ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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Ethylene Glycol and Propylene Glycol: Health Information Summary

Ethylene glycol is a colorless and odorless liquid used in antifreeze for cooling and heating systems. It has also been used in making plastic bottles and films, in de-icing fluids for aircraft, in the production of polyester fibers, in industrial processes to prevent drying, and in formulations of paint, ink, and brake fluid. Because of its sweet taste, it may be attractive to some animals. Unlike ethylene glycol, propylene glycol has no taste.

Propylene glycol is also used to make polyester materials and in de-icing fluids. It is a "generally recognized as safe" (GRAS) listed compound used in the food processing industry as an additive to keep foods from drying out and as a solvent for food colors and flavors. Liquid propylene glycol can be mechanically turned into a mist to produce artificial smoke used for fire training and in entertainment productions.

Releases of ethylene glycol to the environment are widespread, with the major source being the disposal of used antifreeze and de-icing solutions and, secondarily, by industry during its production. Releases of ethylene glycol to land have resulted in contamination of groundwater since ethylene glycol easily leaches through the soil. Ethylene glycol does not persist in the environment because it is degraded in all media. The estimated time in groundwater for its concentration to be reduced by one-half ranges from two to 48 days depending on the oxygen level of the water.

Health Effects

Although the physical properties of the two compounds are very similar, propylene glycol is considerably less toxic than ethylene glycol, as information presented in this section indicates.

Absorption/Metabolism

Ethylene glycol is rapidly absorbed after ingestion. In a rat study, absorption after ingestion was in the 90-100 percent range. There is no absorption data concerning inhalation exposure of ethylene glycol. Dermal exposure results in some absorption. An average dermal absorption of about 25 percent was estimated from a study with human skin. Little information is available on the absorption of propylene glycol. Ethylene glycol does not build up in the body. Studies indicate that it can no longer be detected in the body two days after an exposure. Information on the metabolism of propylene glycol suggests that it is eliminated about as quickly as ethylene glycol.

Short-term (acute) Effects

Accidental or intentional ingestion of a sufficient quantity of ethylene glycol can cause death. Fatal amounts have ranged from 150-1,500 milliliters, approximately 5-50 fluid ounces. No information on the amount of propylene glycol that is lethal to humans exists. As a comparison of acute toxicity in animals, the dose of ethylene glycol that was lethal to 50 percent of rats ranged from 4,000-9,000 parts per million (ppm) of body weight compared to 8,000-46,000 ppm in rats given propylene glycol.

Human ingestion of ethylene glycol at a dose estimated at 1,000 milligrams per kilogram of body weight (mg/kg) results in central nervous system and behavioral effects that include numbness, visual disturbances, light-headedness, headache and lethargy. At doses of 3,000 mg/kg, symptoms including ataxia (a drunken gait), drowsiness, slurred speech and a changing mental status alternating between stupor and agitation become apparent. At higher doses, which may be fatal, effects seen were coma, delirium, convulsive seizures and loss of reflexes.

The most prominent toxic effects of ethylene glycol exposure are the formation of calcium oxalate crystals in the body that can have serious consequences if they form in the kidneys, brain, or lungs and metabolic acidosis, an upset of the acid-base balance in the body, caused by the breakdown of ethylene glycol into several acidic byproducts. Propylene glycol can cause metabolic acidosis but it takes higher concentrations than ethylene glycol to produce this effect. Propylene glycol is also less acutely toxic than ethylene glycol because the acidosis that it causes does not result in the formation of calcium oxalate crystals.

A group of human volunteers were exposed to 7-19 ppm ethylene glycol by inhalation 20-22 hours per day for four weeks. Effects included slight headache and backache. No effects were found on blood or kidney parameters, nor were any effects detected on the immune system or in the results of psychological tests conducted.

Human volunteers exposed to high levels of propylene glycol mist for a short time had increased levels of eye and throat irritation, and cough.

Long-term (chronic) Effects

Rats exposed orally to a high concentration of ethylene glycol had blood effects such as reduced red blood cells and hemoglobin, the protein that carries oxygen. High levels of propylene glycol caused similar effects in dogs. In another study, high concentrations of propylene glycol fed to rats resulted in changes in their blood indicating that red blood cells were being destroyed.

Ethylene glycol has caused kidney damage in animals after long-term exposure, but only at fairly high concentrations of at least 1,000 mg/kg/day. It is not likely that humans would be exposed to such a high amount from levels typically found in the environment.

Carcinogenic (cancer producing) Effects

Because neither ethylene glycol nor propylene glycol has undergone a comprehensive evaluation of its carcinogenic potential, they would both be classified as Group D carcinogens, "inadequate evidence to classify," under the old U.S. Environmental Protection Agency (EPA) cancer guidelines and "inadequate information to assess carcinogenic potential" under the new guidelines. However, in three rodent studies with long-term oral exposure to ethylene glycol, no carcinogenic effects were detected. Additionally, there is no evidence from occupational

exposures that ethylene glycol is carcinogenic to humans. The one animal study conducted to examine propylene glycol's carcinogenic potential did not find an increase in cancer.

Reproductive/Developmental Effects

The results of several animal studies indicate that high oral exposures to ethylene glycol can cause effects such as reduced numbers of offspring per litter and reduced survival. Developmental effects were also observed such as skeletal malformations, missing ribs, and abnormal development of the spinal cord and/or brain. Ethylene glycol exposures of 500 mg/kg/day were the lowest at which developmental effects were seen. In general, studies designed to investigate propylene glycol's affect on development and reproduction did not find any adverse effects.

Health Standards and Criteria

The state drinking water guideline for ethylene glycol is 7,000 micrograms per liter (ug/l = ppb) while the EPA Lifetime Health Advisory (LHA) for it is 14,000 ppb. The LHA is based on kidney toxicity that was observed at some ethylene glycol exposure concentrations in a rodent study.

There is no federal or state drinking water guideline for propylene glycol, and EPA has no approved oral or inhalation toxicity values for it. However, DES has determined that 30,000 ppb is an appropriate interim drinking water guideline for propylene glycol based on current toxicity information and that there is also dietary exposure because of its use as a food additive.

Suggested Reading and References

Casarett and Doull's Toxicology: The Basic Science of Poisons, Sixth Edition. Klaassen, C.D., ed. McGraw-Hill Publishing Co., Inc., New York, N.Y. 2001.

Toxicological Profile for Ethylene Glycol and Propylene Glycol. Agency for Toxic Substances and Disease Registry (ATSDR). Atlanta, Ga. September, 1997.

Toxicological information on ethylene glycol Integrated Risk Information System (IRIS). U.S. EPA, Office of Health and Environmental Assessment. Last significant revision: September, 1989.

Health Advisory for Ethylene Glycol. U.S. EPA. Office of Drinking Water. Washington, D.C., March, 1987.

Toxicological information on propylene glycol. Compiled on the Hazardous Substance Data Bank (HSDB). National Library of Medicine. Bethesda, Md. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB