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RESEARCH AND DEVELOPMENT – OFFICE OF SCIENCE POLICY

The Technical Support Times is an online newsletter highlighting EPA's field activities, research, and new documents on current topics. This issue is the first in a series of periodic publications from the Hazardous Substances Technical Liaisons (HSTL), which are available on the intranet at http://intranet.epa.gov/ospintra/scienceportal/.

Michael Gill, the Office of Research and Development (ORD) HSTL for Region 9, compiled this article from various EPA resources.

FOCUS ON: THE OXYGENATE MTBE

Methyl tertiary-butyl ether (MTBE) is a chemical compound manufactured by the chemical reaction of methanol and isobutylene. MTBE is consumed in very large quantities (peaking at more than 290,000 barrels per day in the United States in 1999 and decreasing to 273,000 barrels in 2003) and is used almost exclusively as a fuel additive in motor gasoline. It is one of a group of chemicals commonly known as "oxygenates" because they raise the oxygen content of gasoline. At room temperature, MTBE is a volatile, flammable, and colorless liquid that dissolves rather easily in water.

MTBE has been used in U.S. gasoline at low levels since 1979 to replace lead as an octane enhancer (helps prevent the engine from "knocking"). Since 1992, MTBE has been used at higher concentrations in some gasoline to fulfill the oxygenate requirements set by Congress in the 1990 Clean Air Act Amendments. Oxygen helps gasoline burn more completely, reducing harmful tailpipe emissions from motor vehicles. Most refiners have chosen to use MTBE because of its blending characteristics and for economic reasons.

A growing number of states have detected MTBE in groundwater, including states and localities that were not required to use MTBE in gasoline. In some instances, these contaminated waters are sources of drinking water. The bulk of these problems have originated from leaking underground storage tanks. EPA's Underground Storage Tanks program has jurisdiction over these issues. Low levels of MTBE can make drinking water supplies undrinkable because of the offensive taste and odor. In addition, the toxicity of MTBE to humans is not fully understood and EPA has been involved in a number of toxicity studies. Because toxicological studies on MTBE are inconclusive, EPA has yet to publish any final cancer or noncancer health assessment information, which is necessary to guide cleanup. This situation has led many states to set their

MTBE *continued on page 2*

INSIDE

OSP INTRANET
HTTP://INTRANET.EPA.GOV/OSPINTRA/

OSP INTERNET
HTTP://WWW.EPA.GOV/OSP

MTBE *continued from page 1*

own action levels. For the latest action levels across the United States, see page 14 of the Nov/Dec 2004 edition of the Underground Tank Technology Newsletter produced by the University of Wisconsin-Madison (http://uttu.engr.wisc.edu/UT18n6.pdf).

EPA's National Center for Environmental Assessment (NCEA) is developing a draft assessment of the potential health hazards of MTBE, and an internal EPA Integrated Risk Information System (IRIS) toxicological review was set to begin in December 2004. ■

SCIENCE AT WORK

Santa Monica, CA

Work is underway to clean up groundwater polluted with the gasoline additive MTBE in Southern California's Charnock Sub-Basin. Responsible parties are paying more than $3 million per year to provide replacement water to Santa Monica and Culver City residents. Many tools have been used during investigation of these MTBE leaks. Discrete depth samplers were implemented, and capture zone and pore flushing modeling was used during the site investigation. In 1998, various MTBE and tertiary butyl alcohol (TBA—another less common oxygenate) treatment feasibility studies, using carbon and advanced oxidation technologies, were conducted. EPA Region 9 and the State of California have invested heavily in the work at this site. To date, more than 100 million gallons of contaminated groundwater have been treated, 17,000 pounds of hydrocarbons have been removed using soil vapor extraction (SVE), and 4,100 cubic yards of contaminated soil have been excavated and removed. The contaminated groundwater is being extracted, treated, and discharged. The groundwater is treated using a variety of technologies, including air stripping, carbon adsorption, and ultraviolet oxidation. (Reference: http://www.epa.gov/region09/cross_pr/mtbe/charnock/)

South Lake Tahoe, CA

South Lake Tahoe is the site of another MTBE cleanup in California. Most of the work is being performed by local authorities, although EPA was involved in the past. The South Lake Tahoe commercial advanced oxidation groundwater treatment system (called HiPOx) operated for about 1.5 years until January 2000, producing drinking water for the South Lake Tahoe Public Utility District at 800 gallons per minute. This technology also was one of three tested by the Office of Research and Development (ORD) at a technology demonstration at the Naval Base Ventura County, Port Hueneme, CA, in 2000-2001 (see below). This site is one of the first in the Nation where a court settlement forced various oil companies to pay the local utility's district for the groundwater cleanup (2002). (References: http://www.epa.gov/ORD/NRMRL/Pubs/600R02094/600R02094chap6appA.pdf and http://www.ewire.com/display.cfm/Wire_ID/1360)

MTBE Technology Studies in New York State

In an effort to study new characterization and remediation technologies, numerous studies have been conducted at New York State MTBE spill sites. Many studies have been done under the oversight of the New York State Department of Environmental Conservation (NYSDEC) and USEPA. One example includes the study of an enhanced bioremediation compound known as "Hydrogen Releasing Compound" (HRC from Regenesis Corporation). HRC and monitored natural attenuation (MNA) have been used in a Lindenhurst, NY, groundwater aquifer to protect an East Patchogue, Long Island, site's groundwater and surface waters. Furthermore, multilevel wells were used to assist in the three-dimensional subsurface characterization of a Hampton Bays, Long Island, site. A picture of one of the multilevel well installations (and a cross-sectional graphic view) is shown below.

SCIENCE *continued on page 3*

SCIENCE *continued from page 2*

Thanks to Joe Haas, NYSDEC and Interstate Technology Regulatory Council MTBE Team Training Coordinator, for providing information for this article.

Remedies at MTBE Sites in Kansas

The Office of Solid Waste and Emergency Response (OSWER) Clu-In Web Site has a searchable database of case studies for MTBE sites. They can be found at http://clu-in.org/products/mtbe/ by clicking on the "treatment profiles" box. When looking under "Kansas," one sees approximately 100 different case studies. A review of a cross-section of the remedies shows that many remedies were used, including granular activated carbon (GAC), packed tower air strippers, shallow tray air strippers, and *in situ* bioremediation (injection of oxygen release compounds), but most sites used the combined remedies of air sparging (for groundwater) and SVE for soil. ■

IN THE LABORATORY

Project managers are faced with a number of issues before cleaning up an MTBE contaminated site. They may include the following questions:

- How toxic is MTBE to human health?
- Based on this toxicity, what should my cleanup goals be?
- What site characterization tools and cleanup technologies might be effective at my site?

To assist in answering these questions, EPA's ORD has performed research on a number of MTBE topics. As one can imagine, many other entities, including academia and industry (such as the American Petroleum Institute), do similar research. Below are some highlights of ORD research on MTBE.

Risk Assessment and Research Strategies
EPA's NCEA has prepared health risk assessments and research strategies on MTBE and fuel oxygenates. (Reference: http://cfpub2.epa.gov/ncea/cfm/oxygenates/oxygenat.cfm)

Exposure Research
For several years, EPA's National Exposure Research Laboratory (NERL) has conducted research on MTBE exposure issues utilizing a wide variety of measurement methods and exposure scenarios. (Reference: http://www.epa.gov/nerl/nerlmtbe.htm)

Health and Environmental Effects Research
EPA's National Health and Environmental Effects Research Laboratory (NHEERL) conducts research on the uptake, metabolism, and elimination of MTBE in humans. (Reference: http://www.epa.gov/nheerl/mtbe/)

NRMRL Cleanup Technology Research and Demonstrations
EPA's National Risk Management Research Laboratory (NRMRL) conducts research on the treatment of soil and drinking water contaminated with MTBE. A series of three technology cleanup demonstrations was performed by NRMRL at the Naval Base Ventura County in Port Hueneme, CA. Photos from each of the tests can be seen on page 4. Complete information on these demos can be found at http://www.epa.gov/swerust1/mtbe/mtbedemo.htm. (Reference: http://www.epa.gov/ORD/NRMRL/mtbe.htm)

Extramural Environmental Research Grants
EPA's National Center for Environmental Research (NCER) administers EPA's Science To Achieve Results (STAR) Program, including funding on MTBE research under different competitive solicitations. (Reference: http://epa.gov/ncer/grants)

Analysis of Reformulated Gasoline: MTBE, Ethanol, and Alkylate Alternatives
Life cycle analysis work is being performed on various reformulated gasoline components, including MTBE, by

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Jane Bare and others at ORD's NRMRL in Cincinnati. A report on the status of their work was presented at the ORD Science Forum in June 2004 in Washington, DC. (Reference: http://www.epa.gov/ord/scienceforum/2004/ordposter/Bare_Jane.pdf)

MTBE Research Under "RARE" Program

Two MTBE studies were conducted for Region 9 EPA under the Regional Applied Research Effort (RARE) program. This research is funded and overseen by ORD but is defined by regional needs. The work, conducted by Battelle, was completed through ORD's NERL. The reports, both dated February 2003, are titled:

1. "Human Exposure to Methyl tert-Butyl Ether (MTBE) While Bathing with Contaminated Water"

2. "Inhalation Exposure to Methyl tert-Butyl Ether (MTBE) Using Continuous Breath Analysis" (Reference: http://intranet.ord.epa.gov:9876/OSP/RARE.nsf/)

"Remedial Costs for MTBE in Soil and Groundwater"

This paper written by Barbara T. Wilson and John H. Wilson of the ORD Ada Laboratory appeared in the journal *Contaminated Soil Sediment and Water*. It can be found at http://www.aehsmag.com/issues/2002/july_august/pdfs/10c.pdf.

OnSite: The Online Site Assessment Tool

Various online calculator tools were developed by Jim Weaver of ORD's Athens Laboratory and can be used for assessing impacts to groundwater from contaminants. The focus is on fuel constituents, which include MTBE. (Reference: http://www.epa.gov/athens/onsite)

FIGURE 1. E-Beam Technology, Haley and Aldrich, Inc.

Oxygenate Health Assessments

Within EPA's NCEA, health assessments (hazard identifications and dose-response assessments) are done each year for a number of chemical compounds that may impact human health. Some of these health assessments are done for oxygenates (MTBE and others, including ethyl tertiary butyl ether). A draft Integrated Risk Information System (IRIS) Toxicological Review and IRIS file for MTBE began internal EPA IRIS consensus review in August 2004. (See http://epa.gov/iris/frn_02_09_04.htm)

ORD's Ada Laboratory Update

The Ada Laboratory has performed a number of studies on MTBE and how well it naturally attenuates. Conventional wisdom holds that MTBE does not easily degrade under anaerobic conditions in ground water. Laboratory studies conducted by the Ground Water and Ecosystems Restoration Division show that anaerobic transformation of MTBE to TBA is pervasive and extensive in certain sections of the United States. This is particularly true in southern California, where the risk to groundwater from MTBE is high. (Reference: http://www.epa.gov/ada/topics/mtbe.html)

Recent research highlights from the Ada Laboratory include the following:

- Performance of Conventional Remedial Technology for Treatment of MTBE and Benzene at Underground Storage Tank (UST) Sites in Kansas. Greg Hattan, Barbara Wilson, and John T. Wilson. *Remediation* 14(1):85-94 (2003).

FIGURE 2. HiPOx Process, Applied Process Technology, Inc.

FIGURE 3. *In Situ* Bioremediation of MTBE in Groundwater Using Propane Oxidizing Bacteria, Envirogen, Inc.

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- Use of Compound-Specific Stable Carbon Isotope Analyses to Demonstrate Anaerobic Biodegradation of MTBE in Groundwater at Gasoline Release Site. Ravi Kolhatkar, Tomasz Kuder, Paul Philip, Jon Allen, and John T. Wilson. *Environmental Science & Technology* 26(24):5139-5146 (2002).
- Role of Natural Attenuation in the Life Cycle of MTBE Plumes. John T. Wilson and Ravi Kolhatkar. *Journal of Environmental Engineering* 128(9):876-882 (2002).
- Fate and Transport of MTBE and Other Gasoline Oxygenates. 2003. John T. Wilson. In: *Handbook for Managing Releases of Gasoline Containing MTBE*. Editors: Ellen Moyer and Paul Kostecki. Amherst Scientific Publishers. Pages 19-61.
- Aerobic *In-Situ* Bioremediation. 2003. John T. Wilson. In: *Handbook for Managing Releases of Gasoline Containing MTBE*. Editors: Ellen Moyer and Paul Kostecki. Amherst Scientific Publishers. Pages 243-260.
- Remedial Costs for MTBE in Soil and Groundwater. Barbara H. Wilson and John T. Wilson. 2002. *Contaminated Soil Sediment & Water*. Association of Environmental Health and Sciences. Amherst, Massachusetts, July/August 2002. Pages 47-51. ■

AVAILABLE RESOURCES

Technical support for MTBE or any other waste-related sites (Superfund, Brownfields, Resource Conservation and Recovery Act) is available. You can contact the HSTL in your Region for more information. See page 6 or visit our intranet site at http://intranet.epa.gov/ospintra/cp/stl.html. Some helpful references for MTBE are listed below:

Office of Underground Storage Tanks Page
(Reference: http://www.epa.gov/oust/mtbe/index.htm) This Web page summarizes cleanup-related information and the many links to other EPA program offices, as well as to non-EPA sites.

MTBE Topics
The Clu-In Web Site has a number of important resources, including:

- http://clu-in.org/products/mtbe/, which contains information about completed and ongoing applications of treatment for MTBE in drinking water and media at contaminated sites;
- http://clu-in.org/contaminantfocus/, a section on MTBE as a "contaminant focus area," which contains information on technologies and many other aspects of MTBE;
- http://clu-in.org/download/remed/542r04009/542r04009.pdf, which is a very useful EPA report released in 2004 entitled "Technologies for Treating MtBE and Other Fuel Oxygenates," specifically about MTBE cleanup.

General EPA Web Page on MTBE
(Reference: http://www.epa.gov/mtbe/) This page will guide you to other related MTBE information on the EPA Web Site.

ITRC MTBE and Other Fuel Oxygenates Team
In 2000, the Interstate Technology & Regulatory Council (ITRC) formed an MTBE Team. Its name has since been changed to the MTBE and Other Fuel Oxygenates Team. This group consists mostly of State regulators, but also industry, academia, and EPA representatives. The Team has conducted training seminars on MTBE cleanup issues in at least three States and currently is working on guidance documents. Please consult the Web page for status information on the Team's progress. It can be found at http://www.itrcweb.org (look for MTBE under "Teams").

Scientist to Scientist Meeting
A meeting was held in Argonne, IL, on June 20-21, 2000, to allow all ORD researchers (and selected

RESOURCES *continued on page 6*

RESOURCES *continued from page 5*

others) to review the state of the science of MTBE research. Presentation material and a summary of the meeting can be found at the following EPA intranet site: http://intranet.ord.epa.gov:9876/development/RCT/WasteRCT.nsf/fe151d3dc656f5d58525686500479371/650926eb8aa39c5685256a250047e776?OpenDocument. ■

HAZARDOUS SUBSTANCES TECHNICAL LIAISON (HSTL) PROGRAM

The Hazardous Substances Technical Liaison Program was created in 1990 in a joint effort by ORD, OSWER, and the Regional Offices to expand the technical support available to regional staff. It is managed within ORD's Office of Science Policy (OSP) at EPA Headquarters.

The HSTL Program was created to:

- Station a HSTL in each EPA Region to facilitate access to scientific and technical support from ORD's laboratories and centers.
- Provide and facilitate technical support programs in regional hazardous waste and emergency response programs.
- Promote the use of sound science and engineering in regional decision making in the hazardous waste and emergency response programs.

The name of the program was changed in 2001 (from "Superfund Technical Liaison Program" or STLP) to reflect an expansion in the mission of the program to all work that focuses on hazardous substances and/or hazardous wastes, as well as Superfund.

Technical liaisons are senior scientists and engineers located in the regional Superfund offices. They interact on a daily basis with Superfund Remedial Project Managers (RPMs), On-Scene Coordinators (OSCs), RCRA Project Managers, Federal Facility Project Managers, regional management, and other regional scientists and engineers. The liaisons foster communications—especially the transfer of scientific and engineering products—between Laboratories and the Regions. They also provide direct assistance by applying their expertise in a variety of areas. ■

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