HYGIENIC GUIDE SERIES

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION

Vinyl Chloride
(Chloroethene)

CH_2=CHC1

Chemical Abstracts Registry No. 75014

Significant Physical Properties

Vinyl chloride is a colorless gas at standard conditions but is usually handled as a liquid.

Molecular weight	62.50				
Melting point	-153.7				
Boiling point	- 13.8				
Vapor pressure	mm Hg	130	470	1293	2943
	°C	- 50	- 25	0	25
Explosive limits, vol % in air	3.6-26.4				
Liquid density, g/ml at 25°C	0.9013				
Autoignition temperature	472°C				
Flash point	-78°C (Cleveland Open Cup)				
Vapor density (air=1)	2.55 at 25°C and 760 mm				
1 ppm	0.00255 mg/liter				
1 mg/liter	391 ppm				

I. Hygienic Standards

A. WORKDAY EXPOSURE CONCENTRATIONS: The Occupational Safety and Health Administration promulgated a standard for exposure to vinyl chloride[1] effective April 1, 1975. The standard set the permissible exposure limit as not greater than 1 ppm averaged over any 8-hour period. OSHA classifies vinyl chloride as a cancer-suspect agent. In 1975, The American Conference of Governmental Industrial Hygienists' TLVs list placed vinyl chloride in the intended changes group and classified it lc., human carcinogen awaiting reassignment of TLV pending further data acquisition.

B. SHORT TERM EXPOSURE CONCENTRATIONS: OSHA[1] restricts short term exposures to a maximum concentration of 5 ppm averaged over any period not exceeding 15 minutes. Direct contact with liquid vinyl chloride is prohibited. Prior to 1975 ACGIH recommended a 500 ppm ceiling concentration.

C. ATMOSPHERIC CONCENTRATION IMMEDIATELY HAZARDOUS TO LIFE: Mice and rats survived 30 minute exposures to 100,000 ppm but were killed by 300,000 ppm. A two hour exposure to rats at 150,000 ppm caused respiratory failure.[2] Guinea pigs were killed by 200,000 to 400,000.

II. Toxic Properties

Prior to 1974, the primary hazard of occupational exposure to vinyl chloride was considered to be due to its anesthetic and explosive properties. There was conflicting opinion as to the significance of pathological changes in the liver of dogs, guinea pigs, rabbits and rats exposed for periods up to six months. On January 22, 1974 NIOSH disclosed that B. F. Goodrich had reported that deaths of several of its employees from angiosarcoma of the liver may have been occupationally related. Subsequent investigation led to the promulgation of CFR 1910.1017 Standard for Exposure to Vinyl Chloride, effective April 1, 1975.

A. INHALATION: The primary effect of acute exposure to vinyl chloride is narcosis. Two industrial deaths are reported from acute exposure to vinyl chloride.[3] The first signs of intoxication appeared at 8000-12000 ppm when human volunteers were exposed for five minute periods to 4000, 8000, 12000, 16000 and 20000 ppm.[4] Exposures to 13 human volunteers for 7-

The Committee wishes to acknowledge the assistance of Roger L. Dansel in the preparation of this Hygienic Guide.

OLI 3397

1/2 hours to 50, 200 and 500 ppm produced no clinical changes or neurological responses.[5] Filatova and Gromsberg[6] reported angioneurosis of a spastic character in workers exposed to 20-315 ppm vinyl chloride in a polyvinyl chloride process. Wilson, *et al.*[7] reported several cases of acroosteolysis in the hands of workmen working in vinyl chloride polymerization processes; no estimates of exposure levels were cited. Suciu, *et al.*[8] reported the presence of "narcotic syndrome", asthenic nervous symptoms, Raynaud's syndrome and hepatomeglia among a group of 186 employees working in polyvinyl chloride plants; exposure levels were not quantified. Maltoni[9] observed that vinyl chloride inhalation produced in rats, Zymbal gland carcinomas, nephroblastomas, angiosarcomas and angiomas of the liver and other sites, skin carcinomas, hepatomas and brain neuroblastomas; in mice, lung adenomas, mammary carcinomas, angiosarcomas and angiomas of the liver and other sites, skin epithelial tumors; in hamsters, liver angiosarcomas. Several reports[10-15] make reference to the mutagenic potential of vinyl chloride. An excess of chromosomal aberration in lymphocytes of workers exposed to vinyl chloride as compared to controls was observed.[16-18]

B. SKIN CONTACT: Rapid evaporation of liquid vinyl chloride in contact with clothing or skin may cause freezing or frost bite. Inhibited vinyl chloride may leave a residue in clothing that could cause skin irritation.

C. EYE CONTACT: Eye contact with liquid vinyl chloride may cause frost bite.

D. INGESTION: The quantity of vinyl chloride likely to be ingested incidential to industrial handling will not cause injury.

III. Industrial Hygiene Practice

A. INDUSTRIAL USES AND OCCURRENCES: Most of the vinyl chloride produced is polymerized to polyvinyl chloride. It is also copolymerized with other monomers and is used as a chemical intermediate.

B. EVALUATION OF EXPOSURE:

1. *Air Sampling and Analysis:*
   a. Direct field methods:
      (1) Combustion type instruments may be used in the absence of interfering substances.[19]
      (2) Gas Chromatography is the method of choice when more than one air contaminant is present.
   b. Personnel monitoring methods:
      (1) Adsorption on charcoal and desorption with carbon disulfide followed by gas chromatographic measurement is the method of choice.[20]

C. HAZARDS AND THEIR RECOMMENDED CONTROL. The imminent danger when uncontrolled conditions exist are fire and explosion. Vinyl chloride polymerizes readily in the presence of air, sunlight or heat,[21] but is safely shipped in commerce without a polymerization inhibitor. Uncontrolled polymerization may cause closed vessels to explode. The odor is not detectable below 4000 ppm by many persons and therefore is not an adequate warning property to prevent overexposure by inhalation.

1. *Inhalation:* There is little dispute that vinyl chloride is carcinogenic to man. OSHA has concluded that employee exposures to vinyl chloride must be limited to a one ppm time-weighted average and to a ceiling concentration of five ppm. NIOSH approved chemical cartridge respirators are the minimum respiratory protective equipment for performing any task in vapor concentrations that exceed the above limitations. Sampling, disconnecting transfer lines, entry of storage and polymerization vessels are tasks that have high potential for overexposure and that require work practices and engineering controls to limit exposure.
2. *Skin contact:* Protective garments are to be worn to prevent skin contact with liquid vinyl chloride or with polyvinyl chloride residue from vessel walls.
3. *Eye contact:* Prevent eye contact by use of chemical safety goggles whenever there is danger of the liquid entering the eyes.
4. *Fire and explosion:* Since vinyl chloride is a gas at standard conditions, the fire and explosion hazard is high. Precautions must be taken to prevent leaks in closed systems and to avoid contacts with sources of ignition.

IV. Medical Information

A. EMERGENCY TREATMENT:

1. *Inhalation:* Mild overexposure requires no treatment other than removal from the contaminated area. Severe overexposure may produce deep anesthesia. If this occurs remove the patient from the area, place in a supine position, keep breathing passage open and call a physician. If breathing has stopped, begin mouth-to-mouth resuscitation without interruption until breathing is resumed. Federal regulation[1] requires that each employee exposed to an "emergency" which is likely to or does result in massive release of vinyl

chloride shall be afforded appropriate medical surveillance.

2. *Skin contact:* Remove contaminated clothing and wash skin thoroughly with water. If frostbite has occurred refer to a physician.
3. *Eye contact:* Irrigate immediately with copious quantities of water for at least 15 minutes and place under care of an ophthalmologist.

B. SPECIAL PROCEDURES. OSHA requires that all vinyl chloride workers be on a medical surveillance program.[11] The details are found in the OSHA vinyl chloride standard.

V. References

1. **Code of Federal Regulations:** Title 29, Part 1910.1017
2. **Mastromatteo, E., A. M. Fisher, H. Christie and H. Danziger:** Acute Inhalation, Toxicity of Vinyl Chloride to Laboratory Animals. *Am. Ind. Hyg. Assoc. J. 21*:394 (1960).
3. **Danziger, H.:** Accidental Poisoning by Vinyl Chloride: Report of Two Cases. *Can. Med. Assoc. J. 82*:828 (1960).
4. **Lester, D., L. A. Greenberg and W. R. Adams:** Effects of Single and Repeated Exposures of Humans and Rats to Vinyl chloride. *Am. Ind. Hyg. Assoc. J. 24*:265 (1963).
5. **Baretta, E. D., R. D. Stewart and J. E. Mutchler:** Monitoring Exposures to Vinyl Chloride Vapor: Breath Analysis and Continuous Air Sampling. *Am. Ind. Hyg. Assoc. J. 30*:537 (1969).
6. **Filatova, U. S. and E. S. Gronsberg:** Hygienic Working Conditions in Polyvinyl Chloride Tar Plants. *Gigi Sanit 38*:42 (1957).
7. **Wilson, R. H., W. E. McConnick, C. F. Tatum and J. L. Creech:** Occupational Acroosteolysis. J.A.M.A. 201:577 (1967).
8. **Suciu, I., J. Drejman and M. Velaski:** Contributions to The Study of Affections Caused by Vinyl Chloride. *Medicina Interne 15*:967 (1963).
9. **Maltoni, Cesare:** The Value of Predictive Experimental Bioassays in Occupational and Environmental Carcinogeneses. An Example: Vinyl Chloride. *Ambio 4*:18 (1975).
10. **Bartsch, H., C. Malaviellle and R. Montesano:** Human, Rat and Mouse Liver-mediated Mutagenicity of Vinyl Chloride in S. Typhinurium Strains. *Int. J. Cancer 15*:429 (1975).
11. **Leopiano, N., R. Barale, S. Varonosilli, *et al*:** Evaluation of the Genetic Effects of Vinyl Chloride Monomer Under the Influence of Liver Microsomes. Mutation Research. In press.
12. **Rannug, U., A. Johansson, C. Rammel and C. A. Wachtmeister:** The Mutagenicity of Vinyl Chloride After Metabolic Activation. *Ambio 3*:194 (1974).
13. **Huberman, E., H. Barsch and L. Sachs:** Mutation Induction in Chinese Hamster V79 Cells by Two Vinyl Chloride Metabolities, Chloroethylene Oxide and 2-Chloro-acetaldehyde. *Int. J. Cancer 16*:639 (1975).
14. **Infante, P. F.:** Oncogenic and Mutagenic Risks in Communities With Polyvinyl Chloride Production Facilities. *Ann. N.Y Acad. Sci. 271*:49 (1976).
15. **Infante, P. F., J. K. Wagoner, A. J. McMichael, R. J. Waxweiler and H. Falk:** Genetic Risks of Vinyl Chloride, *Lancet* (1976).
16. **Ducatman, A., K. Hirschhorn and I. J. Selikoff:** Vinyl Chloride Exposure and Hyman Chromosome Aberrations. *Mutat. Res. 31*:163 (1975).
17. **Funes-Cravioto, F., B. Lambert, J. Lindsten, *et al*.:** Chromosome Aberrations in Workers Exposed to Vinyl Chloride. *Lancet i*:459 (1975).
18. **Purchase, I. F. H., C. R. Richardson and D. Anderson:** Chromosomal and Dominant Lethal Effects of Vinyl Chloride. *Lancet ii*:410 (1975).
19. **Scheffer, A. W. and H. R. Hoyle:** Nine Years Experience with the Davis Halide Meter. *Am. Ind. Hyg. Assoc. J. 22*:93 (1961).
20. **National Institute for Occupational Safety and Health:** Analytical Method P and CAM #178. 5600 Fishers Lane, Rockville, MD 20852.
21. **Manufacturing Chemists' Association, Inc.:** Chemical Safety Data Sheet SD-56, Revised 1972.

Prepared under the auspices of the Hygienic Guides Committee: Howard E. Ruzon, Chairman; O'Neil M. Banks, Ph.D.; Lial W. Brower; Paul E. Caplan; William D. Christensen; Emil E. Christofano; Criz E. Calles; Richard D. Fulwiler, Sc.D.; David Gidley; Charles E. Holdsworth, Ph.D.; Bruce S. Horvath; William C. Jans; Mars Y. Longley, Ph. D.; Frank L. Mitchell, D.O.; John D. Neefus, Ph. D.; Jeffrey Pattison; William E. Shoemaker; H. J. Trochimowicz, Sc.D.; Eugene G. Wood; Usha Wright.

Copyright 1978
American Industrial Hygiene Association

Revised Feb. 1978

OLI 3399