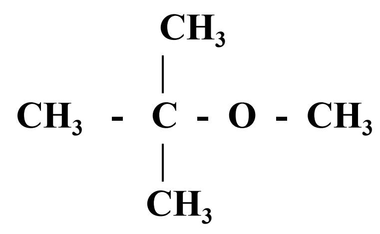
UNLEADED FUEL: MTBE ADDITIVE GOES UNDERGROUND IN A DIFFERENT FASHION

By Ritchie Morris

***To use, or not to use (unleaded petrol); That, is the question?*. More importantly, to manage, or not to manage the use of unleaded petrol (ULP) is of relevance when considering the array of environmental concerns that have been raised following the introduction of ULP into South Africa. "Perhaps, before looking at a whole host of possible environmental implications related to ULP, we should consider what has been found to be an important issue in overseas countries where unleaded fuel has been in use for many years", so suggests Ritchie Morris, Environmental Hydrogeologist (www.megateam.co.za). This article provides information on the subsurface fate and mobility of the ULP additive, methyl *tert*-butyl ether (MTBE), and the effect it has on other ULP constituents which form soil and groundwater contaminants**

The use of ULP in South Africa over the past year or so has invoked numerous debates regarding the environmental consequences. Most have dealt with air emissions and the use, or non-use of catalytic converters. Morris points out that there is the hidden issue related to the additives in ULP, specifically MTBE and the influences it has over other constituents of ULP when they are released to the subsurface.

Studies undertaken internationally and locally have shown that about 30% of underground storage tanks (UST's) and related pipework leak. Experience has shown that product releases vary from petrol, diesel to industrial paraffin, in decreasing order of prevalence. To date, important constituents to consider when investigating subsurface contamination from petrol are the monocyclic aromatic hydrocarbons which include the BTEX compounds (benzene, toluene, ethyl-benzene and the xylenes). Internationally MTBE is becoming an important issue due to the increasing prevalence in groundwater and its behavioural influences over the other constituents mentioned above. MTBE is fairly mobile and persistent in the subsurface and is tentatively classified by the US Environmental Protection Agency as a possible human carcinogen (Squillace, *et al*, 1997).



Methyl *tert*-butyl ether

Groundwater forms a strategic source of domestic supply for many smaller towns in South Africa and is increasingly being developed in the larger urban areas. Consequently, it is important that industry, the petrol supplier, water resources manager and/or scientist/consultant involved with the management of subsurface contamination understand the manner in which MTBE effects the other constituents and its own fate and mobility characteristics.

MTBE is a synthetic organic ether containing 18.2% oxygen and is used almost exclusively as an octane enhancer in ULP. Bass *et al* (1995) report that typical concentrations of MTBE in ULP range from 2% to 8% by volume, but may be as high as 15% in some premium blends. MTBE is fairly soluble in water, being an order of magnitude higher than other major petrol constituents such as BTEX. Concentrations in groundwater resulting from a petrol release are often in the range of 100 to 1000mg/ℓ (parts per million, ppm). This is roughly three orders of magnitude above many international clean-up standards, the New York and Massachusetts drinking water standards for MTBE being 50 and 700 μg/ℓ (pp billion) respectively. Consequently, it can be expected that the fraction of MTBE in the aqueous phase will be 1 to 2 orders of magnitude greater than the BTEX compounds of ULP.

Morris confirms the above and notes that several subsurface contamination investigations undertaken in South Africa since 1995 have found MTBE at the concentrations reported by Bass *et al* (1995). Squillace *et al* (1997) report that of 210 urban wells sampled across the USA, 27% contained MTBE. Their investigations have found that MTBE is more frequently detected in shallow ambient groundwater in urban areas than in rural areas. They also note that MTBE in groundwater can originate from both point and non-point sources. Point sources would be leaks from UST's as referred to previously. Possible non-point sources would include atmospheric deposition and stormwater runoff - bringing one back to the emissions issue eluded to at the start of this article and discussed in the previous edition of this magazine.

MTBE persists in groundwater under both aerobic and anaerobic conditions (Barker *et al* 1990) because it resists physical, chemical and microbial degradation. This is supported by Bass, *et al* (1995) who note that many *insitu* remediation technologies which are effective on petroleum hydrocarbons are ineffective on MTBE. The reason for this is that the relatively high solubility of MTBE, as opposed to the BTEX compounds, suggest that MTBE in the subsurface would be found mostly dissolved in groundwater, rather than adsorbed to the soil particles. Adsorbed phase contamination is fairly easy to remove *insitu* by enhancing natural biodegradation.

MTBE induces a co-solvancy effect on the BTEX components and consequently it can be expected that benzene, a confirmed human carcinogen, will exist at higher concentrations in groundwater contaminated by ULP. In addition, given the high mobility of MTBE in groundwater, it can be expected that it, together with benzene, will be the first petrol constituents to reach a receptor. It is therefore necessary to consider the whole contaminant-pathway-receptor-impact concept, following a risk based approach, when managing subsurface contamination from ULP.

Morris emphasises the need for protection of our valuable groundwater resources which, he predicts, will become even more and more important as demands increase on existing conventional (surface water) supplies. He recommends that the following actions be put in place:

- The petrol supplier or retailer should ensure that those retail outlets located in sensitive areas, where the consequences and liability associated with a product release would be high, are properly managed and maintained to limit the chance of an environmental incident occurring.
- Strategic groundwater resources, whether they are currently developed or not, should be identified and appropriate groundwater quality monitoring and protection programmes implemented.
- Potential point sources of all contaminants, including ULP, should be mapped in relation to receptors, ie groundwater abstraction wells.
- A risk based approach should be followed when undertaking petroleum subsurface contamination assessment and management.
- A thorough understanding of the fate and mobility of the BTEX components is required and it is advisable to include MTBE when submitting groundwater samples to the laboratory for analysis. He concludes with a quote which has become a philosophy within his group, namely, *"Educate to prevent, is far wiser than remediate with money ill spent".*

References:

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