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## Use of Reformulated Fuel: Alcohol In Fuel Recommendations

NOTICE
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Revised October 2006.
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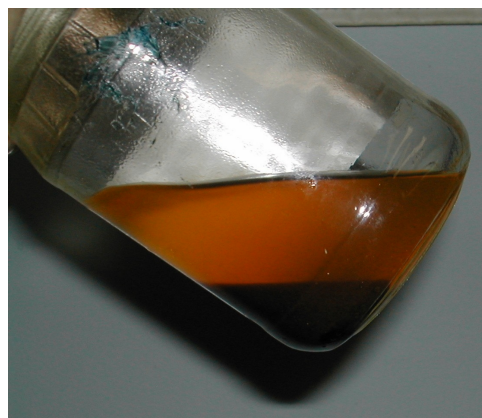
### Models Affected

All MerCruiser Gasoline Engines, Mercury Racing Gasoline Sterndrives (SMC 2006-10R1), Jet Drive, and Mercury/Mariner Outboards (SOB 2006-10)

### Situation

The use of alcohol in gasoline is increasing as an alternative to strictly petroleum-based fuel and used in reformulated oxygenated fuels that are required by the Environmental Protection Agency (EPA) in some areas of the USA. With the increased use of alcohol in fuel, either ethanol (ethyl alcohol) or methanol (methyl alcohol), you should be aware of certain adverse affects that can occur. As the percentage of alcohol increases, the degree and possibility of adverse affects also increases.

- **Corrosion of metal parts:** Alcohol is infinitely soluble in water. In a vented fuel tank, the alcohol attracts moisture, forming a phase of alcohol and water. This phase separates from the gasoline and sinks to the bottom of the fuel tank. The likelihood of phase separation increases with the long periods of storage common to boats. Over extended periods of time, the alcohol-water phase may form strong organic acids that can damage fuel system components. Damage to fuel system components may lead to fuel system restrictions, resulting in a lean running condition that could cause engine failure.



**Fuel sample with phase separation**

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- **Deterioration of rubber or plastic parts:** Nonmetallic components of the fuel system, specifically plastics and elastomers, may be subject to swelling as well as other changes in physical properties and a reduction mechanical strength. These changes can result in a loss of effective sealing capability and cause fuel system leaks.
- **Fuel permeation through rubber fuel lines:** Because the molecules of alcohol are smaller than gasoline, the alcohol may pass through some rubber fuel lines where gasoline would not.
- **Starting and operating difficulties:** Some alcohols can change how temperature affects the fuel, causing vapor lock in warm weather conditions. As alcohol is added to gasoline, the Reid vapor pressure increases. This can cause the fuel to vaporize at lower temperatures. Normally, this vaporizing occurs in two ways:
  - As the fuel is drawn from the fuel tank to the engine, the pressure on the fuel is reduced because of the suction of the fuel pump. The reduced pressure may cause the fuel to turn into a vapor before it reaches the engine, making it difficult for the fuel pump to draw fuel into the carburetor or fuel injection system.
  - As the engine runs, heat builds up in the engine block and components. When the engine is turned off, the heat is radiated and conducted into the fuel system components turning the fuel into vapor, which can make the engine hard to start while still warm.

## Fuel Recommendation

### FUEL RATINGS

Mercury MerCruiser engines will operate satisfactorily when using a major brand of unleaded gasoline meeting the following specifications:

**USA and Canada:** having a posted pump octane rating of 87 (R+M)/2 minimum. Premium gasoline [91 (R+M)/2 octane] is also acceptable and required for some Mercury Racing sterndrive products. Do NOT use leaded gasoline.

**Outside USA and Canada:** having a posted pump octane rating of 90 RON minimum. Premium gasoline (96 RON) is also acceptable and required for some Mercury Racing sterndrive products. Do NOT use leaded gasoline.

**IMPORTANT:** Mercury Hi-Performance engines require a higher octane fuel. See your operation manual for octane requirements.

### USING REFORMULATED OXYGENATED GASOLINE (USA ONLY)

This type of gasoline is required in certain areas of the USA. The two types of oxygenates used in these fuels are alcohol (ethanol or methanol) or ether (MTBE or ETBE). If ethanol is the oxygenate used in the gasoline in your area, refer to **Gasoline Containing Alcohol**. Reformulated gasoline are acceptable for use in your Mercury Marine engine.

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## GASOLINE CONTAINING ALCOHOL

If the gasoline in your area contains either ethanol (ethyl alcohol) or methanol (methyl alcohol) potentially adverse effects can occur. Methanol causes more severe effects. Increasing the percentage of alcohol in the fuel worsens these effects. Some of these adverse effects are caused by the alcohol in the gasoline absorbing moisture from the air, resulting in a separation of the water-alcohol mixture from the gasoline in the fuel tank. The fuel system components of your Mercury MerCruiser engine manufactured after 1996 will withstand up to 10% alcohol content in the gasoline. Any alcohol content higher than 10% will cause severe engine damage. Contact the boat manufacturer for specific alcohol in fuel recommendations for the specific fuel system components (fuel tanks, fuel lines, fittings, etc.) used in the boat. Be aware that gasoline containing alcohol may worsen the following problems:

- Corrosion of metal parts
- Deterioration of rubber or plastic parts
- Fuel permeation through rubber fuel lines
- Difficulties with starting or operating
- Lean running condition that could cause engine failure

**IMPORTANT:** When operating a Mercury MerCruiser engine with gasoline containing alcohol avoid storing gasoline in the fuel tank. Periods of storage longer than a week are common to boats and create unique problems. Although cars normally consume alcohol-blend fuels quickly enough to avoid problems, boats often sit idle long enough for phase separation to occur. In addition, internal corrosion may take place during storage if alcohol has washed off protective oil films from components of the internal fuel system and engine. We recommend the use of Mercury or Quicksilver Quikleen Engine Treatment fuel additive in each tank full of fuel throughout the boating season to minimize carbon deposit buildup. Use the additive as directed on the container.

## Testing For Alcohol in Fuel

The equipment required is one syringe graduated in cubic centimeters (cc) that will hold 12 ccor more. Obtain locally.

### PROCEDURE:

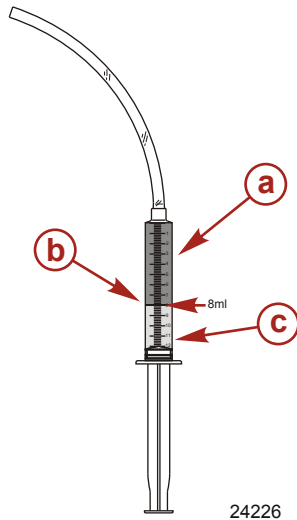
- Draw approximately 6 ccof water into the syringe. Point the syringe upward and squirt out all but 3 cc. Squirting out the extra water removes the unwanted air from the syringe.
- Draw the fuel to be tested into the syringe up to the 12 ccmark.
- Close off the tip of the syringe with your finger and shake the syringe to mix the fuel and water. Slowly remove your finger to relieve the pressure.
- Stand the syringe on a flat surface for about a minute. Be sure to keep the tip up.
- After a minute has passed, examine the syringe. If alcohol is in the fuel, it will have bonded with the water and settled to the bottom of the syringe.
- Use the chart below to determine the percentage of alcohol in the gasoline.

Volume of gasoline	Percentage of alcohol
9.0 cc	0 %
8.6 cc	5 %
8.1 cc	10 %

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Volume of gasoline	Percentage of alcohol
7.7 cc	15 %
7.2 cc	20 %
6.8 cc	25 %
6.3 cc	30 %
5.9 cc	35 %
5.4 cc	40 %



- a - Gasoline
- b - Separation between gasoline and alcohol-water mix
- c - Alcohol-water mix

## CHECKING FOR WATER IN THE FUEL

If you suspect water contamination of the fuel, use a water-finding paste to confirm that water is present. The paste is affixed to the end of a probe (a long wire or stick) and dropped into the fuel tank at its lowest point. If the paste changes color, it indicates that water is in the fuel tank. Water-finding pastes can normally be found at local oil and fuel distributors. Gasoila water-finding paste is one common brand name available.

### Gasoila

800-846-7325

Fax 216-464-2080

[www.gsasupplyco.com](http://www.gsasupplyco.com)

## STORING BOATS WITH ALCOHOL FUELS:

**PORTABLE FUEL TANKS:** Most portable fuel tanks have closable vents. Close the vent while in storage to prevent air from entering the tank.

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**BUILT-IN FUEL TANKS:** Many boats have built-in fuel tanks that are vented to outside air. The preferred method to prepare built-in tanks for storage is to drain as much of the remaining gasoline as possible from the fuel tank, remote fuel line, and engine fuel system. If this is not practical, completely fill the fuel tank to reduce the amount of air available to expose the fuel to contamination. Mercury/Quicksilver Gasoline Stabilizer for Marine Engines or a compatible fuel additive should always be added to any fuel remaining in the tank.

## Warranty

Use of an improper gasoline can damage your engine. Engine damage resulting from the use of improper gasoline is considered misuse of the engine, and damage caused thereby will not be covered under the limited warranty. The fuel system components of Mercury MerCruiser engines manufactured after 1996 will withstand up to a 10% alcohol content in gasoline. Phase separation can occur in any fuel containing alcohol. Damage to the fuel system or engine components due to phase-separated fuel is NOT covered under warranty.

## Mercury MerCruiser's View of Ethanol

Mercury Marine remains very active in developing a thorough understanding of important issues and environments in which our products must operate. Mercury's engineers work constantly to expand our understanding of fuel technologies and their interactions with all Mercury products to ensure they perform properly and reliably. Mercury personnel work in concert with industry groups, such as the National Marine Manufacturers Association (NMMA), to offer input into the overall processes by which many decisions are made regarding fuel regulations and energy policies so future problems are minimized and future developments are beneficial to those who use our products.

Included below is a list of questions and answers that address typical concerns of consumers.

Please feel free to contact any Mercury Marine field representative with questions, or contact us at [public.relations@mercmarine.com](mailto:public.relations@mercmarine.com). Mercury will do its best to help find answers, whether you are seeking general information or wishing to discuss legal proposals, or if you are seeking information regarding ethanol-tolerant materials.

### 1. WHAT ARE ETHANOL AND ETHANOL-BLENDED FUELS?

Ethanol for fuel is highly refined beverage (grain) alcohol, approximately 200 proof, that can be produced from natural products such as corn, sugar cane, and wheat. New technology will allow ethanol to be made from cellulosic feedstocks including corn stalks, grain straw, paper, pulp, wood chips, municipal waste, switchgrass, and other sources. Ethanol used for fuel has been denatured or rendered unsafe to drink by the addition of a hydrocarbon, usually gasoline. The ethanol-blended fuel E-10 refers to fuel that contains 10% ethanol and 90% gasoline. Similarly, E-85 refers to fuel that contains 85% ethanol and 15% gasoline. E-85 is intended only for engines specially designed to accept high-ethanol content fuel blends, such as the Flexible-Fuel Vehicles (FFV) made by some auto companies.

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## 2. HOW IS ETHANOL MADE?

In the USA, ethanol is typically produced by removing the starch or sugar portion of corn and fermenting it. The fermented starch is then distilled into alcohol. Excess water is removed, resulting in very pure 200 proof ethyl alcohol (ethanol). In some parts of the world, ethanol is made from a variety of raw materials. For example, sugar cane is used to produce ethanol in Brazil, while sugar beets and wheat straw are commonly used in Europe.

## 3. WHAT ARE THE CHARACTERISTICS OF ETHANOL?

Ethanol is an oxygenated hydrocarbon compound that has a high octane rating and therefore is useful in increasing the octane level of unleaded gasoline. The EPA, the agency responsible for setting some of the requirements for all gasoline used in the USA, has allowed the use of ethanol in gasoline at levels up to 10% as an octane enhancer and to provide beneficial clean-burning combustion characteristics that help improve certain emissions.

Ethanol is hygroscopic (it has an attraction for water) and will more readily mix with water than with gasoline. It has different solvency behaviors than does gasoline, which allows it to loosen rust and debris that might lay undisturbed in fuel systems. And it can more readily remove plasticizers and resins from certain plastic materials that might not be affected by gasoline alone. Loose debris will plug filters and can interfere with engine operation. Additionally, ethanol is corrosive to some metals, especially in combination with water. Although gasoline does not conduct electricity well, ethanol has an appreciable capability to conduct electricity and therefore can promote galvanic corrosion.

## 4. WHAT IS MTBE AND WHY IS IT BEING REPLACED?

MTBE is methyl tertiary-butyl ether. MTBE is another oxygenated hydrocarbon compound that has a high octane rating. It was initially a preferred compound widely used for octane enhancement as a replacement for leaded compounds in gasoline. When the EPA developed regulations requiring oxygenated gasoline to help reduce smog in certain areas of the country, MTBE was the most commonly used compound to supply the additional oxygen, while ethanol was chosen for this purpose in the Midwest. Recently, most states have banned the use of MTBE because of its tendency to work its way into ground water systems, usually from leaks and spills, as an undesirable contaminant. Ethanol is being used as a replacement.

## 5. DOES ETHANOL AFFECT HORSEPOWER OR FUEL-EFFICIENCY?

Ethanol has a heating value of 76,000 BTU per gallon, which is approximately 30% less than gasoline's heating value (which is approximately 109,000 to 119,000 BTU/gal). The result is an E-10 gasoline that yields slightly lower, approximately 3%, fuel economy. Fuels containing higher levels of ethanol have a corresponding reduction in mileage. For example, E85 fuels produce fuel economy figures approximately 30% less than a standard formulation gasoline.

The octane rating of pure ethanol (200 proof) is about 100 and is therefore useful in elevating the octane value of gasoline. In E-10 blends the presence of ethanol provides about 2.5 to 3% of the overall octane rating. The effect on engine horsepower is determined by the octane result of the blended fuel. Care should be taken to select fuels having the octane rating recommended for the engine as indicated in the owner's manual for proper operation.

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## Compatibility with Mercury Engines

### 1. ARE MERCURY ENGINES COMPATIBLE WITH ETHANOL FUELS?

The fuel-system components of Mercury engines manufactured after 1996 will withstand up to 10% alcohol content in gasoline. This is the maximum level currently allowed by the EPA for use in non flex-fuel vehicles. There are some efforts to establish E-20 (20% ethanol mixed with 80% gasoline) for use in some areas, but that will require agreement from EPA to grant a waiver. Part of the EPA waiver process will require verification from studies that demonstrate that higher levels of ethanol do not create problems with fuel-system materials or operation of hardware. E-20 has not been extensively studied by Mercury and is not acceptable for use in Mercury products. Do NOT use E-20 fuel in Mercury MerCruiser products. It will damage fuel system components and cause a lean running condition that could cause engine failure. E-85 fuels must not be used in any Mercury engines and will seriously damage current Mercury products. It is not currently legal in the USA to market any ethanol fuel as gasoline if it contains more than 10% ethanol.

### 2. WILL THE USE OF FUELS CONTAINING ETHANOL VOID MY ENGINE WARRANTY?

Fuels containing up to 10% ethanol are considered acceptable for use in Mercury MerCruiser engines manufactured after 1996. Fuels containing higher levels of ethanol are not considered acceptable for use. The warranty will be void on any fuel system or engine components damaged by the use of fuels containing more than 10% ethanol.

### 3. WHAT ABOUT THE FUEL-SYSTEM COMPONENTS ON THE BOAT?

It is important to follow boat manufacturers' recommendations when selecting appropriate fuels. Use of an inappropriate fuel can result in damage to the engine and boat components that may require repair or replacement. Fuels with ethanol can attack some fuel-system components, such as tanks and lines, if they are not made from acceptable ethanol-compatible materials. This can lead to operational problems or safety issues such as clogged filters, leaks, or engine damage.

### 4. HOW DOES ETHANOL AFFECT MY FIBERGLASS FUEL TANK?

Fiberglass tanks manufactured prior to 1991 may not be compatible with gasoline containing ethanol. It has been reported that, in the presence of ethanol, some resins may be drawn out of fiberglass and carried into the engine where severe damage could occur. If an older fiberglass tank is used, check with the manufacturer to determine if gasoline with ethanol can be safely used.

### 5. ARE OLDER FUEL LINES PRONE TO FAILURE? WHAT ABOUT GASKETS?

During the 1980s, many rubber components for use in fuel systems were developed to withstand exposure to fuels containing ethanol. If rubber components in a fuel system are suspected to be of this vintage or older it may be advisable to replace them with newer ethanol-safe components before using fuels containing ethanol. Check with the manufacturer for advice or frequently inspect these fuel-system components for signs of swelling or deterioration and replace if problems are noted.

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## Recommended Practices

### 1. ETHANOL IS REPLACING MTBE IN MY REGION? WHAT SHOULD I DO?

Before gasoline with ethanol is introduced to your fuel tank, ask your boat manufacturer if any special precautions should be considered with the use of fuel containing ethanol. Check for the presence of water in the fuel tank. If any is found, remove all water and dry the tank completely. As a precaution, it is advisable to carry a few extra water separating-fuel filters in case filter plugging becomes a problem during boating.

### 2. SHOULD I ADD AN ADDITIONAL FINE-MICRON FILTER TO THE SYSTEM TO PREVENT DEBRIS FROM ENTERING THE ENGINE?

Mercury already provides the appropriate level of filtration to protect the engine from debris. The addition of another filter to the system will create another possible flow restriction that can starve the engine of fuel.

### 3. HOW CAN A MARINA PREPARE FOR THE CHANGE FROM MTBE TO ETHANOL AS THE FUEL OXYGENATE?

Check with the manufacturer to make certain the tank and lines will not experience problems with ethanol. Inspect the tank for water and, if present, pump out all water and thoroughly clean the tank. Install ethanol-compatible filters. The tank should be less than 20% full before adding the first load of fuel with ethanol.

### 4. WHAT IS PHASE SEPARATION, AND HOW DO I DEAL WITH IT?

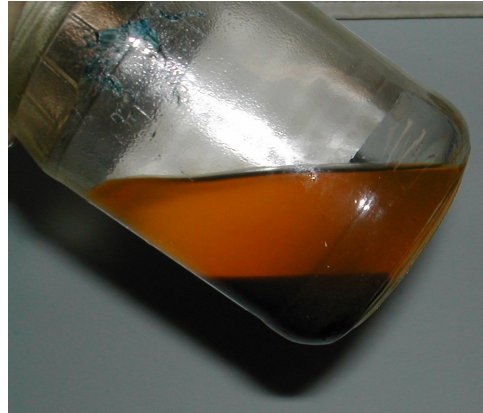
If significant amounts of water are present in a fuel tank with gasoline that contains ethanol, the water will be drawn into the fuel until the saturation point is reached for the three-component mixture of water, gasoline, and ethanol. Beyond this level of water, phase separation could cause most of the ethanol and water to separate from the bulk fuel and drop to the bottom of the tank, leaving gasoline with a significantly reduced level of ethanol in the upper phase. If the lower phase of water and ethanol is large enough to reach the fuel inlet, it could be pumped directly to the engine and cause significant problems. Even if the ethanol-water phase at the bottom of the tank is not drawn into the fuel inlet, the reduced ethanol level of the fuel reduces the octane rating by as much as 3 octane numbers, which could result in engine problems.

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The level at which phase separation can occur is determined by a number of variables, including the amount of ethanol, the composition of the fuel, the temperature of the environment and the presence of contaminants. It is very important A) that the system is inspected for significant quantities of water in the tank before using gasoline with ethanol, and B) to limit exposure of the fuel tank to excess water. For our method, see the recommendation in **Checking for Water in the Fuel** Section. If phase separation has occurred, you must completely remove all free water from the system and replace the fuel before continuing operation. Otherwise, engine damage will occur.



Sample of fuel from fuel tank in which phase separation has occurred. The upper phase is gasoline with a reduced level of ethanol. The lower level is a mixture of ethanol and water.

**5. IS AN ADDITIVE AVAILABLE THAT CAN PREVENT PHASE SEPARATION?**

There is no practical additive that can prevent phase separation from occurring. The only practical solution is to keep water from accumulating in the tank in the first place.

**6. ARE THERE ANY ADDITIVES THAT CAN ALLOW THE PHASE-SEPARATED MIXTURE TO REMIX WHEN ADDED TO THE FUEL TANK?**

No, the only way to avoid further problems is to remove the water, dispose of the depleted fuel, clean the tank and start with a fresh, dry load of fuel.

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