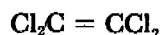


HYGIENIC GUIDE SERIES

Tetrachloroethylene

(Perchloroethylene)



(Revised 1965)

Significant Physical Properties

Tetrachloroethylene is a clear, colorless, nonflammable liquid with a distinctive, somewhat ethereal odor. The trade names under which it is sold include Perclene, Nema and Per Sec.¹

Molecular weight:	165.85
Specific gravity of liquid:	1.61 at 25°C/4°C
Boiling point:	121.0°C
Solubility:	Miscible with most organic liquids, insoluble in water.
Vapor pressure:	mm. Hg 5 10 18.45 30 40 °C 2.4 14 25 34.4 40.1
At 25°C and 760 mm. Hg:	Saturated air contains 2.43% (24,300 ppm) by volume.
	Relative density of saturated air = 1.12 (air = 1)
	1 ppm = 0.0068 mg/liter
	1 mg/liter = 147.4 ppm

I. Hygienic Standards

A. RECOMMENDED MAXIMAL ATMOSPHERIC CONCENTRATIONS (8 hours): 100 parts of tetrachloroethylene vapor per million parts of air, by volume (ppm).² This is based on human experience and animal studies.³

B. SHORT EXPOSURE TOLERANCE: Mild inebriation occurred in humans 45 minutes after exposure to 1,000 ppm but narcosis did not result in 95 minutes.⁴

In rats, a single exposure to 6,000 ppm caused unconsciousness within a few minutes, after several hours at

3,000 ppm and not at all at 2,000 ppm which was inhaled for 14 hours.⁵

C. ATMOSPHERIC CONCENTRATION IMMEDIATELY HAZARDOUS TO LIFE: A concentration of 5,000 ppm could be tolerated for only six minutes before it forced four human subjects to leave the chamber to avoid being overcome. Vertigo, nausea and retarded mental activity resulted during the next ten minutes in fresh air.⁴

A concentration of 20,000 ppm caused the death of rats in approximately 4½ minutes and in 12 to 18 minutes at 12,000 ppm.⁵

The Committee wishes to acknowledge the assistance of Judith Stockberger Nycum in this revision and of the Industrial Hygiene and Clinical Toxicology Committee of I.M.A. for their assistance in the preparation of the medical information section of this Guide.

II. Toxic Properties

A. INHALATION: Six humans exposed to 106 ppm of tetrachloroethylene for one

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hour noticed the odor immediately but did not find it objectionable. At 216 ppm eye irritation usually developed within 30 minutes and persisted throughout the exposure period. After two hours there was no loss of motor coordination or mental alertness but minimal central nervous system effects were noted. Furthermore, at 280 ppm four subjects felt that motor coordination was impaired and that to coordinate required mental effort.⁵

Groups of six human subjects were exposed to as much as 194 ppm for 187 minutes. Chemical, physiological and clinical laboratory studies were carried out and correlated with three different vapor exposures. These data may be used to evaluate a three-hour exposure and to estimate whether a person had been exposed to more than an average concentration of 200 ppm of tetrachloroethylene vapor.⁶

An industrial accident resulted in unconsciousness from an exposure to average concentrations of 275 ppm of tetrachloroethylene for three hours followed by 1,100 ppm for 30 minutes. There was apparent clinical recovery one hour after exposure but the monitored concentration in the patient's expired air diminished slowly over a two-week period. During the second and third post-exposure weeks, the results of liver function tests became abnormal which suggested that acute exposure had a prolonged effect upon the liver and was capable of causing mild hepatitis.⁷

Rats exposed for seven months for eight hours per day, five days per week to a concentration of 70 ppm exhibited no pathological effects, while congestion and slight granular swelling of the kidneys and decreased glycogen storage in the liver were noted at 230 ppm. At 470 ppm, injury to the liver and kidney was more prominent.⁴

Repeated seven-hour inhalation periods of a concentration of 2,500 ppm caused rapid death of rats. There was severe central nervous system depres-

sion and frequent loss of consciousness without severe organic injury. Rats, as well as monkeys and rabbits, tolerated repeated exposure to 400 ppm without ill effects while guinea pigs reacted adversely.⁵

B. **SKIN CONTACT:** Continuous immersion of the thumbs for 40 minutes in tetrachloroethylene resulted in a mild burning sensation within five to ten minutes which progressed to moderate burning within 15 to 20 minutes. This sensation persisted for ten minutes after removal and subsided within one hour. In all cases there was marked erythema which subsided one to two hours post-exposure.⁸ Only one of ten rabbits succumbed in a 24-hour covered skin penetration test at a dosage level of 20 ml/kg.⁹

C. **EYE CONTACT:** Usually the first warning of excessive exposure to tetrachloroethylene vapor in man is a mild burning sensation in the eyes but serious eye injury is not likely to follow. Immediate pain and blepharospasm in rabbit eyes were noted when tetrachloroethylene was sprayed from a pressurized fire extinguisher at a distance of one foot. The corneal epithelium became granular and optically irregular and patches of epithelium were lost, but the eyes recovered completely within two days.¹⁰

D. **INGESTION:** The mouse oral LD₅₀ is approximately 8.85 gm/kg undiluted or 10.9 gm/kg when administered in an oil vehicle.¹¹

Browning reports that some cats and dogs survived doses as large as 25 ml/kg while others died at 4.0 ml/kg.¹² Spector gives this range as 6.5 to 25 gm/kg for dogs.¹¹

III. Industrial Hygiene Practice

A. **INDUSTRIAL USES:** Tetrachloroethylene is used widely as a solvent in the dry cleaning and metal degreasing industries and also as a chemical intermediate.

B. EVALUATION OF EXPOSURE:

1. *Air sampling and analysis:*

- (a) Direct field methods: The Davis Halide Meter or any instrument calibrated for halogenated hydrocarbons may be used.
- (b) Laboratory methods: The sulfur lamp method and the technique involving hydrolysis with metallic sodium followed by the determination of the halide content have been used for nonspecific determinations.^{13,14} More specific techniques include the use of infrared spectrophotometry and gas chromatography.¹⁵ The tetrachloroethylene vapor may be collected on silica gel or in plastic bags.^{13,14,15}

C. HAZARDS AND THEIR RECOMMENDED CONTROL:

1. *Inhalation:* The solvent vapor may be perceptible at concentrations as low as 50 ppm. However, an individual may adapt to the odor within a short time, so this level cannot be considered as having good warning properties. Inhalation of vapor above 200 ppm may present a hazard in that rapid onset of light headedness may result, thus increasing the risk of accidental injury.⁶ Careful handling of tetrachloroethylene and proper ventilation should be maintained to keep the vapor concentration below the recommended TLV level. In the case of large spills which may create atmospheric concentrations exceeding 20,000 ppm vapor, self-contained breathing apparatus approved by the U. S. Bureau of Mines, should be used.
2. *Skin:* Tetrachloroethylene liquid produces minimal discomfort when in cursory contact with the skin. If it is not confined to the skin beneath an impenetrable barrier, there

is little likelihood that toxic amounts of the compound will be absorbed through the skin during normal industrial handling.⁸ However, repeated contact should be avoided because of the resulting dermatitis, due to defatting action, and the subsequent enhancement of skin penetration.

3. *Eyes:* Safety glasses should be worn if any possibility of eye contact with tetrachloroethylene exists as it is irritating and causes lacrimation and burning. Permanent damage would not be expected.
4. *Ingestion:* Tetrachloroethylene is not readily absorbed *via* the gastrointestinal tract as demonstrated by animal studies. It is not a serious hazard unless liver disease is already present.
5. *Fire and explosion:* Although tetrachloroethylene is nonflammable and nonexplosive, it can be decomposed thermally to form such hazardous materials as phosgene and hydrochloric acid.

IV. Medical Information

- A. *EMERGENCY TREATMENT:* Remove the patient from the contaminated area and give artificial respiration if needed. Any contaminated clothing should be removed and the skin area washed with soap and water. If the eyes are involved they should be flushed immediately with water and then irrigated with 0.85% saline for 15 minutes. Ingested material should be removed by induction of vomiting or by gastric lavage with saline solution.¹⁶
- B. *SPECIAL PROCEDURES:* As with other chlorinated solvents, treat symptomatically paying particular attention to cardiac rhythm after anesthesia. Oxygen therapy should be used if cardiac disturbances occur. Vasopressor drugs such as epinephrine are contraindicated. A low-fat, high-protein, high-carbohydrate diet should be maintained

in cases of liver or kidney involvement.¹⁶

V. References

1. Synthetic Organic Chemical Manufacturers Association: *Synthetic Organic Chemical Manufacturers Association Handbook: Commercial Chemical Names*. American Chemical Society, 1155 Sixteenth Street, N. W., Washington, D. C. (1965).
2. American Conference of Governmental Industrial Hygienists: Threshold Limit Values for 1964. *AMA Arch. Environ. Health* 9: 545 (1964).
3. Committee on Threshold Limit Values: *Documentation of Threshold Limit Values*. American Conference of Governmental Industrial Hygienists, 1014 Broadway, Cincinnati 2, Ohio (1962).
4. Carpenter, C. P.: The Chronic Toxicity of Tetrachloroethylene. *J. Ind. Hyg. Toxicol.* 19: 323 (1937).
5. Rowe, V. K., D. D. McCollister, H. C. Spencer, E. M. Adams, and D. D. Irish: Vapor Toxicity of Tetrachloroethylene for Laboratory Animals and Human Subjects. *AMA Arch. Ind. Hyg. & Occup. Med.* 5: 566 (1952).
6. Stewart, R. D., H. H. Gay, D. S. Erley, C. L. Hake, and A. W. Schaffer: Human Exposure to Tetrachloroethylene Vapor. *AMA Arch. Environ. Health* 2: 516 (1961).
7. Stewart, R. D., D. S. Erley, A. W. Schaffer, and H. H. Gay: Accidental Vapor Exposure to Anesthetic Concentrations of a Solvent Containing Tetrachloroethylene. *Ind. Med. Surg.* 30: 327 (1961).
8. Stewart, R. D., and H. C. Dodd: Absorption of Carbon Tetrachloride, Trichloroethylene, Tetrachloroethylene, Methylene Chloride, and 1,1,1-Trichloroethane Through the Human Skin. *Amer. Ind. Hyg. Assoc. J.* 25: 439 (1964).
9. Unpublished Data: Chemical Hygiene Fellowship, Mellon Institute, Pittsburgh, Pa.
10. Grant, W. M.: *Toxicology of the Eye*. p. 519, Charles C Thomas Publishers, Springfield, Illinois (1962).
11. Spector, W. S.: *Handbook of Toxicology*. Vol. I, p. 290 (1955).
12. Browning, E.: *Toxicity of Industrial Organic Solvents*. p. 182, Her Majesty's Stationery Office, London (1953).
13. Elkins, H. B.: *The Chemistry of Industrial Toxicology*. 2nd Ed., p. 398, John Wiley & Sons, New York (1959).
14. Coleman, A. L.: *Standard Method for Determination of Chlorinated Hydrocarbons in Air*. American Conference of Governmental Industrial Hygienists, 1014 Broadway, Cincinnati, Ohio (1952).
15. American Industrial Hygiene Association: *A.I.H.A. Analytical Abstracts*. American Industrial Hygiene Association, 14125 Prevost, Detroit, Mich. (1965).
16. Deichmann, W. B., and H. W. Gerarde: *Symptomatology and Therapy of Toxicological Emergencies*. pp. 118, 388, Academic Press, New York (1964).

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