



## Transformational Technologies - Reliable Refrigeration

In 1968 Sir Robin Knox-Johnston went round the world in *Suhaili* on tins of corned beef laced with curry powder. Although he didn't know it, even in those days he could have chosen differently - a couple of enterprising Americans, Michael Adler and Ken Grunert, independently of one another, were already adapting air conditioning technology from cars to create engine-driven refrigerators and freezers at sea. By the early '70s, both they, and pioneers from Frigoboat, Indel (Isotherm) and Waeco in Italy and Germany were producing constant-cycling DC refrigeration units.

When we built *Nada I* in the early '80s we were talked into building our own engine-driven fridge and freezer system by one of the 'experts' in the local marina. The fridge worked fine, but the freezer never froze anything.

In frustration I began to study refrigeration with little idea of what I was getting into. I discovered that most of the engineering to date was 'seat of the pants.' The tables in standard textbooks for sizing the components in a refrigeration system generally did not cover the kinds of temperatures and pressures commonly found in marine systems, especially engine-driven systems.

After spending more time on this than went into my then 650 page 'Boatowner's Mechanical and Electrical Manual' I finally got it figured out, resulting in a book titled 'Refrigeration for Pleasureboats.' I built myself a pretty powerful engine-driven freezer using 'holding plates' in the icebox.

The problem with this, as all cruisers with such a system know, is that to keep food from spoiling the engine has to be run every day. You become chained to your boat. My thinking rapidly evolved towards DC-driven systems that will keep running until the batteries die. Unfortunately, the efficiency on most of these was pretty dismal, with the result that cruisers

with such systems often ran their engines two or three hours a day battery charging (as opposed to the hour a day we achieved with the engine-driven system). The batteries would only hold up a day or two in the absence of charging, so there was not much improvement here.

The answer was to couple a larger, more efficient, DC-driven refrigeration compressor with a water cooled condensing unit (another key component) to holding plates, resulting in a heavy duty DC system that would pull up to 40 amps at 12 volts when running, but which only ran an hour or two a day, keeping the daily energy

load within bounds. Such a system was typically coupled to a powerful DC system that included a large battery bank, enabling a boat to be left for days without the fridge and freezer melting down (my goal with DC-based refrigeration has always been seven days; this allows extended exploratory trips ashore).

We pulled out the engine-driven system and started again with a heavy-duty DC system. We put a similar system on the next boat. These systems worked great. When we circumnavigated Cuba in 1995, we were able to freeze down enough 'chicken nuggets,' which was about the only thing seven-year-old Paul would eat at that time, to feed him for six weeks without a pit stop (after which we had to go back to Key West to re-supply).

Meantime the small hermetic compressors used in constant-cycling refrigeration units (without holding plates) grew ever more powerful and efficient, and new approaches to condensers resulted in breakthrough units from Frigoboat and Isotherm that provide the efficiencies of water cooling without requiring a water pump. By the time we commissioned *Nada III* in 2005 I could no longer justify the expense, weight and volume of a heavy duty, holding plate, DC refrigeration system. For less than the price of one of these, we could buy two efficient Frigoboats or Isotherms (we chose Frigoboat) that were small, lightweight, quiet, easy to install, and required no maintenance. The two units - one for the fridge and one for the freezer - provided redundancy so that if one or the other failed we would still have refrigeration. We put the money saved into excellent icebox insulation to further reduce the energy load.

Today it is almost unthinkable to go cruising, especially in the tropics, without refrigeration. So long as someone on board knows how to cook, Sir Robin's Spartan existence has given way to a world of gourmet potential, resulting in a transformed existence on board. J