

## **MTBE Frequently Asked Questions**

### **What is MTBE ?**

MTBE (methyl tertiary butyl ether) is a chemical compound that is manufactured by the chemical reaction of methanol and isobutylene. MTBE is an "oxygenate", i.e. a component that contains oxygen. Oxygenates are used widely as a component of unleaded gasoline. MTBE is the most commonly used fuel oxygenate. It can be blended with petrol in any proportion up to 15%.

Thanks to its adequate properties, MTBE is used as an "octane enhancer" to achieve the required octane level of gasoline. MTBE is a good alternative to other typical gasoline components.

### **Why use MTBE ?**

MTBE has many properties that make it a good gasoline component for technical and environmental reasons:

- MTBE can be used as fuel that can supplement the supply of gasoline components.
- Its high octane rating makes it an ideal substitute for other octane components, e.g. lead.
- It is an oxygenate, which can be used in the formulation of cleaner-burning gasoline.

Lead has traditionally been added to gasoline due to its high octane rating, which prevents engine "knock". Lead is, however, a toxic compound, and leaded gasoline has been phased out in most areas of the world, including Europe. MTBE, which has a very high octane number but is not toxic, is ideally suited to produce high octane, unleaded gasoline.

Adding oxygen to gasoline allows more complete combustion of the fuel, and this reduces exhaust emissions of CO (carbon monoxide). Furthermore, when used as part of the gasoline formulation, MTBE leads to a reduction in emissions of exhaust pollutants such as VOCs (volatile organic compounds), NO<sub>x</sub> (nitrogen oxides) and PM (particulates). Reducing these pollutants improves air quality.

By reducing the Ozone Forming Potential (OFP) of volatile organic compounds, MTBE performs significantly better than other octane blending components. It generates about half of the ozone when compared to iso/alkylates and one-tenth that of aromatics.

For all these reasons MTBE has been widely used all over the world for the last 20 years.

### **Is MTBE used in Europe ?**

MTBE was invented in Europe, and has been widely used for over 20 years as a safe and clean octane enhancer, substituting lead.

Because of its properties, MTBE is a good alternative to other typical gasoline components, leading to a reduction in the emissions of regulated as well as unregulated pollutants. In the 1990's some European countries - e.g. Finland - found these properties beneficial for the environment and decided to add up to 9-13 % of MTBE in gasoline. CO emissions were reduced by 10-20% and hydrocarbons by 5-10%.

As air quality became a real issue in Europe, the EU adopted a directive setting new specifications for gasoline (EC Directive 98/70/EC). Oxygenated compounds such as MTBE will help the refining industry reach these new, stringent standards, so that Europe can enjoy better air quality.

## **Is MTBE used in the USA ?**

In the USA, MTBE is used as an octane-enhancer and as the oxygenate of choice of the refining industry, following the implementation of the federal Clean Air Act and other state regulations.

In 1990 the United States adopted the Clean Air Act Amendments (CAAA). These require the use of oxygen in gasoline in areas with unhealthy levels of air pollution. The CAA does not specifically require MTBE, just oxygen. Although refiners may choose to use other oxygen-containing components, such as ethanol, MTBE is the most widely used oxygenate.

### **The Clean Air Act sets out two types of gasoline specifications:**

**Winter Oxyfuel Programme:** Implemented since 1992, this requires the use of oxygenated fuel (gasoline containing 2.7 percent oxygen by weight) during the cold months in cities that have elevated levels of carbon monoxide. Ethanol is primarily used as an oxygenate for this type of gasoline, as the cold weather compensates for the usual drawback presented by its high volatility.

**Year-round Reformulated Gasoline Programme:** Since 1995, the CAA requires reformulated gasoline (RFG) year-round in cities with the worst ground-level ozone (smog). RFG is gasoline with very tight environmental specifications, which must among other ingredients contain a minimum of 2 percent oxygen by weight, and which is specially blended to have fewer polluting compounds than conventional gasoline. Today, about 30 percent of US gasoline is reformulated, of which about 87 percent contains MTBE. Refiners have chosen MTBE as the main oxygenate in RFG in cities outside of the Midwest primarily for economic reasons and because of its blending characteristics. Unlike ethanol, MTBE can be shipped through existing pipelines, and its volatility is lower, making it easier to meet the emission standards.

Further to the federal Clean Air Act, and to address its unique air pollution problems, California has adopted similar, but more stringent requirements for its gasoline (California RFG). In view of widely-publicised, although limited, occurrences of groundwater contamination, California has decided to phase out MTBE from gasoline from 2004. Implementation of this proposed legislation is uncertain and in fact California still relies on MTBE as its source of oxygen in gasoline, given the economic and environmental advantages that it brings.

### **Are there any alternatives to MTBE ?**

Potential alternatives to MTBE include oxygenates such as alcohols or other ethers, aromatics and fuel components such as alkylates and isomerates. Oxygenates are produced from a variety of feedstocks. Methanol, derived primarily from natural gas, is one feedstock used in the production of MTBE. Ethanol, another oxygenate, is derived primarily by a fermenting process from corn and other agricultural products and is used directly as an additive or as a feedstock for the production of ETBE.

When Europe started to phase down lead octane additives in petrol in the 1980s, many refiners usually replaced them with aromatics, which represented the lowest-cost alternative at the time.

Towards the end of the 1990s, new environmental regulations started to limit the aromatic content of gasoline. A convenient replacement for aromatics is MTBE, a high octane, easy-to-blend, reasonable cost oxygenate, which is essentially a drop-in blending component for the refiner.

There are a few other non-aromatic octane options such as alkylates, isomerates and ethanol, but they are very limited in terms of both octane contribution and supply availability. In addition, they provide fewer air quality benefits. Each of the various octane alternatives has advantages and disadvantages in numerous related aspects, which need to be considered in

an objective comparison. These include octane contribution, supply availability, cost, and environmental impact.

Of all the options for replacing lead and aromatics in petrol, MTBE is the most effective from both octane supply and air quality perspectives.

### **What about ethanol ?**

The car industry and the oil industry do not want to use ethanol for technical reasons. It is a fact that they consider MTBE to be a far better compound than ethanol: this is documented for instance in the World Wide Fuel Charter developed by all the world car maker associations. Concerning the environmental impact of ethanol, the Danish EPA recently mentioned that use of ethanol could cause a remarkable increase (50-70%) in the release of acetaldehyde, which is classified as a respiratory irritant in the EU and is categorised as a possible human carcinogen by WHO (IARC Group 2B). Adding ethanol to gasoline will also increase the volatility of the gasoline and thereby cause an increase in the emission of volatile organic compounds (VOCs). Technically and environmentally, MTBE is a far better compound than ethanol.

### **What are the air quality benefits of using MTBE in gasoline ?**

Adding MTBE to gasoline allows a more complete combustion of the fuel, reducing the exhaust emissions of toxic compounds:

- Carbon monoxide emission is reduced on average by at least the same percentage as MTBE content in gasoline.
- Unburned hydrocarbons: for each 1 or 2 % of MTBE, there is a 1 % reduction in total HC emissions.
- Particulate matter: it is estimated that each 1 % of MTBE results in a 2 to 3 % PM emission reduction.
- Ozone: MTBE generates about half the ozone compared with iso/alkylates and one-tenth that of aromatics.
- Benzene: it is estimated that for each 1 % of MTBE there is an equivalent percentage reduction in benzene emission, both evaporative and exhaust.
- Olefins: MTBE displays low vapour pressure and low volatility compared to olefins.
- Lead: MTBE is an effective substitute for lead, a toxic compound that has been phased out in most parts of the world.

### **What are the results in the USA of reformulated gasoline (RFG) that contains oxygenates ?**

RFG has been helping improve the air for millions of Americans since 1995. The use of RFG compared to conventional gasoline has resulted in annual reductions of smog-forming pollutants (volatile organic compounds and nitrogen oxides) and toxics (such as benzene). With the second phase of the RFG programme, which began in January 2000, the US Environmental Protection Agency estimates that smog-forming pollutants are being reduced annually by at least 105,000 tonnes, and toxics by at least 24,000 tonnes. Refiners are required to reduce the emissions of volatile organic compounds, toxics, and nitrogen oxides by 27, 22, and 7 percent, respectively, compared to the conventional gasoline they produced in 1990.

An independent study by the University of California at Berkeley found a decrease in motor vehicle emissions following cleaner-burning gasoline's introduction in the spring of 1996. Analyses of weather data and air pollution levels also indicate that the use of cleaner-burning

gasoline has reduced peak smog levels. Benzene levels in California's air decreased by approximately 50 percent in 1996 following the gasoline's introduction.

### **What would be the consequences for air quality if MTBE were not used any more ?**

Without MTBE, real world air quality could easily worsen. High olefins concentration is just one example. To produce MTBE, refiners convert C4 olefins, making good environmental use of that reactive components, which would otherwise have to be converted to isomerates or alkylates before being blended in the gasoline pool.

Both in the USA and in Europe, MTBE has been found in a number of groundwater areas and in the soil under several gasoline stations. What is happening ?

Gasoline does not belong in the soil or in the groundwater: it belongs in storage tanks, or in the tanks of cars. If gasoline is found in the soil or groundwater, it is because tanks, pipelines or equipment are leaking. The oxygenated fuel industry is very much concerned about leaks and spills, and recognises the need for dealing with this matter.

### **How real is the contamination of groundwater ?**

It is very important to put matters in perspective. Despite media and political hype, the real extent of groundwater contamination with gasoline containing MTBE is very limited, even in California, where the authorities have nevertheless proposed to phase out MTBE.

In California, the most recent data published (May 2000) by the Department of Health Services show that of all public drinking water systems sampled (1763), which serve 29.9 million people, or 88 % of the population, only 1.9 % had detectable levels of MTBE over the taste and odour threshold . Even as the absolute number of water wells sampled increased, the MTBE concentrations detected were fairly low (less than 10 ppb on average), and the percentage of systems impacted remained remarkably stable over the last five years. Contrary to popular perception, the situation is not getting worse: MTBE was for instance generally detected in only one or two consecutive years, in drinking water sources sampled for three to five consecutive years.

In Denmark, the only European country claiming to be impacted by groundwater contamination, the level of occurrence of MTBE contamination is more comparable with other European countries (e.g. the UK, Germany, Finland, the Netherlands) than with the United States. The remediation sites identified by the Danish authorities are by definition old retail sites, equipped with traditional equipment and technology.

### **How does Europe compare to the USA ?**

The American situation is unique and it cannot be assumed that groundwater problems experienced in the United States will automatically be repeated in Europe. A direct comparison between the US and EU situations is not justified because of essential differences in economic structure, technical equipment and aquifers. Specifically, the major differences are:

- In the USA, detection tolerances mean that a spill of up to 5 gallons of gasoline per tank, per day (18.9 litres/tank/day) is possible at service stations. A leak of that amount would not be tolerated in Europe.
- In the USA, high volume delivery is achieved by pumping gasoline under pressure from the storage tank to the dispenser unit. In the EU, gasoline is usually "sucked" from the storage tank. The whole of the dispensing system is not pressurised, making extensive leaks much less likely.
- Gasoline is considerably cheaper in the USA, essentially because of the very low level of taxation. In addition to environmental concerns, Europeans have a strong

economic incentive to prevent leakage, because of higher taxes on gasoline in the EU.

- In the USA, important economic interests in favour of alternative octane enhancers, such as ethanol, are driving the campaign against MTBE.

### **Some people are saying that MTBE moves fast in soil and degrades very slowly in natural conditions. Are they right ?**

In certain hydrogeological conditions, MTBE moves faster through the soil than other gasoline components. However, every compound in gasoline can end up in drinking water supplies, if tanks leak. Not using MTBE does not solve the problem of leaking tanks, and of other compounds that also risk ending up in drinking water supplies.

In some ways, the mobility of MTBE can be seen as an advantage. MTBE's strong taste and odour are easily detectable. Even in minute quantities, its presence will deter people from drinking water contaminated with gasoline, thus acting as an early warning signal. When MTBE is not used, gasoline could enter the drinking water system unnoticed for some time.

MTBE does degrade slowly in natural conditions, eventually forming carbon dioxide and water. The process can be speeded up by oxygen feed, nutrients and microbe augmentation.

### **Would it not be safer just to phase out MTBE ?**

Phasing out MTBE would not solve the problem of leaking tanks. There is no justification for attributing the issue of leakage solely to MTBE, while ignoring other gasoline components. Besides, phasing out MTBE is not that easy. The situation in California shows how difficult it is. Although California has decided to phase out the use of MTBE by 2003, the state actually uses more MTBE now than when it decided on the ban. This is because MTBE is a compound with a lot of technical advantages, which helps produce a cleaner-burning gasoline.

### **How easily biodegradable is MTBE ?**

It is often alleged that MTBE is a persistent substance in soil and groundwater, yet research has demonstrated that aerobic decomposition occurs in natural conditions. Anaerobic decomposition of MTBE is slower, but in many cases the situation can be readily improved by oxygen feed, nutrients and microbe augmentation.

### **Can releases of MTBE in soil and water be cleaned up ?**

Yes, MTBE contamination can be cleaned up in the soil and water by using a large array of well-proven remediation technologies such as air stripping, granular activated carbon (GAC), advanced oxidation, and soil vapour extraction (SVE).

Traditional "pump and treat" technologies available for water plants have been proven effective in remediation of gasoline-contaminated water, even if it contains MTBE. In the event of a contamination incident, activated carbon cartridges installed at the tap could be utilised as a temporary solution. These household filters have been commonly used for many years by private consumers to remove off-taste and odour from drinking water, and the devices work well for gasoline components, including MTBE. No matter what method is used, the key issue in groundwater remediation is immediate action to eliminate the contamination source, usually a piece of leaking equipment or contaminated soil.

Nevertheless, gasoline does not belong in soil or groundwater, with or without MTBE. The problem must - and can - be solved by cool-headed and sensible co-operation between the oil companies and the authorities. The steps that need to be taken include:

- eliminating past contamination on a risk-based assessment basis, using proven remediation technologies;

- upgrading retail sites to high environmental standards;
- developing responsible attitudes and practices to prevent further contamination due to technical systems and operational failures;
- minimising the impact of accidental releases by immediate intervention.

Again, the problem of MTBE in groundwater is not inherent to the product itself, but has arisen from the way the product has been handled.

### **What are the consequences of car pollution on human health ?**

Numerous studies and reports have been undertaken in Europe and in the USA to determine the impact of car emissions on human health. The results are alarming. In Europe, the 1999 WHO report on Health costs due to road traffic-related air pollution revealed that car-related pollution kills more people than car accidents in the three European countries where the study took place (Austria, France, Switzerland). The main findings of this report were:

- long-term exposure to air pollution from cars in adults over 30 years of age caused an extra 21,000 premature deaths per year from respiratory or heart disease. This is more than the total annual deaths from road traffic accidents in the countries studied (9,900)
- each year air pollution from cars causes 300,000 extra cases of bronchitis in children, plus 15,000 hospital admissions for heart disease, 395,000 asthma attacks in adults and 162,000 attacks in children

To address this issue, further improvements in vehicle technology, traffic management schemes, better public transportation and vehicle inspection programmes are all possible long-term solutions. One of the simplest, quickest and most cost-effective ways to produce cleaner air is to use cleaner fuel, as has been demonstrated by the experience of clean-air programmes in North America and Europe.

### **Is MTBE safe ?**

The human health impact of MTBE has been extensively studied, with the first tests screening health risk conducted over 30 years ago. Based on all the available evidence, MTBE has never been classified as carcinogenic by any regulatory body anywhere in the world.

In addition to research on the possible carcinogenicity of MTBE, there have been numerous toxicological studies. The weight of scientific evidence shows that MTBE has a low order of acute and sub-acute toxicity. It is not teratogenic, mutagenic, neurotoxic, nor is it a reproductive toxicant. The WHO International Programme on Chemical Safety (IPCS) says that "based on collective evidence, it appears unlikely that MTBE alone induces adverse acute health effects in the general population under common exposure conditions."

### **Does MTBE cause cancer ?**

No. In 1998 the International Association of Research on Cancer (IARC), which is a part of the World Health Organisation, classified MTBE in category 3. The scale is from 1 to 4. A substance in Group 3 is "not classifiable as to its carcinogenicity to humans". This means that there is not sufficient data to claim a possible cancer risk to man from exposure to MTBE.

N.B : IARC classifies all substances it examines in four different categories:

Group 1: Substances that are human carcinogens (e.g. asbestos, benzene, and alcoholic beverages)

Groups 2A/2B: Products in these groups are probably/possibly carcinogenic to humans (e.g. PCBs, hypochlorite salts)

Group 3: A substance in this group is "not classifiable as to its carcinogenicity to humans". MTBE belongs to this group, as well as caffeine, nylon and talcum powder, for instance.

Group 4: This category groups products that are 'probably not' carcinogenic to humans. Today there is only one substance belonging to this group, caprolactam.

A number of other well-respected organisations have reached a similar conclusion. The US National Toxicology Program does not include MTBE as a material "reasonably anticipated to be a human carcinogen." According to California Proposition 65, MTBE is not considered as a carcinogenic or reproductive hazard. The European Centre for Eco Toxicology and Toxicology of Chemicals (ECETOC) says that MTBE is not carcinogenic according to criteria in the EU Dangerous Substances Directive 67/548/EC.

Very recently, in November 2000, the European Union "Working Group on the Classification and Labelling of Dangerous Substances" examined the status of MTBE in a meeting of the relevant Competent Authorities of the 15 Member States held in Ispra (Italy). This meeting of experts resulted in the European Union deciding that MTBE will not be classified as a carcinogen, mutagen or reproductive toxin

### **What happens if someone drinks water containing MTBE ?**

Drinking water containing small quantities of MTBE does not cause any adverse health effects. In any case, should it reach drinking water, MTBE would quickly attract public attention to a gasoline leak because, like all ethers, it has a strong taste and odour, and is detectable at very low levels of concentration. In view of this, the US EPA has recommended an MTBE concentration in drinking water within the range of 20 to 40 ppb or below. These quantities are 20,000 to 100,000 times lower than the lowest concentration that has caused observable health effects in animals, thus ensuring not only consumer acceptance, but also an exceptionally large margin of safety from any possible toxic effects.

Still, should the precautionary principle not dictate that MTBE be phased out from gasoline?

The Precautionary Principle is a cornerstone for the development of environmental policies in the European Union. EFOA recognises the Principle as an excellent framework for decision-making on solid scientific grounds.

The Precautionary Principle should be applied when there is "sufficient likelihood" that serious or irreversible damage to health or the environment would occur. This is completely in line with the Principle as stated in the Rio Declaration, which calls for a science-based approach with control measures that are commensurate with the defined risk.

A prerequisite for the application of the Precautionary Principle is a scientific risk assessment, identifying the degree of scientific knowledge on the issue in question, possible uncertainties, risk acceptability and risk reduction measures. In the EU, this is a strictly defined and comprehensive process, which will result in regulations that are proportionate to the environmental objectives to be achieved, and will provide a balanced approach to regulation.

The Risk Assessment Report is finalised and was published in the Official Journal of the European Union on 4th December 2001. It is the most appropriate instrument that will enable the European Union to determine the best course of action concerning the continued usage of MTBE in the EU.

To this end, EFOA concurs with the European Commission and other authorities that the Risk Assessment Report constitutes the objective and scientific basis on which any further regulation on MTBE might be considered.