Watermakers II

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The immortal line "Water, water every where, but nary a drop to drink" was first penned by a commercial fisherman whose desalinator broke down on a long offshore tuna trip.

Well, OK, maybe not first penned. But the problem of converting seawater to something that can be used to drink, wash, and process product is one of the technological challenges of vessels which operate too far from port, or whose tankage space is too limited, to allow carrying all the needed freshwater.

Tuna boats, tenders, processing ships and cruising yachts all use watermakers, although in different ways. The tuna boat and yacht probably use relatively small units, run them intermittently, and only supply the modest demands of their crews, something like five gallons per person per day. A tender may be supplying water to numerous catcher boats, and a factory ship may need thousands of gallons per day to supply her processing lines, so they install large capacity commercial duty units which run almost continuously.

A properly working watermaker can remove virtually all the salts and minerals from seawater, making it fit for any use. It can also remove cysts, bacteria and viruses, rendering polluted water safe to drink, although there is much disagreement within the industry about whether reverse osmosis desalination alone is adequate purification, and some manufacturers recommend backing up the desalinator with an accessory UV sterilizer or with chemical disinfectant. What a watermaker does not do well is remove silt and chemical or fuel contaminants; actually, the desalinator will do both but will soon be clogged or destroyed in the process. If silty water must be used, it first has to undergo thorough filtration to remove all the sediments so they do not clog up the system.

Two Methods

Two technologies dominate desalination: evaporation and reverse osmosis. An evaporative desalinator, as the name implies, boils water in a vacuum chamber, which leaves salts and contaminants behind, and then condenses the vapor to recapture pure water. It is kind of like a compact moonshiner's still, and uses waste heat drawn through a heat exchanger from the cooling system of the vessel's main engine or a genset. The upside is there is no high pressure pump so there is no large power drain. The downside is that it only works when the engine is producing heat, and it requires a lot of maintenance, including acid baths, to keep the system free of mineral scale.

Despite what some in the industry say, the evaporative desalinator is not dead. It is an archaic technology to be sure, and it tends to be somewhat more bulky and maintenance intensive than the other choice. But on larger vessels where mains and auxiliaries are running constantly, evaporative units offer some advantages. They work efficiently in colder water (more on water temperature later), don't need to be "pickled" or preserved between uses, and can be made in extremely large capacity units. The smallest evaporative units available are about 200 gallons per day and require the heat output of 38 diesel operating horsepower to work, but evaporative desalinators really are most practical in applications of 1,000 to 2,000 gpd or more.

Reverse osmosis (RO) is the technology which has captured the yacht and small boat market, and has stolen a big part of the ship and stationary market as well. It uses one or more semi-permeable membranes with microscopic pores, wound into tubes into which seawater is forced under high pressure (700-900 psi). The relatively small molecules of pure water can squeeze through the pores, leaving the larger salt and mineral molecules behind, to be flushed out by the brine discharge. Only 5% to 10% of the salt water supplied to the machine actually emerges as fresh water, and the remainder is returned to the sea with a slight additional salt concentration.

Watermakers commonly are rated in gallons per day, but many units are not intended to operate continuously. It is recommended that the heavy duty units be sized to 20% to 25% greater capacity than the anticipated daily water demand to allow for some down time for maintenance. The smaller, less expensive units, while capable of running virtually around the clock, will wear out fairly soon if used that way. A lower duty cycle increases longevity, and the larger the capacity the more efficient a unit is, so there are two advantages to oversizing. The recommendation is that small-unit capacity should be no less than three to four times daily water demand, and more if the operator wants to minimize the genset or battery charging time. Some manufacturers rate their machines in gallons per hour, which is a better measure than gallons per day of how well a unit will perform in intermittent use.

RO ratings are also based on fairly warm water: 76F°, 78F°, and 82F°, depending on make. Production drops off with colder water because pores contract. For example, a unit rated at 77° water will produce only 65% of its rated output at 50°. Some makes have optional pre-heater units which use engine heat to bring cold seawater up to optimal temperature.

Power Source

Marine supply firms offer a range of RO units which run on 12V-DC power, which is appealing for yachts and small boats without AC power. The biggest DC units are rated at up to 200 gpd (8 gph), but most are smaller and few 12-volt systems can produce more than six gallons per hour. If your needs are greater than that, you probably need to look at an AC powered watermaker, in most cases using a generator for power. AC motors are more efficient in their use of energy than DC and can be sized for demand. Better yet, direct belt drive off a main or auxiliary engine can produce abundant watermaking power, and is a much more efficient use of energy than

generating electricity to power an electric motor. Systems run off a main may need flow control to compensate for frequently changing engine speeds, whereas an auxiliary can be set for constant output. At least one company markets a self-contained unit with its own dedicated two-cylinder diesel to power it.

In the small boat and recreational market, power drain is a major point in competitive advertising. These small units use 12V-DC and some draw as little as a few amps. While this may be an important selling point for sailors or small boat operators who spend a lot of time at anchor, it is of less concern to commercial operations. These units get low power drain by using extremely small (as little as 1/18th hp) motors in their pressure pumps, and the way they can do it is by pumping very low volumes of water. So a popular brand may consume only four amps, but it is producing only about 1.5 gallons of water per hour—not enough to be of much use. A more practical way of judging energy efficiency is watts (amps * volts) per gallon; most small units need 30 to 50 watts to produce a gallon of fresh water.

Most manufacturers market both self-contained and modular units. The former are simpler to install if you have adequate space, the latter are more adaptable to fitting into crowded hulls. Installation probably will take a couple of days, even by a skilled technician, because placement and quality of connections is important. Most units are designed to be mounted above the waterline and are supplied water by a low pressure booster pump, but some are made to go below waterline and are gravity fed. It is important to study carefully the specs and designs of competing units before making a choice, or better yet, have a specialist design a system for your application.

The Basics

An essential component of the installation is the appropriate pre-filtration system. Some manufacturers recommend a coarse strainer, then in sequence a 30-micron or 10-micron pre-filter and a 5-micron final filter to remove all silt from the water. A vacuum gauge between the filters and the boost pump will tell you when the filters are clogging.

RO watermakers are fairly simple machines, but because they process salt water and operate under high pressure, they require frequent maintenance. Seawater of course is very corrosive, and even with the highest quality stainless steel fittings, the units should be back-flushed with charcoal-filtered or non-chlorinated freshwater when not in use and inspected frequently, to minimize corrosion and catch it before it ruins something. Membranes should be flushed daily during use. The pressure pump oil should be checked daily and changed every 500 hours or so.

What's more, watermakers need to be serviced when they are not in use. Because bacteria trapped on the membranes will grow and attack the fabric if left standing, the unit must be "pickled" if it is to go more than a couple of weeks without running. This is done by low pressure flushing with a solution of sodium bisulphate. When it is put back into service, the initial production of fresh water is contaminated by the pickling and must be dumped.

Membrane maintenance is important because the cost of membranes is close to half the cost of an entire unit. Even with proper maintenance, membranes commonly must be replaced every three to five years. Other maintenance generally is less expensive, and usually can be accomplished by a competent engineer or operator, but it must be done.

Commercial grade watermakers are not cheap. The so-called "survival" or light duty units of around 1.5 gph start as low as $2000, but the commercial grade continuous duty sets of 8 gph start at around $6000 and increase steeply from there. There is a wide range of prices for watermakers, but like so many other kinds of equipment, you pretty much get what you pay for. ✦