



November 2005

CAS No. 75-09-2

Methylene Chloride

General

Methylene chloride is a highly volatile solvent used widely in paint removers, aerosol products and as a process solvent in the chemical and pharmaceutical industries.

Background

In March 1999 methylene chloride was placed on the Priority Existing Chemical (PEC) Candidate List because of concerns over its human health effects, particularly its hazardous effects in confined spaces. In July 2002 NICNAS sought comments on the proposal to recommend methylene chloride as a PEC following a death in Victoria and one in New South Wales related to methylene chloride use in open tank paint stripping, and became aware of the development of an 'alert' by WorkSafe Victoria on paint stripping using methylene chloride in a tank.

A literature search by NICNAS indicated that the toxicological profile of methylene chloride is well known as it has been assessed in a number of international review programs, such as International Program on Chemical Safety (IPCS) Environmental Health Criteria (EHC) report (1996); Cosmetic Ingredient Review (1998); the Agency for Toxic Substances and Disease Registry (ATSDR) review (2000). Consequently, it is considered that this information sheet together with the guidance provided by WorkSafe Victoria on the use of methylene chloride in open tank paint stripping is sufficient to address concerns on this chemical.

Fatalities in Australia

Two fatalities have recently occurred in the paint stripping industry, one in Victoria and the other in New South Wales. In each case the deceased person, who had been working alone, was discovered slumped over an open tank of methylene chloride. Within the headspace of the tank methylene chloride vapour was found at levels exceeding those considered immediately dangerous to life. Both the deceased had worked without adequate ventilation and suitable respiratory protection.

WorkSafe Victoria has produced an alert for paint stripping using methylene chloride in a tank and the details can be found at: www.workcover.vic.gov.au/dir090/vwa/alerts.nsf/alertsInter/4B354468F8D04E08CA256D6B00002BA5?OpenDocument

Identity and Physicochemical Properties

CAS Name	Methane, dichloro
CAS No	75-09-2
Commonly used synonyms	Methylene chloride
	Methylene dichloride
	Dichloromethane
	DCM
	Methane, dichloride
Structural Formula	CH ₂ Cl ₂

Methylene chloride is a clear, highly volatile, non-flammable liquid with a penetrating ether-like odour. It boils at 40°C and hydrolyses slowly in the presence of moisture, producing small quantities of hydrogen chloride. As a vapour under abnormal conditions (elevated temperatures, high UV light exposure, flame, sparks, red hot surfaces), methylene chloride may be decomposed to give small amounts of hydrogen chloride, carbon monoxide and phosgene. Commercial methylene chloride is normally stabilised to prevent decomposition. Poorly stabilised methylene chloride can react violently with aluminium or other light metals.

Import, Manufacture and Use

Australia

Methylene chloride is included in the Australian High Volume Industrial Chemicals (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 imported methylene chloride is in the range of 1,000 to 9,999 tonnes per year. Additionally, the HVIC List contains information on broad industry categories identified as using methylene chloride. They are: chemical industry – basic chemicals (supply); engineering industry - civil; paints and lacquers and varnishes industry; and plastic industry. Information received from a survey indicates methylene chloride is used as a solvent in paint strippers, adhesives, waterproof membranes and for general flushing; in cold tank degreasing (including automotive industry); urethane foam manufacturing; print developing; detergents; as a laboratory solvent; and aerosol filler and gardening aerosol (sealing pruned branches).

Worldwide

The IPCS reports that the worldwide usage pattern of methylene chloride comprises aerosols (20-25%), paint remover (25%), process solvent in the chemical and pharmaceutical industry (35-40%), miscellaneous uses (eg polyurethane foam manufacturing) and metal cleaning (10-15%). The usage of methylene chloride is tending to decrease in Western Europe.

Current Regulatory Status of Methylene Chloride in Australia

Methylene chloride **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 (TWA) of 50 ppm (174 mg/m³)
- the NOHSC (1999) *List of Designated Hazardous Substances*, as Harmful with a classification of Carcinogen Category 3 and labelled with the risk phrase R40; "Possible risks of irreversible effects"
- the National Drugs and Poisons Schedule Committee (May 2003) *Standard for the Uniform Scheduling of Drugs and Poisons*, in Schedule 5 (Caution) with inclusion of appropriate Appendix E Standard Statements and Appendix F Warning Statements and Safety Directions
 - Schedule 5 states that dichloromethane (methylene chloride) must carry the signal word "CAUTION" except: in preparations in pressurised spray packs labelled as degreasers, decarbonisers or paint strippers and containing 10% or less of dichloromethane; in other preparations in pressured spray packs; or in paints and tinters containing 5% or less of dichloromethane.
 - Appendix E requires standard statements indicating a contact point for advice/further information and first aid instructions.
 - Appendix F distinguishes warning statements and safety directions for dichloromethane:
 - in paint or lacquer removers;
 - other than in paint or lacquer removers.
- the Federal Office of Road Safety (FORS) (1998) *Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code)*, in Class 6.1 – Toxic substances (UN Number 1593) with all packaging and labelling details. In addition, it is noted that when involved in a fire methylene chloride may evolve extremely toxic fumes (phosgene).

Data Sources for Human Health Effects

Information on the health effects of methylene chloride was sourced exclusively from the IPCS EHC report (1996). 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. The IPCS EHC publication series is recognised as a source of scientifically credible, independent, peer-reviewed toxicological assessments.

An overview of the data from the IPCS EHC report (1996) on human health effects is presented below. This report is available on line at www.inchem.org/documents/ehc/ehc/ehc164.htm. The IPCS (1996) and ATSDR (2000) reviews are in agreement on the health effects methylene chloride causes in humans.

Health and Safety Information

Methylene chloride is rapidly absorbed through the lung, the gastrointestinal tract and the skin (at a much slower rate compared to other routes). Once absorbed it is distributed throughout the body and can cross the blood-brain barrier and be transferred across the placenta.

Animal data

Acute toxicity

The acute toxicity of methylene chloride is low. In experimental animals, 6-hour inhalation LC₅₀ values of 40,200 - 55,870 mg/m³ have been obtained along with oral LD₅₀ values of 1410 - 3000mg/kg bw.

Irritation

Methylene chloride is moderately irritating to the skin and eyes.

Skin sensitisation

No data are available on skin sensitisation.

Effects from repeated exposures

The predominant effects following repeated inhalation exposure to methylene chloride is central nervous system (CNS) depression, with a lowest observed effect concentration (LOEC) of 7,100mg/m³ identified for all animal species. Additional target organs reported in various species chronically exposed to methylene chloride include the liver and, occasionally, the kidney. The no observed adverse effect concentration (NOAEC) for chronic inhalation exposure was judged to be 710mg/m³ in rats. With continuous exposure, slight cytoplasmic vacuolisation in the liver of both mice and rats was observed at 88-350mg/m³. Repeated oral administration of methylene chloride to rats caused effects on the liver from about 200mg/kg bw/day.

Genotoxicity

Methylene chloride is mutagenic in bacteria. *In vitro*, gene mutation assays and tests for unscheduled DNA synthesis were negative and assays for sister chromatid exchange were either negative or equivocal, while positive results were seen in chromosome aberration assays.

In vivo, the majority of the studies (e.g. chromosome aberration, micronucleus or UDS assays) were negative. Positive responses are restricted to tests using B6C3F1 mice and high concentrations of methylene chloride. It is proposed these positive results are due to the mutagenic mediation of an isoenzyme glutathione-S-transferase in this species. Overall, within the limitations of the tests available, it is considered that there is no conclusive evidence that methylene chloride is genotoxic *in vivo*.

Carcinogenicity

Increased incidence of benign mammary tumours was observed in the rat, but not in the mouse or hamster by inhalation or oral administration. The mechanism of mammary tumour formation in the rat is probably related to the effect of methylene chloride on prolactin levels in this species, and it is unlikely, therefore, to be of relevance to humans.

Existing Chemicals Information Sheet

Methylene chloride is carcinogenic in the mouse, causing both lung and liver tumours, following lifetime exposure to high concentrations (7,100 and 14,100 mg/m³). These tumours were not seen in the rat or the hamster. It is proposed that this difference in species sensitivity is due to the existence of an isoenzyme of glutathione-S-transferase isoenzyme that specifically metabolises methylene chloride to the reactive intermediates responsible for tumour induction in the mouse. Markedly lower levels of this enzyme in rats and hamsters are consistent with the fact that these tumours do not appear in these species.

Reproductive toxicity

In the studies available, methylene chloride was not a reproductive toxicant in a rat 1-generation oral study and a rat 2-generation inhalation study, nor as methylene chloride a developmental toxicant in inhalation and oral developmental studies in rodents.

Human data

Acute toxicity

The main toxic effects of methylene chloride are reversible CNS depression and carboxyhaemoglobin (CO-Hb) formation. Neurobehavioural disturbances have been reported following exposure to concentrations of 694mg/m³ for 1.5 – 3.0 hours. More significant effects occur at concentrations in excess of 2000mg/m³. Narcosis has been reported to occur following exposure to 69,000mg/m³ for 0.5 hours. Exposure to 100 or 530mg/m³ for 7.5 hours led to CO-Hb levels of 3.4 and 5.3% respectively in volunteers. IPCS states that a CO-Hb level of 5.0% is judged to be acceptable.

Irritation

Methylene chloride irritates the skin and eyes especially when evaporation is prevented. Prolonged contact may cause chemical burns.

Effects from repeated exposures

Several mortality studies are available, however, excesses in mortality from specific diseases (e.g. ischaemic heart disease) cannot be attributed to exposure to methylene chloride.

Carcinogenicity

Epidemiology studies are inadequate for drawing any firm conclusions on the carcinogenicity of methylene chloride. However, levels of glutathione-S-transferase enzyme, which is believed responsible for tumour induction in the mouse liver and lung, are lower in human livers. It is expected that enzyme activity in human lung will be lower than human liver. Thus, the carcinogenic potency of methylene chloride is anticipated to be low in humans.

Reproductive toxicity

No epidemiological studies are available that establish a causal relationship between methylene chloride exposure and reproductive toxicity.

Outcome of the IPCS report (1996)

The IPCS (1996) review concluded that, *“Effects on the CNS have been observed in both animals and humans and a threshold in humans has been defined, based on the level of the metabolite carbon monoxide in the blood, leading to exposure limits of the order of 177 mg/m³”* (50ppm). The threshold in humans defined for CNS effects, from which the exposure limit has derived, was not reported.

Conclusions

Overall, the toxicity of methylene chloride in humans appears to be restricted to CNS depression and CO-Hb formation that are seen if large amounts of methylene chloride are inhaled. Exposure to higher concentrations can lead to narcosis and sometimes death, as observed following excessive inhalation of methylene chloride without adequate ventilation. Deaths have also been reported following accidental ingestion. Therefore, the risk to humans from methylene chloride will depend on the level of exposure to the chemical. An exposure standard (50ppm 8-hour TWA) exists for methylene chloride in Australia for workers.

References

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4. NDPSC Standard for the Uniform Scheduling of Drugs and Poisons (2003). National Drugs and Poisons Schedule Committee, Canberra, Australian Government Publishing Service.
5. NOHSC (1995) Exposure Standards for Atmospheric Contaminants in the Occupational Environment. National Occupational Health and Safety Commission, Canberra, Australian Government Publishing Service.
6. NOHSC (1999) List of Designated Hazardous Substances. National Occupational Health and Safety Commission.
7. WorkSafe Victoria (2003) Alert: Paint stripping using methylene chloride in a tank. www.workcover.vic.gov.au/dir090/vwa/alerts.nsf/alertsInter/4B354468F8D04E08CA256D6B00002BA5?OpenDocument