USGS
science for a changing world

Photograph courtesy of Gregory Delzer.

National Survey of MTBE and Other VOCs in Community Drinking-Water Sources

—Rick Clawges, Barbara Rowe, and John Zogorski

Abstract

Methyl tert-butyl ether (MTBE) is a volatile organic compound (VOC) that is added to gasoline either seasonally or year round in many parts of the United States to increase the octane level and to reduce carbon monoxide and ozone levels in the air. The chemical properties and widespread use of MTBE can result in contamination of private and public drinking-water sources. MTBE contamination is a concern in drinking water because of the compound's low taste and odor threshold and potential human-health effects.

Because of this concern, a survey was initiated in collaboration with researchers and water suppliers. The purpose of this survey is to provide sound, unbiased, scientific information on the occurrence of MTBE and other VOCs in ground water, reservoirs, and rivers that are sources of drinking water used by communities of various sizes throughout the Nation. This fact sheet presents a general description of the survey.

Introduction

Compounds that contain oxygen, called oxygenates, have been added to gasoline in the United States since the late 1970's to increase gasoline's octane level. This practice began with the phase-out of lead from gasoline. The use of oxygenates was expanded by the Clean Air Act Amendments of 1990, which mandated that oxygen be added to gasoline in areas where concentrations of ozone in the summer or carbon monoxide in the winter exceed established air-quality standards.

The Clean Air Act Amendments do not specify the particular oxygenate that must be added to gasoline, and several compounds have been used. The most commonly used fuel oxygenate is MTBE. The second most commonly used oxygenate is ethanol. MTBE is widely used because of its low cost, ease of production, and favorable transfer and blending characteristics. Production of MTBE has increased dramatically over time (fig. 1). In the United States, almost all MTBE is used in gasoline.

The U.S. Environmental Protection Agency (USEPA) has tentatively classified MTBE as a possible human carcinogen, but no drinking-water standard has been established for MTBE (U.S. Environmental Protection Agency, 1997). The USEPA, however, has issued a taste and odor drinking-water advisory of 20 to 40 µg/L (micrograms per liter). The USEPA also has required that monitoring for MTBE be completed by selected Community Water Systems (CWSs) under the Unregulated Contaminant Monitoring Rule.

The large-scale use of MTBE and its high solubility, low soil adsorption, and low biodegradability, has resulted in its detection in ground water and surface water. Routine monitoring of ambient water quality by the USGS's National Water-Quality Assessment Program between 1993 and 1998 documented the frequent occurrence of MTBE at low levels, especially in shallow urban ground water. This finding, in part, led to other assessments of MTBE and its environmental impacts. In 1997, the Office of Science and Technology Policy,

Photograph courtesy of Barbara Rowe.

In many areas of the U.S. where air quality is poor, fuel oxygenates are added to gasoline. The most commonly used fuel oxygenate is methyl *tert*-butyl ether (MTBE).

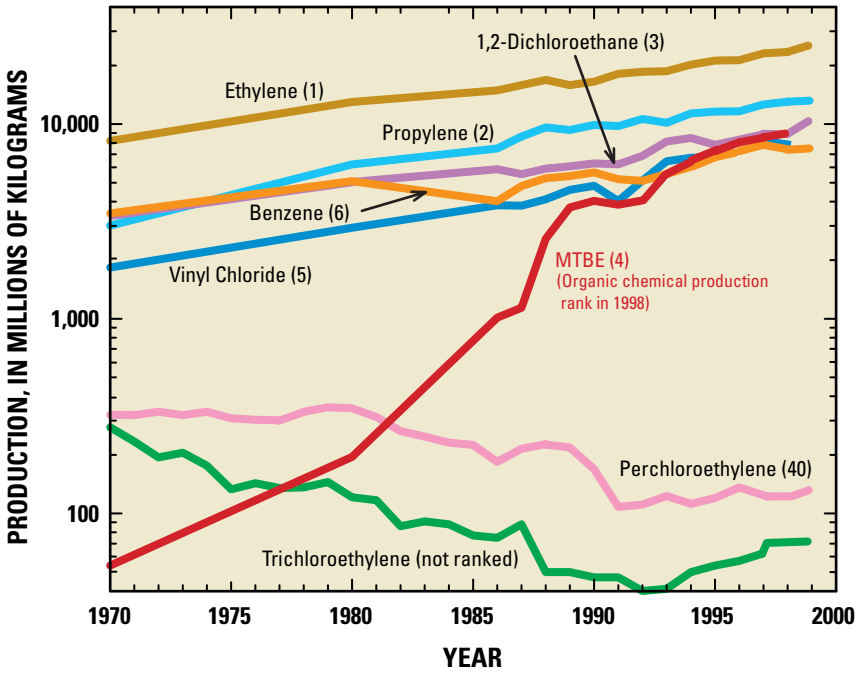

Figure 1. Organic chemical production in the United States, 1970-1999. Note the rapid growth in the production of MTBE during this time period. In 1998, MTBE was the fourth largest high-volume organic chemical (after Johnson and others, 2000).

Executive Office of the President, released an interagency assessment of the scientific basis for, and efficacy of, the winter oxygenated gasoline program (Office of Science and Technology Policy, 1997). Shortly thereafter in 1998, the MTBE Blue Ribbon Panel was created by a Charter from the Clean Air Act Advisory Committee to provide independent advice and counsel to the USEPA related to the use of MTBE and other oxygenates in gasoline. The Panel produced a final report (Blue Ribbon Panel, 1999), which provided numerous findings and recommendations concerning the use of MTBE and other oxygenates in gasoline.

Studies by numerous researchers, as well as many State and local environmental agencies, have discovered high levels of MTBE in soils and ground water at leaking underground gasoline-storage-tank sites and frequent occurrence of low to intermediate levels of MTBE in reservoirs used for both public water supply and recreational boating.

In response to these cumulative findings, the American Water Works Association Research Foundation (AWWARF), which represents many CWSs in the Nation, initiated a survey to better understand the extent of MTBE contamination in source waters used by communities in the United States. Before that survey was initiated in 1998, few CWSs had monitored for MTBE, other gasoline oxygenates, and their by-products in source waters.

The researchers participating in this survey have capabilities and previous experience in the design and completion of national occurrence studies. Additionally, the USGS has personnel located across the United States, and 43 USGS offices will assist in sample collection for this survey (fig. 2).

Photograph courtesy of John Zogorski.

MTBE and other VOCs can be released into large rivers and reservoirs directly from boat and personal watercraft engines, as well as from accidental spills at fueling stations.

Survey Design

The national survey will be accomplished in two phases. A random source-water survey will be used to determine the frequency of detection and the range in concentration of MTBE and other VOCs in drinking-water sources through a representative sampling of approximately 1,000 CWSs. The CWSs chosen will represent the distribution of varying size (population served) and source

(ground water and surface water) categories presently existing within each State. The design also considers the number of people served by each source-size category. The survey design weighs equally these two factors.

A focused source-water survey will be used to determine temporal patterns in the detection of MTBE and other VOCs and will include sampling of community source waters considered to be more susceptible to MTBE contamination. Samples will be collected multiple times from each source water to investigate the effect of seasonal variations on contaminant concentrations. For example, variations in MTBE and VOC concentrations for reservoirs are thought to be more evident in samples collected during spring and summer (when watercraft use is frequent) than in samples collected during fall and winter (when watercraft use is infrequent). The approximately 120 CWSs participating in the focused source-water survey will have source waters with known MTBE contamination, or will be located in areas where MTBE might be likely to occur (for example, an urban area with high ozone levels where oxygenates are required at high levels in gasoline).

Pho aph courtesy of Joseph Bachman, U S Envir tal P otection A

Ground water is an important source of water for many communities in the United States. Here a USGS employee prepares to collect a water sample from a community well.

Photograph courtesy of Joseph Bachman, U.S. Environmental Protection Agency.

Photograph courtesy of Barbara Rowe.

Surface water is also an important source of water for many communities. A VOC hand sampler (left) was used for collection of surface-water samples from reservoirs and rivers, such as Brandywine Creek, Delaware (above).

Participation by CWSs in this national survey is voluntary. Source waters in all 50 States, Puerto Rico, and selected Native American Lands will be sampled in the survey. Samples will be collected from wells, reservoirs, lakes and rivers during May 1999 through April 2001. Samples will be analyzed for MTBE, three other gasoline oxygenates (*tert*-amyl methyl ether, ethyl *tert*-butyl ether, and diisopropyl ether) and degradation products of these oxygenates. Additionally, samples will be analyzed for 62 other VOCs, including a wide range of gasoline hydrocarbons, chlorinated solvents, and fumigants (Ivahnenko and others, in press). This comprehensive sampling will allow comparison of the frequency of occurrence and concentrations of MTBE and other ether oxygenates with that of other VOCs in source waters.

Potential Uses of Survey Results

Findings from the survey may be used to assess the magnitude and spatial extent of current MTBE contamination and to provide an improved understanding of the need, if any, to reduce or eliminate the use of this compound in commerce. In addition, the survey may identify: (1) sizes of CWSs and types of source waters that are most susceptible to contamination; and (2) where source-water protection and associated monitoring are most urgently needed.

A Coordinated Effort

This national survey is a collaborative effort between the AWWARF, the Metropolitan Water District of Southern California, the Oregon Graduate Institute, the USGS, and participating CWSs. USGS responsibilities include survey design, collection of some of the water samples, performing a

Figure 2. Location of selected U.S. Geological Survey offices collecting water samples in the focused source-water survey.

literature review, and preparing reports describing the survey and significant findings. Responsibilities of the other participants vary and range from survey planning to analysis of water samples.

References Cited

Blue Ribbon Panel on Oxygenates in Gasoline, 1999, Achieving clean air and clean water—The report of the Blue Ribbon Panel on Oxygenates in Gasoline: EPA 420-R-99-021, U.S. Government Printing Office, Washington, D.C., 126 p.

Ivahnenko, T., Grady, S.J., and Delzer, G.C., in press, Design of a national survey of methyl *tert*-butyl ether and other volatile organic compounds in community drinking-water sources: U.S. Geological Survey Open-File Report 01-271, 42 p.

Johnson, R., Pankow, J.F., Bender, D.A., Price, C.V., and Zogorski, J.S., 2000, MTBE—To what extent will past releases contaminate community water supply wells?: Environmental Science & Technology, v. 34, no. 9, p. 210A-217A.

Office of Science and Technology Policy, 1997, Interagency assessment of oxygenated fuels: Washington, D.C., OSTP, The Executive Office of the President, 258 p.

U.S. Environmental Protection Agency, 1997, Drinking water advisory—Consumer acceptability advice and health effects analysis on methyl tertiary-butyl ether (MTBE): EPA-822-F-97-009, Office of Water, 34 p.

For additional information contact

John Zogorski, VOC National Synthesis
National Water-Quality Assessment (NAWQA) Program
U.S. Geological Survey
1608 Mountain View Rd.
Rapid City, SD 57702
(605) 355-4560 (ext. 214)
jszogors@usgs.gov
http://sd.water.usgs.gov/nawqa/vocns

Printed on recycled paper