Special Report
Methanol in Gasoline

Since the energy crisis of the early 1970s, a great deal of research has been done into ways America can reduce its dependence on foreign sources of oil and extend our domestic oil supply. Grain alcohol, "gasohol," was one development to come out of that crisis. The use of methanol as a high-octane blending component was another.

Unfortunately, in some areas methanol was misused. It caused problems like stalling and rough idling, and has raised concern that improper blends may damage engine parts and components. As a result, methanol/gasoline blends became suspect, and the dramatic, positive potential of this abundant and relatively inexpensive fuel was threatened.

The fact is that, when properly blended and used with a co-solvent, or stabilizing agent, to enhance its integration with gasoline, methanol is a clean, high-energy fuel that could extend America's supply of gasoline by 5 to 10% without any adverse effect on the consumer's automobile.

The development of methanol as a high-octane blending component was a result of the oil embargoes of the 1970s. Methanol can help keep gas lines from returning and reduce our dependence on foreign oil.
Why Methanol

Those who object to the use of methanol are often unaware that it has been in their gasoline for years. It is used in small quantities in many gasolines as a deicer or anti-freeze. And those who say it won't work as a fuel don't know — or ignore — that methanol is widely considered "the fuel of the future," and that it is expected one day to be the sole fuel for millions of cars and trucks designed to use it. In fact, for years methanol has fueled Indianapolis-type, high-performance race cars.

The reasons we should be moving ahead with methanol as a blending component in the gasoline we use today lay in three areas: energy, environment, and economics.

Energy

Worldwide supplies of oil are dangerously finite, and the embargoes of 1973-74 and 1978-79 dramatically illustrated not only how dependent we are on the volatile Middle East, but also just how limited America's own crude oil resources are. A number of important steps, including simple conservation, have been taken since then to eliminate gas lines and reduce our dependence on foreign oil. But we cannot ignore the need to develop new energy sources for the future.

Methanol, which can be made from natural gas, coal, or even municipal solid wastes, is an alternate fuel America can have in abundance from domestic resources.

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Environment

Lead enhances the octane level of gasoline, but at the same time can contribute significantly to air pollution. As one part of a massive effort to improve our environment, the U.S. Environmental Protection Agency mandated a reduction in the lead content of gasoline. As a result, new cars are equipped with pollution control systems which cannot tolerate leaded gasoline. The Environmental Protection Agency (EPA) has recognized the value of a mixture of about 5% methanol and about 5% of a co-solvent or stabilizing agent called gasoline-grade tertiary-butyl alcohol (GTBA) as an octane-enhancing lead substitute for gasoline. In 1981, this blend of methanol and GTBA was granted an EPA waiver and therefore approved as a fuel additive in gasoline. This mixture has been found to reduce hydrocarbon emissions by 20% and carbon monoxide emissions by 40% over conventional gasoline.

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Properly blended methanol and GTBA, a co-solvent, reduce both hydrocarbon and carbon monoxide emissions.

Economics

Quite simply, the use of methanol as a gasoline blending component and octane enhancer would be good for the American economy. Currently, methanol costs significantly less than unleaded gasoline. That can be good not only for individual consumers, but for state and local economies as well. If we can keep the cost of energy, especially auto fuel, lower, consumers will have more disposable income to save, invest, or use to purchase additional consumer goods.

In concert with other conservation efforts, methanol along with co-solvents when blended into gasoline could expand our gasoline supplies by 5 to 10%. That means less domestic crude is used, less foreign crude is imported. That's good for our balance-of-payments. But just as importantly, the acceptance and widespread use of methanol would put more people to work in the coal industry, in conversion plants, in refineries, and in dozens of other related industries.

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The widespread use of methanol would put more people to work in mines, in conversion plants, and in dozens of related industries which would benefit every area of the nation.
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Atlantic Richfield Research and Testing

Atlantic Richfield Company has done extensive testing of methanol/gasoline blends, and the fact is that, properly blended and properly used, they have no detrimental effect on the performance of automobiles. Cars start as well, run as well, and get comparable mileage. There are no more or different mechanical problems when cars are run on proper methanol/GTBA/gasoline blend than there are when they are run on any other commercially-available fuel. In short, a consumer who has his car fueled with a correct methanol/gasoline blend rather than gasoline won’t even know it.

Before we introduced our methanol/co-solvent blend, trade-named OXINOL® blending component, Atlantic Richfield spent five years and more than $5,000,000 in laboratory and field tests to prove the viability of the product and to develop the procedures for properly using it.

Our testing with methanol/co-solvent blends looked at all aspects of vehicle performance, using fuel, governmental, and automotive industry-approved test methods. The testing studied vehicle driveability, fuel system component compatibility, long term engine wear, engine oil compatibility and vehicle performance.

sar-Gel™ water-alcohol-indicating paste was developed for use at gas stations to test for water in storage tanks.

Incorrectly blended methanol can react with gasoline in storage tanks and cause water separation. The GTBA co-solvent in OXINOL octane enhancer eliminates this problem.
Development of the Proper Blend

During the testing we studied a variety of methanol concentrations, co-solvent ratios and fuel blending techniques. The tests at the ARCO Petroleum Products Company's Fuels Research Center in Harvey, Illinois, confirmed that there is a very limited range of formulations that will make an effective methanol/gasoline blend. And almost no methanol blend will perform properly without a co-solvent like GTBA. Too much methanol can damage engine components. Too little has virtually no beneficial effect. ARCO ultimately discovered that about 10 (vol)% OXINOL component which contains about 5% methanol/5% GTBA is the optimum formulation today. It is the formulation that was granted an EPA waiver. In addition, fuels containing this blend can meet all present and proposed American Society for Testing and Materials (ASTM) criteria for an effective consumer product.

The Effect of About 10(Vol)% OXINOL Blends (about 5[vol]% methanol) on Automotive Fuel Systems - Laboratory Testing

Even with its advantages in economy, cost and energy independence, we knew methanol/gasoline had to perform as a quality fuel without damaging engine components, fuel systems, or pollution-control devices. And we knew that some automobile manufacturers were concerned about that.

To answer those concerns, we went to the major domestic automobile makers and made an extensive list of the many metals, plastics, and elastomers that are in use in today's automobiles. We conducted side-by-side soak tests using gasohol, gasoline, and OXINOL/gasoline blends. Each material was soaked for 30 days.

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<tr>
<th>Material Compatibility Eleostomers and Plastics</th>
<th>Material Compatibility Metals</th>
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<tr>
<td>Nitrile (NBR)</td>
<td>Aluminum Alloy</td>
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<tr>
<td>Viton (HK)</td>
<td>Copper</td>
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<td>Neoprene (Chloroprene)</td>
<td>Magnesium Alloy</td>
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<td>Hydrin 100—Homo-Polymer (CO)</td>
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<td>Hydrin 200—Co-Polymer (ECO)</td>
<td>1010 Carbon Steel</td>
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<td>Cork Gasket</td>
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<td>Polypropylene</td>
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<td>Nylon 616</td>
<td>Cartridge Brass</td>
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<td>Delrin (Acetal Polymer)</td>
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<td>Teflon (Perfluorocarbon Polymer)</td>
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<td>Terns Alloy (approximately 90% Pb, 10% Sn)</td>
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at 110°F, and each was exposed to vapors as well as soaking. For corrosion tests on the metals, no corrosion inhibitors were used in the fuels, to insure a “worst-case situation.”

In every case, the effect of the OXINOL blend was the same as the other fuels. In addition, Atlantic Richfield conducted a number of 50,000 mile durability tests, on standard dynamometer equipment, to simulate the effect of long-term use of the OXINOL blend on engine wear. Engine parts were scientifically measured before and after the 50,000 mile test. No unusual engine wear or deposits were found.

Long-Term Effects

Of course, we realized that lab testing, no matter how sophisticated, cannot fully duplicate actual over-the-road driving conditions. For that reason we had selected a 1979 Pontiac Grand Prix, a 1979 Oldsmobile Toronado, and a 1980 Toyota Corolla when they were new, and fueled them exclusively with the OXINOL-blended gasoline for over two years of normal driving. Mileage at the end of the test was 21,000 miles for the Pontiac, 80,000 miles for the Oldsmobile, and 51,000 miles for the Toyota. All parts of vehicle fuel system — the carburetor, fuel line, pump and filter, fuel tank and fuel float, and the EGR valve — were removed from the cars and carefully inspected. There was no corrosion or deterioration, the fuel tank termination was intact, and fuel system deposits were completely normal.

As part of OXINOL development, various materials were subjected to material compatibility tests. These aluminum “coupons” were soaked in (left) commercial gasoline, (center) 100% methanol and (right) 100% OXINOL.

None of the tests revealed any more or different effects on engine parts with OXINOL-blended gasoline than with commercial gasoline. This is the float and accelerator pump for a 1979 Aspen.

This carburetor bowl and choke from a 1977 AMC Pacer shows no detrimental effect from the use of gasoline with a proper blend of OXINOL blending component.

Market Test Studies

After the fuel passed these rigorous tests, we went to the marketplace for additional data. We supplied OXINOL-blended gasoline to Sun Oil Co. for their own consumer test while we did expanded testing with 100 service stations in the suburban Pittsburgh area. These were classic consumer tests in which the “driver off the street” who had purchased OXINOL-blended gasoline was surveyed by phone or questionnaire and asked about his car’s performance. The overall response was uniform and positive — more positive, in fact, than even we expected. In almost every case, consumers judged the gasoline/OXINOL blend to be as good as base gasoline alone for performance and driveability.

Extensive consumer market testing was done both by ARCO and Sun Oil Company. In virtually every case, consumers judged OXINOL/gasoline as good as gasoline alone for performance and driveability.
Field Experience Yields Know-How

These market tests also allowed us to look at factors affecting methanol blends in such key parts of the gasoline distribution system as pipelines, terminals and service stations. From the experience, we developed special but relatively simple procedures for refiners, blenders, and service station operators to successfully introduce methanol/gasoline into their systems. And we developed special products like OXINOL 30, a blend which "absorbs" excess water from gas station storage tanks, and Sar-Gel® special water indicating paste, which station operators can use to check tank water levels when alcohols are present.

Dozens of cars were used in controlled tests on methanol-blended gasoline. Three cars—a 1979 Pontiac Grand Prix, a 1979 Olds Toronado, and a 1980 Toyota Corolla were fueled exclusively with OXINOL-30 blended gas from the time they were new. After an average of 50,000 miles there were no adverse effects on the engine, fuel system or pollution-control devices.

Commercial Use

Following this limited test, we were confident this methanol blend could be handled trouble-free by service stations, so we expanded into a full-scale regional introduction of the product. Between January of 1982 and August of 1983, more than a quarter of a billion gallons of properly-blended methanol/gasoline were dispensed through 20 terminals to more than 2,000 service stations and into thousands of cars and trucks. This blend has been fully accepted by consumers as a quality fuel.

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The Importance of Proper Blending and Handling

Our research and market experience has shown methanol blends, if handled correctly, can provide a quality motor fuel. But what happens when they are improperly blended?

Lack of Co-Solvent or Stabilizing Agent

A problem arises when methanol is blended without the use of a co-solvent. Incorrectly blended methanol reacts with the gasoline and causes naturally-occurring water to separate out of the mixture. This is the source of most of the problems with methanol that have unfortunately been widely publicized. The water separates in the gas station storage tanks and accumulates at the bottom. When this water-rich mixture is pumped into an automobile fuel system, it causes rough idling, stalling, and other problems.

Water separation is the reason for the GTBA in correct methanol/gasoline blends. The gasoline-grade tertiary-butyl alcohol acts as a link between the gasoline and the methanol and virtually eliminates fuel separation.

Excess Methanol Concentration

Methanol, like any alcohol, adds oxygen to the motor fuel. Excessive methanol in the fuel causes “enleanment” of the air/fuel mixture. This mixture will not burn properly in the engine and can cause rough idling and poor acceleration due to loss of power.

In order to avoid these problems, Atlantic Richfield does not recommend methanol concentrations above 5 (vol)% in gasoline blends at the present time. Also, we do not recommend any methanol unless an equal amount of co-solvent is used.

Off-Spec Gasoline

All gasolines should be blended to meet state and/or industry specifications. When methanol is added to a finished specification gasoline, the fuel may no longer meet these standards. Methanol, like ethanol, will increase the volatility of the fuel, forming vapor more readily. If not corrected, this can lead to vapor pockets forming in the fuel line. These pockets cut off the flow of fuel to the carburetor. This problem, referred to as vapor lock, results in poor acceleration or vehicle stalling. Vapor lock can also occur in service station lines going to pump dispensers.

Because of this potential problem, Atlantic Richfield recommends that methanol plus co-solvent be blended with other gasoline blendstocks to produce a finished gasoline that meets all state and industry specifications. This recommendation is also a legal requirement of the waiver.
granted by the Environmental Protection Agency when OXINOL blends are used in unleaded gasoline. Unlike ethanol, which is often blended with specification gasoline to form gasohol, methanol should not be blended with specification gasoline. Gasoline product quality will suffer.

**Service Station Tank Preparation**

Before methanol blends are delivered to service stations, dealers must prepare their stations by removing free water from underground tanks and installing filters on pump dispensers to trap rust and dirt which the methanol may loosen from tank walls. The special water/alcohol paste must also be used during the introduction period to insure problem-free use.

Atlantic Richfield's experience has shown that if ASTM standards are followed when blending methanol into gasoline, and when the service stations are properly prepared, methanol blends can and have been used without any problem and will provide fully satisfactory performance for consumers.

**Controlling the Use of Methanol**

Atlantic Richfield recognizes that continued improper use of methanol in gasoline can result in negative consumer reaction and adverse government regulation. It is in the best interest of all parties to insure that only proper use of methanol occurs.

Fortunately, regulations and standards already exist which can be utilized to control the use of methanol blending. The U.S. EPA under authority of the Federal Clean Air Act of 1977, restricts the quantity and conditions under which methanol can be blended into unleaded motor fuels. Also, the American Society for Testing and Materials has issued specifications for automotive gasoline. States which have adopted and enforce these standards have had good experience with methanol-blended motor fuels. If other states were to adopt and enforce these same rules, then they would be able to deal effectively with fuel manufacturers who choose to use methanol improperly.
Methanol and the Future

One strong, clear fact stands out as a result of these years and miles and millions of dollars spent testing methanol in gasoline: if it is properly blended with a co-solvent, neither the consumer nor his automobile is adversely affected. And methanol/GTBA blends can have a wide range of positive effects on the American scene.

- Methanol blended into all gasolines would save us 500,000 barrels of crude oil every day.
- Development of resources for methanol production would add jobs, tax revenue, and increased development for almost every state in the nation.
- Methanol blends reduce carbon monoxide and hydrocarbon emissions without affecting the way a car performs or the mileage it gets.
- Methanol/gasoline blends can reduce costs to the consumer.

It is important, indeed critical, that the use of methanol in gasoline be understood by the public, by government, and by the media. Because of the wide range of materials that can be used to produce methanol, virtually every state in the nation stands to gain from its aggressive development as a fuel. Unfortunately, a few instances of negative publicity, which stem from problems of improper use of methanol, can have a devastating effect on the fledgling methanol fuels industry and could severely retard, if not destroy, its potential for the energy independence and economic health of America.

We should help, not hinder, the development of this fuel for America's future.

If it is properly blended with a co-solvent, neither the consumer nor his car is adversely affected by a methanol/gasoline blend. Over seven billion miles of driving have shown that.

Development of resources for methanol production would contribute to the economic welfare of almost every state, while reducing costs to the consumer.

The proper blending of methanol into gasoline could save us 500,000 barrels of crude oil every day, and dramatically reduce our dependence on foreign oil imports.
ARCO Chemical Company
Division of AtlanticRichfield Company

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