Vinyl Chloride

What is vinyl chloride?

Vinyl chloride is a colorless gas with a mild, sweet odor. It is a man-made chemical that does not occur naturally in the environment. Most of the vinyl chloride produced in the United States is used to make polyvinyl chloride (PVC). This material is used to manufacture a variety of plastic and vinyl products including pipes, wire and cable coatings, packaging materials, furniture and automobile upholstery, wall coverings, housewares, and automotive parts. Much smaller amounts of vinyl chloride are used as a cooling gas and in the manufacture of other compounds.

How might I be exposed to vinyl chloride?

Humans are exposed to vinyl chloride from environmental and occupational sources. Vinyl chloride has been found in at least 133 of 1177 hazardous waste sites on the National Priorities List (NPL). Vinyl chloride is mainly released into the air and discharged in wastewater from the plastics industries (primarily vinyl chloride and PVC manufacturers). Most of the vinyl chloride that enters the environment eventually ends up in air where it gradually breaks down into less harmful substances. The levels of vinyl chloride found in the environment are usually more than a thousand times lower than levels found in occupational settings. Outdoor levels in the environment are usually expressed in terms of parts of vinyl chloride present in a billion parts of air or water (ppb). Outdoor levels of vinyl chloride result from the discharge of exhaust gases from factories that manufacture or process vinyl chloride, or evaporation from areas where chemical wastes are stored. Highest outdoor levels have been measured in air near vinyl chloride factories or over chemical waste storage areas. Tests published in 1976 suggest that the air inside new cars may contain levels of vinyl chloride higher than expected for that location, because vinyl chloride may seep into the air from the new plastic parts. Levels of vinyl chloride are expected to drop rapidly, however, when doors or windows are opened or when the heater or air conditioner is operated.

Vinyl chloride that enters drinking water comes from factories that release wastes containing it into rivers and lakes and from its seepage into underground water in areas where chemical wastes containing it are stored.
Small amounts of vinyl chloride can enter the drinking water from contact with polyvinyl chloride pipes. In the past, higher than expected amounts were present in foods packaged in plastic that contained vinyl chloride. Currently, the U.S. Food and Drug Administration (FDA) limits the amount of vinyl chloride allowed in packaging materials that contact food in order to limit the intake of vinyl chloride.

Vinyl chloride manufacturing or processing factories may have indoor levels of vinyl chloride that are much higher than those from outdoor sources. Levels expressed in terms of parts of vinyl chloride per million parts of air (ppm) have been measured in vinyl chloride manufacturing plants.

How does vinyl chloride get into my body?

The most likely way that vinyl chloride can enter your body is if you breathe air containing it. This path of exposure is of concern for persons employed in vinyl chloride manufacturing or processing, for people living in communities where vinyl chloride plants are located, and for individuals living near hazardous waste disposal sites. Vinyl chloride can also enter your body if you eat food or drink water containing it. Passage of vinyl chloride through the skin is not likely to be an important pathway.

How can vinyl chloride affect my health?

Short-term exposures to very high levels of vinyl chloride in air can cause dizziness, stumbling and lack of muscle coordination, headache, unconsciousness, and death. Long-term exposure to lower but unmeasured amounts in factories where vinyl chloride is made or processed has caused "vinyl chloride disease." This disease is characterized by severe damage to the liver, effects on the lungs, poor circulation in the fingers, changes in the bones at the end of the fingers, thickening of the skin, and changes in the blood.

An increased risk of developing cancer of the liver and possibly several other tissues has been linked with breathing air in factories containing vinyl chloride. The U.S. Department of Health and Human Services has determined that vinyl chloride is a known carcinogen.

Studies designed to determine if the low levels of vinyl chloride measured in outside air, drinking water, or food could cause harmful effects in humans have not been performed.

Some of the health effects observed in humans have also been seen in laboratory animals. Effects on the nervous system of animals have occurred after short-term exposure to very high levels of vinyl chloride in air.
Effects on the liver developed in animals after short-term exposure to high levels and after longer-term exposure to lower levels of vinyl chloride. Kidney effects also occurred after exposure to high levels. Laboratory animals developed cancer in several tissues after eating food or breathing air that contained vinyl chloride. Effects on the testes were seen in male rats that breathed air containing vinyl chloride, but information is not sufficient to determine whether humans exposed to vinyl chloride develop effects on the testes.

Is there a medical test to determine if I have been exposed to vinyl chloride?

Vinyl chloride can be measured in urine and body tissues, but the tests cannot be used to determine what levels of vinyl chloride you were exposed to. Measuring the amount of the major breakdown product of vinyl chloride in the urine may give some indication of recent exposure; however, people differ in the quantity of excretion of this breakdown product. Neither of these tests is routinely available at your doctor's office. The laboratory tests commonly used by doctors to evaluate liver damage and liver function are usually not helpful for determining if liver damage from vinyl chloride exposure has occurred.

What levels of exposure have resulted in harmful health effects?

The graphs on the following pages show the link between exposure to vinyl chloride and known health effects. In the first set of graphs labeled "Health effects from breathing vinyl chloride" (Fig. 1.1), exposure is expressed in parts of vinyl chloride per million parts of air (ppm). In the second set of graphs, the same relationship is shown for the known "Health effects from ingesting vinyl chloride" (Fig. 1.2). Exposures are expressed in milligrams of vinyl chloride per kilogram of body weight per day (mg/kg/day). In both graphs, effects in animals are shown on the left, effects in humans on the right.

The first column, labeled "Short-term exposure," refers to effects associated with exposure durations of 14 days or less. The column labeled "Long-term exposure" refers to exposures lasting longer than 14 days. The levels marked on the graphs as "Minimal risk for effects other than cancer" are estimates based on information obtained from laboratory animals and, therefore, are subject to the uncertainties involved in using animal data to predict effects in humans.

Vinyl chloride is regarded worldwide as a chemical that causes cancer in humans, but exposure levels necessary to cause cancer in humans are not known. The Environmental Protection Agency (EPA), therefore, used available data in animals to estimate that breathing air containing 1 ppm
Vinyl chloride every day for 70 years may place as many as 1100 persons in a population of 10,000 (or 1,100,000 persons in a population of 10,000,000) at risk of developing cancer. Eating food containing 1 ppm vinyl chloride every day for 70 years may place as many as 644 persons in a population of 10,000 (or 644,000 persons in a population of 10,000,000) at risk of developing cancer. Similarly, drinking water containing 1 ppm vinyl chloride every day for 70 years may place as many as 657 persons in a population of 10,000 (or 657,000 persons in a population of 10,000,000) at risk of developing cancer. It should be noted that these risk values are plausible upper-limit estimates based on information obtained from animal studies. Actual risk levels are unlikely to be higher and may be lower.

**What recommendations has the federal government made to protect human health?**

EPA stated that community drinking water systems that regularly serve the same 25 persons for at least 8 months of the year must limit vinyl chloride in the drinking water to 2 μg/L (2 ppb), starting January 9, 1989. In order to limit intake of vinyl chloride in food to levels considered to be safe, the Food and Drug Administration (FDA) recently changed its regulations regarding the vinyl chloride content of various plastics that contact food and carry water used in food processing, and of plastics that are used in food packaging. Limits range from 5 to 50 ppm, depending on the nature of the plastic and its use.

In order to control the handling of vinyl chloride, EPA has named the chemical as a hazardous component of solid waste. If quantities greater than 1 pound are released to the environment, the National Response Center of the Federal Government must be notified immediately.

The Occupational Safety and Health Administration (OSHA) regulations state that a worker must not be exposed to a concentration of vinyl chloride in air that exceeds 1 ppm over any 8-hour work period in a 40-hour workweek and that the concentration must not exceed 5 ppm for more than 15 minutes. The National Institute for Occupational Safety and Health (NIOSH) recommends that workers exposed to any measurable amount of vinyl chloride wear an air-supplied respirator. EPA has determined that factories must limit the release of vinyl chloride in air to 10 ppm.
Where can I get more information?

If you have more questions or concerns, please contact your state health or environmental department or:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road, E-29
Atlanta, Georgia 30333
Fig. 1.1. Health effects from breathing vinyl chloride.
<table>
<thead>
<tr>
<th>SHORT-TERM EXPOSURE (LESS THAN OR EQUAL TO 14 DAYS)</th>
<th></th>
<th>LONG-TERM EXPOSURE (GREATER THAN 14 DAYS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EFFECTS IN ANIMALS</td>
<td>DOSE (mg/kg/day)</td>
<td>EFFECTS IN ANIMALS</td>
</tr>
<tr>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>DEATH</td>
<td>QUANTITATIVE DATA WERE NOT AVAILABLE</td>
<td>EFFECTS ON BLOOD</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
<td>DECREASED LIFE SPAN AND LIVER EFFECTS</td>
</tr>
<tr>
<td>1.0</td>
<td>1.0</td>
<td>MINIMAL RISK LEVEL FOR EFFECTS OTHER THAN CANCER</td>
</tr>
<tr>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1.2. Health effects from ingesting vinyl chloride.