67

ALTERNATIVE FUELS

Figure 67-1 The ethanol molecule showing two carbon atoms, six hydrogen atoms, and one oxygen atom.

FREQUENTLY ASKED QUESTION: What Is Switchgrass?

Switchgrass (Panicum virgatum) can be used to make ethanol and is a summer perennial grass that is native to the eastern United States. It was once abundant in the Great Plains, but was also found in the eastern United States in Alabama and Mississippi. Switchgrass is resistant to many pests and plant diseases, and is capable of producing high yields with very low applications of fertilizer. This makes it the ideal feedstock in sustainable biofuels. However, switchgrass is very tolerant of poor soils, flooding, and drought, and is one of the world's most productive agricultural crops.

There are two main types of switchgrass:

- Upland types—usually grow 5 to 6 feet tall
- Lowland types—grow up to 12 feet tall

Better energy efficiency is gained because less energy is used to produce ethanol from switchgrass.
Some retail stations offer a variety of fuel choices, such as this station in Ohio where E10 and E85 are available.

The location of the variable fuel sensor can vary, depending on the make and model of vehicle, but it is always in the fuel line between the fuel tank and the fuel injectors.

A cutaway view of a typical variable fuel sensor.
Figure 67-6 A pump for E85 (85% ethanol and 15% gasoline). E85 is available in more locations every year.

TECH TIP: Purchase a Flex-Fuel Vehicle

If purchasing a new or used vehicle, try to find a flex-fuel vehicle. Even though you may not want to use E85, a flex-fuel vehicle has a more robust fuel system than a conventional fuel system designed for gasoline or E10. The enhanced fuel system components and materials usually include:

- Stainless steel fuel rail
- Graphite commutator bars instead of copper in the fuel pump motor (ethanol can oxidize into acetic acid, which will corrode copper)
- Diamond-like carbon (DLC) corrosion-resistant fuel injectors
- Alcohol-resistant O-rings and hoses

The cost of a flex-fuel vehicle compared with the same vehicle designed to operate on gasoline is a no-cost or a low-cost option.

Figure 67-6 A flex-fuel vehicle often has a yellow gas cap, which is labeled E85/gasoline.
Figure 67-7: A vehicle emission control information (VECI) sticker on a flexible fuel vehicle indicating that it can use ethanol from 0 to 85%.

**FREQUENTLY ASKED QUESTION**

How Does a Sensorless Flex-Fuel System Work?

Many General Motors flex-fuel vehicles do not use a fuel compensation sensor and instead use the oxygen sensor to detect the presence of the lean mixture and the extra oxygen in the fuel. The powertrain control module (PCM) then adjusts the injector pulse-width and the ignition timing to optimize engine operation to the use of E85. This type of vehicle is called a virtual flexible fuel vehicle, abbreviated V-FFV. The virtual flexible fuel vehicle can operate on pure gasoline or blends up to 85% ethanol.

**TECH TIP: Avoid Resetting Fuel Compensation**

Starting in 2006, General Motors services designed to operate on E85 do not use a fuel compensation sensor, but instead use the oxygen sensor and refueling information to calculate the percentage of ethanol in the fuel. The PCM uses the fuel level sensor to sense that fuel has been added and starts to determine the resulting ethanol content by using the oxygen sensor. However, if a service technician were to reset fuel compensation by clearing long-term fuel trim, the PCM starts the calculation based on base fuel, which is gasoline with less than or equal to 10% ethanol (E10). If the fuel tank has E85, then the fuel compensation cannot be determined unless the tank is drained and refilled with base fuel. Therefore, avoid resetting the fuel compensation setting unless it is known that the fuel tank contains gasoline or E10 only.
Frequently Asked Question: How Long Can Oxygenated Fuel Be Stored Before All of the Oxygen Escapes?

The oxygen in oxygenated fuels, such as E10 and E85, is not in a gaseous state like the CO₂ in soft drinks. The oxygen is part of the molecule of ethanol or other oxygenates and does not bubble out of the fuel. Oxygenated fuels, just like any fuel, have a shelf life of about 90 days.

Figure 67-8 - The molecular structure of methanol showing the one carbon atom, four hydrogen atoms, and one oxygen atom.

Figure 67-9 - Sign on methanol pump shows that methyl alcohol is a poison and can cause skin irritation and other personal injury. Methanol is used in industry as well as being a fuel.
Figure 67-10  Propane fuel storage tank in the trunk of a Ford taxi.

Figure 67-11  The blue sticker on the rear of this vehicle indicates that it is designed to use compressed natural gas.

Figure 67-12  A CNG storage tank from a Honda Civic GX shown with the fixture used to support it. Honda specifies that three technicians be used to remove or install the tank through the rear door of the vehicle due to the size and weight of the tank.
Figure 67-13. The fuel injectors used on this Honda Civic GX CNG engine are designed to flow gaseous fuel instead of liquid fuel and cannot be interchanged with any other type of injector.

FREQUENTLY ASKED QUESTION

What Is the Amount of CNG Equal to in Gasoline?

To achieve the amount of energy of one gallon of gasoline, 122 cubic feet of compressed natural gas (CNG) is needed. While the octane rating of CNG is much higher than gasoline (130 octane), using CNG instead of gasoline in the same engine would result in a reduction of 10% to 20% of power due to the lower heat energy that is released when CNG is burned in the engine.

Figure 67-14. This CNG pump is capable of supplying compressed natural gas at either 3,000 PSIG or 3,600 PSIG. The price per gallon is higher for the higher pressure.
FREQUENTLY ASKED QUESTION

What Is a Tri-Fuel Vehicle?
In Brazil, most vehicles are designed to operate on ethanol or gasoline or any combination of the two. In this South American country, ethanol is made from sugarcane, is commonly available, and is lower in price than gasoline. Compressed natural gas (CNG) is also being made available, so many vehicle manufacturers in Brazil, such as General Motors and Ford, are equipping vehicles to be capable of using gasoline, ethanol, or CNG. These vehicles are called tri-fuel vehicles.

CHART 67–1

<table>
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<th>COMPONENT</th>
<th>REGULAR GRADE</th>
<th>PREMIUM GRADE</th>
<th>COLD WEATHER</th>
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<td>27.5%</td>
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</tr>
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CHART 67–2

The characteristics of alternative fuels compared to regular unleaded gasoline show that all have advantages and disadvantages.
Figure 67-15 A Fischer-Tropsch processing plant is able to produce a variety of fuels from coal.

WARNING: Do not smoke or have an open flame in the area when working around or refueling any vehicle.