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Ethanol - Is ethanol hurting your fuel system?

David S. Yetman

While anecdotal evidence against the additive is piling up, the facts remain elusive

A great deal of printer's ink has been used lately to report a rash of apparently fuel-related problems being suffered by boaters, especially in the Long Island Sound area of the Northeast but in other areas, as well. The reported problems range from failing fiberglass fuel tanks and contamination of fuel system and engine components to clogging of filters and orifices by a mysterious sludge and engines that run rough or stall.

It has been strongly suggested that the cause of these problems is the ethanol that is now blended in some gasoline, or an undesirable interaction between ethanol and the fuel additive MTBE as one replaces the other in many areas of the country. At this early juncture, the connection between the alleged problems and various fuel additives hasn't been scientifically established and might not be for some time — but there are smoking guns that raise real suspicions about ethanol.

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The reason we must deal with ethanol and MTBE (methyl tertiary butyl ether) at all can be explained by a bit of history. The federal Clean Air Act Amendments of 1990 began the implementation of programs that mandated the use of reformulated gasoline containing oxygenates in areas of the country with unhealthy levels of air pollution. As of 2003, 87 percent of the country's reformulated gasoline was blended with MTBE. Its use continued to grow until it began to show up as a contaminant in ground water. The resulting furor has led to 22 states banning or severely restricting its use, with still others considering the same. The replacement of choice is ethanol. (See accompanying story for more on MTBE, ethanol and oxygenates.)

Many of the problems that are being attributed to oxygenates are anecdotal and as such have not been rigorously verified. Let's take a closer look at them.

Failing fiberglass fuel tanks

Published reports focus on weeping, leaking and loss of structural integrity, though mostly on older, pre-1970 fiberglass tanks. The majority of fiberglass tanks are manufactured using fiberglass-reinforced polyester, which is classified as a thermoset plastic — one that hardens in the presence of a catalyst, is insoluble, and cannot be remelted to a liquid state by heat or chemical reaction.

We normally think of the resulting material, known as fiberglass-reinforced plastic or FRP, as being a perfect barrier to liquids. But as anyone who has dealt with hull blistering knows, it is subject to water infiltration by osmosis. It also can be permeable to chemicals whose molecules are small and, in chemistry terms, highly polar. Permeable means that gases or liquids can seep into and through the material. Polyester FRP can be permeable to ethanol, whose molecules are both small and highly polar. And although ethanol is the primary suspect, improperly manufactured MTBE can contain an excess of another alcohol compound, methanol, which is even more destructive than ethanol.

The polyester resins that are used to make FRP come in many variations with different properties. Some could be subject to attack by a particular chemical, but choosing the right resin compound can overcome that. After the introduction of ethanol-blended gasoline in the late 1970s, two of the largest manufacturers of FRP tanks modified their formulas to address concerns about alcohol compatibility with their products. In 1995 one of them told customers that its FRP tanks made before 1981 weren't warranted for use with any alcohol-blended fuels.

There are dissenting opinions, but the evidence suggests that tanks made using polyester resins that aren't specifically formulated for use with fuels containing oxygenates may eventually suffer both permeability and structural problems. One study found that FRP that wasn't formulated for use with ethanol gained up to 10 percent additional weight from absorbing ethanol when immersed in it. The study also found that the hardness of the FRP was reduced by up to 80 percent from the inner surface to a point halfway through the laminate's thickness after five years of exposure to gasoline blended with ethanol. And it projected that structural stiffness could be reduced by up to 30 percent by long-term exposure. Its conclusion was that "gasohol storage may lead to increased frequency of buckling failures in tanks that were not designed to store oxygenated fuels."

Having established that ethanol can permeate and degrade FRP that wasn't designed to resist it, it's logical to suspect that the additive could be the cause of the problems reported in marine use, especially in older tanks. And since ethanol also is a solvent, it could be responsible for carrying any byproducts of FRP breakdown or manufacturing residues from the tank to the fuel system. Styrene is created during the FRP curing process, and many resins leave an uncured surface deposit to facilitate the adhesion of subsequent layers of fiberglass. Any of these could be components of the reported fuel system and engine contaminants.

The prevalence of problems with fiberglass tanks in older boats could be the result of a manufacturer's failure to use the proper resins or their unavailability at the time. It could also be the result of insufficient wall thickness, or manufacturing processes that were poorly understood by early users of the material. The geographical concentration of complaints could be explained by the popularity of particular brands of boats in an area, the longer-term presence of oxygenates there, or improper blending that resulted in unintended high oxygenate concentrations in some locales.

Without hard evidence, the effect of oxygenates on FRP is only a tantalizing clue for now; there are no iron-clad conclusions to be drawn. We will have to wait for more research to be done before the exact causes are proven, but in the interim it makes sense to keep a watchful eye on existing fiberglass tanks.

Sludge, clogged filters, operating problems

Sounding technical consultant Erik Klockars operates Klockars Engine Works in Niantic, Conn., an area that has generated many reports of fuel-related problems suspected to be caused by some aspect of oxygenate use. He has seen unexplained powdery and gritty residues building up in carburetor float bowls, even on systems that are well-protected by filtration. He also reports seeing fuel systems clogged with a greenish sludge that has to be laboriously removed before proper engine operation can be restored.

It has been suggested that these problems could be the result of mixing ethanol- and MTBE-blended fuels. However, I have been unable to find any information in available research reports on difficulties caused by incompatibility between the two. But the reported formation of sludge and clogging of filters and other fuel system components does have a potential explanation, and the cause is associated with the properties of ethanol.

Ethanol has an affinity for water and will absorb it until the amount of water in solution reaches a point where a process called phase separation causes alcohol to drop out of the fuel and collect in the bottom of the tank. There, the water/alcohol mixture encourages the growth of bacteria, which can collect in the form of sludge and be drawn into the fuel system, clogging filters, plugging fuel passages and causing fuel starvation. Beyond the sludge, if the water/alcohol solution is allowed to build up to the point where it is picked up and delivered through the fuel system, it could result in poor running, stoppage or even damage to the engine. Bouncing around in rough seas could stir up tank contents with the same results.

It would be reasonable to ask why these problems aren't affecting automobiles, where a great majority of ethanol-blended gas is consumed. The answer might lie in the fact that the fuel in automotive tanks is kept in a sealed system, is present in smaller quantities, is used more completely, and is refreshed far more often than that in boats. Marine tanks might contain hundreds of gallons of fuel that sit for relatively long periods of non-use in an environment where there is no shortage of moisture to be absorbed by the ethanol. And a gasoline engine powering a boat can require a fuel flow rate that is 10 times (or more) than that of an automobile, requiring much more contaminant to be filtered out.

Solutions

The causes of gasoline tank deterioration and possible resulting contamination have yet to be proven, so no accurate solutions can be prescribed without further research. If ethanol is proved to be a factor in deterioration, older fiberglass tanks may have to be replaced or upgraded with spray-on applications of such internal coatings as urethane or polysulfide to overcome their permeability. In the meantime, owners of boats equipped with any fiberglass gasoline tank should be watchful for signs of problems. The danger presented by a tank that may seep, leak or suffer a catastrophic failure cannot be overemphasized. And potential buyers of boats so equipped should remain aware of the expensive problems that could lie ahead.

Prevention of clogged filters, fouled systems and the resulting operational problems may be more straightforward and less expensive. Adding a biocide to the tank will kill bacteria and algae but will leave the remains to continue clogging things. Better filtration and more frequent filter cleaning or element replacement are more reliable defenses. Boats that are equipped only with rudimentary fuel filters will benefit from the installation of more effective filtration up-line, closer to the tank. At the very least, a bowl-type filter housing that acts as a water separator and has a cleanable or replaceable element should be installed. Having primary and secondary filters isn't overkill, and carrying spare filter elements is a must.

For boats that use greater quantities of fuel, one or more high-capacity filters, such as those used for diesel systems, might be a better solution. Filter systems like the Racor Turbine series have features that spin out solid matter, separate water and drop both into a large containment bowl. They also are equipped with large, easily replaceable filter elements to further block solid contaminants from entering the fuel system. In commercial and long-distance cruising applications, two such filter systems are often installed in parallel, with bypass valves that allow either to be used when the other is blocked or being serviced. Efficient filters aren't cheap, but their ultimate cost is less than the cost of breakdowns, towing charges and service bills that might otherwise result.

Reformulated gasoline, whether blended with ethanol or some other oxygenate, almost certainly is destined for wider use and is here to stay. The automotive world is adapting to it without a hiccup, and in spite of the problems that could arise from our different circumstances, we in the boating world will have to find ways of adapting too.

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Oxygenates such as MTBE and ethanol originally were used in gasoline as anti-knock compounds to replace lead when it was banned from that use. More recently, their increased use has been in response to EPA requirements for gasoline with higher oxygen content, which results in more complete fuel combustion and lower exhaust emissions. Currently, oxygenates are used only in gasoline, though there is no reason they couldn't be mandated for diesel in the future.

MTBE, or methyl tertiary butyl ether, is an efficient oxygenate that by 1998 was allowed to be blended with gasoline in strengths of up to 15 percent by volume. It was the popular choice because it had no effect on vehicle performance and was compatible with existing fuel systems and delivery methods. It is a clear liquid that blends well with both gasoline and water, and is classified as a potential human carcinogen by the EPA and the State of California. It is a particularly dangerous contaminant because it has a long life, is not absorbed by soils, and travels quite rapidly for long distances in ground water and aquifers.

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Ethanol, or ethyl alcohol, is distilled from fermented corn or other plant life. It is the alcohol that is found in alcoholic beverages, is non-toxic to humans in small amounts, and is biodegradable. (When used industrially, it is denatured to make it toxic and unfit for human consumption.) While it is an effective oxygenate, it has a number of drawbacks when used alone as a fuel or when blended with gasoline.

It has an affinity for water that can result in the problems discussed in the main story, such as the growth of bacteria in the bottom of fuel tanks, and which also makes it difficult to transport by pipeline. Its energy content is about 30 percent lower than gasoline, so performance and fuel economy can suffer slightly when it is blended with gasoline. It is more volatile than gasoline and can evaporate more easily, so the effective life of the blend is shorter.

It doesn't blend easily with gasoline, so it must be mixed just before it is loaded into a tanker for delivery. Improper mixing can result in stratification in the tanker that will allow the delivery pump to pick up concentrated ethanol, which can damage engines and fuel systems.

The EPA currently limits the levels of ethanol as an oxygenate to 10 percent to keep from voiding manufacturer warranties on engines and fuel systems. That also is a level that seems to be tolerated by microprocessor-controlled engine management systems without modification.