820K87003

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TRANS-1,2-DICHLOROETHYLENE

Health Advisory
Office of Drinking Water
U.S. Environmental Protection Agency

I. INTRODUCTION

The Health Advisory (HA) Program, sponsored by the Office of Drinking Water (ODW), provides information on the health effects, analytical methodology and treatment technology that would be useful in dealing with the contamination of drinking water. Health Advisories describe nonregulatory concentrations of drinking water contaminants at which adverse health effects would not be anticipated to occur over specific exposure durations. Health Advisories contain a margin of safety to protect sensitive members of the population.

Health Advisories serve as informal technical guidance to assist Federal, State and local officials responsible for protecting public health when emergency spills or contamination situations occur. They are not to be construed as legally enforceable Federal standards. The HAs are subject to change as new information becomes available.

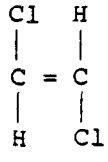
Health Advisories are developed for One-day, Ten-day, Longer-term (approximately 7 years, or 10% of an individual's lifetime) and Lifetime exposures based on data describing noncarcinogenic end points of toxicity. Health Advisories do not quantitatively incorporate any potential carcinogenic risk from such exposure. For those substances that are known or probable human carcinogens, according to the Agency classification scheme (Group A or B), Lifetime HAs are not recommended. The chemical concentration values for Group A or B carcinogens are correlated with carcinogenic risk estimates by employing a cancer potency (unit risk) value together with assumptions for lifetime exposure and the consumption of drinking water. The cancer unit risk is usually derived from the linear multistage model with 95% upper confidence limits. This provides a low-dose estimate of cancer risk to humans that is considered unlikely to pose a carcinogenic risk in excess of the stated values. Excess cancer risk estimates may also be calculated using the One-hit, Weibull, Logit or Probit models. There is no current understanding of the biological mechanisms involved in cancer to suggest that any one of these models is able to predict risk more accurately than another. Because each model is based on differing assumptions, the estimates that are derived can differ by several orders of magnitude.

This Health Advisory is based on information presented in the Office of Drinking Water's Health Effects Criteria Document (CD) for the Dichloroethylenes (U.S. EPA, 1984a). The HA and CD formats are similar for easy reference. Individuals desiring further information on the toxicological data base or rationale for risk characterization should consult the CD. The CD is available for review at each EPA Regional Office of Drinking Water counterpart (e.g., Water Supply Branch or Drinking Water Branch), or for a fee from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161, PB #86-117785/AS. The toll-free number is (800) 336-4700; in the Washington, D.C. area: (703) 487-4650.

II. GENERAL INFORMATION and PROPERTIES

CAS No. 156-60-5

Structural Formula



Synonyms

- 1,2-DCE; trans-1,2-DCE; 1,2-dichloroethene

Uses

- In a mixture with the cis-1,2- isomer, as captive intermediates in the production of other chlorinated solvents.

Properties (Irish, 1963; Windholz et al., 1976)

Chemical Formula	$C_2H_2Cl_2$
Molecular Weight	96.95
Physical State	clear, colorless liquid
Freezing Point	-49.4°C
Boiling Point	47°C
Melting Point	--
Density	--
Vapor Pressure	265 mm Hg (25°C)
Specific Gravity	1.27 (25°C)
Water Solubility	6300 ug/L (25°)
Log Octanol/Water Partition Coefficient	--
Taste Threshold (water)	Not available
Odor Threshold (water)	Not available
Odor Threshold (air)	1,100 ppm (Lehmann and Schmidt-Kehl, 1936)
1 mg/L	252 ppm (25°c and 760 Torr.)
1 ppm	3.97 mg/m^3 (25°c and 760 Torr.)

Occurrence

- The 1,2-dichloroethylenes are synthetic chemicals with no known natural sources (U.S. EPA, 1983).

- There is little information on the current production and use of the 1,2-dichloroethylenes. The production volume for 1,2-dichloroethylene (mixed isomers) was 1,000 lbs or less in 1978 (U.S. EPA, 1978).

- The major releases of the 1,2-dichloroethylenes are from the manufacturing plants in the Gulf Coast region of the U.S., where they used as captive intermediates. Releases are expected to be small. The 1,2-dichloroethylenes, particularly the cis- isomer, have been identified as degradation products of trichloroethylene and tetrachloroethylene in ground water (Parsons et al., 1984; Vogel and McCarty, 1985).

- There is little direct information on the fate of the 1,2-dichloroethylenes in the environment. However, the behavior of these compounds has been estimated based upon the information on similar chlorinated compounds (U.S. EPA, 1979). 1,2-Dichloroethylenes released to the atmosphere are expected to degrade chemically in a matter of hours; when released to surface waters, they are expected to volatilize rapidly to air. 1,2-Dichloroethylenes are chemically stable in water and mobile in soils. Once released to land, 1,2-dichloroethylenes are expected to migrate with ground water. 1,2-Dichloroethylenes have been shown to degrade biologically to vinyl chloride in some groundwaters. These compounds are not expected to bioaccumulate in plants or animals. Based upon their similar physical properties, the two isomers of 1,2-dichloroethylene are not expected to behave differently in the environment.

- Monitoring studies have found that the 1,2-dichloroethylenes occur as widespread, but relatively rare, contaminants of ground water. The cis- isomer has been reported to occur at higher levels than the trans- isomer. The majority of the 1,2-dichloroethylenes has been found to co-occur with trichloroethylene. Levels of the 1,2-dichloroethylenes are greater than 0.5 ug/L in approximately 1 % of all ground waters. Levels as high as 300 ug/L have been reported for the trans- isomer, while levels of 800 ug/L have been reported for the cis- isomer. The 1,2-dichloroethylenes occur in surface water at lower amounts. The 1,2-dichloroethylenes in air are in the ppt range except near production sites where they may reach the low ppb range. Based upon their volatility and limited use, levels of 1,2-dichloroethylenes in food are expected to be negligible (U.S. EPA, 1983).

- The major source of exposure to the 1,2-dichloroethylenes is from contaminated water except in the areas near production sites where air exposures may dominate.

III. PHARMACOKINETICS

Absorption

- trans-1,2-Dichloroethylene is a neutral, low molecular weight, lipid soluble material which should be readily absorbed by any route (oral, inhalation, dermal) at the levels expected to be encountered in contamination incidents (U.S. EPA, 1984a).

Distribution

- Kinetic data to define the tissue distribution of trans-1,2-dichloroethylene after oral exposure are not available. If this isomer follows the same absorption and distribution pattern as 1,1-dichloroethylene, the highest concentrations would be expected to be found in the liver and kidney (McKenna et al., 1978).

Metabolism

- The metabolic end products of chlorinated ethylenes are predominantly alcohols and carboxylic acids. In rat liver microsomal preparations, supplemented with NADPH, trans-1,2-dichloroethylene was transformed to 2,2-dichloroethanol and 2,2-dichloroacetic acid (Costa and Ivanetich, 1982). Presumably, these products were formed by reduction or oxidation of 2,2-dichloroacetaldehyde.

- The positions of the chlorine moieity on the chlorinated ethylenes appear to play an important role in metabolism. Trans-1,2-dichloroethylene (which possesses a relatively greater degree of asymmetry) was metabolized at a slower rate than cis-1,2-dichloroethylene in an in vitro hepatic microsomal system (Costa, 1983).

Excretion

- No data concerning the excretion of trans-1,2-dichloroethylene are available. If it is similar to 1,1-dichloroethylene, then the rate of elimination will be relatively rapid, with most of a single dose being excreted in the urine within 24 to 72 hours after cessation of exposure (Jaeger et al., 1977).

IV. HEALTH EFFECTS

Humans

- At high concentrations, the dichloroethylenes, like other chlorinated ethylenes, possess anesthetic properties (Irish, 1963). It appears that the trans- isomer is about twice as potent as the cis- isomer in depressing the central nervous system (Albrecht, 1927).

Animals

Short-term Exposure

- The oral LD_{50} in the 200 g rat was 1,300 mg/kg (Freundt et al., 1977). When administered intraperitoneally, the LD_{50} was six-fold higher (7,800 mg/kg).

- At high exposure (8,000 to 16,000 ppm) levels, trans-1,2-dichloroethylene can cause narcosis and death in rats in four hours (Torkelson and Rowe, 1981).

- No significant immunological effects were observed in male mice exposed by gavage to 22 or 220 mg/kg for 14 consecutive days (Munson et al., 1982). In addition, no changes in body or organ weights (liver, kidney, thymus and lung) were observed.

Long-term Exposure

- Freundt et al. (1977) exposed Wistar rats to air containing trans-1,2-dichloroethylene at 0, 200, 1,000 or 2,000 ppm (0 to 7,940 mg/m^3). Brief (8-hour) or prolonged (8 hours/day, 5 days/week for 1, 2, 8 or 16 weeks) exposure at 200 ppm produced slight degeneration of the liver lobule and lipid accumulation in the Kupffer cells. At 8 and 16 weeks of exposure, severe pneumonic infiltration was observed. Exposure at 1000 ppm for 8 hours resulted in significant reductions in serum albumin, urea nitrogen and alkaline phosphatase. Eight-hour exposures at both 200 and 1,000 ppm produced a significant decrease in the number of leucocytes.

Reproductive Effects

- No information was found in the available literature on the potential of trans-1,2-dichloroethylene to produce reproductive effects.

Developmental Effects

- No information was found in the available literature on the potential of trans-1,2-dichloroethylene to produce developmental effects.

Mutagenicity

- trans-1,2-Dichloroethylene at a medium concentration of 2.3 mM was not mutagenic, with or without microsomal activation, when assayed in *E. coli* K12 (Greim et al., 1975).

- trans-1,2-Dichloroethylene did not cause point mutation, mitotic gene conversion or mitotic recombination in a diploid strain of *Saccharomyces cerevisiae*, with or without microsomal activation (Galli et al. (1982a). They also reported that it had no genetic effects in an *in vivo* (intravenous host-mediated assay) mutagenicity study (Galli et al., 1982b).

Carcinogenicity

° No information was found in the available literature on the carcinogenic potential of trans-1,2-dichloroethylene.

V. QUANTIFICATION OF TOXICOLOGICAL EFFECTS

Health Advisories (HAs) are generally determined for One-day, Ten-day, Longer-term (approximately 7 years) and Lifetime exposures if adequate data are available that identify a sensitive noncarcinogenic end point of toxicity. The HAs for noncarcinogenic toxicants are derived using the following formula:

$$HA = \frac{(NOAEL \text{ or } LOAEL) \times (BW)}{(UF) \times (\_\_\_ L/day)} = \_\_\_ mg/L (\_\_\_ ug/L)$$

where:

NOAEL or LOAEL = No- or Lowest-Observed-Adverse-Effect-Level in mg/kg bw/day.

BW = assumed body weight of a child (10 kg) or an adult (70 kg).

UF = uncertainty factor (10, 100 or 1,000), in accordance with NAS/ODW guidelines.

___ L/day = assumed daily water consumption of a child (1 L/day) or an adult (2 L/day).

One-day Health Advisory

Freundt et al. (1977) reported the effects of trans-1,2-dichloroethylene after inhalation by mature female Wistar rats (180 to 200g) at 200 ppm (800 mg/m^3, the currently established TLV/MAC in many countries) or at 1000 or 3000 ppm (4000 or 12000 mg/m^3, respectively). A brief (8 hour) exposure at 200 ppm did not result in significant adverse effects on the liver. There was slight pulmonary capillary hyperemia and distention of the alveolar septum. This effect was, most likely, transitory in nature and would not occur after oral administration.

A number of biochemical and hematological parameters also were tested. No changes in serum cholesterol, albumin, uric acid, urea nitrogen, glucose, alkaline phosphatase, SGOT or SGPT were observed after the single 8-hour exposure at 200 ppm. Exposure at 1,000 ppm for 8 hours resulted in significant reductions in serum albumin, urea nitrogen and alkaline phosphatase. Eight-hour exposures at both 200 and 1,000 ppm caused a significant decrease in the number of leucocytes. Since leucocyte count may be affected by external stimuli [physical exertion, stress and food intake (Lentner, 1984)], the number of leucocytes in this study (2.5×10^3) appears to be lower than normal for rats [6 to 17 x $10^3/mm^3$ (Harkness and Agner, 1983)] and there is no dose response noted in the 200 and 1,000 ppm groups, it is difficult to evaluate

the reported decrease in leucocytes. Accordingly, this parameter will not be used in setting the NOAEL. Clinico-chemical parameters were not studied at the 3,000 ppm exposure level.

A NOAEL of 200 ppm over a single 8-hour exposure was identified for trans-1,2-dichloroethylene based upon the normal biochemical parameters and on the slight liver effects in only 1 of 6 rats.

The One-day Health Advisory for the 10-kg child is calculated as follows:

Step 1: Determination of the total absorbed dose (TAD)

$$TAD = \frac{200 \times 3.97\ (mg/m^3) \times 0.006\ (m^3/hr) \times 8}{(0.19\ kg)} = 200\ mg/kg$$

where:

200 x 3.97 (mg/m^3) = total absorbed dose converted from ppm to mg/m^3.

0.006 = conversion factor to obtain m^3/hr for 190 g rats, i.e., 100 ml/min x 60 min/hr divided by 1,000,000 (ml to m^3).

8 = duration of exposure in hours.

0.19 = average weight in kg of exposed rats.

Step 2: Determination of a One-day Health Advisory

$$\text{One-day HA} = \frac{(200\ mg/kg/day)\ (10\ kg)}{(100)\ (1\ L/day)} = 20.0\ mg/L\ (20{,}000\ ug/L)$$

where:

200 mg/kg/day = TAD.

10 kg = assumed body weight of a child.

100 = uncertainty factor, chosen in accordance with NAS/ODW guidelines for use with a NOAEL from an animal study.

1 L/day = assumed daily water consumption of a child.

Ten-day Health Advisory

Appropriate studies for the calculation of the Ten-day HA are not available. The Longer-term HA for a 10 kg child (1.43 mg/L) is recommended as a conservative estimate for a ten-day exposure.

Longer-term Health Advisory

Freundt et al. (1977) also studied the effects of administering trans-1,2-dichloroethylene at 200 ppm (8 hr/day for 5 days/week) for 16 weeks. They found slight to severe fatty infiltration in the parenchymal and Kupffer cells of the liver (5 of 6 rats) and severe pneumonic infiltration (3 of 6 rats).

Based on the liver and lung effects, a LOAEL of 200 ppm was identified for trans-1,2-dichloroethylene.

The Longer-term HA is calculated as follows:

Step 1: Determination of the total absorbed dose (TAD)

$$TAD = 200 \text{ mg/kg (see One-day HA)}$$

Step 2: Determination of a Longer-term HA for a 10-kg child

$$\text{Longer-term HA} = \frac{(200 \text{ mg/kg/day}) (5) (10 \text{ kg})}{(1{,}000) (7) (1 \text{ L/day})} = 1.43 \text{ mg/L } (1{,}430 \text{ ug/L})$$

where:

200 mg/kg/day = LOAEL for hepatic and pulmonary effects.

5/7 = correction factor for 5 day/week dosing regimen.

10 kg = assumed body weight of a child.

1,000 = uncertainty factor, chosen in accordance with NAS/ODW guidelines for use with a LOAEL from an animal study.

1 L/day = assumed daily water consumption of a child.

A Longer-term HA for a 70-kg adult is calculated as follows:

$$\text{Longer-term HA} = \frac{(200 \text{ mg/kg/day}) (5) (70 \text{ kg})}{(1{,}000) (7) (2 \text{ L/day})} = 5 \text{ mg/L } (5{,}000 \text{ ug/L})$$

where:

200 mg/kg/day = LOAEL for hepatic and pulmonary effects.

5/7 = correction factor for 5 day/week dosing regimen.

70 kg = assumed body weight of an adult.

1,000 = uncertainty factor, chosen in accordance with NAS/ODW guidelines for use with a LOAEL from an animal study.

2 L/day = assumed daily water consumption of an adult.

Lifetime Health Advisory

The Lifetime HA represents that portion of an individual's total exposure that is attributed to drinking water and is considered protective of noncarcinogenic adverse health effects over a lifetime exposure. The Lifetime HA is derived in a three step process. Step 1 determines the Reference Dose (RfD), formerly called the Acceptable Daily Intake (ADI). The RfD is an estimate of a daily exposure to the human population that is likely to be without appreciable risk of deleterious effects over a lifetime, and is derived from the NOAEL (or LOAEL), identified from a chronic (or subchronic) study, divided by an uncertainty factor(s). From the RfD, a Drinking Water Equivalent Level (DWEL) can be determined (Step 2). A DWEL is a medium-specific (i.e., drinking water) lifetime exposure level, assuming 100% exposure from that medium, at which adverse, noncarcinogenic health effects would not be expected to occur. The DWEL is derived from the multiplication of the RfD by the assumed body weight of an adult and divided by the assumed daily water consumption of an adult. The Lifetime HA is determined in Step 3 by factoring in other sources of exposure, the relative source contribution (RSC). The RSC from drinking water is based on actual exposure data or, if data are not available, a value of 20% is assumed for synthetic organic chemicals and a value of 10% is assumed for inorganic chemicals. If the contaminant is classified as a Group A or B carcinogen, according to the Agency's classification scheme of carcinogenic potential (U.S. EPA, 1986), then caution should be exercised in assessing the risks associated with lifetime exposure to this chemical.

Lifetime toxicity data for trans-1,2-dichloroethylene do not exist at this time. Data from the chronic drinking water study in rats as used for the Lifetime Health Advisory for 1,1-dichloroethylene will be used instead. The same caveats and assumptions as were described above for the Longer-term HA also apply here.

The Lifetime HA is calculated from a 2-year chronic study in rats (Quast et al., 1983). 1,1-Dichloroethylene, at concentrations of 0, 50, 100 or 200 ppm (0 to 20 mg/kg/day) in drinking water, was administered to animals of both sexes. No consistent treatment-related changes were observed in any parameter measured. The only histopathology observed was in the livers of both sexes receiving the highest dose, changes characterized by a minimal amount of mid-zonal fatty change. No liver degeneration was noted. A LOAEL of 100 ppm (10 mg/kg) was identified, based upon a trend towards increased fatty deposition in the liver.

A Drinking Water Equivalent Level (DWEL) and Lifetime HA for the 70-kg adult are calculated as follows:

Step 1: Determination of the Reference Dose (RfD)

$$RfD = \frac{(10 \text{ mg/kg/day})}{(1{,}000)} = 0.01 \text{ mg/kg/day}$$

where:

10 mg/kg/day = LOAEL.

1,000 = uncertainty factor, chosen in accordance with NAS/ODW guidelines for use with a LOAEL from an animal study.

Step 2: Determination of the Drinking Water Equivalent Level (DWEL)

$$DWEL = \frac{(0.01\ mg/kg/day)\ (70\ kg)}{(2\ L/day)} = 0.35\ mg/L\ (350\ ug/L)$$

where:

0.01 mg/kg/day = RfD.

70 kg = assumed body weight of an adult.

2 L/day = assumed daily water consumption of an adult.

Step 3: Determination of the Lifetime Health Advisory

Lifetime HA = (0.035 mg/L) (20%) = 0.07 mg/L (70 ug/L)

where:

0.35 mg/L = DWEL.

20% = assumed relative source contribution from water.

Evaluation of Carcinogenic Potential

- There are no data available which describe the carcinogenic potential of trans-1,2-dichloroethylene.
- Applying the criteria described in EPA's guidelines for assessment of carcinogenic risk (U.S. EPA, 1986), trans-1,2-dichloroethylene is classified in Group D: Not classified. This category is for agents with inadequate animal evidence of carcinogenicity.

VI. OTHER CRITERIA, GUIDANCE AND STANDARDS

- The Threshold Limit Value (TLV) in the occupational setting for the 1,2-dichloroethylene isomer mixture is 200 ppm (790 mg/m^3) (ACGIH, 1982).

VII. ANALYTICAL METHODS

- Analysis of trans-1,2-dichloroethylene is by a purge-and-trap gas chromatographic procedure used for the determination of volatile organohalides in drinking water (U.S. EPA, 1984b). This method calls for the bubbling of an inert gas through the sample and trapping of 1,2-dichloroethylenes on an adsorbant material. The adsorbant material is heated to drive off the 1,2-dichloroethylene onto a gas chromatographic column. This method will differentiate between the two isomers of 1,2-dichloroethylene. This method is applicable to the measurement of 1,2dichloroethylene over a concentration range of 0.03 to 1500 ug/L. Confirmatory analysis for 1,2-dichloroethylene is done by mass spectrometry (U.S. EPA, 1985a). The detection limit for confirmation by mass spectometry is 0.2 ug/L.

VIII. TREATMENT TECHNOLOGIES

- Very few data are available concerning the removal of trans-1,2-dichloroethylene from drinking water. However, the available data suggest that both granular activated carbon (GAC) adsorption and aeration will be somewhat effective in reducing the levels of this chemical in water.

- Dobbs and Cohen (1980) developed adsorption isotherms for trans-1,2-dichloroethylene. It was reported that Filtrasorb® 300 carbon exhibited adsorptive capacities of 0.95 mg, 0.29 mg and 0.09 mg trans-1,2-dichloroethylene/gm carbon at equilibrium concentrations of 100, 10 and 0.1 ug/L, respectively. No field data are available on the adsorption of trans-1,2-dichloroethylene from contaminated water.

- Theoretical considerations indicate that trans-1,2-dichloroethylene is amenable to treatment by aeration on the basis of its Henry's Law Constant of 225 atm (U.S. EPA 1985b,c). In a laboratory study, distilled water containing 217 ug/L of trans-1,2-dichloroethylene was passed through a diffused-air aeration column. A 97% reduction of the compound was reported in a countercurrent operation at an air-to-water ratio of 15:1 (U.S. EPA, 1985b,c).

- Air stripping is an effective, simple and relatively inexpensive process for removing trans-1,2-dichloroethylene and other volatile organics from water. However, the use of this process then transfers the contaminant directly into the air stream. When considering use of air stripping as a treatment process, it is suggested that careful consideration be given to the overall environmental occurrence, fate, route of exposure and various hazards associated with the chemical.

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