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This document is circulated on behalf of OICA
for GRPE information regarding
the evolution of fuel quality

ACEA Position on Metal Based Fuel Additives

November 2001

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1. Introduction

With the increasing stringency of current and future emission legislation, significantly enhanced in-use requirements and the ACEA voluntary CO_2 reduction commitment, the issue of fuel quality remains of paramount importance.

One of the Industry concerns is the risks posed by the use of metallic fuel additives, primarily as octane enhancers.

It is possible that some of the Oil Industry are contemplating the use of additives such as ferrocene (iron) and methyl cyclopenta dienyl manganese tricarbonyl (MMT). These substances have come to prominence following the phase-out of lead in gasoline. While having a lesser immediate impact upon the proper operation of modern emission control systems than lead poisoning, experience shows that significant deleterious effects are associated with the use of these materials over time.

Experience in other territories suggests that the use of MMT is not compatible with current emission control and on-board diagnostic systems. Of even greater concern is the impact of metallic fuel additives upon the new and emerging technologies, designed to satisfy future environmental legislation.

2. Technical concern related to metal based fuel additives:

Spark Plug fouling

General Motors (GM), and others have reported spark plug fouling with both MMT and Ferrocene, the former predominately in Canada, and the latter in areas of the former Soviet Union. Reports indicate that spark plug failures are due to iron and manganese deposits on the plug insulation and electrode, resulting in:

- Increased hydrocarbon emissions from the incomplete combustion of fuel
- Catalyst damage from consequential substrate overheating
- Premature component failure (e.g. plug replacement) at circa 10 000 km, where normal life would be more than 100 000 km – see attached report, video evidence also available.

OBD Impact

European EURO 3 emission requires the fitment of on-board monitoring of emission control systems. Where premature failures, such as described above are identified by the system, the system's sensors are often contaminated and cause the false illumination of the malfunction indicator lamp (MIL). To the extent that false MILs become a common problem, the confidence of the motoring public in the system will be seriously undermined.

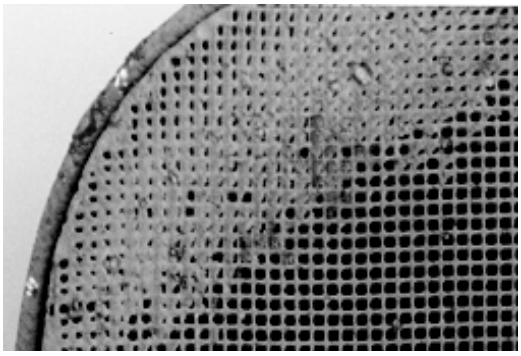
MMT can also mask a deteriorating or failed catalyst, preventing the on-board diagnostic catalyst monitoring system from identifying the failed converter. OBD systems sense the catalyst's ability to store oxygen for the conversion process (known as the oxygen storage capacity) and infer the efficiency or "health" of the converter. Oxygen that is used in the conversion of the exhaust gases is stored and transferred via the surface of the catalyst coating. MMT also has the ability to provide oxygen storage. When MMT is deposited on the surface of a catalyst, it can provide enough oxygen storage activity that the catalyst monitor will interpret the unit as operating normally. Unfortunately, that oxygen (stored as manganese deposits) is NOT available to the catalytic conversion process. In the event that a catalyst becomes damaged or fails, the presence of MMT in the system can cause a false reading by the OBD system, potentially allowing a failed catalyst to go unnoticed and unrepaired.

Heated Exhaust Gas Sensor (HEGO) or Lambda sensor

Deposits of manganese and iron affect the sensor, thus corrupting the vital control of the air to fuel ratio. This generally results in a rich bias, compromising both emissions and fuel economy (CO_2).

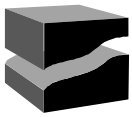
Catalyst plugging.

There is considerable visual evidence (photographs, video, and actual components) that the use of MMT causes catalyst plugging—two examples are shown below.



Valve deposits

Metallic-based fuel additives can create deposits on valves, which in turn may cause emission and drivability concerns due to a hydrocarbon absorption/de-sorption process, which causes control aberrations. MMT and Ferrocene are both associated with increased valve deposits.



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New technologies

New technologies such as gasoline direct injection, catalytic/DeNox traps filters are largely untested with such additives. The majority of work conducted on these additives is predicated on relatively high emission vehicles designed to meet now obsolete standards. New more stringent standards either in force (EURO 3) or projected to come into force in the near future (EURO 4 –2005) leave absolutely no room for deterioration due to metal additive poisoning.

Reference fuels

Legislation requires manufacturers to demonstrate product durability over 80 000km (soon to be 100 000km). This demonstration is achieved using fuels of defined specification – nominally typical of market place product. Such fuels are necessarily free of metallic additives. Vehicles developed on such reference fuels should not therefore be tested, or run, on fuels containing metallic additives.

In-use compliance

Unlike lead poisoning, the effect of Ferrocene and MMT has been apparent only after the accumulation of several years average mileage. Like lead, these effects are irreversible. This is unacceptable at a time when in-use requirements are becoming increasingly stringent. Emission problems would not necessarily appear until a relatively large mileage had been achieved, and a large number of affected vehicles had been sold.

The emission related effects are:

- Increased hydrocarbon emissions
- Increased carbon monoxide (CO) emissions
- Decreased NO_x emissions in some cases – probably due to MMT affecting the oxygen sensor and thus richening the air/fuel mixture and, in addition, impacts on combustion chamber deposits.
- Increased fuel consumption, CO_2, and particulate emissions – especially for manganese.

Diesel vehicles with particulate filter

The use of the particulate filter on diesel-engined vehicles represents a new exhaust post-treatment technology, which removes solid particles from the exhaust gases. The regeneration or cleaning of the particulate filter is enabled by the on-board introduction of specific additives into the fuel in the vehicle fuel tank through a closed system.

The ash formed by the use of the specific additives is trapped in the particulate filter and does not pose a risk to the environment or to the engine. In these circumstances, the use of ash-forming additives may be accepted, when used exclusively with a particulate filter.

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3. Situation in the US and Canada

The extent to the legal use of MMT in North America has become confused. Initially the USA and Canada sought to ban the use of MMT, following representations from the Motor Industry - who had become alarmed at the increasing incidence of premature catalyst and sensor failures. This lead Canada to ban the importation of MMT, but this was successfully challenged as improper trade legislation. Before considering any further action with respect to fuel additive regulation, Environment Canada is now waiting for the results of the industry test programme.

The Industry Programme, which included GM, DaimlerChrysler, Ford, Honda and VW, has been conducted in two phases, the first examining Tier 1 and a few Low Emission (LEV) technology vehicles, and the second concentrating on solely LEV. This is a massive exercise, probably the largest ever conducted by the Industry. Results from both are expected late 2001/early 2002.

In the USA, as a result of court decisions, Ethyl received a waiver enabling it to market MMT despite the objections of the Environmental Protection Agency. EPA is also waiting for the results of the above-mentioned Programme and another speciation and critical health effect study, being conducted by the maker. A more detailed description of the US regulatory experience is reported in Annex I.

EPA may take further regulatory action if new data indicate that MMT has harmful effects on vehicle emissions or human health.

Reports that MMT is “widely used in U.S fuels” are misleading, as surveys over a number of years have not detected its use in pump fuels. It is however, available as an additive, intended to boost octane, and sold through accessory outlets in bottles.

Meanwhile the use of MMT is banned in California Phase 3 Reformulated fuels and in EPA Phase 2 fuels, both of which are mandated for use in air quality non-attainment areas.

One should also bear in mind that the North American experiences cannot be directly translated into Europe. In fact there are differences between US and European technology, European engines are typically smaller, and use higher speed and load factors than US product. Similarly European catalysts tend to be smaller and fewer. Experience suggests that the effects of metal additives will therefore be greater in the European environment. This would also apply to other components such as sensors and spark plugs.

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4. Conclusions

The Motor Industry believes that substantial emission system risks exist related to the use of metallic additives. Now that the catalyst poisons lead and sulphur are finally being eliminated, we believe the potential addition of other metallic compounds to fuels is a retrograde step, having great risk to current and future European air quality strategies and vehicle technologies.

In light of the concerns identified above, we believe it would be prudent to prohibit the use of metallic fuel additives at this time. While motor industry opposition to the use of MMT and ferrocene is absolute with respect to its use in catalytic equipped product, no such concern, other than any potential health risk, exists with respect to its use in non-catalyst equipped product. Nevertheless, also in the case of old cars with non-hardened valve seats, ACEA member companies agreed that potassium-based additives are the best solution to protect engines against valve recession once the lead has been removed.

If further study demonstrates that, European vehicles under European operating conditions, such additives do not increase vehicle emissions (including CO_2), this could be reconsidered in the future. The co-operative Programme described in this document will contribute to our understanding of the effects of MMT, although it should be remembered that European conditions and vehicles differ from those employed in that programme.

In the event that such material is permitted in market fuels, Industry will NOT accept responsibility for subsequent in-use compliance failures where such materials were involved.

Attachments:

- North American Regulatory Experience
- MMT: emission controls – AECC presentation at the IPIECA meeting, 11.09.2001 (fuels n°223 dated 18.09.2001)
- DELPHI: Plugged Z18XE catalyst – Failure investigation report
- DELTA motor corporation response to the SASOL report of 23.05.2001 and the ETHYL report of July 2001
- FORD Motor Company – The fuel additive ferrocene
- WWFC
- ACEA position paper on MMT (1997)

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Annex I

North American Regulatory Experience

In 1977, Congress effectively banned the use of a number of fuel additives, including MMT, in unleaded gasoline. Such additives could be used only if they were approved by EPA under a waiver process set forth in the Clean Air Act.

In the late 1970s, California also prohibited the use of MMT in gasoline in the state. A sunset review of this regulation in 1998 reaffirmed its prohibition.

In 1990, amendments to the Clean Air Act prohibited the adding of manganese to federal reformulated gasoline[1]. This is the gasoline that must be used in the nine worst air quality areas of the U.S. Consequently, about 30% of all gasoline sold in the U.S. cannot contain MMT.

Prior to 1991, Ethyl submitted three applications for a waiver to market MMT. Two of these were rejected by EPA, and the third was withdrawn.

Ethyl's fourth waiver application was submitted in 1991. EPA initially denied the waiver on the grounds that MMT hinders the performance of emission control devices; the agency later reversed its decision on this issue.[2] EPA continued to deny the waiver based on concerns about MMT's potential health effects, and Ethyl filed suit challenging this decision.

In 1995, as a result of two court rulings, EPA was forced to grant a waiver for MMT. The courts held that EPA had no authority (under the section of the Clean Air Act used by EPA) to deny a waiver for MMT on the basis of concerns about the additive's health effects.

According to news reports, the EPA Administrator granted the waiver for MMT reluctantly, saying that "We...continue to have health concerns [about MMT]."

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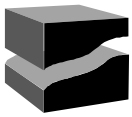
[1] This prohibition is subject to a separate waiver process for federal reformulated gasoline. To date, no one has sought a waiver for the introduction of manganese-based additives into federal reformulated gasoline.

[2] EPA stated that MMT "will not cause or contribute" to failures of emission control systems, and Ethyl quotes this statement at every opportunity. However, the analysis which led to this conclusion was flawed. EPA was presented with data from Ford showing substantial increases in HC emissions due to MMT usage, 1988 data from Ethyl indicating several model failures for HC and CO, and 1992-93 data from Ethyl indicating little or no MMT-induced emission increases. EPA officially evaluated this data using extremely lenient statistical criteria that, by EPA's own admission, are "obsolete". Although there were four HC failures and five CO failures out of 19 engine families tested, EPA's overly conservative criteria would have required at least 13 out of 19 engine families to fail the emissions standard for MMT to fail the overall test. EPA then employed a more rigorous test for illustrative purposes but subjected only the more favorable 1992-93 Ethyl- generated data to this test. EPA has acknowledged the inadequacies of its approach and stated its intention to develop more reasonable statistical criteria for the future.



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Under the Clean Air Act, testing of the health effects of MMT must continue over the coming years. EPA still has the authority to regulate or prohibit the use of MMT if tests demonstrate that MMT causes health problems or interferes with emission control systems.

Therefore, while it is now legal in the United States to sell MMT in conventional unleaded gasoline, there has been no determination by the government that MMT is safe. In fact, the U.S. EPA has made it clear that it would have denied the waiver for MMT due to health concerns if it had the power to do so under the law.

Presently, the Environment Protection Agency are waiting for the results of the Industry test Programme and another speciation and critical health effect study, being conducted by the maker.

It is entirely possible that EPA may take further regulatory action if new data indicate that MMT has harmful effects. Therefore, it would be premature to assume that the recent court decisions represent a final resolution of the MMT controversy in the United States.

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