWA of 0.2 mg/m<sup>3</sup>

Copper is **not** listed in:

- the NOHSC (1999) List of Designated Hazardous Substances
- the National Drugs and Poisons Schedule Committee (May 2003) Standard for the Uniform Scheduling of Drugs and Poisons
- the FORS (1998) Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code), 6<sup>th</sup> edition

It is the responsibility of manufacturers and importers who supply copper 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*. If hazardous, the manufacturer or importer has a responsibility to classify and label the substance appropriately.

Information on the human health effects of copper is generally derived from studies on copper salts, from which the dose in Cu/mg is determined. It should be noted that a number of copper salts are regulated in Australia, being included in the List of Designated Hazardous Substances, the Schedule of Drugs and Poisons and/or the Australian Dangerous Goods Code.

### **Data Sources for Human Health Effects**

Information on copper was sourced exclusively from the IPCS report (1998). The IPCS, established in 1980, is a joint venture of the United Nations Environment Programme (UNEP), the International Labour Organisation (ILO), and the World Health Organization (WHO). The overall objectives of the IPCS are to establish the scientific basis for assessment of the risk to human health and the environment from exposure to chemicals, through international peer review processes, as a prerequisite for the promotion of chemical safety, and to provide technical assistance in strengthening national capacities for the sound management of chemicals.

An overview of the data from the IPCS report (1998) on human health effects is presented below.

### **Health and Safety Information**

Absorption of copper occurs primarily through the gastrointestinal tract. From 20 to 60% of dietary copper is absorbed. Small amounts can also be absorbed through inhalation and skin contact. Once absorbed the liver is the major organ for the distribution of copper in mammals, routing it through the blood to other tissues.

### **Animal Data**

#### *Acute Toxicity*

A wide range of LD50 values have been reported (15 – 857 mg Cu/kg), with the most soluble salts generally being more acutely toxic than those with lower solubility. Copper is of low acute toxicity by the dermal (LD50 values > 1124 and > 2058 mg Cu/kg in the rat and rabbit respectively) and inhalation route (LC50 value > 1303 mg Cu/m<sup>3</sup> in the rabbit for an unspecified exposure duration).

#### *Irritation*

No data on skin or eye irritation are presented in the IPCS report.

#### *Effects from Repeated Exposure*

In short-term, repeat oral studies in the rat the most common effects observed were on the liver, kidney and lungs, as well as alterations in haematology (particularly anaemia) and in blood biochemistry. With the exception of sheep and pigs that are more susceptible to the toxicity of copper compounds (i.e. effects seen at 1.5 – 7.5 mg Cu/kg bw/day), effects were qualitatively similar with other copper compounds and in other species. In a long-term, repeat oral study in rats, no adverse effects were observed at 17 mg Cu/kg bw/day.

### *Genotoxicity*

Copper as copper sulfate was not mutagenic in bacterial assays. A significant increase in unscheduled DNA synthesis was seen in rat hepatocytes at a concentration that was moderately cytotoxic. A positive result was seen in a mouse micronucleus assay at 1.7mg Cu/kg bw (the top dose) but no effects were seen in another study up to 5.1 mg Cu/kg bw. The weight of evidence from in vitro and in vivo assays indicates that copper (as the sulfate) is not genotoxic.

### *Carcinogenicity*

No reliable animal carcinogenicity studies are available.

### *Reproductive toxicity*

Animal data are inadequate to assess reproductive or developmental potential.

## **Human Data**

### *Acute Toxicity*

Acute toxicity has been observed in humans following deliberate ingestion of copper salts. Symptoms observed include vomiting, lethargy, acute haemolytic anaemia, renal and liver damage, and in some cases coma and death. It has been reported that occupational exposure to high concentrations of copper fume results in metal fume fever (a flu like illness).

### *Irritation*

No data on skin or eye irritation are presented in the IPCS report.

### *Skin sensitisation*

It is reported that copper may induce allergic contact dermatitis in susceptible individuals.

### *Effects from Repeated Exposure*

In humans, gastrointestinal illness is associated with ingestion of excess copper, through contamination of beverages including drinking water. Doses that induce such effects are not well characterized.

Copper is an essential element for humans and adverse health effects are related to deficiency as well as excess. Copper deficiency is associated with anaemia, neutropenia (decreased number of neutrophilic lymphocytes in the blood) and bone abnormalities.

### *Carcinogenicity*

No reliable human data is available.

### *Reproductive toxicity*

Data in humans is inadequate to assess reproductive or developmental potential

## **Outcome of the IPCS (1998) review**

The IPCS report (1998) concluded that, "From available data on human exposures worldwide, but particularly in Europe and Americas, there is a greater risk of health effects from deficiency of copper intake than from excess copper intake."

Overall, there are no data in the IPCS report to indicate copper is an irritant, genotoxic, carcinogenic or a reproductive toxicant. The data indicate that copper may have a limited skin sensitization potential, that is induce allergic contact dermatitis in susceptible individuals. There are reports that single exposures to copper fume results in metal fume fever in workers. An occupational exposure standard exists for copper fume in Australia. In humans, gastrointestinal effects are associated with single and chronic ingestion of excess copper, though the greatest risk of human health effects is from an inadequate dietary intake of copper.

### References

1. FORS (Federal Office of Road Safety) (1998) Australian Code for the Transport of Dangerous Goods by Road and Rail, 6th ed. Canberra, Australian Government Publishing Service
2. IPCS (1998) Copper: Environmental Health Criteria 200, Geneva, International Programme on Chemical Safety, World Health Organisation
3. National Drugs and Poisons Schedule Committee (2 May 2003) Standard for the Uniform Scheduling of Drugs and Poisons (2003), Canberra, ACT, Australian Government Publishing Service
4. NOHSC (1995) Exposure Standards for Atmospheric Contaminants in the Occupational Environment. Canberra, ACT, Australian Government Publishing Service
5. NOHSC (1999) List of Designated Hazardous Substances. Sydney, NSW, National Occupational Health and Safety Commission.