

Motor fuel components: environmental occurrence and potential future risks

Science Summary SC040087/SS

The use of biodiesel should present little or no additional risk to groundwater compared to fossil fuels, according to a new report by the Environment Agency.

This report outlines a joint project between the Environment Agency and the Energy Institute, whose members include major oil companies. The project was sparked by a commitment made in our earlier work (Environment Agency R&D Publication P97) to review the incidence of groundwater pollution from fuel-derived ether oxygenates after five years.

The study reported here had two main aims:

- To establish the occurrence and fate of fuel ether pollution of groundwater and surface waters in England and Wales.
- To assess the potential new risks posed by changes in fuel composition, such as those driven by market or legislative changes such as the EU Biofuels Directive.

A review of groundwater monitoring and site data held by the Environment Agency and the individual oil companies showed the extent and degree of contamination of groundwater by ether components of petrol. These components include methyl-tertiary-butyl-ether (MTBE) and the related compounds ethyl-tertiary-butyl-ether (ETBE) and tertiary-amyl-methyl-ether (TAME). Data from the national groundwater monitoring network was included.

The project also reviewed published information on alternatives to MTBE such as ethanol and ETBE which, though not used at present in the UK, may find use in the future alongside biofuels such as biodiesel.

These fuel components (ethers and biofuels) have been proposed as ways to improve atmospheric pollution and so are often seen as environmentally beneficial (for example, in decreasing carbon dioxide emissions for climate change mitigation). The aim of this report was to establish that, in decreasing air pollution, we would

not place unanticipated burdens on another part of the environment, that is, groundwater.

Currently, petrol containing ether oxygenates is only manufactured at one of the eight oil refineries in the UK supplying petrol. This refinery manufactures petrol containing variable percentages of MTBE and TAME but on average, the petrol contains 3.4 per cent (by volume) MTBE and 0.9 per cent (by volume) TAME. Prior to 2005, one other refinery produced petrol containing an average of 1.5 per cent (by volume) MTBE and therefore it can be expected that the overall use of ether oxygenates in the UK is slightly less than in the previous study in 2000. Petrol manufactured in the UK does not contain ETBE or DIPE. The type and content of ether oxygenates in imported petrol, which accounts for less than 10 per cent of the volume of petrol sold in the UK, is unknown. The overall average content of ether oxygenates in petrol sold in the UK was approximately one per cent for the years 2001 to 2005.

Four oil companies provided site investigation data from 632 sites (mostly petrol stations). This offered a good representation of the 2,500 sites owned by these companies. Groundwater monitoring data indicated that approximately 60 per cent of these sites had MTBE concentrations above the tentative taste and odour threshold of 15 $\mu\text{g.L}^{-1}$. Less than two per cent of sites were reported to have detectable concentrations of TAME. The greatest detected concentrations of MTBE and TAME in groundwater were 350,000 $\mu\text{g.L}^{-1}$ and 115,000 $\mu\text{g.L}^{-1}$, respectively. Maximum concentrations of MTBE detected at individual sites were typically less than 10,000 $\mu\text{g.L}^{-1}$ and had a geometric mean of 321 $\mu\text{g.L}^{-1}$. Care should be taken in extrapolating these data to all 12,300 (open and closed) fuel stations in the UK.

Four water companies conduct routine sampling for MTBE in water supplies. One of these reported that MTBE had been detected in the raw water from three abstraction wells. This lasted between one and four months in these wells and reached peak concentrations of 0.9 $\mu\text{g.L}^{-1}$, 3.4 $\mu\text{g.L}^{-1}$ and 12.3 $\mu\text{g.L}^{-1}$.

Currently, some 2,000 groundwater wells are monitored in England and Wales for MTBE, ETBE and TAME and approximately 100 wells are monitored for MTBE in Northern Ireland. MTBE was found above the detection limit of 0.5 ug.L^{-1} in 0.6 per cent of wells monitored in England and Wales in 2005 and 0.9 per cent of wells in 2006. Two of the monitoring wells in England and Wales had MTBE above 15 ug.L^{-1} in 2005 and/or 2006.

ETBE has not been detected in any of the groundwater samples collected by the Environment Agency. TAME has been detected in six routine monitoring wells up to a maximum of 0.18 ug.L^{-1} . MTBE has been detected in five wells in Northern Ireland. Detected concentrations were less than twice the detection limit of 0.2 to 10 ug.L^{-1} and were not repeated in subsequent monitoring.

There is little data on the occurrence of ether oxygenates in surface water. For this study, the Environment Agency provided data for 90 surface water sampling locations analysed for MTBE, eight locations analysed for ETBE, six locations analysed for TAME and three locations analysed for DIPE. However, most of this data related to individual pollution incidents and therefore was skewed to reflect conditions around suspected incidents.

The potential for ethers and biofuels to affect groundwater resources is a function of their likely use, fate and transport in the environment. The feasibility of cleaning up biofuels is also a factor that should be considered. Current use of biofuels is dominated by petroleum fuels blended with up to five per cent bioethanol and biodiesel and up to 15 per cent ETBE (though ETBE is not at present used in the UK, it is used quite widely in Europe). Advances in technology will mean that blended fuels with higher ratios of these biofuels will become more common. Other biofuels such as methanol or butanol may also come onto the market place, for use as additives to petroleum fuels.

The report concludes that biodiesel should present little or no additional risk to groundwater compared to fossil fuels. Alcohols such as ethanol present little risk themselves, but have the potential to extend groundwater plumes of other hydrocarbons in petrol. Ethers such as ETBE present perhaps the greatest risk, particularly if used at higher concentrations than those traditionally used for MTBE in the UK (the maximum concentration permissible is 15 per cent in petrol).

We have been fortunate in the UK in having our groundwater spared some of the pollution generated by fuels in other countries. We should continue to be vigilant and to learn from the experience of other countries, particularly at a time where there is strong pressure to change fuel formulas. It would be most unfortunate if, in protecting our atmosphere, we were to put our water supplies at risk.

This summary relates to information from Science Project SC040089, reported in detail in the following reports which are available from the Energy Institute:

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Further copies of this summary and related report(s) are available from the Energy Institute at the address above or via their website: <http://www.energyinst.org.uk>

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