VI. WORK PRACTICES

Strict adherence to detailed work practices is mandatory if unhealthful occupational exposures to tetrachloroethane are to be prevented. The characteristics of tetrachloroethane which determine the nature and extent of the prescribed work practices are: (a) its rapid absorption following respiratory and dermal exposures; (b) its anesthetic properties and the associated acute effects; (c) its ability at low concentrations to cause severe chronic effects; and (d) its odor properties which are not sufficient to provide adequate exposure warning. The work practices specified in this document are derived from the tetrachloroethane manufacturer's literature [6 (pp 9-11)], the Manufacturing Chemists' Association's Chemical Safety Data Sheet SD-34 [2], plant visit observations [6], and, where pertinent, from established work practices for other chlorinated hydrocarbon solvents.

Tetrachloroethane is manufactured by the chlorination of acetylene [6 (p 4)]; in the United States, tetrachloroethane is used mainly as an intermediate in the manufacture of trichloroethylene and tetrachloroethylene [6 (p 4)]. Information is available on the safe handling of chlorine, acetylene, trichloroethylene, and tetrachloroethylene in their respective chemical safety data sheets issued by the Manufacturing Chemists' Association [105-108].

Storage, Handling, and Use

Tetrachloroethane should be stored in cool, dry places in tightly closed containers made of galvanized iron, black iron, or steel. Dehydrochlorination of tetrachloroethane, with the formation of trichloroethylene and traces of phosgene [3], occurs slowly in the presence of air. Although nonflammable and nonexplosive, tetrachloroethane may decompose pyrolytically to toxic and corrosive substances such as hydrogen chloride and chlorine [3]. Proximity to open flames and hot surfaces therefore should be avoided in the storage, handling, and use of this substance. Contact of tetrachloroethane with sodium, potassium, and other chemically active metals such as hot iron, aluminum, and zinc also should be avoided [1,3]. The vapor density of tetrachloroethane is 5.79 times greater than that of air. Tetrachloroethane, therefore, should not be stored in pits, depressions, basements, or unventilated areas. Because of its toxicity, processes in which large quantities of tetrachloroethane are used should be carried out in closed systems. Well designed hoods and ventilation systems can be used to maintain exposures at or below the concentration limit specified in this standard. Further measures should include the use of personal protective equipment and clothing.

Equipment Maintenance

All equipment used for handling tetrachloroethane must be emptied and purged prior to disassembly or entry. Pipelines should be disconnected and capped. Under conditions necessitating tank entry or work with tetrachloroethane-contaminated equipment, maintenance personnel must use either an impervious protective suit and a self-contained, pressure-demand mode breathing apparatus or a combination supplied-air suit with an auxiliary self-contained air supply. Safety precautions for emergency rescue require that all maintenance personnel be informed of the toxic properties of tetrachloroethane and of the need to wear personal protective equipment [2]. Anyone entering an empty tank should be observed constantly by a properly equipped standby worker familiar with emergency procedures, in case rescue work is necessary.

Emergencies

In areas where tetrachloroethane is handled, safety showers and eyewash fountains are necessary to minimize the effects of accidental skin and eye exposure.

Spills of tetrachloroethane must be anticipated. Storage tanks and drum storage areas should be diked to contain the contents. In addition, it is advisable to have facilities for pumping diked spills to other tanks, as well as, for transferring the contents of leaking tanks to other suitable containers. Normal work should be discontinued in spill areas until the environmental concentration of tetrachloroethane has been reduced to within the limit prescribed by this standard. A warning system, including appropriate postings, should be instituted to keep unauthorized personnel out of such areas until the hazard no longer exists. Disposal of tetrachloroethane or tetrachloroethane-contaminated materials should be carried out in compliance with local, state, and federal regulations.

Skin and Eye Protection

Tetrachloroethane is readily absorbed through the skin [36,57] and thus can cause systemic poisoning by this route. For this reason, gloves and other protective clothing impervious to tetrachloroethane should be worn by workers who handle the liquid. There are commercially available gloves coated with polyvinyl alcohol that are very resistent to chlorinated solvents [109]. This type is recommended for duties involving the handling of liquid tetrachloroethane. However, polyvinyl alcohol is water soluble, and this type of glove is therefore impractical for general work activities.

The eyes of workers should be protected against possible contact with tetrachloroethane from either liquid splash or high vapor concentrations. Contact can cause lacrimation, burning, and other symptoms of inflammation; serious eye damage may result if immediate care is neglected. Protection should be provided with chemical safety goggles and face shields, which are especially appropriate when liquid tetrachloroethane is handled. Because of the added potential for eye irritation and damage, it is advisable that contact lenses not be worn by those working with tetrachloroethane [110].

Sanitation

Good sanitation and personal hygiene practices should minimize the risk of exposure to tetrachloroethane, especially by ingestion. As little as 3 ml of tetrachloroethane taken orally have been shown to cause loss of consciousness in humans [20,21]. Because of this, food and beverage consumption should not be allowed in any tetrachloroethane work or storage area. An eating area that is clean and removed from the general work location should be designated. It is also recommended that smoking be prohibited in areas where liquid tetrachloroethane is handled. Before drinking, eating, or smoking in the properly designated areas, employees should thoroughly wash their hands.

Respiratory Protection

Adequate respiratory protection against tetrachloroethane under the various conditions which may be encountered in individual operations can be provided by many types of approved respirators. Each has particular applications and limitations from the standpoint of protection, as well as advantages and disadvantages from the standpoint of operational procedures and maintenance. Detailed information on the selection and use of respirators can be obtained from the Respiratory Protective Devices Manual [111] published by the AIHA and the ACGIH in 1963. The American National Standards Practices for Respiratory Protection, ANSI Z88.2-1969 [112], also classifies, describes, and states the limitations of respirators.

There are three categories of respirators: atmosphere-supplying, air-purifying, and those that are both atmosphere-supplying and air-purifying.

One factor affecting the overall performance of demand-type (negative pressure) respirators is the variability of the face seal. Facepiece leakage is the major limitation of half-mask and quarter-mask facepieces operated with negative pressure. To provide uniform regulations that take into account the variations in the sizes and shapes of American workers' faces, NIOSH recommends that respirators with half-mask or quarter-mask facepieces, operated with negative pressure, be used only for protection at levels below 10 times the TWA. On the same basis, NIOSH recommends that the full facepiece, operated under negative pressure, be used at up to 50 times the TWA limit.

NIOSH periodically issues lists of approved or certified respiratory protective devices. All devices approved by the Mining Enforcement and Safety Administration are listed in Information Circular 8559 and its supplements. All types of devices certified by the NIOSH Testing and Certification Laboratory are listed in a separate publication available from the Testing and Certification Laboratory, NIOSH, Morgantown, West Virginia 26505.

VII. RESEARCH NEEDS

Epidemiologic studies of worker populations exposed to tetrachloroethane at or below the recommended environmental limit are needed. The gastrointestinal, hepatic, and neurologic effects that have already been documented in the work environment should be investigated in such studies, since the insufficiency of the available environmental exposure data have made it difficult to correlate tetrachloroethane exposure and effects. The only reports found of effects from long-term exposure to tetrachloroethane on organs other than the liver were those in which such effects were secondarily associated with severe hepatic poisoning. The effects of extended exposure on the renal, cardiovascular, pulmonary, and other organ systems, as well as possible carcinogenic effects of tetrachloroethane, also should be considered in epidemiologic studies. Variations in blood cell counts, hemoglobin content, and other blood tests have been described in the human case reports and in animal studies involving tetrachloroethane, but the accumulated data are inadequate and inconclusive. Further research in this area may result in the development of a biologic monitoring system that could be used to indicate worker overexposure to tetrachloroethane before the appearance of clinical signs or symptoms.

Alcohol has been either suggested or demonstrated to be a potentiator of the effects of several chlorinated hydrocarbons, such as carbon tetrachloride, chloroform, and trichloroethylene. Animal studies should be conducted to determine what interaction, if any, exists between alcohol and tetrachloroethane. Furthermore, since tetrachloroethane is used as a starting material in the manufacture of both trichloroethylene and tetrachloroethylene, the possibility of mixed exposures to these three haloalkanes exists. Research is needed to determine if there are additive, synergistic, or inhibitory effects of tetrachloroethane in combination with these chlorinated hydrocarbons.

A study by Yllner [55] on mice is the only detailed study found on the metabolic pathways for tetrachloroethane. Experiments on other species are needed to further elucidate the distribution, metabolism, and excretion of tetrachloroethane after it is inhaled, ingested, or absorbed through the skin.

Information is needed on the possible carcinogenic or teratogenic effects of tetrachloroethane; the results of the National Cancer Institute's Carcinogenesis Bioassay study will be evaluated as soon as they are made available to NIOSH. The only identified mutagencity study [56] of tetrachloroethane involved two bacterial assay systems; the results were inconclusive. Studies are now being conducted by NIOSH to investigate any mutagenic potential of tetrachloroethane. Experiments involving mammalian species are essential if information on carcinogenicity, mutagenicity, and teratogenicity relevant to human occupational exposures to tetrachloroethane is to be obtained.

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