HOW TO MAKE AN ICE-BOX

JOHN CAMPBELL tells how he made an efficient box for his refrigerator

FOR AN icebox, refrigerator, or freezer to be efficient, there is one primary requirement — it must be well insulated — you really can't over do it. What constitutes good insulation? Really, there are two factors, the type of insulating material, and its thickness.

One of the earliest materials used was cork. Compared to some of the modern plastic materials, cork is woefully inefficient. A common modern insulating material is styrofoam, or expanded polystyrene. This is that soft white granular-looking foam widely used for packaging as well as insulation. Only about 80 per cent of the heat which will pass through cork will pass through the equivalent thickness of styrofoam in the same time.

Even more efficient is a closed-cell rigid polyurethane foam, often just called urethane foam. Compared to styrofoam, it is about thirty per cent more efficient. Or to compare it to cork, only about 56 per cent of the heat will pass through urethane, as will pass through the equivalant thickness of cork in the same time.

These efficiencies relate directly to running time for the refrigeration compressor: a urethane-insulated box will require the compressor to run for only about half the time that would be required for a cork-insulated box, all other factors being equal.

Urethane foam comes in two forms. It can be bought in preformed sheets of various thickness. It may be brown, grey, pale blue, or pale green. It can be recognised by its very small cellular structure, and its somewhat crisp feel. It can easily be crumbled to a fine powder.

It can also be bought in a liquid form. Two liquids are mixed, the resulting mix rapidly expanding and forming the same rigid foam. The chemical 'blower' is an isocyanate and the gases given off are harmful — so watch out if you ever use this two-part foam. There are applications for both kinds of the foam, but generally speaking, the preformed sheet foam is the best insulator. If the foam mix is allowed to expand in an enclosed space, it can often result in a denser foam, which is not such a good insulator. So, if a choice can be made, use the more-uniform preformed sheets of urethane foam.

The other factor that we briefly touched on is thickness. Again, in general terms, if the thickness of insulation is doubled, the rate at which heat passes will be halved. This again obviously effects the speed at which the ice melts, or the length of time the compressor must run. (See PBO last month).

In practice, using the most efficient preformed urethane foam sheets, three inches of insulation for a refrigerator, and four inches for an icebox or freezer, is a realistic minimum. It is, however, definitely a case of more is better.

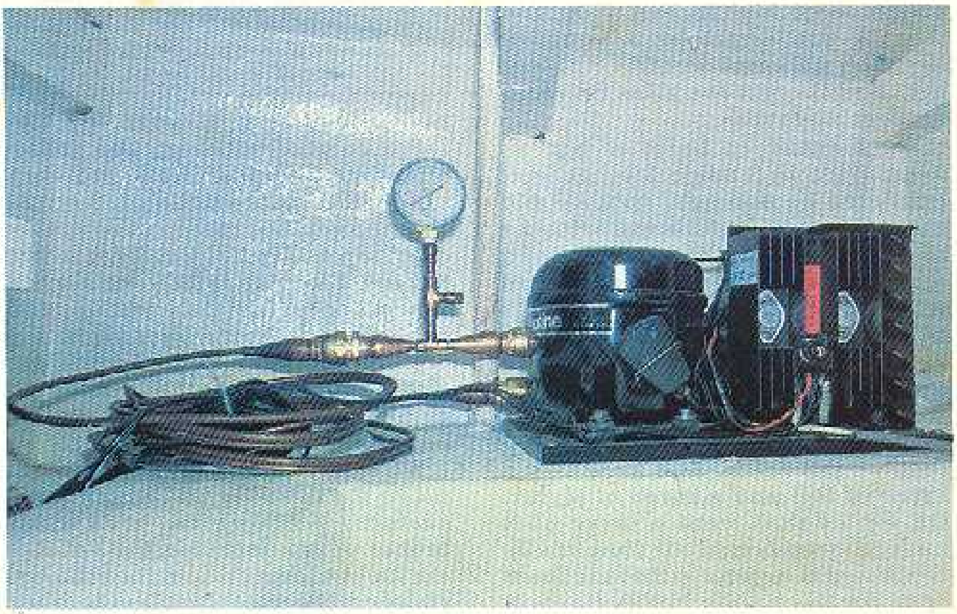
Urethane foam is a closed-cell foam. That means that each 'bubble' in the foam is intact and cannot be penetrated by water. In other words, a closed-cell foam cannot soak up water like a sponge — note that styrofoam can absorb water.

However, water vapour can migrate through the foam, passing between the 'bubbles'. The efficiency of the insulation can be considerably increased if a vapour barrier is incorporated into the construction of the box. The best material to use is Mylar sheet. If Mylar cannot be bought readily as such, one of the heavier grades of the 'cling type' food wrapping films is an acceptable substitute, or even PVC sheets. Whatever the material, all joins must be glued or taped to make a waterproof barrier — aluminium faced 'ducting' tape is the type to use.

One form of heat that can readily penetrate conventional insulation is infra-red heat. Luckily it can easily be reflected by a shiny metallic foil. A good material to use is heavyweight cooking foil. Another excellent material is 'space blanket' material. These 'space blankets' combine a Mylar film and a metallic foil in the one sheet, so a layer of 'space blanket' can serve both as a vapour barrier and a reflective layer.

How does all this work in practice? Starting from scratch, we found it easiest to begin from the outside and work inward. We built basically a plywood box to the

12v system on our boat mounted on top of the box (right). Looking down into ice-box. Evaporator on left holds icecube trays and frozen food.



outside dimensions of the insulation. We were able to use the glass hull to form one side and the bottom of the box. Since our box was to be against a bulkhead, we only actually had to make two sides of the box. These were made from ⅜ inch plywood, and glassed to the hull and bulkhead. Against a wooden hull, it is essential to leave a ventilation space of a couple of inches between the hull and the box.

Once our plywood box was erected, the next job was to line it with the Mylar film. We chose to stick it on using polyester resin. Once the entire box was lined, we covered the Mylar with kitchen foil; again glued using polyester resin.

When the box was lined with foil, and the fumes from the resin had cleared, we began the jigsaw puzzle of fitting the foam insulation in place. We used two-inch thick sheets of urethane foam throughout. It is easy to cut with a serrated bread knife, and complicated shapes can be easily sanded to shape with coarse sandpaper. Avoid breathing the dust though; I am told it is harmful.

Our hull has a series of stiffening stringers moulded in. The first job was to fair in between these with urethane. Once that was done, we began lining the box in earnest.

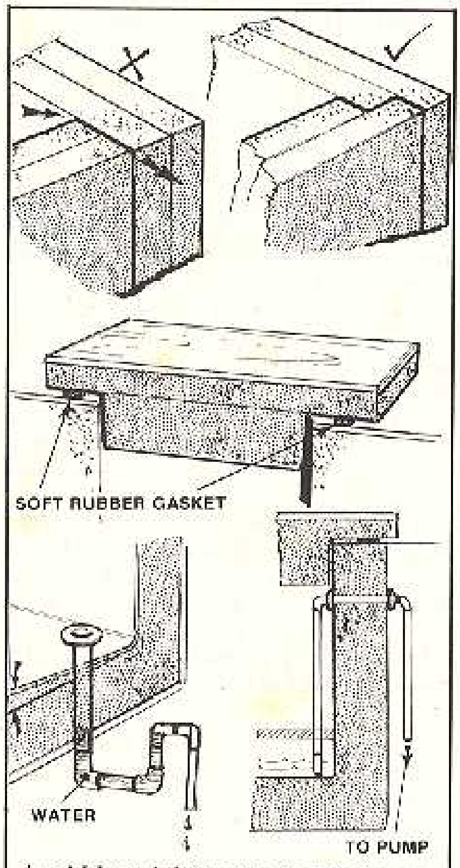
The secret is to avoid any butt joints, or indeed, any joints in the foam that go right through the insulation. Use stepped joints in the corners and stagger all other joints so that no direct paths are available to invading heat.

If one-inch sheet foam is used, it will bend to follow the curve of the hull. The bending will be helped by the judicious application of a bit of heat from a hair drier. On our own box, we were using two-inch foam exclusively, which is reluctant to bend. To follow the curve, we cut strips about four inches wide, and sanded the edges to a snug fit between adjacent strips. Care was taken to stagger the joins between successive layers.

We wanted to build a box of around 2½ to 3 cubic feet, as well insulated as possible, so we could use 12 volt refrigeration without always having flat batteries. To that end, we began with six inches of insulation all over, increasing it to eight inches on the bottom and against the side of the hull where the sun can shine right on it.

Once all the foam insulation was in place, we levelled off the top face of the foam, and glued on a layer of foil and a layer of Mylar. On top of that went a layer of ⅜ inch plywood, and all that really remained now was to line the foam box. We have seen boxes lined in plywood, Formica, glass, stainless steel, or a combination of several. We decided the easiest material for such a small box was to lay up a resinglass liner in place, glassing directly to the foam. (That of course, cannot be done with styrofoam, as polyester resin dissolves it.)

We used two layers of 1½oz. mat all over, with good overlaps along each edge. The glass was carried up over the edge of the top opening onto the plywood. We then applied a layer of tissue, using pigmented gel coat and then a final coat of waxed pigmented gel coat. The resulting non-tacky surface is smooth enough to keep clean, and



Avoid butt joints; use stepped ones. External top gains space. U-trap stops cold leaking out. Pumped drain has pick-up tube high up to avoid water leaks.

has proved very durable.

For ease of building, and subsequent ease of cleaning or stowing, we decided not to build a top on the box as such, but rather to cover the open top with a lid. The lid is in two halves. The idea is that for normal access, only half the lid is opened, reducing the flow of hot air in and cold air out. For a major stowing or cleaning, both halves could be removed to provide complete access.

We built our box under the cockpit so the top does not form a work surface. We wanted to use six inches of insulation in the lids, but six inches going down into the box reduced the volume considerably. What we did was to make the lids overlap the top of the box for two inches of thickness. The remaining four inches step down inside the box. The lids we made very easily by gluing three layers of foam together. After they were trimmed to shape, we glued foil and Mylar over the top, then glassed all over them with two layers of mat. We then gel coated them as the inside was done. A soft rubber gasket fitted round the rim completed the job. (A perfect rim-seal is required to stop 'leaks'. Magnetic sealing strips are available in the UK from such outlets as Transatlantic Plastics. Editor).

Since we were fitting a refrigeration unit, we had to provide a route into the box for the refrigerant tubes. What we did was to glass in a piece of pvc pipe passing through the side of the box, and we fitted the pipe high in the box to reduce the posibility of cold air flowing out through the pipe around the tubes with neoprene foam to make it as air-tight as possible.

It is as well to fit some sort of drain to the box, particularly if it is to be just an ice box. Many people like to just gravity-drain the box into the bilge. If this is done, then it is essential to use a U-trap in the drain to prevent cold air flowing out at will. (Or better still fit a brass stop-cock — gate valve — in the pipe to give a positive closure — Ed.).

We prefer not to run anything into the bilge, and so we fitted a hand pump to drain the box over the side. Rather than fit a drain in the bottom of the box and risk possible leaks, we have found it better to use a pick-up pipe that enters the side of the box high up, and reaches down to the bottom. This method not only eliminates the possibility of leaks, but also reduces the chance of cold air flowing out. Once again, the use of plastic fittings will greatly reduce the flow of heat into the box.

We also made a plywood shelf that rests on supports about eight inches off the bottom. Any food that may be damaged by water can rest on this shelf. Cans of drink, or bottles can be stowed below the shelf where accummulated water will not harm them. The shelf is well perforated with holes to encourage easy circulation of the cold air within the box.

We have found this box to be extremely efficient. It will comfortably keep block ice for more than a week. With the 12 volt Adler Barbour Cold Machine refrigeration unit fitted, the heat loss is such that two thirty-watt solar panels will keep the system running, and keep us in ice cubes. ●