

**TECH TIPS — Subject: E10 Fuel
Models: All**

As E10 fuel has been introduced into various regions of the United States, reports, good and bad, have been widely circulated in the general public and particularly within the boating community. Alternative fuel blends to decrease our dependence on foreign oil will be with us until internal combustion engines are replaced with alternate power sources. Following are questions and answers that may help you when addressing customer issues and questions.

Q. What is E10 fuel?

- A. E10 fuel is a blend of ethanol (10%) and gasoline (90%).

Q. What is ethanol?

- A. Ethanol is highly refined alcohol that is made from grain (typically corn) or the cellulose from other plants.

Q. Why is ethanol added to gasoline?

- A. EPACT2005 (Energy Policy Act), Public Law 109-058 requires the increased use of renewable motor fuels. In most areas, ethanol is the most readily available renewable fuel that can be added to conventional gasoline without major changes.

Q. When is ethanol added to gasoline?

- A. Ethanol is added to gasoline by local or regional distributors.

Q. What are the negative properties of ethanol?

- A. Ethanol has several properties that contribute to fuel system issues.
- Ethanol is a strong cleaner (solvent).
 - Ethanol is hygroscopic (e.g., it has a strong attraction to moisture).
 - E10 fuel's usable life span may be less than the normal length of off- season boat storage.

Q. Wouldn't the cleaning properties of ethanol be good for a fuel system?

- A. No, fuel systems that have been used for non-oxygenated gasoline will have varnish deposits and surface corrosion (rust and aluminum oxides). This includes the tanks and pipes used for fuel storage and transportation. Ethanol will clean varnish as well as surface corrosion from any surface it contacts. Ethanol may dissolve

plastic resins used to make some fiberglass tanks. The amount of material cleaned from all of these systems can quickly exceed the filtration capacity of fuel system filters resulting in restricted fuel flow. Ultimately engine performance is reduced and potentially damage to the engine can occur.

Q. What issues are caused by ethanol's attraction to water?

- A. Ethanol molecules have a stronger bond to water molecules than to gasoline molecules. In the absence of water, ethanol and gasoline molecules will bond. When water is added to E10 fuel, the bond between the ethanol and gasoline will weaken. When the percentage of water in E10 fuel reaches approximately 0.5%, the bond between the ethanol and gasoline molecules will breakdown and the ethanol molecules will attach to the water molecules. This is called phase separation.

Q. What happens when phase separation occurs?

- A. Several things happen:
- The ethanol and water molecules settle to the bottom of the fuel tank forming a distinct layer of water & ethanol on the bottom and gasoline without ethanol on the top.
 - Fuel for the engine is drawn from the bottom of the tank. An engine will not run properly, if at all, on ethanol and water. The ethanol and water mixture is very corrosive to some metals and can damage internal engine components.
 - The remaining gasoline, without ethanol, will have an octane level below the original E10 fuel's octane level, approximately 2 ~ 3 points lower. This octane level may be below the requirements of the engine.

Q. Can phase separation be reversed?

- A. No, there are no additives or processes that will recombine phase separated ethanol and gasoline.

Q. Can I use the gasoline remaining after removal of the phase separated water and alcohol?

- A. No, as mentioned above, the remaining gasoline will have a lower octane level that may not be compatible with your engine.

Q. How long can E10 fuel be stored?

A. There are many different opinions concerning how long it is ok to store any fuel (E10 fuel or gasoline), 2 weeks, 90 days, 1 year, or longer, before losing the properties that are required for proper and safe operation of your engine. There are too many variables (e.g., the age of fuel when purchased, temperature, humidity, use of stabilizers and the type of storage containers) to accurately predict how long.

Q. Why do boats seem to have more issues attributed to E10 fuel than cars?

A. Cars are having issues but are somewhat more tolerant due to typical usage patterns and differences in their fuel systems. Major differences are:

- Modern automotive fuel systems (fuel filler, fuel tank, distribution lines and engine components) are closed or non-vented. Once the fuel is pumped into the tank, there is very little circulation of outside air (containing moisture) into the fuel system.
- Boats are operated and often stored in a very wet environment increasing the risk of water directly entering the fuel system.
- Boats have vented fuel systems which allow moisture laden air to circulate into the fuel tank as the fuel is drawn out of the tank and as the fuel expands and contracts during heating and cooling cycles of the outside air.
- Automotive fuel tanks are typically much smaller than boat fuel tanks and are refilled more frequently. A full tank of fuel in a car or truck, typically 20 ~ 40 gals, may be used and refilled every week or two. Boat fuel tanks, typically 40 ~ 100+ gals per tank, may only be refilled once a month during the boating season and typically may sit unused for many months during the off season.
- Some boats use fiberglass fuel tanks. Polyester resins can be dissolved by ethanol.

Q. Are Yamaha engines compatible with E10 fuel?

A. All current models as well as most engines built since the late 1980's have been designed with fuel system components that are tolerant to fresh fuel containing ethanol up to 10% (E10). Outboard fuel systems can still be affected by: water, dissolved gum, varnish, corrosion par-

titles, and dissolved resins that E10 fuel has cleaned from the distribution system and your boat's fuel tanks.

Q. Can I use fuel with a higher percentage of ethanol, such as E15 or E85?

A. No, all of the negative issues discussed above will be increased and may cause major damage to the engine.

Q. What can I do to prevent issues with E10 fuel?

A. Total prevention of issues may not be possible but there are steps you can take to minimize the occurrence and severity of the negative affects of E10 fuel:

- If at all possible, do not use E10 fuel.
- Ideally (before switching to E10 fuel) have your fuel tank completely drained to remove any accumulated water. As little as 16 oz. of water can promote phase separation in 25 gals of E10 fuel. The result would be 2.75 gals of unusable ethanol and water mixture on the bottom of the tank.
- If the tank can be completely drained, the internal surfaces should be mechanically cleaned to remove rust or aluminum oxides. Fuel polishing companies may be able to provide this specialized service.
- Consider replacing the fuel tank in an older boat.
- If your boat has fiberglass fuel tanks built prior to the early 1990's, consult with your boat builder concerning E10 compatibility.
- If unable to completely drain and clean your tank before switching to E10 fuel, add as much E10 fuel as possible to minimize the possibility of phase separation. Example: 16 oz of water may cause phase separation in 25 gals of E10 but 16 oz of water in 30 gals would be safe from phase separation.
- Install a Yamaha 10-micron water separating/fuel filter between the boat's fuel tank and the engine.
- Change the 10-micron filter every 25 hours of use until there are no indications of excessive water and contaminants collecting in the filter. Normal filter changes are recommended every 50 hours of use.
- Carry extra filters and change more frequently if there are indications the efficiency of the filter is rapidly diminishing due to excessive water and contaminants.

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- Do not drain a used filter and reinstall. Contaminated fuel can enter the filtered side of the filter while draining.
- Buy name brand fuel.
- Buy fuel from the same source if possible.
- Buy fuel from stations that have newer, cleaner storage tanks.
- Occasionally, test your fuel to verify the amount of ethanol is not higher than 10%. The blending of ethanol with gasoline by distributors is not a precision process. Inexpensive test kits are available, GOOGLE E10 Fuel Test Kit.
- Regularly use Yamaha Fuel Stabilizer to retard fuel aging.
- Stabilize fresh fuel before storing. Stabilizers do not help fuel that has already aged. Stabilizers are most effective when immediately added to fuel fresh from the gas station or marina fuel pump.
- Ensure stabilized fuel is circulated throughout the engine's fuel system components, not just the fuel tank, prior to storage.
- Drain fuel from carburetors and fuel vapor separators (VSTs) that have open air vents.
- Storage in sealed containers, in a cool and dry location, will extend the usable life of the fuel.
- Store fuel tanks approximately 7/8 full, minimizing the amount of air space above the fuel inside the fuel tank. Note, storing completely full may allow some fuel spillage as the fuel expanded during hot weather. Do not attempt to seal a vented boat fuel system. The inability to vent could cause damage to the fuel tank or other fuel system components.
- Minimize the time fuel is allowed to age in your fuel tank or other storage containers.
- Do not attempt to use fuel with ethanol content higher than 10%.
- Consult with your local dealer concerning maintenance procedures and new developments that are occurring in your market area.

TECH TIPS — Subject: Testing E10 Fuel
Models: All

When dealing with performance and fuel system issues, it is very helpful to know if the gasoline your customer is using contains ethanol and what percentage. Yamaha outboard motors have been designed to operate on a maximum of 10% ethanol.

Inexpensive ethanol test kits are available from a number of sources. The test kit shown, Briggs & Stratton part number 100023, is available from lawn and garden equipment parts distributors. Google “Briggs & Stratton 100023.”

