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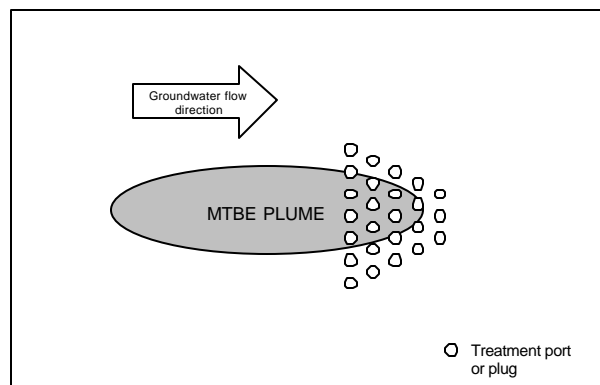
TECH MEMO #108: IN-SITU REMEDIATION OF MTBE

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By Jim Jacobs, CHG (510) 232-2728; ext. 222

THE MTBE PROBLEM: Methyl tertiary butyl ether (MTBE) is a controversial issue critical to the protection of groundwater resources. A January 16, 2000 airing of the 60 Minutes television program on MTBE highlighted the problem posed by this chemical to national groundwater resources. Sampling of groundwater in California and other states has shown that MTBE is more persistent and more mobile than other fuel compounds. Having a taste and odor like turpentine has made MTBE-contaminated ground water sources unusable for human consumption. The strong odor and taste of MTBE at relatively low concentrations would make drinking of large amounts of high level MTBE contaminated water unlikely, thus reducing the exposure and potential resulting human health risks from MTBE. For more information, refer to Jacobs et al., (2001), EPA (1997) and DHS (2001).

FATE AND TRANSPORT: The MTBE problem is associated with gasoline leaking from underground storage tanks, surface spills of gasoline or from small gasoline engines. Even though the majority of underground tanks in this country have been upgraded, the amount of MTBE already released with gasoline into the environment is so large that the problem of ruined drinking water sources will exist for several decades. Compared to other fuel compounds, MTBE adsorbs to soils much less, is poorly biodegraded, and dissolves in groundwater at much higher concentrations. Due to these characteristics, MTBE migrates much faster and further in the groundwater than equal amounts of other gasoline compounds. For more information, refer to USGS (2001).



Plan view, treatment ports for in-situ remediation by jetting (Jacobs et al., 2001).

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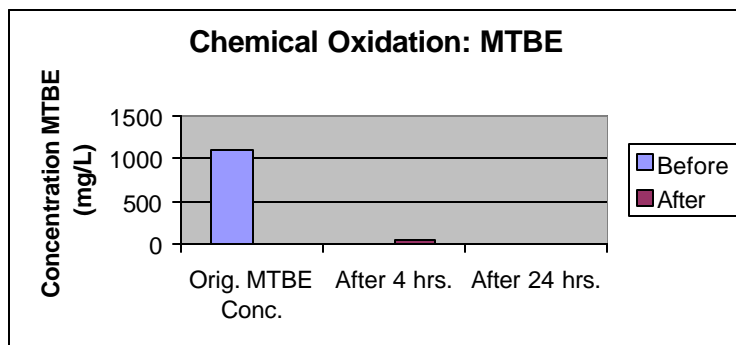
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GROUNDWATER INVESTIGATION: The investigation of a groundwater resource impacted with MTBE requires more detailed and more rapid sampling of soil and groundwater than other fuel-impacted sites due to the potential for faster and deeper migration of MTBE compared to other compounds. The presence of other oxygenates should also be tested at all sites containing MTBE.

REMEDICATION: Although remediation of MTBE is generally more challenging than other gasoline related compounds, successful methods of MTBE remediation have been developed using chemical oxidation and aerobic bioremediation.

Chemical Oxidation of MTBE – Hydrogen peroxide, a liquid oxidant and ozone, a gas phase oxidant have been shown to be effective in MTBE remediation, for both above ground and in-situ applications. Ozone must be generated on-site and can be installed using pulsed injection ports or a horizontal network of diffusion pipes within a trench. Hydrogen peroxide has been used to destroy MTBE in the laboratory (Jacobs et al., 2001) and injection ports work for close spacing of the treatment chemicals. Hydrogen peroxide when in contact with a metal catalyst such as iron (II), which is commonly known as Fenton's reagent, forms the more powerful oxidizer, the hydroxyl radical. Degradation products from MTBE include a long list of generally unstable or biotreatable chemicals, with carbon dioxide and water created as the end products of complete oxidation. After the oxidation phase of MTBE treatment, the free oxygen liberated during the oxidation process will be available for the second phase of remediation: aerobic bioremediation.



Bench tests using 1,086 mg/L MTBE (4 hr. test) and 981 mg/L MTBE (24 hr. test) with equal volumes of 20% hydrogen peroxide (Jacobs et al., 2001).

Bioremediation of MTBE – Aerobic biodegradation of MTBE has been demonstrated at the USSN Hydrocarbon National Environmental Test Site at Port Hueneme, California

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where the dissolved MTBE groundwater plume is over 1,500 m long. Laboratory microcosm experiments prepared with water from Port Hueneme groundwater showed that MTBE was rapidly metabolized after inoculation with a high-activity MTBE-degrading bacterial consortium (MC-100). Field tests at Port Hueneme the oxygen and MC-100 plot, MTBE concentrations decreased after 30 days and throughout the 261-day experiment eventually to less than or equal to 0.001 to 0.01 mg/L. Tertiary butyl alcohol (TBA) concentrations also declined in the bioaugmented plot to less than 0.01 mg/L (Salanitro et al., 2000).

DELIVERY SYSTEM FOR OXIDATION OR BIOREMEDIATION OF MTBE

Jetting, as a remediation technology, uses a variety of liquids injected under high-pressure to perform chemical or biological processes. In jetting, small diameter lances are advanced through soil using the high-pressure tips. Jetting can be used in both in-situ or ex-situ applications to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. The in-situ applications usually involve the addition of liquids to oxidize, bioremediate, neutralize or precipitate contaminants in the subsurface without digging and handling of the soil and groundwater. Jetting as a remedial technology, is usually a more economical and less disruptive to site activities than the more conventional approaches. The main benefits of in-situ remediation systems over conventional methods are the lower final cost for remediation, minimum cost for operations and maintenance, no moving parts that could break and no discharge permits or waste disposal of liquids for in-situ groundwater treatment. Remediation Injection Process (RIP®), a proprietary form of jetting, uses high-pressure injection technology placed on close spacing to solve the in-situ delivery problem.

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United States Geologic Survey (USGS), 2001, <http://water.wr.usgs.gov/mtbe/> and
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