TTN Home
ATW Home
Rules & Implementation
National-Scale Air Toxics Assessment
Risk Studies
Education & Outreach
About Air Toxics
Pollutants & Sources
State, Local, Tribal Resources
Publications
Contacts
Technical Resources

You are here: EPA Home » Air & Radiation » TTN Web - Technology Transfer Network » Air Toxics Web site » Vinyl chloride

Vinyl chloride

75-01-4

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

Most vinyl chloride is used to make polyvinyl chloride (PVC) plastic and vinyl products. Acute (short-term) exposure to high levels of vinyl chloride in air has resulted in central nervous system effects (CNS), such as dizziness, drowsiness, and headaches in humans. Chronic (long-term) exposure to vinyl chloride through inhalation and oral exposure in humans has resulted in liver damage. Cancer is a major concern from exposure to vinyl chloride via inhalation, as vinyl chloride exposure has been shown to increase the risk of a rare form of liver cancer in humans. EPA has classified vinyl chloride as a Group A, human carcinogen.

Please Note: The main sources of information for this fact sheet are the Agency for Toxic Substances and Disease Registry's (ATSDR's) *Toxicological Profile for Vinyl Chloride* and *Case Studies in Environmental Medicine. Vinyl Chloride Toxicity*.

Uses

- Most of the vinyl chloride produced in the United States is used to make polyvinyl chloride (PVC), a material used to manufacture a variety of plastic and vinyl products including pipes, wire and cable coatings, and packaging materials. (1)
- Smaller amounts of vinyl chloride are used in furniture and automobile upholstery, wall coverings, housewares, and automotive parts. (1)
- Vinyl chloride has been used in the past as a refrigerant. (1)

Sources and Potential Exposure

- Ambient air concentrations of vinyl chloride are generally quite low, with exposure occurring from the discharge of exhaust gases from factories that manufacture or process vinyl chloride, or evaporation from areas where chemical wastes are stored. (1,2)
- Air inside new cars may contain vinyl chloride at higher levels than detected in ambient air because vinyl chloride may outgas into the air from the new plastic parts. (1,2)
- Drinking water may contain vinyl chloride released from contact with polyvinyl pipes. (1,2)
- Vinyl chloride is a microbial degradation product of trichloroethylene in groundwater, and thus can be found in groundwater affected by trichloroethylene contamination. (3)
- Occupational exposure to vinyl chloride may occur in those workers concerned with the production, use, transport, storage, and disposal of the chemical. (1,2)

Assessing Personal Exposure

- Vinyl chloride can be detected in urine and body tissues, but the tests are not reliable indicators of total exposure. (1,2)

Health Hazard Information

Acute Effects:

- Acute exposure of humans to high levels of vinyl chloride via inhalation in humans has resulted in effects on the CNS, such as dizziness, drowsiness, headaches, and giddiness. (1,2)
- Vinyl chloride is reported to be slightly irritating to the eyes and respiratory tract in humans. (1,2)

- Acute exposure to extremely high levels of vinyl chloride has caused loss of consciousness, lung and kidney irritation, and inhibition of blood clotting in humans and cardiac arrhythmias in animals. (1)
- Tests involving acute exposure of mice have shown vinyl chloride to have high acute toxicity from inhalation exposure. (5)

Chronic Effects(Noncancer):

- Liver damage may result in humans from chronic exposure to vinyl chloride, through both inhalation and oral exposure. (1,2)
- A small percentage of individuals occupationally exposed to high levels of vinyl chloride in air have developed a set of symptoms termed "vinyl chloride disease," which is characterized by Raynaud's phenomenon (fingers blanch and numbness and discomfort are experienced upon exposure to the cold), changes in the bones at the end of the fingers, joint and muscle pain, and scleroderma-like skin changes (thickening of the skin, decreased elasticity, and slight edema). (1,2)
- CNS effects (including dizziness, drowsiness, fatigue, headache, visual and/or hearing disturbances, memory loss, and sleep disturbances) as well as peripheral nervous system symptoms (peripheral neuropathy, tingling, numbness, weakness, and pain in fingers) have also been reported in workers exposed to vinyl chloride. (1)
- Animal studies have reported effects on the liver, kidney, and CNS from chronic exposure to vinyl chloride. (1,6)
- EPA has established a Reference Concentration (RfC) of 0.1 milligrams per cubic meter, and a Reference Dose (RfD) of 0.003 milligrams per kilogram per day for vinyl chloride. Please see IRIS for current information. (8)

Reproductive/Developmental Effects:

- Several case reports suggest that male sexual performance may be affected by vinyl chloride. However, these studies are limited by lack of quantitative exposure information and possible co-occurring exposure to other chemicals. (1)
- Several epidemiological studies have reported an association between vinyl chloride exposure in pregnant women and an increased incidence of birth defects, while other studies have not reported similar findings. (1,2)
- Epidemiological studies have suggested an association between men occupationally exposed to vinyl chloride and miscarriages in their wives' pregnancies although other studies have not supported these findings. (1,2)
- Testicular damage and decreased male fertility have been reported in rats exposed to low levels for up to 12 months. (1)
- Animal studies have reported decreased fetal weight and birth defects at levels that are also toxic to maternal animals in the offspring of rats exposed to vinyl chloride through inhalation. (1)

Cancer Risk:

- Inhaled vinyl chloride has been shown to increase the risk of a rare form of liver cancer (angiosarcoma of the liver) in humans. (1,2,6)
- Animal studies have shown that vinyl chloride, via inhalation, increases the incidence of angiosarcoma of the liver and cancer of the liver. (1,2,6)
- Several rat studies show a pronounced early-life susceptibility to the carcinogenic effect of vinyl chloride, i.e., early exposures are associated with higher liver cancer incidence than similar or much longer exposures that occur after maturity. (1)
- EPA has classified vinyl chloride as a Group A, human carcinogen. (8)
- 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 an inhalation unit risk estimate of 8.8×10^{-6} $(\mu g/m^3)^{-1}$ for lifetime exposure to vinyl chloride. Please see IRIS for current information. (8)
- EPA has calculated an oral cancer slope factor of 1.5 $(mg/kg/d)^{-1}$ for lifetime exposure to vinyl chloride. Please see IRIS for current information. (8)

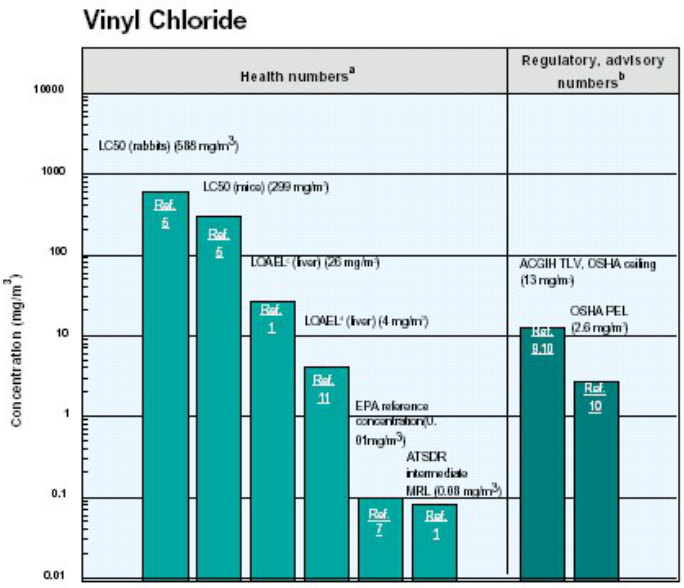
Physical Properties

- Vinyl chloride is a colorless gas with a mild, sweet odor. (1)
- The odor threshold for vinyl chloride is 3,000 ppm. (4)
- Vinyl chloride is slightly soluble in water and is quite flammable. (1)
- The chemical formula for vinyl chloride is C_2H_3Cl and the molecular weight is 62.5 g/mol. (1)
- The vapor pressure for vinyl chloride is 2,600 mm Hg at 25 °C, and it has a log octanol/water partition coefficient (log K_{ow}) of 1.36. (1)
- The half-life of vinyl chloride in air is a few hours. (1)

Conversion Factors:
To convert concentrations in air (at 25°C) from ppm to mg/m^3: mg/m^3 = (ppm) × (molecular weight of the

compound)/(24.45). For vinyl chloride: 1 ppm = 2.6 mg/m^3. To convert concentrations in air from µg/m^3 to mg/m^3: mg/m^3 = (µg/m^3) × (1 mg/1,000 µg).

Health Data from Inhalation Exposure



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.

LC_{50} (Lethal Concentration$_{50}$)--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.

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.

OSHA PEL ceiling value--OSHA's permissible exposure limit ceiling value; the concentration of a substance that should not be exceeded at any time.

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 ACGIH numbers are advisory.

[c]The LOAEL is from the critical study used as the basis for the ATSDR intermediate-duration inhalation MRL.

[d]The LOAEL is from the critical study used as the basis for the CalEPA chronic inhalation reference exposure level.

References

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