Gearhead

By Steve D’Antonio

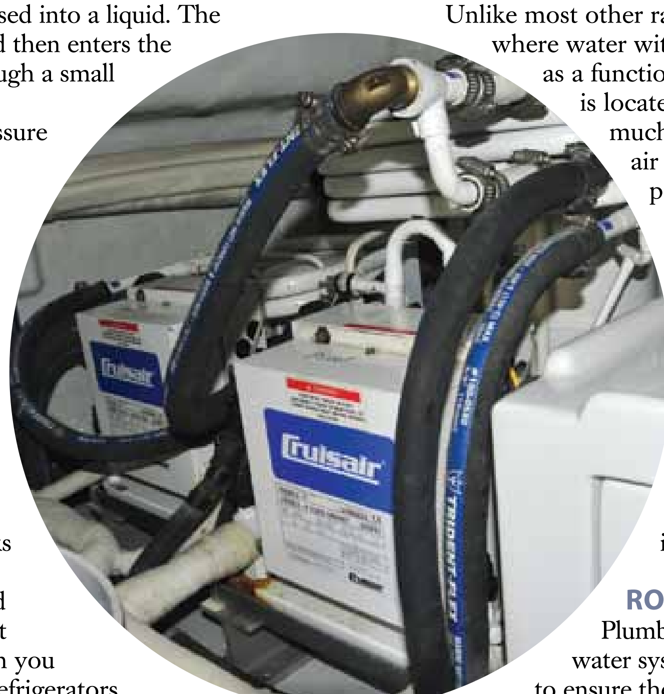
Seawater Wake-Up Call

Plumbing materials are key to A/C system health

As I squeezed my way into a narrow gap in the lazarette I heard an ominous crack shortly after, and sensed drops of extremely cold water landing on the back of my neck and head. I had an inkling of what had happened even before extricating myself from the labyrinth of machinery, plumbing, and equipment.

Air conditioning systems aboard most boats rely on raw or sea water to cool pressurized, hot refrigerant after it leaves the system’s compressor. Via a heat exchanger or condenser, the sea water absorbs heat from the refrigerant—heat that has been created as the gas is compressed within the unit’s compressor—and in the process, the refrigerant is both cooled and condensed into a liquid. The cool, high-pressure liquid then enters the evaporator, passing through a small orifice.

As it does so, the pressure drops, turns back into a gas or evaporates, and, in the process, is able to absorb heat from the cabin, (heat that later passes on to the sea water flowing through the condenser). The refrigerant then returns to the compressor as a cool, low-pressure gas, where the cycle begins anew. The process works in very much the same way for refrigerators and freezers. The hot air that blows on your feet when you stand in front of many refrigerators is heat that is being removed from the condenser.



For household air conditioners the same process occurs with one exception—instead of sea water, air is used to absorb heat from the refrigerant as it passes through a finned radiator-like condenser. It only makes sense, therefore, that aboard a boat the most readily available cooling medium, sea water, should be used to carry out this process. The benefit to this approach is efficiency. Sea water absorbs and carries away with it heat from the air conditioning condensers, using a heat exchanger that is a fraction of the size of an equivalent air-cooled model, and no excess hot air is produced aboard the boat.

‘ACTIVE FLOODING’ RISK

The quid pro quo for using sea water for onboard air conditioning and refrigeration systems is the risk of failure and subsequent flooding. Raw water must be brought aboard though seacocks, strainers, and hoses as it travels to a pump. After it leaves the pump it travels to the metallic air conditioning condenser, then through more hoses and to an overboard, typically above the waterline discharge fitting. For larger systems raw water manifolds are often involved, enabling a single pump to supply multiple air conditioning units, as well as collecting water from multiple units for a single point of discharge.

Unlike most other raw water plumbing systems aboard, where water within hoses and pipes is “pressurized” as a function of how far below the waterline it is located, what’s known as head pressure, much of the plumbing associated with air conditioning systems is under pressure. That is, once it leaves the air conditioning raw water pump, it’s under pressure. As a result, a leak is no longer a function of head pressure—it’s being pumped into the boat, what I refer to as active rather than passive flooding. Failures of air conditioning raw water plumbing have led to downflooding and sinking, while vessels were dockside. Their integrity, therefore, is of paramount importance.

ROBUST AND RELIABLE

Plumbing used in air conditioning raw water systems must be designed and installed to ensure the greatest durability and reliability. Both material selection and the manner in which systems are installed must be carefully thought out.

Among the most common faults involves the use of metallic plumbing that is unsuited for raw water applications, including brass and stainless steel. Not long ago a client contacted me and asked about installing a bilge drying system to remove incidental water accumulation. I asked, “Where is the water coming from?” He answered, “I’m not sure, but don’t all boats have water in the bilge?

In fact, while some bilge water accumulation can be considered normal, from a stuffing box or minor deck leak for instance, for the most part bilges should remain dry. In this case a mechanic was asked to find the source of the

Center: The hose that’s used to supply raw water to and from air conditioning condensers must be rated for seawater use. It should carry a SAE J2006 designation, like this Trident Flex Marine Wet Exhaust & Water Hose.

Right: Metal components used in air conditioning raw water systems must be chosen very carefully. This brass pipe nipple failed after less than a year of use in an air conditioning overboard discharge fitting.

water, which turned out to be a seriously corroded brass (which was thought to be bronze by the professional yard that installed it only 10 months earlier) pipe nipple that conveyed air conditioning raw water overboard. Whenever the air conditioning system ran, which at the boat's Florida location was nearly continuous, water shot sprinkler-like from the porous pipe nipple.

Stainless steel, while highly corrosion resistant when afforded a ready supply of oxygen, can be a liability when used with raw water, particularly if sea water remains inside the pipe when the system shuts down. In this scenario, the water is quickly deprived of oxygen. As it evaporates the salt concentration rises, setting up an ideal environment for corrosion.

PVC ISSUES

Yet another material that is ill suited for air conditioning raw water applications is PVC. While essentially corrosion proof because of its potentially brittle nature, PVC is less than ideal for raw water scenarios. I have a collection of fractured PVC components I've collected over the years that serves as a reminder to avoid this material in raw water applications.

If it is used—preferably only as part of a system supplied by an air conditioning manufacturer, installer, or boatbuilder (for which they take responsibility)—the CPVC variety should be chosen for its greater ductility and crush resistance. Plumbing must also be well supported. While this holds true for all raw water plumbing, it's especially true of CPVC. It should not support the weight of hoses or a large manifold.

There is a contingent of materials that are well suited for air conditioning raw water systems. These include bronze (with a zinc content of less than 10 percent), fiberglass, glass-reinforced nylon, and SAE J2006-rated marine wet exhaust hose. Provided they possess the necessary tensile strength and modulus of elasticity, non-metallic components are very desirable in that the otherwise ever-present threat of corrosion is eliminated.

As for the system that gave me an impromptu saltwater shower, it incorporated a tenuous PVC manifold that broke when my coverall pocket snagged on a fitting, driving home the need for robustness where these and all raw water plumbing components are concerned. Simply put, if you have to worry about its failure as a result of being leaned, sat, or stepped upon, it's probably not strong enough.

Ask Steve

FULLY CHARGED BATTERIES

Steve, I greatly value your many contributions to *PassageMaker*. In my mind, they alone pay for the subscription.

I think I represent a fair number of boaters who still find themselves anchored to the shoreline. Typical boating consists of a two- or three-hour trip per week. I consider myself lucky if I get four hours in. My boat has four separate AGM battery banks of various sizes; 400Ah of house, two 150Ah for engine starting, and one 150Ah for generator starting. My concern is keeping them fully charged. As I understand things, AGMs absorb initial charging (up to an 80 percent charge) relatively quickly, but the last 20 percent comes far more slowly. My concern is that I moor my boat and therefore do not have the convenience of dockside charging.

Usually, when stepping aboard, I find the house batteries at around 12.7VDC. Since maintaining a proper charge is key to a long battery life, I am thinking of adding a solar panel and four charge controllers wired in parallel, with diodes, for battery maintenance. Any thoughts?

Walter Karopczyc
Upper Nyack, New York

Walt, your attention to detail regarding the maintenance and life of your batteries is admirable.

While more versatile than their flooded brethren, to some extent the charging limitations of AGM batteries are not unique. In fact all conventional, lead acid batteries—flooded, AGM, and gel—accept an initial charge more quickly than they do the final or finishing charge, i.e. the last 10-15 percent is accepted relatively slowly. AGMs and gels can accept the initial charge more quickly, at approximately 100 percent and 50 percent of their amp hour capacity respectively, provided it's available. That is, if an AGM house bank is 500 amphours and the charge source is only 100 amps, then the bank will only accept 100 amps, initially, which is no different than a flooded bank.

Because a conventional battery's internal resistance increases as it accepts charge, the rate of acceptance drops as that charge evolution progresses. Furthermore, AGM batteries in particular should be charged using charge sources that are specifically designed for the purpose, such as externally regulated, temperature compensated alternators and multi-step, temperature compensated battery chargers that are programmed for AGM use. Failing to follow this charge regimen often results in premature failure of AGM batteries.

If you find your banks are at 12.7 volts while under no load and have been at rest for eight hours or more, then that's a good sign as this represents a full state of charge. The start batteries should have no trouble charging and remaining that way. Typically, less than a single amp hour is used for each start cycle, and it's quickly replaced by the alternator.

If the house bank is fully charged it too should remain that way, provided no parasitic loads are present. These loads are often difficult to eliminate—they include pilot lights, displays, bilge pumps, etc. Adding a fully regulated (one that's programmed for AGM applications) solar array makes good sense for keeping these batteries topped off. Solar panels can also be an effective means of pumping that finishing charge into a battery bank that doesn't have the benefit of constant shorepower charger input.

Finally, don't skimp on the solar panel regulator—higher quality units provide the best charge profile for your batteries. For various reasons, my preference is for those relying on MPPT technology, such as those manufactured by Genasun.—Steve D'Antonio

INSPECTION PORTS

Hi Steve, my brother Michael and I have had two new 1/4-inch aluminum 150-gallon diesel fuel tanks installed in our 42-foot trawler. These tanks included inspection ports. The tanks seemed fine until we filled them with 300 gallons of diesel fuel and they both immediately began to weep fuel from both inspection ports. It looks like the vendor won't repair them.

I gather from your *PassageMaker* article (July/August '07) that we need to have the tanks pumped out, probably just below the inspection ports. Our vendor has advised us that the ports were epoxy "sealed" and bolted with six bolts to each tank. Would you be willing to advise us on the following? 1. The process and materials that we need to remove and clean the tank surfaces around the removed inspection ports. 2. The process and materials we need to properly re-attach the port covers. Thanks for your prompt assistance.

Clem O'Brien
North Fort Myers, Florida

Clem, your experience with this fabricator is disappointing at best. If their product failed to perform as one would expect (i.e., a new fuel tank should be guaranteed against leakage by its manufacturer), they should have agreed to correct the problem at no charge to you. While it's too late in your case, the lessons for readers are manifold and significant: Rely only on proprietary tank manufacturers rather than generic fabricators when it comes to building metallic fuel and water tanks; insist that they build tanks that are fully compliant with ABYC H-33 guidelines; insist on a leak-free guarantee; and finally, all tanks should be pressure tested by the installer before they are installed.

When I managed a boatyard, I eventually stopped using a local fabricator to build my tanks because he consistently made mistakes, was incapable of or unwilling to build to ABYC standards, and always seemed to have an excuse for the failures.

Ultimately, more than 15 years ago, I contracted with a dedicated tank fabricator in Florida, Best Fabrications of Bartow, Florida (www.bestfab.com) and have used them for all of my tank-building projects ever since. Shipping tanks to my location in Virginia was far less trouble than dealing with tanks that didn't meet my needs or standards.

In your case, of course, inspection ports should not leak. My preference for inspection ports, and the entire tank, is to ensure that they pass a pressure test (typically 3psi) without, other than on threads, the use of any sealant or form-a-gasket material. The reason for this approach is straightforward. In fuel applications I'm reluctant to rely upon sealant to achieve a leak-free installation, particularly when it is submerged in fuel, as is frequently the case with side inspection ports. This will also be true of top-mounted inspection ports whenever a tank is topped off.

Thus, gaskets and gasket surfaces should be clean, sound, and true enough to provide this sealing ability, again, when free of paste sealants. Make certain gasket surfaces are clean, true, flat, parallel, and free of nicks, scratches, old sealant, or other irregularities.

They can be cleaned with mineral spirits and sanded, lightly, if necessary, using 320-grit Emory cloth. Additionally, you may have to resort to using a thicker, softer gasket in order to account for surface irregularities. Generic fuel-proof gasket material can be purchased in a range of thicknesses and durometer, from McMaster Carr (www.mcmaster.com).

My preferred materials are Viton and then Buna-N in that order, durometer should be "soft," in the 20–30 (similar to a rubber band) ranger on the Shore A hardness scale.

The one exception to the sealant rule involves the fasteners used to secure the inspection ports. These fasteners should, by the way, be through-bolts or machine screws rather than self-tapping screws. Threads may be sealed with a fuel-proof sealant such as Leak Lock (www.highsidechem.com). As an aside, through-bolted inspection port kits are available from SeaBuilt (www.seabuilt.com). These rely on through-bolts and gaskets to achieve a leak-free seal and are available in sizes from 6–21 inches. If your ports refuse to seal, or if they rely on tapping screws, while you shouldn't have to do it for a new tank, installing these port kits may be the easiest and most reliable solution.—Steve D'Antonio