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Tetrachloroethylene (Perchloroethylene)

127-18-4

Hazard Summary-Created in April 1992; Revised in January 2000

Tetrachloroethylene is widely used for dry-cleaning fabrics and metal degreasing operations. The main effects of tetrachloroethylene in humans are neurological, liver, and kidney effects following acute (short-term) and chronic (long-term) inhalation exposure. Adverse reproductive effects, such as spontaneous abortions, have been reported from occupational exposure to tetrachloroethylene; however, no definite conclusions can be made because of the limitations of the studies. Results from epidemiological studies of dry-cleaners occupationally exposed to tetrachloroethylene suggest increased risks for several types of cancer. Animal studies have reported an increased incidence of liver cancer in mice, via inhalation and gavage (experimentally placing the chemical in the stomach), and kidney and mononuclear cell leukemia in rats. In the mid-1980s, EPA considered the epidemiological and animal evidence on tetrachloroethylene as intermediate between a probable and possible human carcinogen (Group B/C). The Agency is currently reassessing its potential carcinogenicity.

Please Note: The main sources of information for this fact sheet are EPA's [Integrated Risk Information System](#) (IRIS), which contains information on oral chronic toxicity and the [RfD](#), and the Agency for Toxic Substances and Disease Registry's (ATSDR's) [Toxicological Profile for Tetrachloroethylene](#). Another secondary source is EPA's [Health Effects Assessment for Tetrachloroethylene](#).

Uses

- Tetrachloroethylene is used for dry cleaning and textile processing, as a chemical intermediate, and for vapor degreasing in metal-cleaning operations. (1)

Sources and Potential Exposure

- Prior to 1981, tetrachloroethylene was detected in ambient air at average levels of 0.16 parts per billion (ppb) in rural and remote areas, 0.79 ppb in urban and suburban areas, and 1.3 ppb in areas near emission sources. (1)
- Tetrachloroethylene has also been detected in drinking water; one survey prior to 1984 of water supplies from groundwater sources reported a median concentration of 0.75 ppb for the samples in which tetrachloroethylene was detected, with a maximum level of 69 ppb. (1)
- Occupational exposure to tetrachloroethylene may occur, primarily in dry cleaning establishments and at industries manufacturing or using the chemical. (1)

Assessing Personal Exposure

- Tetrachloroethylene can be measured in the breath, and breakdown products of tetrachloroethylene can be measured in the blood and urine. (1)

Health Hazard Information

Acute Effects:

- Effects resulting from acute, inhalation exposure of humans to tetrachloroethylene vapors include irritation of the upper respiratory tract and eyes, kidney dysfunction, and at lower concentrations, neurological effects, such as reversible mood and behavioral changes, impairment of coordination, dizziness, headache, sleepiness, and unconsciousness. (1)
- Animal studies have reported effects on the liver, kidney, and central nervous system (CNS) from acute inhalation exposure to tetrachloroethylene. (1)
- Acute animal tests in mice have shown tetrachloroethylene to have [low](#) toxicity from inhalation and oral exposure. (1)

Chronic Effects (Noncancer):

- The major effects from chronic inhalation exposure to tetrachloroethylene in humans are neurological effects, including sensory symptoms such as headaches, impairments in cognitive and motor neurobehavioral functioning and color vision decrements. Other effects noted in humans include cardiac arrhythmia, liver damage, and possible kidney effects. (1,5)

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- Animal studies have reported effects on the liver, kidney, and CNS from chronic inhalation exposure to tetrachloroethylene. (1,5)
- EPA has not established a Reference Concentration (RfC) for tetrachloroethylene. (4)
- The Reference Dose (RfD) for tetrachloroethylene is 0.01 milligrams per kilogram body weight per day (mg/kg/d) based on hepatotoxicity in mice and weight gain in rats. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. It is not a direct estimator of risk, but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfD, the potential for adverse health effects increases. Lifetime exposure above the RfD does not imply that an adverse health effect would necessarily occur. (4)
- EPA has medium confidence in the RfD based on low confidence in the study on which the RfD was based due to the lack of complete histopathological examination at the no-observed-adverse-effect level (NOAEL) in the mouse; and medium confidence in the database because it is relatively complete but lacks studies of reproductive and teratology endpoints subsequent to oral exposure. (4)
- ATSDR has calculated a chronic-duration inhalation minimal risk level (MRL) of 0.04 parts per million (ppm) (0.3 milligrams per cubic meter, mg/m³) for tetrachloroethylene based on neurological effects in humans. The MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure. (1)
- Repeated skin contact may cause irritation. (1)

Reproductive/Developmental Effects:

- Some adverse reproductive effects, such as spontaneous abortions, menstrual disorders, altered sperm structure, and reduced fertility, have been reported in studies of workers occupationally exposed to tetrachloroethylene. However, no definitive conclusions can be made because of the limitations of the studies. (1)
- In one study of residents exposed to drinking water contaminated with tetrachloroethylene and other solvents, there was a suggestion that birth defects were associated with exposure. However, no firm conclusions can be drawn from this study due to multiple chemical exposures and problems with the analysis. (1)
- Increased fetal resorptions and effects to the fetus have been reported in animals exposed to high levels of tetrachloroethylene by inhalation. (1)

Cancer Risk:

- Epidemiological studies of dry cleaning workers exposed to tetrachloroethylene and other solvents suggest an increased risk for a variety of cancers (esophagus, kidney, bladder, lung, pancreas, and cervix). These studies are complicated by potential exposure to other chemicals and personal lifestyle factors such as alcohol consumption and smoking were not taken into account. (1,5,6)
- One human study reported that there was a potential association between drinking water contaminated with tetrachloroethylene and other chemicals and an increased risk of childhood leukemia. The statistical significance of the incidence of leukemia has not been resolved. (1)
- Animal studies have reported an increased incidence of liver tumors in mice, from inhalation and gavage (experimentally placing the chemical in the stomach) exposure, and kidney and mononuclear cell leukemias in rats, via inhalation exposure. (1,5,6)
- Less than 5 percent of absorbed tetrachloroethylene is metabolized by humans to trichloroacetic acid (TCA), with the remainder being exhaled unchanged. TCA is classified as a Group C, possible human carcinogen based on limited evidence of liver tumors in mice (but not rats). (4,7)
- EPA does not currently have a classification for the carcinogenicity of tetrachloroethylene. The International Agency for Research on Cancer (IARC) has classified tetrachloroethylene as probably carcinogenic to humans.
- EPA uses mathematical models, based on animal studies, to estimate the probability of a person developing cancer from breathing air containing a specified concentration of a chemical. EPA has calculated a provisional inhalation unit risk estimate of 5.8×10^{-7} ($\mu\text{g}/\text{m}^3$)⁻¹. A provisional value is one which has not received Agency-wide review. (7)
- EPA has calculated a provisional oral cancer slope factor of 0.051 (mg/kg/d)⁻¹. (5)

Physical Properties

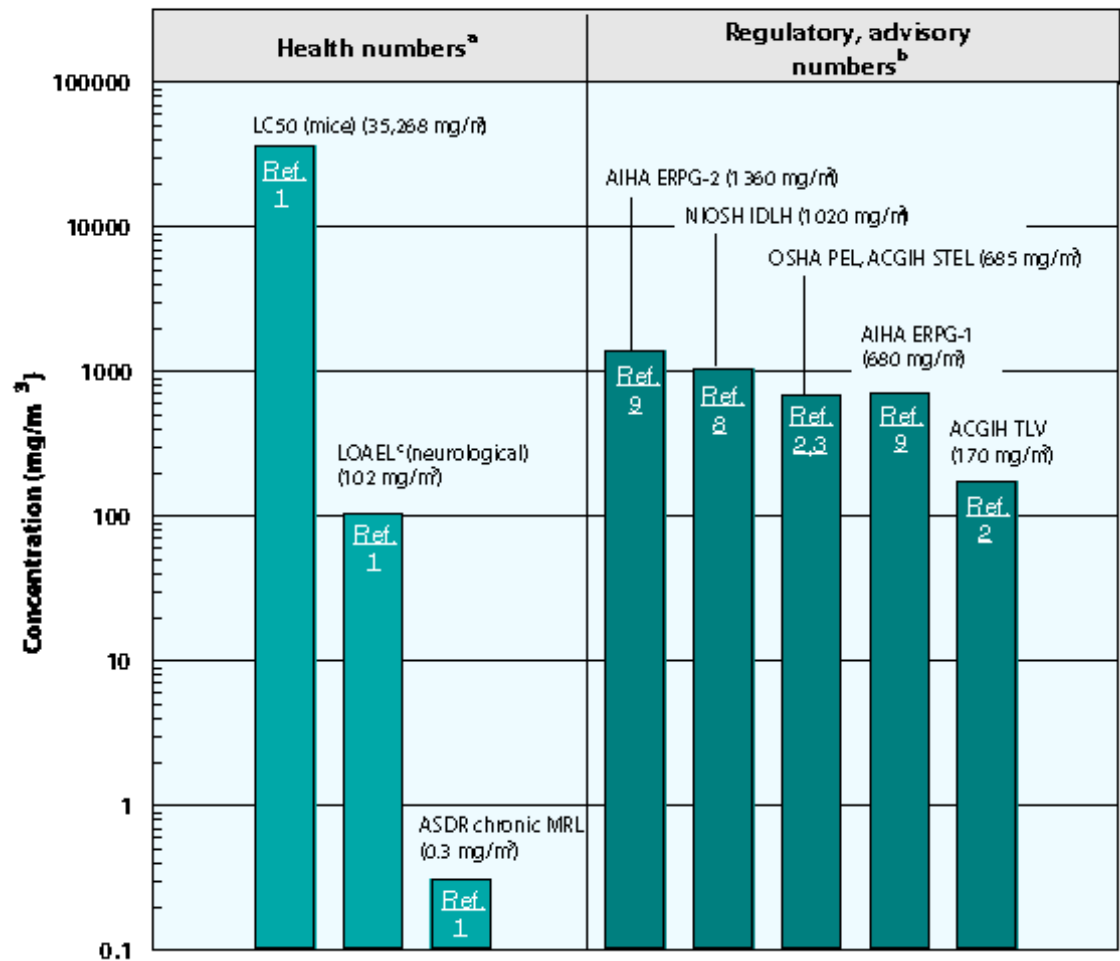
- Tetrachloroethylene is a nonflammable colorless liquid with a sharp sweet odor; the odor threshold is 1 ppm. (1)
- The chemical formula for tetrachloroethylene is C₂Cl₄, and the molecular weight is 165.83 g/mol. (1)
- The vapor pressure for tetrachloroethylene is 18.47 mm Hg at 25 °C, and it has a log octanol/water partition coefficient (log K_{ow}) of 3.40. (1)

Conversion Factors:

To convert concentrations in air (at 25°C) from ppm to mg/m³: $\text{mg}/\text{m}^3 = (\text{ppm}) \times (\text{molecular weight of the compound}) / (24.45)$. For tetrachloroethylene: $1 \text{ ppm} = 6.78 \text{ mg}/\text{m}^3$. To convert concentrations in air from $\mu\text{g}/\text{m}^3$ to mg/m³: $\text{mg}/\text{m}^3 = (\mu\text{g}/\text{m}^3) \times (1 \text{ mg}/1,000 \mu\text{g})$.

Health Data from Inhalation Exposure

Tetrachloroethylene



AIHA ERPG--American Industrial Hygiene Association's emergency response planning guidelines. ERPG 1 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed up to one hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor; ERPG 2 is the maximum airborne concentration below which it is believed nearly all individuals could be exposed up to one hour without experiencing or developing irreversible or other serious health effects that could impair their abilities to take protective action.

ACGIH STEL--American Conference of Governmental and Industrial Hygienists' short-term exposure limit; 15-min time-weighted-average exposure that should not be exceeded at any time during a workday even if the 8-h time-weighted-average is within the threshold limit value.

ACGIH TLV--American Conference of Governmental and Industrial Hygienists' threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.

LC₅₀ (Lethal Concentration₅₀)--A calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50% of a defined experimental animal population.

NIOSH IDLH-- National Institute of Occupational Safety and Health's immediately dangerous to life or health concentration; NIOSH recommended exposure limit to ensure that a worker can escape from an exposure condition that is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from the environment.

OSHA PEL--Occupational Safety and Health Administration's permissible exposure limit expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.

The health and regulatory values cited in this factsheet were obtained in December 1999.

^a Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

^b Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice. OSHA numbers are regulatory, whereas NIOSH, ACGIH, and AIHA numbers are advisory.

^cThe LOAEL is from the critical study used as the basis for the ATSDR chronic inhalation MRL.

References

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