Refrigeration Maintenance and Repair

Published on July 22, 2018
Submitted by Dave McCampbell, *SV Soggy Paws*

Refrigeration Maintenance and Repair

After installation, a properly engineered, installed and cared for modern marine refrigeration system should last at least 15-20 years without any major repairs or replacements. If properly done with good insulation the cold box should last the life of the boat. However, since Murphy resides aboard many boats, and we sometimes don't get it right the first time, the system and box sometimes need help.

Below are a number of maintenance, repair and other tips I have learned over the past 22 years fiddling with my refrigeration systems. Since there is a huge amount of information available on the internet these days, and this is meant to be a short article, I have provided links to a couple of trusted refrigeration websites that will provide details. After a careful study of this information you should be at least as informed as that third-world mechanic you might consider paying to come aboard your boat and mess with your refrigeration system.

Refrigerant leaks- A refrigerant leak could be caused by many things, including corroded tubing, a loose tube connection, a deteriorated connection O-ring, and a punctured evaporator plate. Most leaks can be found by using bubbles from dish soap and water solution or a commercial soapy cleaner like 409. If really small, an electronic leak detector is useful. A hole in tubing will require removing the refrigerant, carefully sealing with silver solder, and use of a vacuum pump. Evaporator plate punctures usually require replacing the plate ($$). A soldering job or use of metal glue such as JBWeld might provide a temporary fix depending on the location of the puncture. Tube connection O-rings are easy to replace but require having a spare aboard.

Adding refrigerant- Adding refrigerant is a common repair action. On modern evaporator plate systems, this is best done by observing the frost line on the inside of the evaporator plate. Modern Danfoss/evaporator plate systems have too little refrigerant for gauge pressures to be effective. Therefore, refrigeration mechanics that show up with gauge sets to judge refrigerant status should be immediately suspect. Most modern marine refrigeration systems use a Schrader valve giving access to the suction side of the compressor for adding refrigerant. Automotive systems use a different valve system compatible with devices that connect to the 12 oz cans of R134a, commonly available in automotive stores. Gauge sets don't connect to the small cans but do connect to the larger ones. So, some jury rigging (hose splicing) might be

necessary in order to allow using the small can refrigerant with a marine system. Make sure you don't buy any refrigerant that has additives such as leak sealers or dye.

A system is properly charged when the frost line migrates from the capillary tube entirely across the evaporator plate, stopping at the suction line or a couple inches beyond. Slowly add only R-134a refrigerant in SMALL amounts, with no additives, until satisfactory. Never allow the frost line to reach the compressor or you will be very sorry. See the following link for details:

R-134a Recharge Guidelines

Gauges and vacuum pump- With the old large compressor cold plate system we had on the CSY, I found a gauge set, vacuum pump, flaring tools, tube cutters, and spare fittings to be essential. With modern Danfoss/evaporator plate systems, they are rarely used unless you awaken Murphy. They are certainly useful if Murphy climbs inside your system with moisture and dirt, or if you need to evacuate the system with a vacuum pump. As overseas cruisers we carry a vacuum pump, gauge set, recharge connections and 4 cans of 134a.

Electronic Control Module (ECM)- The Electronic Control Module for Danfoss compressors is the brains of your refrigeration system. Newer models seem to work better and have LED fault diagnosis capability. Make sure it does not get wet or suffer from excessive heat in a small enclosed space, and for overseas cruising, carry a spare. See the links below for electrical testing and LED fault codes diagnosis:

Electrical Testing 12-24v Danfoss Systems

Danfoss/Secop Compressor Fault Codes Explained

Diagnosing Flashing Lights on Your Control Module

Cooling options – Air, water or 'keel cooler' are the choices. If electrical efficiency is important to you, the power consumption of an air-cooled system will be considerably higher than that of a water-cooled system, and very much higher than for a keel cooler system. If you choose the keel cooler, which is the most efficient, you could add an air-cooled option which makes cooling your system easier while on the hard. Until recently we have successfully used a water trickle system over our keel cooler for the refrigerator system while on the hard. See the below link to learn why it is better to use water or keel cooling in the tropics (in addition to taking the heat generated by the compressor OUTSIDE the boat!):

Air or Water Cooled?

Evaporators and blocked capillary tube – This is a fairly rare, but difficult issue, and may need a gauge set and vacuum pump to resolve. Adding a filter dryer in the compressor discharge line will usually prevent this. Recently manufactured systems usually have this as part of the initial install. Replacing the evaporator and capillary tube is expensive but will always fix the problem. See the below links for more details:

Capillary Tube Issues in Evaporator Plate Systems

Curing Blockages in Refrigerator Systems

And here is a note on comparing holding/cold plates and evaporator plates:

Aluminum Evaporator Plates vs Holding Plates on Small 12/24v Compressors (pdf)

Compressors – Danfoss (now Secop) compressors are usually very reliable. However, when something goes wrong inside, it probably means a replacement is in order. Modern versions of the Danfoss BD-35/50/80 have variable speeds, capacities and amp draws. The longer and slower a compressor runs the more efficient it is, amps vs cooling. Therefore, it is best to design any refrigeration system to be able to keep up with normal heat loads with the compressor running at its lowest speed. See the following links for a wealth of information on their design and troubleshooting:

Variable Speed Refrigeration and Air Conditioning Compressors

Technical Data Sheet on Danfoss BD Compressors (pdf)

What Makes You Think Your Compressor is Bad?

BD35 and BD50 Troubleshooting Guide (pdf)

Troubleshooting – Compressor IS Running (pdf)

Troubleshooting – Compressor IS NOT Running (pdf)

Cold box construction – The size, construction details, insulation type and R value of your cold box plus your cruising location temperature will determine daily heat load, amp hour use and which combinations of compressor, evaporator plate and cooling system are best to use. It is worth doing this calculation to see if your current or proposed system is right for your box. See the below link for a good method for determining daily amp hour use for a keel cooler system (assume tropical conditions, R5 for the insulation value and no additional amp hours for cooling units). This has proved highly accurate for our keel cooler systems, both freezer and refrigerator, on two different boats.

Consumption Guide for Frigoboat 12/24v Keel Cooler System

Below is a typical basic daily heat load calculation in BTUs. A number of additional sources of heat are not included. Compare this with your system's BTU capacity for another check.

Calculations For Your Own Box

At least one hole will be required in the box to bring in sensor wires and evaporator plate tubing. The edges of this hole should be well sealed so that no moisture can get into the box material or insulation, and insulation material should be carefully fitted around the tubing and wiring. The hole size should be minimized, and it should be placed as high as possible in the

box. Drains are generally not recommended due to the significant heat gained through them. All door gasketing should be carefully installed and checked periodically for leakage with a dollar bill test. See the below links for detailed information on design and defrosting.

Cold Box Design for Marine Use (pdf)

Defrosting Again!?

Should I Keep My Refrigerator Full to Save Energy?

Front loading refrigeration box under construction and completed.

Purchase advice - Most modern marine refrigeration systems are based on the same evaporator plate/Danfoss compressor/134a refrigerant technology. Use of a cold plate (aka holding plate) in this type of system makes no sense for a number of reasons.

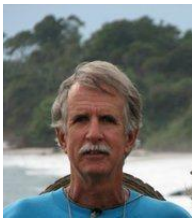
If purchasing, first look at major manufacturers' websites for data on their systems. Then see what owners say about their units AND SERVICE on the marine forums. Then go to a boat show and look at each system under consideration for engineering and construction quality. If efficiency is an issue, choose one that offers a 'keel cooler.' Otherwise, systems with like size and cooling all have about the same efficiency, and there is little difference in price.

Hopefully, the above information will give you the confidence to purchase and care for your modern marine refrigeration system. Just remember that when out cruising, especially overseas, most 'refrigeration' technicians deal mostly with commercial refrigeration and air conditioning, not marine refrigeration. There can be a big difference in trouble shooting technique and repair. Better to learn to do most of it yourself. And it gives you a good excuse to buy more tools, because as we all know, on a cruising boat you can never have too many tools!

Comments on this article and other technical matters are welcomed in the Tech Talk Forum on the SSCA website at www.ssca.org. As a member, you can opt into this special interest forum by going to:

Member Profile → Forums → Forum Memberships → Available Forums → SSCA Tech Talk Forum.

Click the green icon to the right of the forum name to subscribe. When the pencil icon appears, click it to manage your forum preferences. If you have issues subscribing, contact Home Base at office@ssca.org.



Author: Dave McCampbell is a retired US Naval Diving and Salvage officer with over 40 years cruising and 8 sailboats worth of maintenance experience. He and wife Sherry, currently based in the Philippines, recently spent 8 years crossing the Pacific. They have sold Soggy Paws, their CSY 44 monohull of 19 years, and moved to the 'enlightened side', purchasing in 2015, Soggy Paws, the St Francis 44 catamaran.

If you've found this article useful, you'll find more similar information aimed directly at sailors/cruisers on the members-only portion of the SSCA website (www.ssca.org).