story + photos MAX PARKER

Keep Your Cool

Air conditioning is a must-have in many cruising climates. These troubleshooting tips can keep it working.

When asked to name a system failure most likely to ruin a cruise, many people will guess engine problems or some other major mechanical issue. But in our experience, the culprits are often more subtle. Right up there with failed heads are problems with the air conditioning. In most climates, air conditioning can make or break a summer cruise.

How Does It Work?

As builders outfit more boats with air conditioning, two questions often come up: What is the difference between home air conditioning units and marine air conditioning units, and why are the marine versions so much more expensive?

Many jokes have been made about the "marine tax," as it seems that simply adding "marine" to the title of an object doubles the price. Granted, many times there are upgraded metals and corrosion-resistant components and electronics, but the real answer is that the production volume is so much smaller, the design and build costs need to be amortized over fewer units.

All types of refrigeration equipment, be they air conditioning or refrigerator/freezers, work on the same principle with the same basic components. Refrigeration gas gets compressed and pressurized (and heated) in a compressor. The hot gas travels through piping to a condenser, which turns the gas into a liquid and absorbs some of the heat. The liquid then travels to what is aptly called an expansion valve, where it expands and loses pressure and heat. This expansion is where the cold happens, as the liquid then travels into an evaporator. The evaporator has a long series of tubes to maximize surface area so that air coming in contact with it can exchange heat with the cold refrigerant. As the refrigerant absorbs the outside heat, it turns back into a gas that pushes back into the compressor, where the process can start again.

On most home air conditioning equipment, a large fan pulls air through the condenser. This outside unit is composed of a grid of tubes routed through aluminum fins set up in four panels around the fan. On a boat, we utilize raw water instead of air to cool the condenser. The water is typically cooler than the air temperature, and is much more efficient than air for transferring heat. Because of this difference, marine units can have a considerably more compact condenser located entirely belowdecks.

Sea Water Heat Transfer

To use water as a coolant inside the boat, we need a thru-hull fitting, seacock, strainer, plumbing and pump. Multiple air conditioning units will need a manifold so the pump can supply each unit. As with all other systems drawing seawater into the boat, the components need to be rated for below-waterline service. Bronze or Marelon fittings and wire-reinforced hose are the rule. Vinyl drinking-water hose and nylon, or PVC plumbing fittings, must not be used.

The pump needs to be rated for the gallons per hour necessary for each unit. It is common to use a single pump for multiple units, but each unit will need its own discharge. The discharges should be located just above the waterline so their water flow can be monitored. By installing valves at the manifold, water flow can be balanced between the farthest and nearest units by slightly closing the nearest unit's valve.

Boats with multiple units will also need a pump relay so that each unit can call for the pump to turn on. The pump and related piping are critical components, as the failure of one pump can shut down multiple units.

To Split or Not to Split

There are a couple of choices in system design.

Self-contained units have all the components except the raw-water system palletized in a compact unit. This means the compressor and blower unit are tied together, and all ductwork starts and ends with it. Although compressors are becoming quieter and vibration has been reduced, the space constraints on some boats will mean the unit may end up under a bunk or in a hanging locker—a setup that can have sound implications.

For a smaller blower package and additional noise abatement, a split system works well. The compressor/evaporator is mounted remotely (usually in a machinery space) with refrigerant lines led to a remote blower unit. In a split system, all the seawater plumbing can be contained at the compressor/evaporator unit. This setup typically keeps the hoses short and contained in the machinery space for easier troubleshooting. On the downside, long copper refrigerant tubing will need to be run and insulated from the compressors to the blower units, and an experienced HVAC technician will need to make sure they do not leak before charging them with refrigerant.

Larger boats (typically more than 50 feet length overall) can utilize chiller units that keep the compressors/evaporators in the equipment space as well. These systems cool a closed loop

BELIZE YACHTS

Left: Climate control aboard this 58-foot cruising yacht is handled by a bank of six split-system compressor/condensing units. Conveniently rack-mounted in the sound-insulated engine room, the shared seawater plumbing is compact and direct.

of fresh water that is pumped to the blower/heat exchanger units through hoses. A chiller system can be efficient and provide climate control to a large number of air handlers.

Drip Trays

A mundane but critical point: Machinery that is cooler than the air will condense humidity. Like a coaster under a glass, air conditioning units have drip trays to deal with the condensed water, which can amount to as much as a half gallon an hour. These trays need to be angled to drain to one point, and the drain hose must be considered. It is not uncommon to find perfectly flat or backwards angled trays with an inch of water that cannot ever drain, leaving enough water to rust out the bottom of the compressor.

For units mounted higher than the waterline, condensed water can be plumbed to drain overboard. This situation calls for a drip loop mounted near the thru-hull; without it, engine exhaust can be drawn up into the blower through the drain hose.

For units mounted below the waterline, leading the drain line into the bilge, where a bilge pump can pump it overboard, will result in mildewed, smelly bilges. Best practice calls for leading

Top left: This disassembled seawater pump shows the efficient six-legged, magnetically driven impeller. The pumps are extremely reliable because the motor shaft does not extend into the wet portion of the pump. Consequently, there is no shaft seal to leak. **Top right:** This self-contained air conditioning unit fits snugly under the V-berth, a common installation location. Note the vinyl drinking water hose connected to the blue coil, not approved for below-the-waterline use.

the drain to a sealed sump box and then pumping it overboard.

Drain trays need to be monitored for clogs and tested periodically with a quart of water to be sure they are draining. An overflowing drain tray can easily damage surrounding woodwork. Many a varnished sole has suffered this fate.

Check the Temperature at the Duct

Now that we have covered the basics, let's look at what a boat owner can do to reduce the risk of failure and improve performance.

Start by checking the temperature at the duct. The air coming out of the duct will be about 20 degrees cooler than seawater. For this test, you will need an infrared pyrometer. If the difference between the seawater and the chilled air is less than 20 degrees, you have a problem somewhere. It could be a dirty filter on the return air, a restriction on the seawater supply, a poor refrigeration charge or dust accumulation on the condenser tubes.

Clean the Seawater Loop

Over time, anything that seawater passes through can become scaled or fouled with growth, limiting the heat transfer in the condenser so the refrigerant builds excessive pressure. Most modern air conditioning units have some sort of high pressure cutoff—the dreaded HPF or Hi PS alarm on the display. You'll also see this alarm if you lose seawater cooling entirely from a failed pump, relay, plastic trash bag over the thru-hull, or marine animal (jellyfish, eel, etc.) blockage.

Solving a blockage may involve a diver or a garden hose pressurizing the thru-hull in reverse, but descaling will involve a chemical fluid pump throughout the seawater system. This process is typically performed with a 5-gallon bucket that has a pump mounted in it, and valved hoses that can reach the air conditioning unit's seawater hose barbs. The bucket pump's hoses are attached so that the descaling fluid can be pumped through the unit to clean and dissolve anything inside the lines.

There are also ways to stop blockages before they start. Groco makes sea strainers with motorized grinders that can help deal with clogs, and ElectroSea's Clearline electrically creates chlorine in the plumbing to help prevent marine growth. We also have customers who have tried cutting up pieces of copper pipe and adding it to their strainers. Copper oxide is created in the seawater and seems to slow growth.

For ultimate reliability, install a second thru-hull and plumb it to the strainer, or even add a second strainer. This way, if one intake becomes plugged, the second can be brought online to keep the A/C going (much like having a dual Racor fuel filter setup).

Change the Fan Setting

Many digital thermostats have useful features beyond setting the temperature. Use the owner's manual to walk through the steps. Setting the blower fan to continuous can help with hot spots in a cabin, and can make it easier for some people to sleep. The compressor will still turn on and off as necessary, but the fan will partially mask the sound difference.

Above: It is important to confirm that your drip pad drains properly. Pouring a quart of water into the pan is a good test to make sure the drain is not clogged and that no water remains trapped in the pan. **Top right:** Tweaks to the thermostat settings can improve overall system performance. Spending a little time with the owner's manual can open up the customizing features within. **Right:** A temperature sensor is held in place by a black P-clip on the bottom left of the intake of this air handler, which is located inside a closet behind a grilled door. Moving the sensor out into the cabin can give the thermostat a more accurate indication of the actual cabin temperature.

Turn Off the Display Light

Many thermostats have bright lights and numbers that can light up the cabin. The brightness of the displays can often be adjusted to their lowest settings. Some have nighttime features in their programming that blank the display except for an indicator that the unit is on.

Move the Temperature Sender

A small temperature probe signals the compressor to run or shut off, based on the temperature you selected. By default, these probes come mounted on the return air grill at the compressor (for self-contained units). That setup means the temperature probe ends up inside a locker at some distance from the cabin's ambient air. As a result, the temperature in the cabin will rise faster than the air at the probe mounted on the unit. If you have the thermostat set to 70, the cabin temperature might reach 76 before the air at the probe reaches 70.

There are two solutions to this dilemma. First, if you change the fan setting from intermittent to continuous, the flow of air to the temperature probe will more accurately reflect the cabin temperature. For a long-term solution, you can remove the probe at the unit. Place one (with a longer wire) in an inconspicuous place in the cabin where it will sense the same air you feel.

Max Parker is the vice president of yard operations at Zimmerman Marine, which operates seven boatyards on the Eastern Seaboard. Parker has spent time in most of the trades in his over 25-year career working on boats and still loves to grab a tool bag and fix something when he gets the chance.