

# POWERBOATS

## *What Diesel Mechanics Wish Every Boat Owner Knew*

*By Captain Bernie Weiss*

Diesel machinery is not a difficult subject. In fact, any owner of a diesel-powered boat - sail or power - should learn the fundamentals of engine operation and maintenance. To run well, a diesel engine requires only clean fuel, clean lubricating oil, coolant, and lots of air. In other words, simple routine maintenance will virtually guarantee years of trouble-free service, not to mention the savings of time and money awaiting the arrival of your busy mechanic.

How the diesel engine works, and why in many cases it is superior to the gasoline engine as a marine powerplant, will not be discussed here. That's been well-covered elsewhere. What I will describe here are 10 things that every diesel mechanic hopes - or supposes - or wishes - that every boat-owner knew about diesels. As one mechanic recently told me, "A knowledgeable boat-owner makes my job easier. When I receive the call, the owner can report meaningful symptoms, can explain the engine's relevant history, has probably kept up with maintenance routines, and won't give me a strange look when I explain that the engine may need a new circulating pump, or that the fuel is contaminated and should be polished."

In no particular order, here are ten important maintenance issues that diesel mechanics wish their customers knew:

**1. Don't baby the engine.** Diesels don't like to idle in neutral, or even in gear at low speeds; they do like to work hard under load. Properly matched to its boat, a diesel engine can run at cruising RPM (the "sweet spot") for hour after hour, day after day. What's cruising RPM? Generally, the sweet spot is approximately 75-80% of the maximum RPM as defined in the owner's manual. However, the sweet spot will vary from one engine brand to another. Volvo-Penta, for example, recommends that some of its larger engines be run at 200 RPM below the "obtainable maximum RPM."

Running at the sweet spot, after just a few minutes of initial warm-up, the engine should move the boat at reasonable speed with minimal noise and very little harmonic vibration. The sweet spot also maximizes fuel efficiency and longevity of the engine. Example: My 3-cylinder Yanmar has a rated maximum RPM of 3,600. I routinely run it at 2,800 RPM (75-80% of the max), and at that speed it moves my 12,000-pound sloop at 6.5 knots, consuming approximately 1/2 GPH.

Especially avoid idling the engine for long periods. At idle speeds, fuel combustion is incomplete (compared to cruising RPM under load) so excessive idling wastes fuel. Excessive idling also accelerates wear and tear on the engine, leads to gradual build-up of detrimental varnish on the cylinders, and deposits soot and carbon on the engine's valves and in the exhaust system, particularly at the manifold injection elbow where raw cooling water exiting the engine mates with the exhaust gases.

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So, don't baby your engine. Run it hard. However...after running at cruising RPM for several hours, a brief cool-down at idle speed, with no load, is beneficial. A few minutes is enough.

**2. Give your engine clean - not contaminated - fuel.** Diesel engines must have clean fuel. Fuel is "contaminated" when it contains water, sediment or other solids. Contaminated fuel may also contain biological organisms, some of which thrive in diesel fuel. To minimize contamination, don't store your boat for the winter, and don't let it sit around for weeks at a time with fuel tanks only partly full (or partly empty). A full tank minimizes condensation of water vapor on the tank's interior walls, and thus reduces the volume of condensate entering the fuel system. Diesel fuel left undisturbed in your tank for long periods should be regarded as a culture medium fostering the growth of micro-organisms.

Since diesel engines have a low tolerance for contaminated fuel, filtration is critical. Your engine is equipped with its own fuel filter, of course, and there is also a small fine wire mesh screen at the bottom tip of the fuel pick-up tube inside the fuel tank. At least one additional fuel filter is a highly recommended. It should be a high-efficiency unit specifically designed for diesel service, such as the Racor or Dahl. Such filter should also be a water separator, incorporating a design that - after separating the water from the fuel - allows you to drain the unwanted water from the bottom of the filter bowl. This water separation filter should be the primary filter, the first filter that the fuel encounters after it leaves the wire mesh screen in the pickup tube and the tank. (Filters mounted on the engine itself are considered secondary.)

The elements in all of your fuel filters, including those that trap sediment, sludge, and organic material, should be changed at periodic intervals - every 75-100 hours of operation or annually, whichever comes first. With older boats, and those with possibly contaminated fuel, filters should be attended more frequently. Always carry spare filter elements on board.

**3. Be conservative in your estimate of fuel consumption.** Know your engine's burn rate (gallons consumed per hour), the fuel tank capacity, and thus, know the boat's range between fill-ups. When



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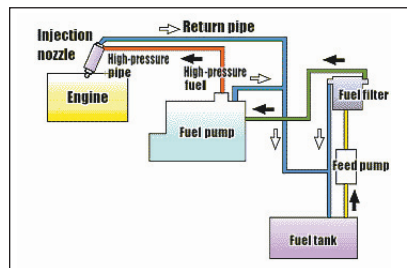
under way, do not delay re-fueling to the point where you have expended nearly all the fuel in the tank. The last 20% should be held in reserve and, in addition, to suck up the last few gallons of fuel from the bottom of the tank is to chance sucking up water (tank condensate), sludge, and other contaminants - perhaps even air - into your fuel lines. If there's a question about whether you'll have enough range to cruise comfortably between fueling stops, be conservative: acquire an auxiliary tank and take extra fuel on board. You can never have too much fuel, unless the boat is on fire.

#### 4. Know how to vent ("bleed") the air out of your fuel system.

Air locks in diesel fuel systems are a fact of life. The typical diesel fuel system operates with a lift pump (a vacuum pump) that lifts or sucks fuel out of the tank, draws it through the pump, then sends it to the filters and injectors, where the injector pump sends fuel to the individual cylinders for combustion. Whenever you open the fuel line between the tank and the engine (for example, to change a filter element) air enters the line. Air may also be sucked into the fuel line through cracked seals and gaskets, poorly fitted connectors and clamps, via the pick-up tube in the fuel tank, etc. This air must be removed, because even a tiny air bubble in the fuel line will block the flow of fuel, and without fuel, the engine will not start; if running, air in the fuel line will cause it to stop.

To clear your fuel line of air, you must vent or "bleed" it out. Consult your engine's manual to identify the bleeding nuts; paint them with white nail polish so you can easily find them again, in the dark, at sea. Given decent access to the engine, bleeding or venting air is a simple procedure that everyone should be able to perform. Using the engine manual, teach yourself how to do this.

While on the subject of air: At any speed, diesel engines require an enormous volume of clean air to support combustion. This air is drawn into the engine through a filter (sometimes called a "silencer"). Periodically, that filter should be cleaned with solvent or kerosene (if a metal mesh) or replaced (if it is paper or fabric). Even a small reduction in the free flow of air will cause a dramatic reduction in the engine's performance.



5. Be diligent about checking your lube oil and oil filter. Diesel engines are rough on oil and usually require more frequent oil and oil filter changes than comparable gasoline engines. Follow the engine manual's recommendation for service intervals - most suggest every 75-100 hours of operation, although some recommend a change every 50 hours. Unchanged oil is probably the single greatest cause of accelerated engine wear and failure. It is also one of the simplest maintenance tasks to carry out. When changing the lube oil, change the filter element. Carry spares on board. Between oil

changes, use the dipstick to check the oil level. Top it off as necessary from your on-board lube oil inventory, but do not exceed the "full" mark on the dipstick; more is NOT better.

Note that fresh lube oil as it comes from the container is golden or honey brown in color. However, within a few minutes of circulating inside the engine, the lube oil turns black due to soot, ash, acids, contaminants, and other carbon byproducts of diesel fuel combustion. This is normal and, by itself, is not enough to prompt an oil change.

6. Minimize risk of fire. Diesel engines vibrate a lot, and the typical marine diesel has a lot of wiring and hoses attached to it, crossing it, behind it and near it. Over time, as the engine vibrates, the fasteners may loosen and fail, the wiring and hoses droop or fall. One hates to see a loose hose or wire (such as the primary wiring harness, or the power supply to your fuel pump, or a hose to the hydraulic pump) cross and contact a hot exhaust manifold, for example; this could be a prescription for fire due to abrasion of insulation around wire, or chafing through the wall of a hose.

From time to time, inspect your engine compartment for these potential risks. Add chafing protection, replace worn insulation, and supplement the fasteners if necessary. Consider re-routing wires and hoses where appropriate.

7. Know how to trouble-shoot the cooling system. Since overheating is a common problem with diesel engines, you have an obligation to familiarize yourself with both of the engine's cooling systems: the raw water (sea-water) system, as well as the fresh water (internal circulating coolant) system. Frequently, a simple do-it-yourself repair or replacement from your on-board spare parts kit will save you both time and money.

In terms of trouble-shooting the over-heating problem, as Yogi Berra has said, "You can observe a lot just by looking." When an engine overheats, I look first at the raw-water overboard discharge:

*If there is no flow or only a dribble*, the most likely causes of overheating are:

- \* Raw-water valve closed.
- \* Raw-water through-hull blocked externally. Check for a plastic bag, or a clump of sea grass or other material, covering or plugging the inlet.
- \* Raw-water filter / strainer clogged with sediment, sand, goo, grass, or living critters such as barnacles, jelly fish, and algae.

*If the overboard discharge is evident but less than normal, perhaps with some steam*, then consider these likely causes:

\* Defective or destroyed impeller in raw water pump. The impeller should be replaced every year or two, as the rubber vanes become brittle with age and may snap off. Also, the vanes' tips may wear unevenly or take on a permanent set, either of which degrades the impeller's function.

\* Heat exchanger dirty or clogged up with sediment and other deposits. The entire raw water cooling system should be flushed pe-

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riodically to remove salt and sediment deposits.

\* Exhaust injection elbow restricted by carbon deposits or other solids, reducing the discharge of cooling water and exhaust gases. Routinely running the engine at high or moderate RPM under load, as opposed to long periods of idling at low speeds, will largely avert this problem.

*If the volume of the raw-water discharge appears normal, with some steam,* then I would suspect one of these common causes:

\* Thermostat stuck closed; likely will require removal or replacement. (Note: Some diesel engines will operate just fine - temporarily - without a thermostat.) It's worth remembering that diesel engines are most efficient at high temperatures: a coolant temperature of about 170-180° F is normal.

\* Low level of coolant (50-50 mix of antifreeze-water). Coolant levels should be checked routinely at the expansion tank, adding more as needed. Caution: Remove the cap on the coolant chamber only after it has cooled to the touch. Replacing the cap, be certain it is closed snugly and seals the system. Frequent replenishment of the coolant suggests a leak and requires further investigation.

\* Broken or slipping V-belt, which drives the water pumps and the alternator. Keep a spare belt on board. From time to time, even a new belt deserves re-tensioning and an inspection for wear. Suspect slippage or excessive wear if you see fine dark "belt dust" settling around the engine mounts or at the engine's base near the belt. To check belt tension, apply thumb pressure midway the longest belt run; tension is OK if pressure deflects the belt by about 1/2 inch.

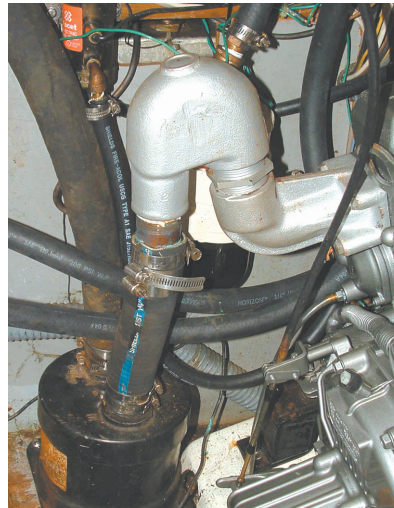
\* Overloading of the engine: Rope wrapped around propeller shaft, dirty bottom, fouled propeller, etc. Also, check for air leaks in the raw water cooling system. Has a hose cracked or collapsed? Are the hose clamps tight?

**8. Know your fuel additives.** When crude oil is refined and distributed as diesel fuel, it acquires additives to reduce smoke, prevent pre-ignition ("knocking"), improve its cetane rating, etc. Few of the many after-market additives further enhance the fuel, but there are some exceptions. Some diesel mechanics actually recommend the following: Biocides, such as Killeme and Biobor, lubricants, such as Lubricity and Stanadyne Performance Formula, and fuel stabilizers, such as Sta-Bil and Pri-D.

Two precautions when using fuel additives: 1) Follow the instructions on the container. 2) Routinely, a little bit is better than a lot. Of course, circumstances may occasionally justify a "shock treatment" - double or triple the usual dose - of fuel additive: stabilizer, lubricant, and/or biocide. Be guided by your mechanic's advice.

**9. Monitor for exhaust leaks.** From time to time, when the engine

is operating, inspect the complete exhaust system from the engine to the through-hull and overboard discharge. Look for leaks, both exhaust (air) and water. Major leaks will be obvious, but early signs of leaks due to hairline cracks in hoses and water pot muffler systems may not be readily apparent. Diesel exhaust contains acidic



sulfur and other gasses that may poison the air within the boat, and over time may cause nearby metals to corrode. To detect air leaks, look for tell-tale traces of black soot. Water leaks should also be immediately repaired. Leaks never resolve spontaneously; they must be addressed as quickly as possible.

**10. Properly dispose of hazardous waste.** Be sure to properly dispose of used coolant, used engine oil and transmission fluid, contaminated fuel, old filters soaked with fuel and oil, etc. These fluids are generally poisonous to people, pets, wildlife, and the environment, and some of them can be recycled.

## Conclusion

Learning how to operate and maintain your diesel engine properly is not difficult. With just a little bit of applied knowledge and skill, and a simple tool kit, you can save time and money. Frequently, evaluating a problem is no more difficult than studying the symptoms, which will either lead straight to the proximal cause or suggest the most logical possibilities.

And of course, (reading between the lines of text above) the key to a satisfying experience with your diesel engine is not necessarily knowing how to repair it, but knowing how to maintain it so that you do NOT have to repair it. Treat yourself and your engine kindly by following the recommended maintenance procedures and schedules.

Finally, because all engines respond well to kid gloves and TLC, fondle it lovingly while whispering soft terms of endearment. (What harm could it do?) ♦

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