VAPOR & SPARK

Sometimes gas inboards make sense; How to keep yours running, and running safely

STORY AND PHOTOGRAPHY BY STEVE D'ANTONIO

Spark plugs are the life force of a gasoline engine. They must be properly selected, gapped, and replaced when worn out or fouled.

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The gasoline engine has a storied past to be sure. If you have an interest in things mechanical, then the saga of the internal combustion engine, both diesel and gasoline, is simply spellbinding. So is the story of their individual components.

When one stops to consider the complexity of the early designs and the limitations of the materials available to fledgling "motor-head" inventors at the end of the 19th century, the achievement is nothing short of astonishing. While the names Otto Daimler and Karl Benz are associated with early engines, where early internal combustion engine and automobile development are concerned, much of the credit for designing and creating the necessary systems goes to a little known engineer named Edward Butler.

Among other achievements, Butler is responsible for the spark plug, magneto, coil ignition, and the jet-type, float-equipped carburetor, and he was the first to use the word "petrol." In 1888, he built the Butler Velocycle, using a direct drive 5/8hp engine. It is acknowledged as the first British car, a model of which was exhibited two years earlier than that of Benz. Fuel economy was impressive, with a reported 40 miles to the gallon, while traveling at a reserved rate of 3–10mph.

The photos still exist, but, remarkably and sadly, Butler scrapped his creation. Part of the reason was a lack of interest, but also because restrictive British laws of the day, which governed the use of self-propelled vehicles, and included (among other requirements) that a person had to walk ahead of the vehicle waving a red flag. Butler, however, continued to develop internal combustion engines for stationary and marine use. Thus, Butler may be one of the first, if not *the* first producer of gasoline-powered engines for waterborne craft.

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WHY A GASOLINE ENGINE?

These are questions I'm asked frequently: "Is it worth it for me to pay more for a boat with a diesel engine?" and "Am I crazy to buy a boat with a gasoline engine?" The answer can take two possible tacks.

From a purely economic point of view, unless you intend to put 400 or 500 hours on the boat per year, it's difficult to justify the significantly higher cost of a diesel engine despite its greater efficiency and economy. For infrequent use, and, again, based on cost alone, gasoline power plants simply make good sense.

From the point of view of reliability, range, and safety, there's virtually no contest between diesel and gasoline engines. Diesel is better. Add economy of operation to the equation and the choice becomes even clearer.

In many cases, however, other factors influence the final decision. Some folks simply want a diesel engine, no matter how infrequently they use it. Other folks find the right vessel for them and accept the fact that it's gasoline powered, and never look back. Ultimately, if the vessel you own or intend to own is or will be gasoline powered, then it makes sense to get the most out of it and ensure that it runs as reliably and as safely as possible.

Gasoline engines have a place in propelling cruising powerboats, particularly those that don't accrue significant hours each season.

Gasoline engines rely on distributors to send spark to each spark plug and cylinder in a carefully choreographed sequence. However, it's important that, for safety purposes, the inside of the distributor remains isolated to prevent ignition of gasoline fumes.

SAFETY

Unlike diesel fuel, the flashpoint of gasoline, the lowest temperature at which flammable vapors are produced, is low indeed—negative 45 degrees Fahrenheit (vapors, rather than liquid fuel per se, are what burn). This means that at any temperature above this threshold, gasoline vapors are produced. By contrast, diesel fuel's flashpoint, which is approximately 125 degrees Fahrenheit, makes diesel inherently less volatile and therefore safer than gasoline (it is considered combustible, where gasoline is flammable).

As a young marine mechanic, I witnessed a fire aboard a 40-foot cabin cruiser. The cause was innocuous enough—one of the engine's cylinder heads were being removed, and while separating the carburetor from the intake manifold, a technician spilled a small quantity of gasoline into the bilge. (Gasoline fumes are heavier than air, and, as such, they congregate and often remain in low areas until they're removed by an exhaust blower.) During the disassembly, he had disconnected the negative battery cable from the block, and as one head was lifted clear, it disturbed the unsecured cable, which swung down and brushed the positive post of the starter, throwing a spark into the fuel. He was fortunate to escape with nothing more than minor burns and singed hair. The vessel, however, was a total loss.

That episode made a strong impression on me. Whenever I work with gasoline engines, I exercise the utmost caution when it comes to spills, leaks, and ignition sources. Among other safety precautions, whenever you work on a gasoline engine's fuel system, ensure the battery switch is in the "Off" position. Every gasoline spill or leak,

Top right to bottom right: For decades, gasoline engines have relied on carburetors to mix air and fuel in a manner that offers the greatest efficiency. Carburetors are complex and susceptible to fuel contamination issues. Today, most gasoline engines rely on fuel injection. The flame arrestor, often mistaken for a simple air filter, is a critical safety component, as it prevents the ignition of flammable vapors within the engine compartment. It requires periodic inspection and cleaning. These pistons have suffered damage as a result of detonation or pre-ignition, a phenomenon peculiar to gasoline engines. The alternators and starters used on gasoline engines are different from those used in diesel and automotive applications. Under no circumstances should components that lack ignition protection be used with gasoline engines.

READ GUIDELINES ONLINE

At the very least, whenever your gasoline-powered vessel is having work done on it, you should insist on compliance with the guidelines within the American Boat and Yacht Council's H-24 standard. To read these guidelines in their entirety, visit www.uscgboating.org/regulations and navigate to the section "Boatbuilders Handbook and Regulations."

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Fuel pumps on many gasoline engines rely on a lever that's driven by the engine's camshaft. Mechanical fuel pumps used on gas engines are different than ordinary fuel lift pumps, in that fuel leaking from within the pump must be captured and sent back to the engine's air intake system, often routed through a clear plastic tube, rather than spilling into the bilge. Check yours to ensure it includes this important safety feature.

almost regardless of quantity, has the potential for disaster. If you are unsure of how to deal with a leak or spill scenario, take no chances, go ashore and call the fire department.

Both the American Boat and Yacht Council (ABYC) and the Code of Federal Regulations (CFR) weigh in on the design and installation of marine gasoline engines and their fuel systems. The former is a voluntary, albeit advantageous, guideline to which all prudent boatbuilders, technicians, and mariners should adhere. The latter, however, is federally mandated law, a violation of which could bring fines and even incarceration. Therefore, it's conceivable that if your gasoline-powered vessel were boarded by the U.S. Coast Guard or other law enforcement agencies, you might be cited for a violation of these regulations.

The good news is that new vessels sold in the United States must meet these requirements, and as long as the vessel is maintained by those familiar with them, you will remain both safe and on the right side of the law. Furthermore, ABYC guidelines parallel or exceed those of the CFR, which makes following them very desirable indeed (and far easier for technicians to access and interpret).

Two final notes on safety:

1. A common oversight of many service professionals and do-it-yourselfers during repairs is the need to maintain ignition protection in the engine compartments of gasoline-powered vessels. The mandate calls for all-electrical gear installed in these spaces to be ignition protected, which means it is incapable of igniting flammable vapors. Gear that is ignition protected will often be so marked or it may be labeled "SAEJ117."

Among the most common violations of this requirement are starters, alternators, and distributor caps. Unlike their seemingly identical automotive counterparts, ignition-protected alternators and starters isolate spark-producing components from the atmosphere around them with gaskets or flame arrestors. Therefore, regardless of what an auto parts store clerk may tell you, never replace one of these components with a unit from an automotive equivalent, under the mistaken impression that the only real difference between it and the marine-specific version is the price.

2. Every vessel that is equipped with an internal combustion engine and designed with an enclosed cabin space should be equipped with a carbon monoxide, or CO, detector. Gasoline engines produce significantly more CO than engines using diesel fuel, and thus, the risk for CO poisoning is far greater. However, regardless of the fuel used, fatalities have occurred as a result of CO produced by *other* vessels. Therefore, CO detectors should be installed aboard every boat that has an enclosed cabin.

THE TROUBLE WITH ETHANOL

No discussion on the subject of gasoline engines would be complete without mention of ethanol or E10, a mixture of gasoline and 10 percent ethanol. Ethanol is routinely added to gasoline as an oxygenator, to improve burn characteristics and reduce emissions (it also reduces fuel economy). However, it has undesirable side effects that most owners of gasoline-powered equipment, from boats to lawn mowers, are now all too familiar with, chief among which are its ability to hold water in suspension.

Unlike ordinary gasoline, ethanol will mix readily with, and hold up to .5 percent water by volume. Beyond that saturation point, however, the water/ethanol mix will, in a process known as phase separation, drop out of suspension, forming a sludge-like mixture on the tank's bottom. The remaining gasoline is now "off spec." That is, it may no longer possess the proper burn characteristics to operate in your engine. Additionally, the water/ethanol mix will, if drawn into the engine, wreak havoc. In short, every effort should be made to avoid such an episode.

Prevention is often the best medicine, and gasoline fuel woes are no exception. E10 has been in use in parts of the Midwest for many years, and Mercury Marine engine service manuals printed in the 1990s devote significant attention to it and methods for avoiding problems. But since its more recent, wider distribution, the marine industry has dealt with a variety of issues in addition to phase separation. These include incompatibility of certain plastic and rubber components, including fiberglass, with ethanol, scouring of fuel systems, and the resultant clogging as a result of ethanol's solvent effect, as well as etching of aluminum and other metallic components within fuel systems.

Many of these problems can be prevented by taking the following steps:

Where available, use non-ethanol fuel.

Add a stabilizer to E10 gasoline at each and every fill-up, especially if the fuel will not be used within 30 days.

If it's not already equipped, install a UL Marine-approved, gasoline-rated fuel filter. While it will not remove water that's held in suspension (which in this quantity is for the most part harmless), it will catch debris dislodged by E10 use.

Ensure that all hoses are approved for use with ethanol. They will be marked "USCG A1-15" for supply or "A2 FIRE ACOL" for fill and vent.

For off-season storage, tanks should be nearly full (to allow room for thermal expansion) and properly stabilized.

The NFPA (National Fire Prevention Association) guidelines recommend against storing vessels with empty or nearly empty fuel tanks, as the vapors within are highly flammable and liquid fuel is not. This has created some debate, with some believing that the less ethanol-laced gasoline you store, the less water it can absorb.

However, the danger this presents likely outweighs this argument. An opposing argument (one I subscribe to), states that more exposed tank surface presents more opportunity for condensation to form, making water "overload" and phase separation more likely. E10 is hydrophilic, meaning it holds water, but, contrary to popular belief, it does not readily absorb water from the air.

More in *Channels* If you learned anything from this examination of gas engines, you will find plenty more technical discussions when you get *Channels*, our free e-newsletter. Go to www.passagemaker.com and click on the subscribe button.

Have you discovered oily vapor rising from the oil fill of your gas inboard? Have you found a cheaper automotive starter to replace the worn one on your old Crusader? Do you know the difference between a compression test and differential leak-down test? If any of these questions apply, you will be well served by reading Steve D'Antonio's online primer on marine gasoline engines. Visit www.passagemaker.com. Click on Magazine, then Web Extras.

OPERATION

Those operating gasoline engines should be familiar with their operation, and the safety precautions associated with their use. These include proper fueling procedures and ventilation of bilges. After fueling and before starting the engine, carry out a sniff test inside the engine compartment and adjacent to the fuel tanks. Any odor of fuel is too much; its source must be identified before the engine starts. (Electronic fuel vapor sensors are a wise investment for gasoline-powered cruising boats, however, they are fallible. Your nose is not.)

Hoses connecting deck fill fittings to tanks are among the most common sources of fuel leakage, and explosion, aboard gasoline-powered vessels. If you haven't inspected your hoses lately (access to it is yet another ABYC/CFR requirement), do so, and while you are at it make sure the bonding wires between the deck fills and the tanks or bonding system are present, tight, and free of corrosion.

Fuel filters play an important role for any internal combustion engine, and gas engines are no exception. Ideally, the spin on variety, like this one, captures sediment and water.

Finally, after fueling is complete, but before starting your engine, operate the blower for at least five minutes.

Gasoline engines make excellent sense for many boats and the boating habits and wallets of many boat owners. Treat yours right, and with the respect it and its fuel deserve, and you'll be rewarded with reliable, safe performance.

Steve owns and operates Steve D'Antonio Marine Consulting (www.stevedmarine.com), providing consulting services to boat buyers, owners, and the marine industry.

Fuel contamination and deterioration are constant sources of concern where gasoline engines are concerned. Gasoline can go sour, turning to a varnish-like sludge, in a relatively short period of time—in some cases, in just a few months.