Refrigeration Refit on *Shadowfax*

1977 Formosa 46

By Charles Moorhead

It was time to replace the refrigeration and update the galley on our '77 Formosa 46 “Shadowfax”. We are thinking of another Mexico cruise, and boat life without refrigeration is just a little too Spartan for us these days. The rest of the galley also needed a facelift. The existing double sink, while a good idea, takes up a lot of precious counter space. My wife wanted more counter space and less sink. And the original countertop was pretty beat up. So it was time. The goal was a more attractive galley with more counter space and refrigeration that wouldn‘t kill the batteries living on anchor. Maybe even good enough to enable us to live on a couple of solar panels without having to run the engine very often in Mexico.

The original refrigeration equipment had died years ago (admittedly after a few years of living aboard and one Mexico trip) and was so rusty I had to drill new holes through “better” metal to hold it in place. Also, it was air-cooled and located in the engine room – less than ideal on all counts. Our Formosa has the single, combined refrigeration and freezer box on the port outboard side of the galley counter, with the sink under the companionway hatch more or less amidships. The original box had been insulated with Styrofoam sheets & chunks with the voids filled with Styrofoam BBs. Those !@#%* BBs found their way out of the box, and just got everywhere. We must have taken a bushel of them out when tearing into the project. Styrofoam gets sort of wet and mushy after many years of service, so there really wasn’t much of the original countertop/refrigeration worth saving.

We decided to tear off the original countertop and reuse the framing. We wanted a bigger refrigerator in the same space formerly occupied by the original insulation and refrigerator. The only way to achieve this is to make the insulation thinner, which means you need to use vacuum insulation panels (VIPs) for insulation if you want good efficiency. We insulated with vacuum insulation panels from www.rparts.com and a single vacuum panel hatch. Using this technology, we were able to construct insulated walls for the box that were only a little over two inches thick that should have an insulation value of about R-30 on all sides. The resulting box is about 1/3 larger than the

original, measuring in at just over 6 cubic feet. We split this volume in half and now have a 3 cubic foot refrigerator and a 3 cubic foot freezer.

After considerable thought, we went with the Frigoboat keel-cooled refrigeration equipment and did not pursue holding plate equipment. I didn't want to give up hard-won refrigerator and freezer box volume to holding plates, and I can't really see how they are better or more efficient in the first place in an electrical refrigerator. Getting rid of your waste heat into the water seemed like the best idea, and keel cooling accomplishes this without pumps, hoses and heat exchangers. There are many good options out there, but that is the one we selected. I guess time will tell.

Here's how it went:

At this stage, we have already demolished the counter and cleaned out the old refrigerator space. We then built a floor for the refrigerator, and a port side wall using 2x2 wooden cleats and marine plywood. We also built framing and plywood in the original (cleaned up) refrigeration space so the resultant cavity is rectangular in shape. This photo shows what the cavity looks like with the first layer of ½" thick polyurethane foam glued to the plywood with liquid nails. Note that the cavity extends under the spice cabinet.

The blue panels shown below are templates for the vacuum panels made from 1" thick Styrofoam. Making templates is advised as one cannot modify the panels once they arrive, and the geometry is complex enough that it would be possible to mess up around the intersections of the panels. You must remember to leave a spot somewhere for the wiring and plumbing to enter the insulated space, so there is a triangular shaped cutout not shown in this photo in the upper left hand corner for this purpose.

Shown below is the same view with the Styrofoam replaced with the new vacuum insulation panels from Rparts. The panels are not really that fragile, but can be easily punctured with a dropped tool, so considerable care is required at this stage. Also worth noting for the duration of the project and for however long the refrigeration lasts is that you absolutely cannot drill into these spaces without a stop of some kind on the drill bit, and must be very careful of the length of fasteners you use. One hole in the VIP, and they are pretty much useless.

Here is the same space with the inner layer of ½" foam, and the pultruded fiberglass panels that are the liner of the refrigerated space glued in place and sealed up with epoxy resin with easy sanding fairing mixture in it.

Here we are looking down into the nearly completed freezer space. The Frigoboat evaporator can be seen lining the back, right side and half of the front side of the freezer box, mounted on small wooden blocks for standoffs. We have made a stand-off shelf for the floor of the box and a half shelf fixed to the left side of the box. Not shown is the tube out the left side of the box, through which pass the plumbing for the evaporator and the wiring. The divider between the freezer and refrigerator is made from more of the 1/8" pultruded fiberglass sheets with an inch of foam for insulation. Under the shelf would be found a Frigoboat thermostatically controlled spillover fan, which I took apart and built in to the partition. The theory goes that you use the refrigeration equipment to freeze the freezer section, and use controlled air circulation from the freezer to chill the refrigerator. Air returns to the freezer over the top of the partition under the hatch, through the glassed-in portion shown lower right. Part of the refrigerator section of the box is shown under the partition.

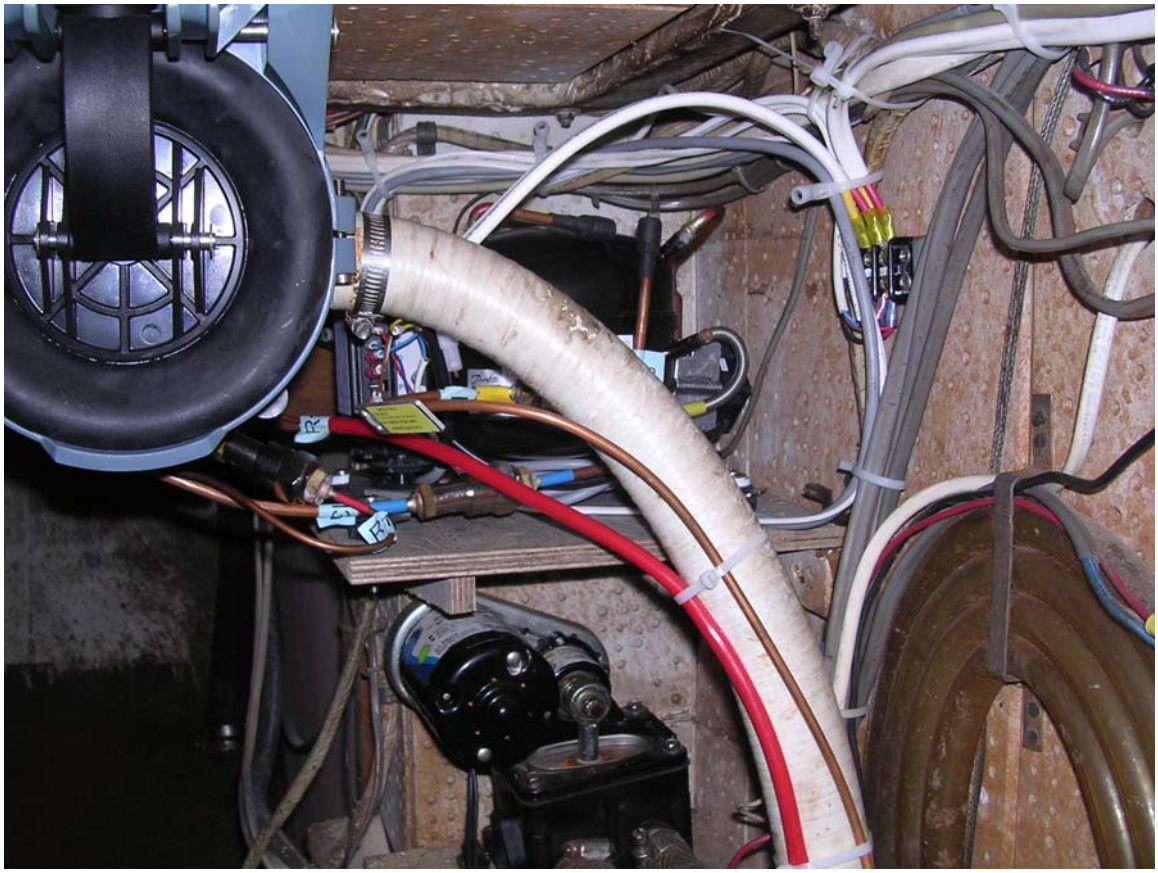
Here we are looking down into the refrigerator, with the partition just visible at the top of the photo. This photo was taken before painting, so the filleting compound still shows red at the seams of the box. Once again, there is a bottom stand-off shelf on the floor, and a movable half-shelf that slides left and right on plastic runners. Just visible in the bottom right of the photo is the bottom of the "snorkel fan" that draws colder air from the bottom of the refrigerator and blows it out right to left across the top of the box. The outlet for the spillover fan is once again under the shelf, along with its thermostat. The bright white spots above and below the reflection of the galley over-counter light are from white LED lights installed to illuminate the interior of the box.

Here is the box with the hatch and top insulation installed before the counter goes in place. The hatch is an RParts medium sized hatch with a VIP in its lid. Under the left hand sheet of foam is another VIP. The top of the interior of the box is another sheet of pultruded fiberglass laid on wooden cleats around the perimeter of the top of the box, and resting on the center partition as well. It was necessary to make a spacer around the hatch frame down to the fiberglass panel and then cut out the hole in the top of the box. The hatch frame must just fit under the countertop. Note the Frigoboat control panel and the rocker switch for the interior LED lights. Unlike the other five sides of the completed box, there are small spaces where there is no VIP providing insulation for the top of the box, but there is at least 3 inches of foam plus another 1.5 inches of maple countertop, and the top of the box is apparently the least important part for insulation, so it should suffice.

at the lowest compressor speed, hence the least current draw.

Here is the Frigoboat keel cooled condenser bedded to the outside of the hull above the turn of the bilge. It should be out of the way from boatyard slings there and is unlikely to be hit by anything in that location.

Tucked up in a corner of the engine room is the Frigoboat compressor. The copper tubing zip-tied to the manual bilge pump intake hose goes to the keel cooled condenser, and cannot be extended, so planning for placement is important.



Now for the finishing details: My wife wanted a hard rock Maple cutting board countertop with an underhung sink. I couldn't see how that was going to last so agreed to modify a standard galley sink so its top would be flush with the countertop, so water could be brushed into the sink as opposed to mopped up. Here is the countertop dry-fitted into the galley with the opening routed to take the sink.

Here is the sink after cutting off its flange and securing bolts, and evening everything out best I could. I trusted to make this a tight fit and seal it up with Sikaflex 291, thinking that would be adequate to hold the sink in place. That didn't work, as the sink has pulled up slightly from the counter-top and is going to have to be rebedded after I figure out how to hold it down in its place more firmly.

Here's how it looks. I think the effect is worth achieving, but ask me again after I have figured out how to remount it successfully.

Here’s how it finished out with a nice single-handle faucet and a little tile to spruce things up.

Here is the refrigerator hatch in place. The hatch opens and rests against the cupboard to the right. Access to both the refrigerator and freezer is tight, but neither is too bad. We have since added a Maple fiddle to the left of the hatch to keep water from the countertop out of the hatch.

And here is the countertop space the cook was so intent on. When the cook is happy, everybody is happy.

I am writing this at anchor in Maple Bay, British Columbia. While scarcely tropical, the indications are good. It's easy to go several days on just one battery, and that refrigerator is full and in use now. When we bought some meat and froze it, the compressor dutifully sped up and ran at full tilt for a while, as it does when asked to freeze a new batch of ice cubes. But normal operation appears to be handled at the lowest compressor speed, hence the least current draw.