ENVIRONMENTAL Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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# Gasoline Oxygenate Additives: Health Information Summary

There are several oxygen containing chemicals that may be added to gasoline to reduce air pollutant emissions and act as octane boosters. The additive most commonly used in New Hampshire, until recently, has been methyl tertiary butyl ether (MTBE). Other gasoline oxygenates include the ethers: diisopropyl ether (DIPE), ethyl tertiary butyl ether (ETBE), tertiary amyl methyl ether (TAME), and the alcohols: ethanol and tertiary butyl alcohol (TBA). Health information specific to MTBE is found in DES fact sheet ARD-EHP-2.

As of January 1, 2007, MTBE, the other ether additives, and TBA were banned from gasoline sold in New Hampshire when their level exceeds 0.5 percent, equivalent to 5,000 parts per million (ppm). A complete absence of banned additives from gasoline is not practical because different gasoline products may be transported in the same vehicles or through the same pipelines, with the potential for low-level cross contamination by the additives. Although most states in the Northeast have banned MTBE in gasoline, only New Hampshire, Rhode Island and Vermont have also prohibited the other ethers and TBA.

Ethanol is now the oxygenate additive of choice because it breaks down more readily in the environment and is also considered to be, in general, less toxic to humans than the other oxygenates.

DES has determined that all of the now banned oxygenates were present in some of the reformulated gasoline sold in NH prior to the ban because they have been detected in State groundwater and drinking water wells. Because TBA is also an environmental breakdown product of MTBE under certain conditions, it may be found where MTBE releases have occurred.

Besides its use as a fuel additive, TBA is a component of paint removers, industrial cleaning compounds, and is used as an intermediate for producing other chemicals. DIPE is used as a solvent for waxes, oils, paints, and rubber cement.

Because the oxygenates do not adsorb to soil strongly and are fairly water soluble, releases to soil will tend to leach to groundwater. Ethanol is the most water soluble of the oxygenates.

## Health Effects

### Absorption/Metabolism

Other than for ethanol, there is no experimental data on absorption of these oxygenates into the body. Ethanol is completely absorbed orally and about 60 percent of it is absorbed through breathing. Using MTBE as a surrogate for the other oxygenates based on their similarity in structure, DES assumes approximately 100 percent oral absorption, 50 percent inhalation absorption, and significantly less absorption through the skin for the other oxygenates. Ethanol is eliminated from the body down to background levels in a matter of a few hours. Although breakdown products of metabolism in the body

are not exactly the same for all of the other oxygenate compounds, the pathways are similar enough to MTBE such that it is likely that almost all of the parent compounds and any breakdown products are eliminated from the body within a few days after exposure.

**Short-Term (acute) Effects**

There is ample evidence that ethanol is a central nervous system (CNS) depressant. CNS depression is also an effect that has been seen with each of the other oxygenates after exposure to very high concentrations in animal studies and in one occupational study with DIPE. Symptoms may include headache, dizziness, and drowsiness. Humans exposed by inhalation to high concentrations of TBA have reported eye, nose, throat, and skin irritation. Occupational exposures to ethanol vapors have also caused eye and respiratory tract irritation, sleepiness, and headache.

**Long-Term (chronic) Effects**

Animals exposed to DIPE by inhalation had increased liver and kidney weights, and at higher exposures, mild toxic changes were observed in these organs. Animals exposed to ETBE by inhalation had increased liver and kidney weights and toxic effects to the testicles and bone marrow. In studies with animals exposed to TBA in drinking water, effects seen include increased kidney weight and kidney toxicity, bladder inflammation, and thyroid lesions. Animals exposed orally to TAME had increased kidney and adrenal gland weights. Ethanol in excess increases the risk of liver damage, including hepatitis and cirrhosis, nervous system damage, changes in heart rhythm, and a reduction in the number of blood cells of all types.

**Carcinogenic (cancer producing) Effects**

Because only a few long-term studies on oxygenates have been conducted, other than for ethanol, there is no conclusive evidence for their potential to cause cancer in humans. TBA exposure resulted in increased kidney tumors in rats and thyroid tumors in mice. In one animal study, TAME exposure did not increase tumors. There are no studies investigating the carcinogenic potential of ETBE or DIPE. Because one of the major breakdown products of ETBE in the body is TBA, it may have the potential to induce cancer. None of these oxygenates has been evaluated by the U.S. Environmental Protection Agency (EPA) in order to classify them according to their potential to cause cancer in humans.

Population studies have linked alcohol ingestion to increased levels of some types of cancer including cancers of the mouth, larynx, esophagus, as well as the liver. Some researchers believe that ethanol may act as a cancer promoter, meaning that it increases the strength of cancer causing substances to which one is exposed.

**Reproductive/Developmental Effects**

Offspring of pregnant rats exposed to a high level of DIPE by inhalation had an increase in minor birth defects. A few animal studies were conducted to investigate TAME’s potential for causing reproductive or developmental effects. Inhalation exposures resulted in decreased sperm count, increased percentage of abnormal sperm, a reduction in the weight of offspring, and delays in offspring reaching maturity.

Excess alcohol consumption during pregnancy can result in a child born with fetal alcohol syndrome, a condition that includes physical and mental disabilities. Studies in both humans and animals link relatively low ethanol exposures during pregnancy to CNS effects, resulting in learning disabilities in offspring.

## Health Standards and Criteria

Other than for MTBE, there are no federal health based standards or guidelines for oxygenates in drinking water. EPA is currently reviewing the health information available on each of the other five additives to develop toxicity standards for inclusion on their Integrated Risk Information System (IRIS) database.

Using the currently available toxicological data on their potential health effects, DES has developed state drinking water standards for four of the additives as follows:

| Oxygenate | Standard (ug/l = ppb)* |
|---|---|
| DIPE | 120 |
| ETBE | 40 |
| TAME | 140 |
| TBA | 40 |

*micrograms per liter of water = parts per billion

The drinking water standards developed for ETBE, TAME, and TBA include an added 10-fold reduction to allow for their suspected cancer potential.

There are no health based standards or guidelines for ethanol in drinking water. Because of the fermentation of sugars, many foods and beverages contain modest amounts of ethanol. The Food and Drug Administration (FDA) does not require labeling foods as containing ethanol if the percentage in the product is less than 0.5 percent, equivalent to 5,000 milligrams (mg) of ethanol per kilogram of food. A typical 12 ounce bottle of beer contains approximately 13,000 mg of ethanol.

In a 2001 report investigating the impacts of replacing MTBE in gasoline with ethanol in the northeast states, a concentration of 400 ug/l of ethanol in drinking water was derived as an exposure likely to be without adverse health effects. Although developed as part of a broader comparison of ethanol to MTBE in gasoline and not intended as a drinking water guideline, standard risk assessment procedures were used to derive this comparison value. Using a comparison approach based on estimated current exposure to levels of ethanol typically found in food and non-alcoholic beverages, the State of California derived a draft health protective concentration of ethanol in water at 1,100 mg/l, equal to a 0.11 percent concentration. As a comparison to the two ethanol drinking water values presented, consuming one beer daily is equivalent to an adult ingesting drinking water containing 6,500 mg/l of ethanol.

There are Occupational Safety and Health Administration (OSHA) enforceable standards (permissible exposure limits or PELs) for DIPE, TBA, and ethanol in workplace air of 500, 100, and 1,000 ppm, respectively, averaged over an eight hour exposure. There are nonenforceable occupational guidelines of 5 ppm for ETBE and 20 ppm for TAME.

For more information, please contact the DES Environmental Health Program, 29 Hazen Drive, Concord, NH 03302-0095; (603) 271-4608.

## 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, 2001.

Health, Environmental, and Economic Impacts of Adding Ethanol to Gasoline in the Northeast States. New England Interstate Water Pollution Control Commission (NEIWPCC) and Northeast States for Coordinated Air Use Management (NESCAUM). July, 2001. At: www.nescaum.org.

Potential Health Risks of Adding Ethanol to Gasoline. Cal EPA, OEHHA. December, 1999. At: www.oehha.ca.gov/air/etoh/ETOHfin2.html.

Hazardous Substances Data Bank (HSDB) information for DIPE and TBA. TOXNET. The National Library of Medicine. National Institutes for Health. Web address: http://toxnet.nlm.nih.gov.

Technical Support Document: Derivation of Proposed Guideline Concentration for Diisoproply Ether (DIPE) in Drinking Water. NH Dept. of Health and Human Services, Bureau of Environmental and Occupational Health. January, 2003.

Technical Support Document: Derivation of Proposed Guideline Concentration for Ethyl Tertiary Butyl Ether (ETBE) in Drinking Water. NH Dept. of Health and Human Services, Bureau of Environmental and Occupational Health. January, 2003.

Technical Support Document: Derivation of Proposed Drinking Water Guideline Tertiary Methyl Amyl Ether (TAME). NH Dept. of Environmental Services, Bureau of Environmental and Occupational Health. August, 2004.

Technical Support Document: Derivation of Drinking Water Criterion for tert-Butyl Alcohol (TBA). NH Dept. of Health and Human Services, Bureau of Environmental and Occupational Health. January, 2004.