

Learn where all the major components on your engine are. This is the fuel lift pump

## TEN THINGS DIESEL MECHANICS THINK EVERY BOATOWNER SHOULD KNOW

By Captain Bernie Weiss

❖ Diesel mechanics is not a difficult subject. In fact, all owners of diesel-powered boats can—and should—learn the fundamentals of operating and maintaining their engines. To run well, a diesel engine requires clean fuel, clean oil, and a lot of air. Routine maintenance will virtually guarantee years of trouble-free service and will keep your busy mechanic at bay.

How a diesel engine works, and why in many cases it is superior to a gasoline engine as a marine power plant, will not be discussed here. That has been well covered elsewhere. What I will describe are 10

things every diesel mechanic wishes every boatowner knew about diesel engines. As one mechanic told me, “A knowledgeable boatowner 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 grief when I explain that the engine may need a set of new injectors, a new circulating pump, or a purging of the entire fuel system.”

Here is the list, in no particular order of priority.

### 1 DON'T BABY THE ENGINE

Diesels don't like to idle in neutral or run in gear at low speeds; they do like to work hard under load. A diesel engine that is properly matched to its boat can run at its cruising rpm (the “sweet spot”) for hour after hour, day after day. What's the cruising rpm? Generally, the sweet spot is approximately 75 to 80 percent of the maximum rpm as defined in the owner's manual. Running at cruising rpm after just a few minutes of initial warmup, the engine should keep the boat moving at a reasonable speed with minimal noise and little harmonic vibration. Running in the sweet spot also maximizes fuel efficiency—it runs hot enough to be at its most efficient operating temperature, but is not being overworked—and increases the engine's lifespan.

However, the sweet spot will vary from one engine to another. Volvo-Penta, for example, recommends that some of its larger engines be run at 200 rpm below the “obtainable maximum rpm.” My three-cylinder Yanmar diesel has a rated maximum rpm of 3,600. I routinely run it at

2,800 rpm (75 to 80 percent of the max), which keeps my 12,000-pound sloop moving at 6.5 knots, with the engine consuming approximately 1/2 gph.

You should especially avoid idling the engine for long periods. At idle speeds, fuel combustion is incomplete compared to cruising rpm under load, so excessive idling only wastes fuel. It also accelerates wear and tear on the engine, causes varnish to build up 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 exhaust gases. Running at cruising rpm blows this stuff out. However, after running at cruising rpm for several hours, a brief cool-down at idle speed, with no load on the engine, 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. Fuel may also contain biological organisms. To minimize

contamination, don't store your boat for the winter or let it sit around for weeks at a time with its fuel tanks only partly full. Keeping the tank full minimizes the condensation of water vapor on the tank's interior walls, thus reducing the volume of condensate entering the fuel system. Diesel fuel left undisturbed in a tank for long periods should be regarded as a culture medium designed to foster the growth of microorganisms.

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 may be a small fine wire-mesh screen at the bottom of the fuel pick-up tube inside the fuel tank. At least one additional fuel filter is recommended. This should be a high-efficiency unit specifically designed for diesel service, such as a Racor or Dahl filter. This filter should also be a water separator that allows you to drain the separated water from the bottom of the filter bowl before enough accumulates for it to continue through the fuel lines to the injectors, where it will stop, if not damage, the engine. This water-separating filter should be the primary (first) filter the fuel encounters after it leaves the tank. Filters mounted on the engine itself should be considered secondary units.

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

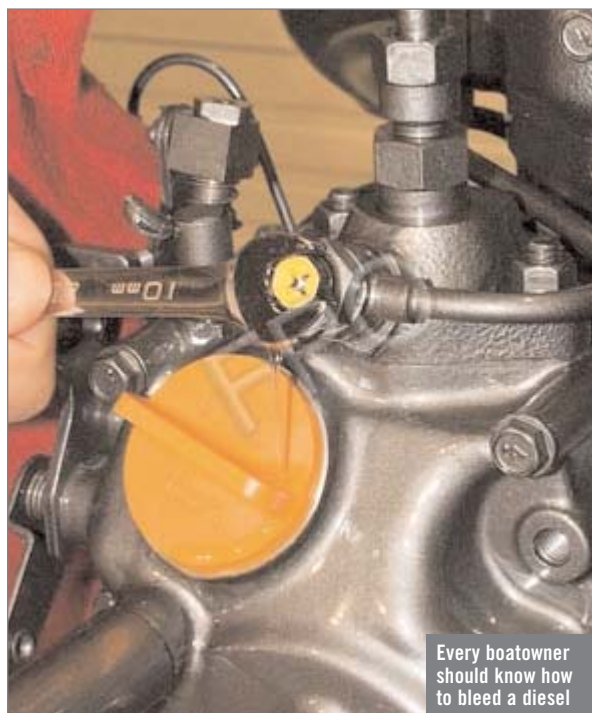
## 3 DON'T RUN YOUR FUEL TANK DRY

Know your engine's burn rate (gallons consumed per hour) and your fuel capacity so you can accurately calculate the boat's range between fill-ups. Do not delay refueling to the point where you have expended nearly all the fuel in your tank. The last 20 percent should be held in reserve. Sucking the last few gallons of fuel from the bottom of the tank increases the chance of pulling water, sludge, and other contaminants—perhaps even air—into the fuel lines. If you're not sure you have enough range to cruise comfortably between fuel stops, be conservative: Acquire some jerry jugs and take extra fuel with you. You can never have too much fuel, unless the boat is on fire.

## 4 KNOW HOW TO BLEED AIR OUT OF YOUR FUEL SYSTEM

Air locks in diesel fuel systems are a fact of life. A typical fuel system has 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 an injector pump sends it 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, and so on. This air must be removed, because even a tiny bubble will block the flow of fuel, which will prevent the engine from starting or will cause it to stop if it is already running.

To clear your fuel line of air, you must “bleed” it out if your engine doesn't have a self-bleeding feature or it can't cope with the air. Consult your engine's manual to identify the appropriate bleeding points; paint them with nail polish so you can find them easily. Given decent access to the engine, bleeding or venting air is a simple procedure that everyone should be able to perform. Use the engine manual to teach yourself how to do this.



Every boatowner should know how to bleed a diesel

## ENGINE

While on the subject of air: When running 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. Periodically, that filter should be cleaned with solvent or with kerosene if it's a metal-mesh filter, or replaced if it is paper or fabric. Even a small reduction in the free flow of air will dramatically reduce 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 an oil and filter change after every 75 to 100 hours of operation; some recommend a change every 50 hours. Unchanged oil is probably the single greatest cause of accelerated engine wear and failure. Changing it is one of the simplest maintenance tasks to perform. 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 an onboard supply, but do not exceed the "full" mark on the dipstick; more is NOT better.

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

### 6 MINIMIZE RISKS OF FIRE

Diesel engines vibrate a lot, and a typical marine diesel has a lot of wiring and hoses attached to it. Over time, fasteners loosen and fail and the wiring and hoses come loose. If 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) should come in contact with a hot exhaust manifold, for example, any of these could cause a fire.

From time to time, inspect your engine compartment for these potential risks. Add chafing protection, replace worn insulation, and add extra fasteners if necessary. Consider rerouting wires and hoses where appropriate.

### 7 KNOW HOW TO TROUBLESHOOT THE COOLING SYSTEM

Since overheating is a common problem with diesel engines, you should familiarize yourself with the engine's cooling system—both the raw-water and the freshwater sides. Frequently, a simple do-it-yourself repair or replacement from a spare-parts kit will save you both time and money.

When troubleshooting an overheating problem, as Yogi Berra once put it, "You can observe a lot just by looking." When an engine overheats, I first check the raw-water overboard discharge.

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

- **THE RAW-WATER INTAKE SEACOCK** is closed.
- **THE RAW-WATER INTAKE** is blocked externally. Check for a plastic bag, a clump of sea grass, or other material covering or plugging the inlet.
- **THE RAW-WATER FILTER** or strainer is

clogged with sediment, sand, goo, grass, or living critters such as jellyfish and algae.

If there is flow, but it is diminished, consider these likely causes:

- **DAMAGED IMPELLER VANES** in the raw-water pump. If the impeller is completely destroyed, there will be no flow. The impeller should be replaced every year or two, as the vanes become brittle with age and may snap off. Also, the vane tips may wear unevenly or take on a permanent set, degrading the impeller's function.
- **THE HEAT EXCHANGER** is dirty or clogged up with sediment and other deposits. Sometimes removing the end cap of a heat exchanger will reveal the cause of overheating. The entire raw-water cooling system should be flushed periodically to remove salt and sediment deposits. Sometimes it will be necessary to remove a clogged heat exchanger so that it can be "boiled out" with an acid bath to purge its water channels and restore it to like-new condition.
- **THE EXHAUST INJECTION ELBOW** is clogged with carbon deposits or other solids, reducing the flow 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 help avert this problem.



Know where the water-pump impeller is and how to change it. Always carry a spare



## The key to a satisfying experience with your diesel engine is not necessarily knowing how to repair it, but rather how to maintain it so that you do NOT have to repair it

If the flow appears normal, then you should suspect one of these common causes:

- **THE THERMOSTAT** is stuck closed and likely should be removed or replaced. (Note: Some diesel engines will operate just fine—temporarily—without a thermostat.) It's worth remembering that diesel engines are most efficient running at high temperatures: a coolant temperature of 180°F is not uncommon.

- **THE COOLANT LEVEL** is low (this should be a 50:50 mix of antifreeze and water). Coolant levels should be checked routinely, and more coolant should be added as needed. Caution: Remove the cap to the reservoir only after it has cooled to the touch. When 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.

- **A V-BELT** driving the water pump and alternator is broken or slipping. Keep a spare belt on board. Even a new belt needs retensioning sometimes and should be regularly inspected for wear. Expect to find some 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 along the longest belt run; tension is okay if the belt deflects about 1/2 inch.

- **THE ENGINE** is overloaded: A rope may be wrapped around the propeller shaft, the boat's bottom may be foul, the propeller could be fouled, and so on.

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

After diesel fuel is refined from crude oil, it is modified with additives to reduce smoke, prevent preignition (or “knocking”), improve its cetane rating, and so on. Few aftermarket additives will further enhance the fuel, but there are some exceptions. Many diesel mechanics recommend the following:

- **BIOCIDES**, such as Kill'em and Biobor. These products kill bacteria, fungi, algae, and other microbial life in your fuel tank. They will prevent sludge from contaminating the tank, clogging up fuel filters, and blocking fuel lines.

- **LUBRICANTS**, such as Lubricity and Stanadyne Performance Formula. Lubricants prolong the life of seals and rings in the engine. Modern diesel fuels with reduced sulfur content—sulfur acts as a lubricant—may be improved by such an additive.

- **FUEL STABILIZERS**, such as Sta-Bil and Pri-D. These additives prevent fuel from undergoing degradation and oxidation during prolonged storage (as on a winterized boat). But if diesel fuel has been aboard a boat undisturbed in storage for more than a year or so, a mechanic will view it with suspicion; frequently he or she will recommend that the fuel be replaced before starting the engine.

Two precautions when using fuel additives: (1) Follow the instructions on the container. (2) A little bit is better than a lot.

### 9 MONITOR FOR EXHAUST LEAKS

From time to time, when the engine is operating, inspect the entire exhaust run from the engine to the overboard discharge. Look for leaks, both gas 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 gases that may poison the air within the boat and, over time, may cause nearby metals to corrode. To detect air leaks, look for telltale traces of black soot. Water leaks should also be immediately repaired. Leaks never get better on their own; they must be addressed as quickly as possible.

### 10 READ AND UNDERSTAND THE OWNER'S MANUAL THAT CAME WITH THE ENGINE

In the case of a new boat, this will be part of the package of literature that is passed to you by the dealer. If you have an older boat, request a manual from the engine manufacturer. If the engine is old and no longer in production, a search on the Internet will often prove fruitful. At the very least, a manual will tell you the recommended intervals between oil changes, the type of lubricants to use, and any other salient information. Better yet, get hold of the engine's workshop manual. Consider going to a diesel-engine course. Many manufacturers offer one- and two-day hands-on courses that can be invaluable in helping you maintain your engine in top condition.

### ▶ CONCLUSION

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

The key to a satisfying experience with your diesel engine is not necessarily knowing how to repair it, but rather 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. **EM**