FATAL GASSING DUE TO METHYLENE CHLORIDE - A CASE REPORT

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ABSTRACT

Methylene chloride is a major component of paint and varnish strippers. Due to its high volatility, its use in unventilated or poorly ventilated confined spaces poses a serious health hazard as a result of accumulation of the solvent vapour. At high levels, methylene chloride can cause severe central nervous system depression and ultimately death, as illustrated in this case report. The importance of adequate forced ventilation, utilisation of proper personal protective equipment and enforcement of a permit-to-work system during work with solvents in confined spaces is emphasised.

Keywords: *methylene chloride, confined spaces, death, ventilation.*

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INTRODUCTION

Methylene Chloride (MC) or dichloromethane, a chlorinated aliphatic hydrocarbon, is a major component of paint and varnish strippers. It is also used as a solvent for waxes, oils, bitumen and cellulose esters. In recent years, this chemical has been increasingly used as a degreasing agent in Singapore (usually in combination with trichloroethylene or tetrachloroethylene) supplanting other more potent ozone-depleting agents such as freon and 1,1,1-trichloroethane which will be gradually phased out under an international agreement reached in 1987 (the Montreal Protocol).

While the use of MC under well ventilated conditions poses little hazard, in confined spaces this solvent may reach dangerously high levels due to its high volatility (vapour pressure = 350 mm Hg @ 25°C). This case report is the first of a fatality due to inhalation of this solvent in Singapore.

CASE REPORT

In early 1994, an accident occurred in company 'X'. This company deals with cleaning, repair and general maintenance of chemical tanks. These cylindrical steel tanks vary in capacity from 20,000L to 24,000L. They are mounted on container frames and are used mainly for the transport of liquid chemicals by sea.

Besides maintenance and repair of these tanks, cleaning is also done in the company premises. There are two main cleaning processes involved: tanks used for carrying oil and oil-based chemicals are cleaned in an automated process using biodegradable chemicals. Those used to transport latex are first inverted onto metal brackets and tank entry by cleaners is effected inferiorly via a 50 cm diameter manhole. Cleaning is accomplished using hand-held power tools with steel brushes. Besides lubricating oils, no other chemicals are used in latex tank cleaning.

Workers usually work in pairs and are provided with dust masks. Forced ventilation is introduced into the confined space by a blower (rated capacity 70 m^3/min) through a trunk hose. As manual cleaning of latex tanks is a physically demanding job, the company pays a cash incentive for every tank cleaned.

On the day of the incident, five workers had to work overtime in order to complete a repair job. Having completed this task, three of them went home leaving 'A', a cleaner, and 'B', his supervisor, behind. 'A' then proceeded to clean an empty latex tank which had been inverted earlier. After about 30 minutes of cleaning, 'A' emerged from the tank and noticed that an air blower was operating on top of a latex tank nearby. This tank was not inverted. Upon mounting this tank, 'A' found his supervisor lying motionless and unresponsive in a supine position inside. He then proceeded to call for the paramedics who arrived within minutes to rescue 'B'.

The supervisor had removed his overalls and donned a chemical suit prior to entry into the tank. He was found unconscious with his full-faced cartridge respirator and a pair of gloves lying at his side. There was also a bucket of paint stripper and a mop lying next to him. Surprisingly, the trunk hose of the air blower had not been inserted through the manhole. The supervisor was evidently coating the hardened latex with paint stripper in an attempt to effect easier cleaning later. This, however, was not the authorised practice of the company.

'B' was brought to the emergency department of a nearby hospital in a collapsed state. He was asystolic and received a total of five doses of epinephrine and six doses of atropine. He was also intubated and sent to intensive care unit where assisted ventilation was required. Unfortunately, 'B' did not regain consciousness and perished 4 days later.

RESULTS

Material safety data obtained on the paint stripper used indicated that it contained 75% of MC with other minor components such as methanol (8%), hydrofluoric acid (2%) and o-dichlorobenzene (3%). Analysis of the bulk samples confirmed that MC was present in the paint stripper at about 74% w/w.

Three air samples from the tank collected on charcoal

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tubes several hours after the accident were analysed and found to contain 134, 151 and 158 mg of MC per m^3 of air respectively. As the tank had been ventilated during the rescue operation, the actual concentration of MC-in-air was probably much higher at the time of the incident. In fact, based on the quantity of the paint stripper used and the volume of the tank, we estimate that the concentration of MC was well above 100,000 ppm when cleaning was carried out [the time-weighted average threshold limit value for methylene chloride is 50 ppm or 174 mg/m^3[1]].

Venous blood samples taken a few hours after admission showed that the concentration of MC-in-blood was 281 mg/L. Although no biological threshold limit value has been adopted for MC, in 2 other case reports of deaths from inhalation of MC[2], the blood levels of this solvent were found to be 2,400 mg/L and 400 mg/L respectively. The levels of carboxyhaemoglobin, however, were found to be within the normal range (<5%).

Post-mortem examination showed cerebral oedema, mucosal haemorrhages in the larynx and bilateral haemorrhagic shock lungs with cut sections showing congestion and pulmonary oedema. Diffuse fatty change was noted in the liver. There were also partial thickness burns with blistering over the right cubital fossa, the back and buttocks as well as the posterior aspect of both upper and lower limbs (total estimated area involved was 25 - 30% total body surface area).

DISCUSSION

Inhalation is the main route of entry for this solvent in occupational settings. Irritation of the nose and throat and mild depression of the central nervous system can occur at exposures of 200 to 1,000 ppm[3]. However, at high exposure levels, MC can cause upper respiratory tract and eye irritation, pulmonary oedema, hepatic damage and severe central nervous system depression[4]. Symptoms of solvent intoxication include headache, nausea, vomiting, incoordination, narcosis, hallucinations and ultimately loss of consciousness and death.

In animal experiments, MC has been found to be associated with an increased incidence of certain tumours[5,6] and is a suspected human carcinogen (IARC group 2B). It is also neurotoxic, causing a reduction in the deoxyribonucleic acid content of Gerbil brains[7].

MC is metabolised in the liver to carbon monoxide[8,9] and blood carboxyhaemoglobin (COHb) levels continue to be raised up to 24 hours after exposure due to metabolism of tissue-retained MC. The COHb thus formed has been reported to cause electrocardiographic abnormalities such as ST segment and T wave changes, atrio-ventricular dissociation and heart block[9].

In one study, a group of workers exposed to 180 to 200 ppm of MC had COHb levels of about 4.5% at the beginning of the work day. This concentration rose to 9% after 8 hours of exposure[10]. COHb levels of 8 - 16% were also found in workers exposed to MC for 3 hours[8]. As was found in this case, however, the levels of COHb in other reported cases of death from inhalation of MC were also not markedly raised, being 3.6%[2] in one case and 3.0% in another[11]. It is possible that in such cases the high levels of MC had caused rapid loss of consciousness and death. Such short, albeit high exposures may not lead to significant increases of COHb.

MC is a moderate skin irritant and can cause burns. In two reported deaths from inhalation of furniture stripping solvent containing MC[2], first to second degree skin burns were found in both cases. A post-mortem examination of the latter case also showed cerebral oedema and hepatomegaly with diffuse fatty change.

Precautions should be taken during work in confined spaces. These include the testing of air prior to entry into the confined space, forced ventilation and the wearing of suitable respirators. A permit-to-work system should also be enforced for all such work. In this case, however, none of these precautions were taken.

Based on the rate of evolution of MC from the paint stripper used, our computations showed that at least 180 m^3/min of forced ventilation was required to dilute the vapour to below its permissible exposure limit of 174 mg/m^3 within the tank. The blower with a rated capacity of 70 m^3/min was grossly inadequate even if it were used for ventilation. In addition, cartridge respirators would not have provided adequate protection against high concentrations of MC vapour where saturation of the activated charcoal and breakthrough would have occurred easily. An air supplied respirator (which was available in the company premises) should have been used instead.

CONCLUSION

This case report highlights the need for worker education on the proper handling of hazardous chemicals and the usage of appropriate personal protective equipment. It also emphasises the hazards of work in confined spaces, especially when using volatile organic solvents and stresses the importance of a permit-to-work system for all work in such conditions. Finally, it serves as a tragic reminder to all establishments utilising MC in its processes to increase vigilance and supervision during its use.

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