A small diesel feed tank for a Nordland yacht under construction. Note the air space all around the tank, and the secured mounting.

FUEL TANKS

Knowing more about fuel tanks and their installation can help with replacement decisions

BY **PETER D. EIKENBERRY SR.**

Fuel tanks are usually buried wherever there is enough space and installed in the early stages of construction, often not to be seen again until disaster strikes. A leak in a gasoline tank can be catastrophic, resulting in an explosion and fire. Diesel fuel is safer and will generally not cause your boat to blow up, but it can make one heck of a mess.

When designing a boat, the major tank concerns are size and how their weight affects the boat's balance and stability. Replacement of the tank is rarely considered, and when it is time to replace those tanks, the best solution is often to cut up and remove them one piece at a time. In some cases, the interior structure must be cut up or a hole made in the hull to remove the tank. On any boat this is distressing and expensive.

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Tank Materials

The most common materials for gasoline tanks are aluminum and cross-linked polyethylene. On diesel-powered boats steel and fibreglass are also used. Occasionally more exotic (and expensive) materials such as Monel and other blends of copper and nickel are used.

A study by Underwriters Laboratories (UL) for the U.S. Coast Guard has shown that aluminum tanks last an average of 10 years. Life spans are comparable for other metal tanks. There is no data on the life of plastic tanks, but plastic has been used since the 1970s with no significant problems. Fibreglass tanks have been used since the '60s and work well with diesel, although there are problems when used for gasoline. Some manufacturers of luxury yachts, such as Hatteras, use fibreglass diesel tanks and have not reported any significant problems.

Tank Standards

In the U.S. and Canada the respective Coast Guards regulate fuel tanks on recreational boats. U.S. standards posit the absolute minimum for safety, so most manufacturers follow the American Boat and Yacht Council (ABYC) standards, which are more comprehensive. In Canada the standards are taken directly from ABYC. ABYC is a non-profit organization that employs volunteer committees of designers, builders, surveyors, government entities, boat owners and other interested parties to determine, by consensus, the standards. Groups such as the National Fire Protection Association, the Society of Automotive Engineers and UL also publish standards. These are incorporated into ABYC standards. If the tank meets ABYC standards, it will also meet the national standards.

Aluminum Tanks

Almost 50 percent of powerboats made in the U.S. and Canada have aluminum tanks. Primarily these are gasoline tanks, but they are also used in some diesel boats. Marine-grade aluminum, type 5052, 5083 or 5086, is remarkably corrosion resistant and best left unpainted. Aluminum, when exposed to air, forms an oxide on its surface, which protects it from corrosion. As long as it is kept dry and the oxide is intact it will last indefinitely. There have been some problems with ethanol/gasoline blends causing corrosion of aluminum tanks from the inside out. To prevent this, boats using fuel containing ethanol should be stored with empty tanks, or the tanks should be topped off with a stabilizer and a co-inhibitor added to the gasoline.

Polyethelyne Tanks

Slightly less than 50 percent of boats built in the U.S. and Canada have molded cross-linked polyethylene (PE) tanks. They don't corrode and they last almost forever. They have no seams or welds to leak. You rarely see PE tanks over 100 gallons (380 litres) because they can't be baffled. PE tanks do permeate a very slight amount of vapor through the tank wall. If the amount is greater than that specified by the regulations, the space containing the tank must be ventilated. But if it is installed properly there is no danger. The problems that have occurred with PE tanks have been caused by people putting a hole in the tank, or by bad gaskets.

Other Materials

The rest are divided between steel, fibreglass and other materials such as stainless steel and more exotic metals. Each has its good and bad points. Steel is used primarily on diesel-powered boats and is strong and durable. When built and installed correctly, and coated inside and out with a barrier coat such as paint or epoxy, it ages well. Unfortunately steel rusts, so the tank must be kept dry and care must be taken not to damage the coatings.

Slightly less than 50 percent of all boats built in Canada and the U.S. have molded cross-linked polyethelyne fuel tanks.

Stainless Steel

(SS) tanks should be constructed from type 316L or 317L stainless steel. It is a common myth that SS does not corrode. It will corrode when wet. Like aluminum, it has a natural oxide that protects the metal, but when the oxide is breached or dissolved corrosion sets in. SS suffers from crevice corrosion, in which any defect in the welds or scratch in the metal will trap moisture, and hidden corrosion will occur beneath the surface. Often it isn't discovered until too late. But SS has been used successfully under the right conditions—it must be kept dry and welds should be minimized.

Fibreglass

would seem to be an ideal material for fuel tanks. It doesn't corrode, it can be made any shape and size, and it can be built into the hull. On gasoline boats, integral tanks are not allowed, but they are allowed on diesel boats. Unfortunately, fibreglass also has serious problems with gasoline. In the past few years there have been reports of leaking fibreglass tanks. This is primarily due to

A 2,500-gallon (9,500-litre) aluminum tank bolted to the transverse bulkhead of a Norland yacht, with space underneath for air circulation.

FROM TOP: COURTESY WESTERN MARINE; PETER D. EIKENBERRY SR.

ethanol in the fuel, but there are other factors involved too. Fibreglass is not impervious, and gasoline with ethanol will migrate through the laminate and dissolve the resin that holds it together. This process usually takes years and most of the boats with problems are 20 or more years old, but it has happened on newer boats. I know of one boat whose fibreglass tanks failed in six months. Personally, I do not recommend fibreglass tanks for gasoline.

Fibreglass is not affected by diesel, and is often used for fuel tanks in large yachts. However, if you build integral tanks, keep in mind that if you hole the boat at the tank, you will be responsible for a major pollution incident. Fibreglass tanks should be gel-coated or given some other impermeable barrier coat on the inside of the tank.

Tank Testing

The ABYC standards specify the construction of the tank. There are material specifications and performance standards. Tanks are required to pass a static pressure test. They must also be capable of passing a pressure impulse test, shock tests, slosh tests and, most importantly, a fire resistance test, although such tests are not mandatory. Strength specifications are stricter for tanks in the forward half of the boat because of the motions the tank is subjected to. The tank manufacturer has to certify the tank has met the pressure test and label the tank accordingly. I recommend you buy a commercially made tank or get one from the original boat builder. If you have a tank custom made, be sure the builder knows and understands both the Federal and ABYC requirements for fuel tanks. Do not have a friend of a friend who knows a welder make a tank for you. It may be cheap, but you will not get any assurance the tank meets the standards, and if the new tank fails a survey you may have to replace it.

Fittings

Gasoline tanks may not have openings below the top of the tank or incorporate tank drains or sight tubes, but diesel tanks commonly do. Sight tubes should have a valve at either end so they can be closed to prevent leaks if the tube breaks. Diesel tanks usually have a clean-out port on the top of the tank. All fittings should be galvanically compatible with the tank, so, for instance, brass should never be used in contact with aluminum. Steel or stainless steel is the most common material for fittings. One item that causes headaches is the tank sender, which tells you how much fuel is in the tank. In most tanks this is the old resistive, float-on-an-arm type. The arm is connected to a variable resistor. As the float goes up and down the arm moves, the resistance changes, and the level is indicated on a gauge. Such senders, however, are affected by motion and notoriously inaccurate. You can find much

Top: Typical aluminum tanks for powerboats. Above: A selection of tank senders from Wema.

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better senders that use capacitance or induction to detect levels. These have no internal moving parts. There are even devices that can detect the height of the fluid inside the tank while remaining outside. All of these are more accurate.

Installation Federal regulations require only that the fittings on the tank be accessible; ABYC says tanks should be installed so they can be easily inspected, maintained and removed. Unfortunately, this is open to interpretation. Ideally, tanks should be installed securely with mounts that allow air to circulate around them. Bilge water should not reach the tank, and drips or condensation must run off. No surfaces of the tank should trap water. It is common to see tanks mounted on a flat surface with neoprene underneath them. Neoprene does not soak up moisture, but moisture can be trapped between the neoprene and the tank. You should avoid this. Also, the straps used to hold the tank should not trap or absorb moisture. Finally, tanks that are not integral with the hull must not support decks or bulkheads—the structure of the boat, in other words.

New plastic tanks require further consideration. They will expand when filled for the first time, so if the tank is restrained with straps or clamps, care must be taken to leave them loose so they do not cut into the tank. If space is not left between the top of the tank and the deck above it, the expanding tank will cause the deck to bulge upwards.

Inspection Tanks should be inspected regularly. This should be done during spring fitting-out, and as part of routine maintenance. The best way to determine if a tank is sound is to have a pressure test, and most repair yards can do this. The tank and the entire fuel system should be pressure-tested annually, and anything that leaks should be replaced immediately. You should also always sniff-test the bilges and engine room before using the boat, as your nose is the best vapour detector.

Regulatory Changes Fuel system regulations are changing in the U.S. The Environmental Protection Agency has proposed evaporative emission limits for fuel systems on gasoline-powered boats. The permeation allowed from plastic tanks will be lowered dramatically, and tank vents may have to contain a charcoal canister to collect vapors. So the way plastic tanks are made will change, which may increase their cost. Metal or fibreglass tanks should not be affected.

These regulations and standards apply specifically to boat manufacturers, but any reputable marina or repair yard will follow them. Surveyors use ABYC standards as the benchmark for surveys, and banks and insurance companies work off the results of those surveys. So for both safety and financial reasons owners should insist that their boats comply with the standards.