Ethanol Gasoline Blends and Small Engines

R. Scott Frazier PhD, PE, CEM
Assistant Professor

Summary

In many parts of the United States, the use of ethanol/gasoline fuel blends is very common. The state of Oklahoma only recently began using 10 percent blended fuels (E10) in many service stations. Along with this new fuel availability are customer concerns regarding compatibility with small engines such as lawn mowers and trimmers. The following presents information so consumers can decide if using ethanol blended fuels is appropriate for them. Also included are some basic suggestions to mitigate some possible problems that might exist.

Small Engines

There are millions of small "utility," or "non-road," engines in the U.S. These are typically air-cooled, single, or twin cylinder, 4- or 2-stroke engines. Most of these engines are carbureted and have minimal emissions control devices. Typical uses for these engines include: lawn mowing, trimming, pumping, emergency electrical generation and various other utility duties. These engines typically range up to 25 horsepower.

What the Manufacturers Recommend

Small engine manufacturers, such as Briggs and Stratton, have the following requirements regarding fuel used in their current 4- and 2-stroke engines [1]:

- Clean, fresh, unleaded gasoline
- Minimum of 87 octane
- Gasoline with up to 10 percent ethanol (E10, gasohol) or up to 15 percent MTBE is acceptable

Therefore, using E10 is acceptable. However; using a higher ethanol blend such as E85 could void the warranty on these engines because it can lead to lean running conditions. But is there still a problem with E10, and what about using E10 in older (pre-1995) utility engines?

E10 Ethanol Blended Gasoline Concerns

Some consumers are concerned that E10 fuel will affect the operation of their small utility engines. Examining information on the web, there are many entries describing various problems associated with using ethanol blended fuel in these engines. Let's examine some of the more common issues.

Corrosion and Wear

Both gasoline and ethanol can be corrosive to many plastics and natural rubber. Interestingly, straight unleaded gasoline can be corrosive to more plastics (and more severely) than ethanol [2]. Highly aromatic additives (e.g., benzene) used to increase octane in straight gasoline are very corrosive to several materials. Detailed automotive tests using 20 percent ethanol were performed by the Minnesota Center for Automotive Research, Minnesota State University, Mankato. These tests [3] found that:

- "The vehicle fuel system materials study used both gasoline-only and 10 percent ethanol blended fuel to compare to 20 percent ethanol blended fuels. The year-long project culminated in four separate and distinct material compatibility documents which conclude that the effects of 20 percent ethanol blended fuels do not present problems for current automotive or fuel dispensing equipment."
- Nineteen metals tested showed 20-year resistance to corrosion with E10 and E20 ethanol blends. Two metals tested (Zamak 5 - Zinc Aluminum alloy and Magnesium AZ91D) showed some corrosion with ethanol. These reactive alloys are not commonly found (unplated) in engines.
- All automotive rubber and elastomers tested showed some swelling, change in tensile strength and elongation from being immersed in various ethanol blends and pure gasoline. It should be noted, however, none of the changes were deemed to be bad enough to fail the test.

These tests, and others [4], seem to indicate compatibility between ethanol and standard engines; however, there may be circumstances where an engine built with very specific types of metals or plastics might experience material changes solely due to contact with ethanol fuel. It is unclear if these changes would cause an engine malfunction. This does not imply that problems do not exist. There is no hard evidence indicating a link between ethanol, component corrosion, and wear related engine malfunctions.

Therefore, E10 blends are generally considered non-corrosive and should not accelerate wear for newer engines (1995 and later). Examinations of manufacturer's statements indicate that ethanol blends up to 10 percent (E10) are acceptable [5]. Older engines may run a slight risk of degradation of rubber, cork gaskets, and exposed magnesium and aluminum surfaces in the fuel system when using alcohol blends or highly aromatic modern fuels. Older engines may have other susceptibilities as well.

Ethanol – Solvent

Ethanol is an effective solvent and can be considered a fuel detergent. On one hand, this can help remove gum and deposits from fuel systems and is the reason alcohol is often used as a gasoline additive. A potential drawback for old, small engines is that neglected fuel systems may begin to precipitate old deposits at a greater rate than normal and clog fuel filters and small passageways. This is the suspected main reason for many ethanol related engine complaints.

It should be pointed out that deposits in fuel tanks and carburetor bowls will eventually cause problems in engines running straight gasoline; however ethanol blends may accelerate the release of deposits. Old fuel systems should be periodically inspected regardless of fuel type.

Water Contamination

Ethanol has hydroscopic qualities in it that attracts and mixes with water. At lower concentrations of water (up to 0.5 percent volume at 60° F), the alcohol will mix and remove the water as the fuel is burned and not harm the engine. At higher concentrations, the water will separate from the fuel and pool at the bottom of its container. This "phase" separation form of water in fuel can cause rust and possibly damage the engine. Fuel that is an E10 blend cannot absorb enough moisture out of the air to cause this phase separation [6]. However, if condensation is allowed to occur, or water is directly splashed in the tank, water phase separation can occur. It should be pointed out that this water separation is more likely to occur in straight gasoline than in an ethanol blend.

Many small engine gas tanks are actually vented so the fuel can continue to flow into the carburetor as it is being used. This makes it important to store these engines away from damp or wet conditions.

For many years, people have purchased small bottles of "dry gas" in automotive stores to remove water from their gas tanks. This is essentially just alcohol that mixes the water into a solution so it can be harmlessly passed through the engine. There are some who theorize that the slight increase in water vapor in the combustion products might form acids in the crankcase oil, however, wear tests are inconclusive. The bottom line is ethanol will attract water in the air (extremely slowly); however, it will probably stay in the solution and be harmless to the engine. Liquid water separating from the fuel is a problem regardless of it being E10 or straight gasoline. A lawnmower or tractor sitting under a tree or a tarp for months may experience fuel/water issues. Fuel containers should be sealed. Even straight gasoline should not be stored for more than 60 days without using stabilizer chemicals. When storing utility engines more than 60 days, it is usually recommended that the fuel be drained from the fuel system.

Prevention of Possible Ethanol Related Problems

Fuel systems are an often neglected part of utility engine systems. Utility engines work in dirty and harsh environments and are often stored in locations that can be damp and dirty, as well as have wide temperature swings. These types of working environments can increase potential problems with any kind of fuel system. E10 ethanol blended fuels may or may not make engines more susceptible to problems. There is no clear evidence one way or the other. In the absence of perfect knowledge, diligence in the form of routine inspection and maintenance is the best way to avoid problems.

There are a variety of fuel stabilizers and driers that may help minimize or eliminate water and corrosion problems. If you suspect the engine problem is caused by ethanol, use a fuel stabilizer that is specifically alcohol free. As always, check with the manufacturer regarding use of additives.

References

1. Briggs and Stratton website discussing fuel requirements, Accessed January 22, 2009, http://www4.briggsandstratton.com/display/router.asp?docid=76786
2. Chemical Compatibility Charts: Ethanol & Unleaded Gasoline, Transflo™ Pumps Private Limited, Website: http://www.transflopumps.com/compatibility.asp
3. E20: The Feasibility of 20 Percent Ethanol Blends by Volume as a Motor Fuel, Executive Summary Results of Materials Compatibility and Drivability Testing, State of Minnesota and Renewable Fuels Association Study, available on Minnesota Department of Agriculture Website: www.mda.statemn.us, February, 2008.
4. Aviation Grade Ethanol 85 (AGE-85) Technical Briefing, Behnken, J., et. al., South Dakota State University, website: http://www.age.com
5. Herman and Associates compilation of utility engine and equipment manufacturer's fuel recommendations. Contact Herman and Associates.
6. Water Phase Separation in Oxygenated Gasoline, David Korotney, Chemical Engineer, EPA Fuels and Standards Branch, 1995, website: http://www.epa.gov/oms/regs/fuels/rfg/waterphs.pdf

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Robert E. Whitson, Director of Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at a cost of 20 cents per copy. 0308 GH.