M15 Methanol Gasoline Blends
35 Years of Research and Experience Supports Its Use

Summary
Developed as a low cost means to quickly reduce dependency on crude oil with minimum infrastructure investment, the blending of gasoline (petrol) with 15 volume percent methanol (M15) has been extensively investigated globally by automakers, oil companies, and governments with a number of in-field vehicle fleet trials comprising large numbers of vehicles and significant laboratory research over the past 35 years.

M15 fuel blends had been chosen as the optimal blend concentration, since they were determined by the auto industry and by the oil industry to be the highest methanol blends that could be conveniently introduced into the gasoline marketplace with no significant loss of performance, or with little or no modification required in the fuel system materials being used in the vehicle fleet during the early 1980s (e.g. vehicles with mostly carbureted/non-pressurized fuel systems). The results from these early fleet trials had shown that minor upgrades in some non-metal materials—along with the use of corrosion inhibitors and some co-solvent alcohols for increasing water tolerance—would provide satisfactory performance in carbureted fuel systems, as long as the methanol fuel blend volatility characteristics were controlled. These earlier studies had also found that the performance of vehicles with injector (pressurized) fuel systems were relatively insensitive to the use of M15 fuel.

Based on this earlier experience, the fuel system component suppliers have since upgraded their materials (non-metals) to be compatible with M15 methanol fuel blends. Automakers have also upgraded their vehicles to fuel injector systems, which essentially allow vehicles produced within the last 20 years to perform well on M15 fuel blends as long as sufficient corrosion inhibitors and some co-solvent alcohols are added to chemically and physically stabilize the M15 fuel blends for commercial use.

Although commercial interest in M15 fuel blending declined globally in the mid-1980s, when the price of crude oil collapsed below US$20 per barrel, the large increase of crude oil prices since 2004 has re-established commercial interest in M15 fuel use in markets like China, because of very favorable economics. In addition to reducing crude oil use, methanol’s clean burning octane and oxygen content also help reduce vehicle air pollution emissions such as carbon monoxide, hydrocarbons, air toxics and PM (particulate matter) from existing vehicles on the road today.
Summary of Experiences:

- Number of earlier large, in-field vehicle fleet studies with M15 fuel blends in New Zealand, Germany, Sweden, and China identified no significant barriers for its use in the on-road vehicles of the 1980s.

- Automotive parts and material suppliers have since upgraded fuel system material formulations to be essentially compatible with M15 fuel blends, following the introduction of methanol blends during the 1980s and the establishment of M15 as a screening fuel for material selection in fuel systems as per guidelines developed by automotive engineers in the 1990s.

- Vehicle engine fuel efficiency generally improves by one to two percent for M15 blends (on energy basis) which allows M15 to reduce petroleum energy use in gasoline by up to 9 or 10%.

- U.S. EPA (Environmental Protection Agency) and others had determined that the toxicity, safety and hazard risks of using methanol fuels to be similar or less than that of conventional gasoline.

- China automakers provide no cautionary statements against the use of M15 (or E10) in their recent vehicle owner manuals.

- China university studies on engine emissions and efficiency performance with methanol blends have not identified any degradation when switching to M15 fuel blends.

Earlier Fleet Studies: M15 Operates Satisfactorily in Unmodified On-Road Vehicles

A number of fleet studies during the late 1970s and early 1980s that were conducted with large numbers of vehicles over one or more years of operation indicated that M15 fuel blends provided satisfactory performance with little or no significant modifications of the on-road vehicles. These large regional studies included Germany (~1000 vehicles), Sweden (~1000 vehicles), New Zealand (~950 vehicles), and China (~500 vehicles). [Ref. 1-10]

The M15 fuel in the programs generally used small amounts of co-solvents alcohols (typically one to three percent volume) to provide sufficient water tolerance or cold-temperature phase stability, and the addition of inhibitors (fuel additives) to maintain corrosion resistance. Although older vehicles with older technology carbureted fuel systems (non-pressurized) observed some drivability performance to be sensitive to higher fuel volatility increases associated with methanol addition to gasoline, these earlier studies also observed that the drivability performance of vehicles with newer technology fuel injector systems (pressurized) was relatively insensitive to the addition of methanol and higher volatility to the gasoline.[Ref. 2, 3 & 11]

Since the mid-1990s, most of the global automakers have now transitioned their vehicle production from carburetors to fuel injection systems, which suggests that M15 will have little drivability performance impact with vehicles currently on the road today.
A number of these studies that also evaluated fuel efficiency observed that it generally increased by one to two percent with the M15 fuel blend. [Ref. 1, 7, 8, 10, 12 & 13] Therefore, even though the theoretical energy content of methanol is equal to about 50% of typical gasoline on a volume basis, the fleet trial experience in these studies suggests that the M15 fuel blend performs as though the methanol contains energy equivalent to a higher 60 to 65% of typical gasoline energy content such that M15 can essentially replace up to nine to 10% of the petroleum used in gasoline.

**Improved Fuel System Materials Provide Methanol Fuel Blend Compatibility**

Early laboratory research and fleet studies found corrosion inhibitors to be effective in controlling the corrosion tendency of M15 fuels. [Ref. 5 & 7] However, these early fleet field studies found that a few of pre-1980 vintage elastomers used in parts of these older vehicle fuel systems could experience shortened service life, but were easily upgraded with available higher quality elastomeric replacement materials in the vehicle fuel systems.

During the early 1980s, the part suppliers (OEM’s) and automakers evaluated and screened the commonly available elastomers and plastics for compatibility with the alcohols blends (methanol and ethanol), and then publicly shared this knowledge [Ref. 11-13] with automakers for use in engineering design selections of fuel system materials in newer vehicles as well as for the fuel system replacement parts. Following the 1980s, the fuel system parts and elastomer suppliers then developed and provided more durable elastomer formulations that better tolerated M15 gasoline blends in addition to other alcohol blends.[Ref. 14-20] In the early 1990s, automakers developed SAE (Society of Automotive Engineers) guidelines that recommended using a M15 gasoline blend as the key screening reference fuel for selecting the materials to be used in the new vehicle fuel systems.[Ref. 24-26] Therefore, as long as the automakers and OEM’s of fuel system components have been following their own SAE-recommended industry guidelines for selecting fuel system materials, the elastomer and the plastic fuel system materials being typically supplied to the automakers since the early 1990s should essentially be fully compatible with gasoline blends containing up to 15% methanol.

In early 2012, U.S. Environmental Protection Agency (EPA) approved the use of two additional commercial corrosion inhibitor additives to be used in the Octamix Fuel Waiver formulation (methanol gasoline blend) as a result of not receiving any unfavorable comments of inadequate corrosion protection for metals found in vehicle fuel systems.[Ref. 27-28] The EPA approval essentially reaffirmed
the basis of the Octamix Methanol Blend Fuel Waiver that properly blended methanol blends with sufficient corrosion inhibitors and co-solvents would not contribute to a shortened service life of vehicle fuel system materials, or to increases in vehicle emissions.

Fuel Use of Methanol Determined as No More Hazardous or Toxic than Gasoline

With the growing interest of methanol fuels during the 1980s, the U.S. EPA evaluated the toxicity, safety, and hazards of handling and using methanol fuels (M85 and M100) as vehicle fuel, and had determined that the health and other risks of methanol fuels to be similar or even less than that of conventional gasoline.[Ref. 29-31] Although the EPA did not evaluate low level methanol fuel blends (like M15 or M5), the exposure risks of lower methanol content fuels were expected to be less than using M85 fuel blends evaluated by the EPA. During their evaluations, the EPA found that any potential estimated methanol exposures would safely fall within the health risk criteria for methanol. Because of the lower methanol content, the methanol exposures with low level methanol gasoline blends (M3-M15) would expect to be much lower than that estimated for M85 fuels by at least a factor of five (5).

Other authorities have also evaluated the potential health risk exposure to methanol when used as a fuel or fuel blending component, and have also found a large margin of safety.[Ref. 32-35]

In addition, as part of their large M15 vehicle fleet trials, New Zealand authorities had reviewed the toxicity and hazard risks associated with methanol fuels, and also had determined methanol in fuels to have similar or lower risks than that of gasoline.[Ref. 4]

When evaluating M15 fleets in China, various China authorities went even further by actually measuring time weighted methanol exposure of personnel in the methanol blend supply chain, and the vehicle drivers and vehicle mechanics. They found that the measured methanol exposures for all personnel fell safely within the health risk exposure standards for methanol.[Ref.36-38]

In the unlikely case of a methanol spill or methanol fuel blend leak into surface waters or ground waters, the exposure risks were estimated to be very low, due to relatively short half-lives for methanol in the water environment. This is a result of methanol’s relatively high biodegradability. [Ref. 39-40]

In 2003, Ford reviewed all the potential benefits of methanol as a preferred, safe, and sustainable fuel in the future, and supported the EPA’s risk review that methanol as a fuel did not present a higher health risk than gasoline.[Ref. 41]
Performs Better Than Gasoline

To support the recent commercialization of M15 fuel in China, a number of Chinese universities conducted additional studies to evaluate M15 performance in newer engines and emissions control systems. [Ref. 12, 42-46] The studies found that the engine performance, emissions, and fuel efficiency with M15 were generally equal to or better than those operating with gasoline.

The vehicle emission studies found that M15 gasoline blends generally reduced vehicle exhaust emissions of VOCs (volatile organic compounds) and CO (carbon monoxide) by 10 to 15%. Also, an emissions test suggested that PM (particulate matter) in the vehicle exhaust might be reduced by over 70% with M15 fuel blends. [Ref 47]

China’s Favorable M15 Market Experience

In the case of China’s goal to reduce its dependency on imported crude oil, the number of provinces that have been commercializing M15 blends has grown significantly since 2004, when the global price of crude oil began ascending from less than US$40 per barrel up to US$100 per barrel and higher. Although M15’s use and experience have been widely expanding since 2004, China domestic automakers have not found it necessary to add any cautionary statements on methanol in their vehicles’ owner manuals, even though the fuel system materials are likely the same as those in other global markets.[Ref. 48-49] China’s successful experience with commercializing and growing the M15 fuel blend market in the existing vehicle fleet without need for modification has been investigated and summarized by the IAGS (Institute for the Analysis of Global Security). [Ref. 50]

REFERENCES:

(1) “Technical and Economical Aspects of Methanol as an Automotive Fuel”, SAE 760545, A. Koenig, W. Lee & W. Bernhardt, Volkswagenwerk AG (Germany)


(3) “Methanol-Gasoline Blended Fuels in West Germany – Specification and Early Field Experience”, B. Nierhauve, ARAL Research Center, West Germany, Proceedings of the IV International Symposium on Alcohol Fuels Technology, Brazil, October 1980, Volume 1, pgs 319-324


(6) “Road Trials to Assess the Hot Weather Driveability Characteristics of Gasoline Containing Oxygenates in European Cars”, SAE 831706, F.H. Palmer (BP Oil) & A. Tontodonati (ENI), SAE 1983

(8) “Vehicle Operating Experience with Methanol as a Substitute for Petrol and Diesel”, SAE 830899, R.J. Joyce, et.al., Liquid Fuels Trust, New Zealand, 1983


(10) “A Review of the Study on Alcohol Fuels for Automotive Engines’, SAE 890433, Chen Xiaofu, Shanghai Automobile and Tractor Research, Shanghai, China, 1989


(13) “Energy Efficiency of Oxygenates from Their Production to Their Engine Use’, SAE 830384, A.W. Preuss, VEBA OEL AG, West Germany, 1983


(15) “Effects of Mixtures of Gasoline with Methanol and With Ethanol on Automotive Elastomers”, SAE 800786, Ismat A. Abu-Isa, General Motors Research Lab, 1980


(20) “Leak Prevention of Reformulated Fuels and Oxygenates”, DuPont Elastomers, H-42581, October 1993


(22) “Development in fuel hoses to meet changing environmental needs”, J.R. Dunn, Rubber World, March 1, 1994


(26) SAE J1681-2000, Surface Vehicle Recommended Practice: Gasoline, alcohol, and diesel fuel surrogates for materials testing, issued 2000
No. 240 / Wednesday, December 14, 2011 / Notices; Regulation of Fuel and Fuel Additives: Modification to Octamix Waiver. Spirit of 21st Century LLC submitted a request to U.S. EPA to modify the waiver. The new request seeks approval on an alternative corrosion inhibitor, TXCeed, to be used within Texas Methanol’s gasoline-alcohol fuel, also known as OCTAMIX. EPA asked for comments on the petition.

Federal Register /Vol. 77, No. 13 / Friday, January 20, 2012 /Notices; Regulation of Fuel and Fuel Additives: Modification to Octamix Waiver, Baker Hughes submitted a request to U.S. EPA to modify the waiver. The new request seeks approval on an alternative corrosion inhibitor, TOLADTM MFA–10A, to be used within Texas Methanol’s gasoline-alcohol fuel, also known as OCTAMIX. EPA asked for comments on the petition.


“Methanol as an alternative transportation fuel in the U.S.: Options for sustainable and/or energy secure transportation”, L.Bromberg and W.K. Cheng, Sloan Automotive Laboratory, Massachusetts Institute of Technology, November 28, 2010


(47) “Comparison of PM emissions from a gasoline direct injected (GDI) vehicle and a port fuel injected (PFI) vehicle measured by electrical low pressure impactor (ELPI) with two fuels: Gasoline and M15 methanol gasoline”, B. Laing, et.al., National Lab of Auto Performance and Emission Test, Beijing Institute of Technology, Journal of Aerosol Science, 57 (2013) 22-31


(49) Chinese Automaker: Chery A3 2009 Vehicle Owners Manual

(50) Methanol Blending in China -Trip Report, Gal Luft, IAGS (International Analysis for the Global Security), May 2012