Story And Photography By Steve D'Antonio

In the first segment of this two-part series on potable water systems, we discussed plumbing, pumps, and water heater operation and safety. We now turn our attention to the details of water heater construction and design, other means of making hot water aboard, and water filtration.

The materials from which a water heater is built can tell you a great deal about how well it will perform and how long it will last. The inner pressure tank may be constructed from glass-lined steel (which is really baked-on enamel, as found in older kitchen appliances), aluminum, or stainless steel (either 304 or 316).

Glass-lined steel is extremely popular and relatively inexpensive to manufacture; it is the material from which the water heater tanks in most homes are made. Problems arise when the glass lining eventually separates from the steel. Usually this will occur around the orifices of the inlet, outlet, heat exchanger, or electric heating element after hundreds or thousands of heat cycles. Once water reaches the steel, the metal quickly rusts, resulting in rusty water and, after some time, a hole in the tank. It's not uncommon, however, for glass-lined steel tanks to last a decade or more, and some are backed by a venerable five-year warranty. To reduce corrosion, steel tanks typically are equipped with a magnesium anode that must be inspected and replaced periodically.

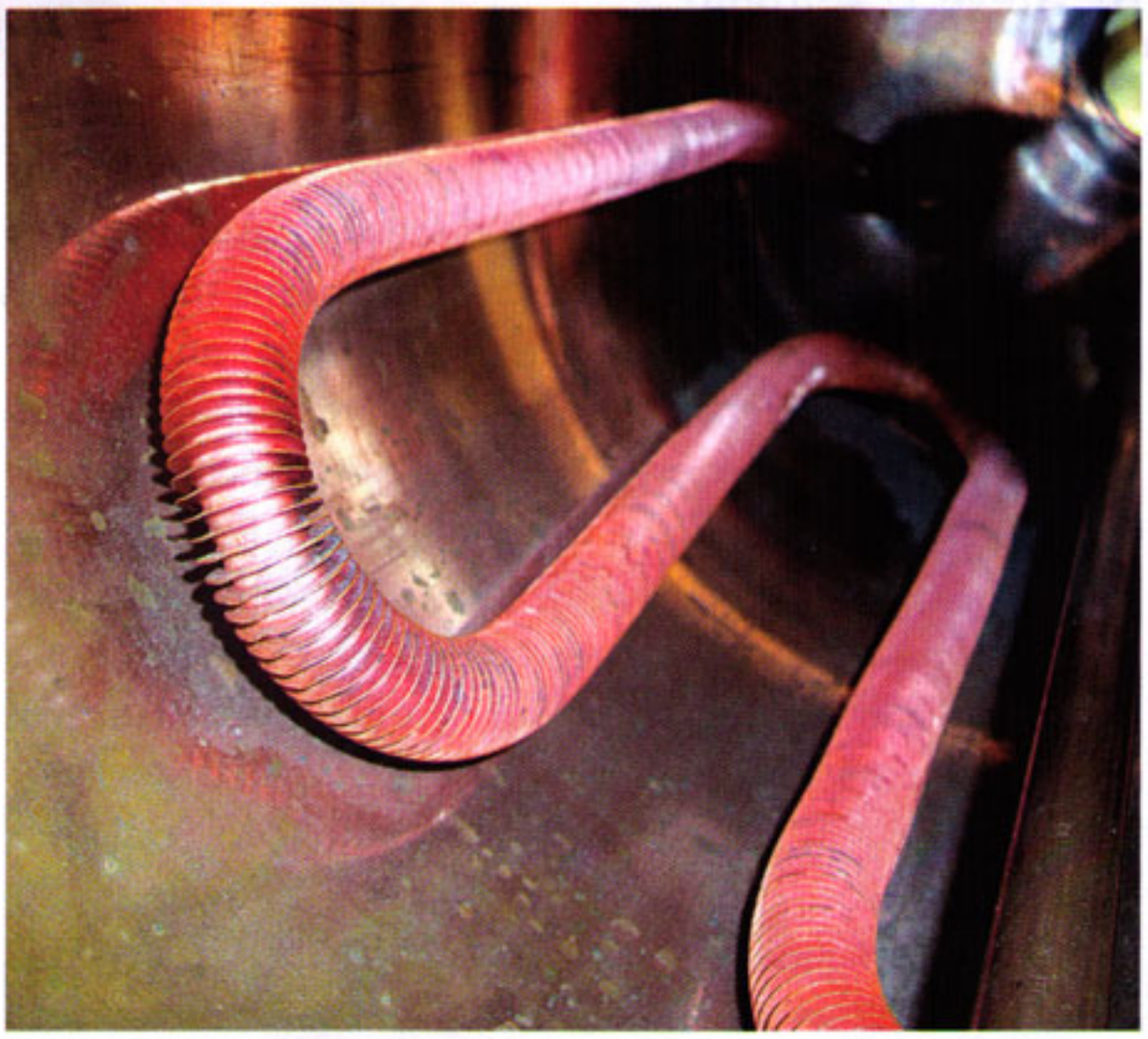
Aluminum water heater tanks don't require a glass lining because the aluminum develops a natural anticorrosive oxide layer, just like you find on aluminum deck gear (it's white and powdery, or gooey if wet). Thus, in theory, water heaters with aluminum tanks don't suffer from corrosion issues. However, manufacturers that offer these heaters frequently make the warranty contingent upon the installation of a galvanic isolator, which prevents corrosion-inducing galvanic current from coming aboard via the shorepower's green grounding wire. If your boat's water heater has an aluminum tank but no galvanic isolator, the warranty might be void.

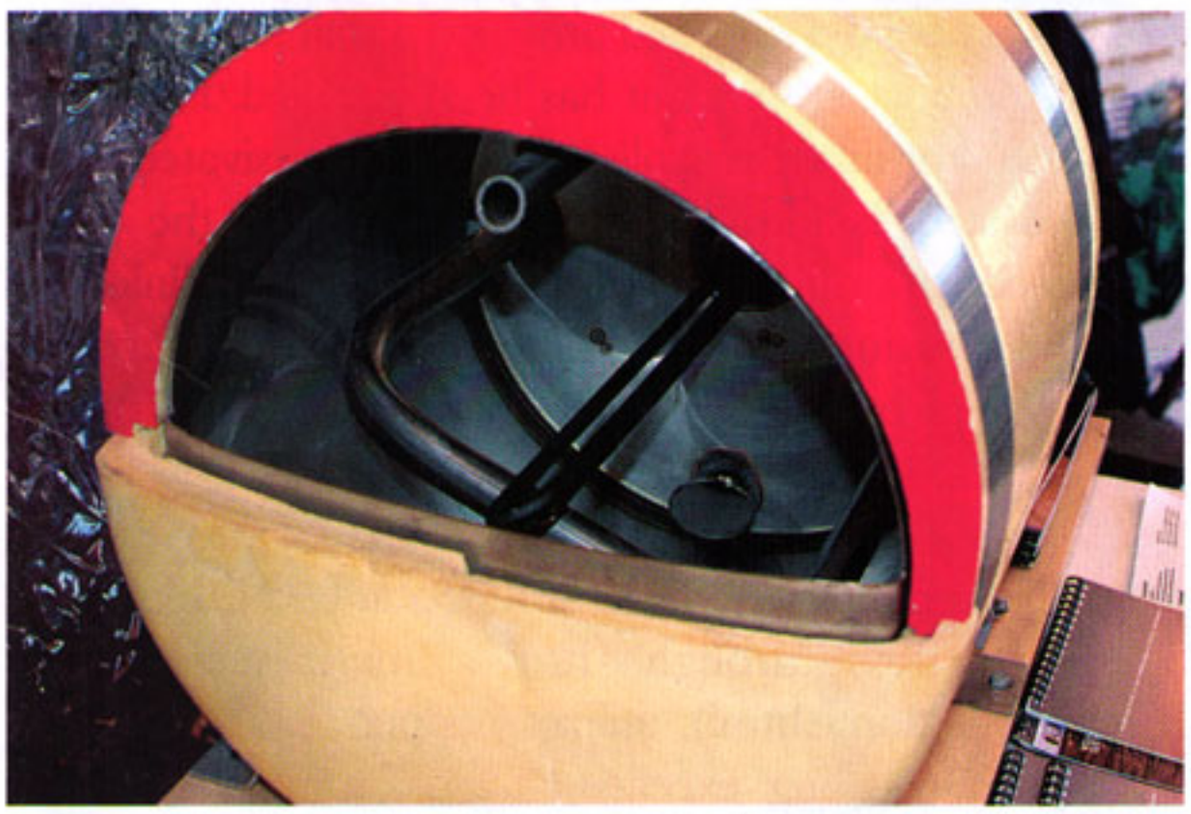
With aluminum tanks, the possibility of galvanic corrosion is an issue that's worth discussing. Aluminum is among the least noble of metals, which means that in the presence of an electrolyte (water, in this case) and nearly any other metal except zinc or magnesium, it can corrode. Minerals found in shore water supplies—particularly well water—as well as copper from plumbing fittings both ashore and aboard can play galvanic havoc with aluminum tanks. The result is a holed or seriously contaminated tank. If you opt for or already have an aluminum water heater tank, be certain you understand the installation and warranty requirements. You may wish to call the manufacturer for additional information and guidance.

The final material that's commonly used for water heater tanks, stainless steel, is expensive. But if the correct grade is used and it's welded properly, a stainless tank may outlast the boat in which it has been installed. For water heaters and ordinary potable water tanks, passivated 316L stainless steel is ideal, and it's preferable to the more crevice-corrosion-prone 304 stainless. 316L stainless is highly corrosion resistant and is not prone to the formation of by-products such as iron oxide (rust) and aluminum oxide (that white powdery stuff).

Although it's rare, at least one water heater manufacturer, Solaris (whose products are available in the United States through https://marinetec-us.com/MarineTec_Home.html), utilizes copper for its tanks. In addition to offering excellent corrosion resistance and longevity, copper is a natural biocide, virtually eliminating biological growth inside the water heater—one of the reasons copper is used for potable water plumbing. Biological growth can be a problem for marine water heaters made from materials other than copper, because when they are depowered, the water inside cools enough to support biological life. Since copper acts as a deterrent to bio-film formation, it also keeps the water from developing odors and other problems that can be a source of health concerns.

Systems Part II





Top: The heat exchanger inside this water heater transfers heat from the engine coolant to domestic water. The "fins" increase surface area to improve efficiency and reduce the time required to heat the water. Above: Where water heater insulation is concerned, more is better. This cutaway reveals ample insulation, particularly in the upper section of the heater's tank. Because heat rises, it is especially important to keep this area well insulated.

WATER HEATER INSULATION AND SHELLS

The insulation used to surround a water heater tank is of vital importance—it's what keeps the water hot. For the most part, marine (and domestic) water heater insulation falls into two categories: fiberglass and closed-cell polyurethane foam. Fiberglass, with its lower *R* value per inch, tends to be less effective (and less expensive) than "blown" or molded polyurethane foam. (The *R* value is a measure of thermal resistance; for insulation, the higher the *R* value, the better.) Additionally, if fiberglass insulation gets wet, it not only becomes ineffective but also will promote the corrosion of steel tanks and outer covers by holding water against these surfaces.

Blown closed-cell polyurethane, which adheres to the tank's surface, is non-hygroscopic, which means it does not absorb or retain water and therefore doesn't suffer from either of these maladies. In contrast, open-cell polyurethane foam may still have a higher *R* value than fiberglass, but it will absorb water and will suffer the same detrimental side effects as fiberglass when exposed to water.

It's worth noting that supplemental insulation can be added to your vessel's (and home's) water heater to improve its heat retention. Water heater blankets are available from home-improvement stores. Any insulation, even the inexpensive pink stuff, will have a noticeable effect. Don't forget to insulate the top of the water heater.

The material used to cover the outside of the water heater's insulation, while important, is much less critical than the aforementioned components. In years past, marine water heaters were simply bantam-sized household units. Their shells were made of painted steel, which, in the marine environment, quickly rusted. Still, as long as the shell didn't incorporate the mounting feet, this was more of a cosmetic issue than an operational one. It looked bad, but the water heater would still work.

Today, water heater manufacturers have wised up. Many units, even the less expensive ones, now have polymer or plastic shells, which are, of course, rustproof. More expensive (but not necessarily better) units often are sheathed in fiberglass or stainless steel. This looks great, but it's not a reason in and of itself to choose one unit over another. Additionally, it's important to note that just because a water heater's outer shell is made of stainless steel—a fact that may be heavily emphasized in the manufacturer's literature—this doesn't necessarily mean the tank, which is the important part, is stainless. Remember: the ability to heat water and retain hot water while offering a long service life are the primary functions of a water heater. If it looks good in the process, that's an added benefit, but it is by no means a prerequisite.

WATER HEATER DESIGN

The design of a marine water heater, from its capacity to mounting options, will play an important role in its performance. Perhaps one of the first criteria to consider when deciding which water heater to purchase is capacity. This may be simple to determine; if your boat makes provisions for nothing larger than a 6-gallon unit, then you can move on to the next decision. If you've got more room, do some simple math based on the size of

the crew and the frequency with which they will use hot water. This means more than just showers—more people means more dishes to wash after each meal, and more hand washing after head calls. Remember that larger units can hold more hot water, but they often take longer to heat water from a cold start.

Most marine water heaters are equipped with adjustable thermostats for the electric heating element. (These are usually adjustable in the range of 120° to 180°F.) A few water heaters, however, do not offer an adjustable thermostat, or it's provided as an option. Naturally, it's desirable to be able to choose the temperature at which your water heater maintains the water within, and a user-adjustable thermostat makes this possible.

In some cases, water heater manufacturers may install a non-adjustable thermostat in conjunction with a built-in, adjustable mixing or tempering valve. The Isotemp water heater from Indel Webasto Marine (www.indelmarineusa.com), for example, uses this combination, as do water heaters made by Solaris (https://marinetec-us.com/Solaris.html) and a few others. Such units, however, are the exception to the rule. Most water heaters use conventional, household-type adjustable thermostats. Typically, the fixed thermostat and mixing valve combination works quite well, keeping the contents of the water heater at a higher temperature (usually around 165°F), which reduces the likelihood of bacterial growth. Since water at this temperature is too hot for ordinary domestic use, the adjustable mixing valve is used to mix the hot water with cold water after it leaves the heater. The clear advantage of this system is that it effectively provides more hot water for a given size tank, and after many hours, the water inside the water heater may still be hot enough for bathing or galley chores (without mixing). It essentially enables the water heater to produce more hot water at a usable temperature by keeping the contents well above the conventional thermostat setting.

Tempering valves are also especially valuable in controlling water temperature when the water heater's water is heated by the engine. If this is the case, it's possible for water leaving the water heater to be nearly as hot as the engine's coolant—something approaching 200°F—hot enough to quickly and seriously scald users. The conventional electric thermostat used by many water heaters will have no effect on water this hot.

The good news is, if your water heater lacks a mixing valve, it's very likely that one can be added. By using a higher thermostat setting on the electric side, this will enable the heater to provide more usable hot water. Note that mixing valve manufacturers often point out in their

Top: A tempering valve is an invaluable addition to virtually any water heater installation. Such valves can be added to most water heaters after the fact. Above: Hot water that's not regulated by a tempering valve or anti-scald valve can cause serious injury. This is especially true of water that's heated by a heat exchanger plumbed to engine coolant.

literature that their products *do not* act quickly enough to be used as anti-scald devices. If anti-scald protection is what you're looking for, a proprietary anti-scald fixture must be installed.

A variation on the mixing valve theme is a device known as a temperature-compensation valve. Again, this type of valve is used when the water heater's water is heated by the engine. The valve senses coolant