Reverse Osmosis

by Ray Barkalow

Purification of Water

IN JANUARY 2014 WE DISCUSSED potential sources of pure water for use on your orchids, and mentioned that reverse osmosis (RO) systems are the most common method used by growers. Based upon inquiries I have gotten about them, there appear to be some fairly widespread misconceptions and misunderstandings about their operations and use, so let's correct those, starting with the design of the system itself.

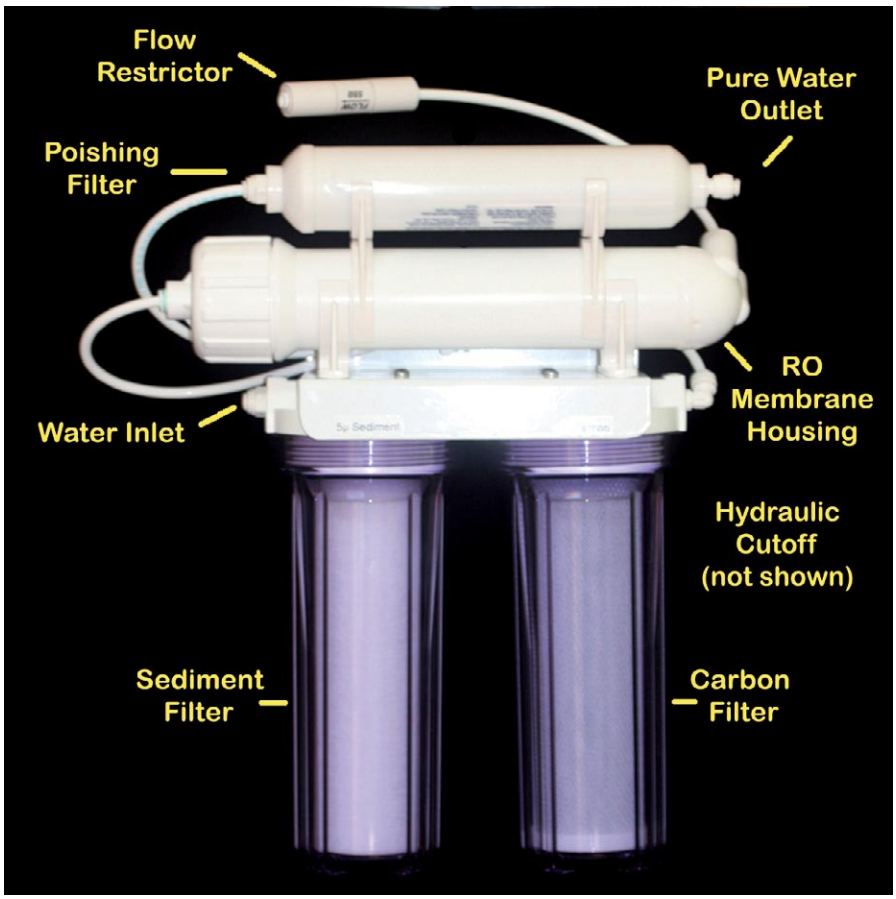
Reverse osmosis systems are typically connected to an existing water supply with a hose adapter or a saddle valve tapped into existing plumbing. Pictured is a typical four-stage system.

Tap water first enters a canister containing a sediment filter to remove suspended solids (stage 1), then into another containing a carbon block filter to remove organic chemicals that may be present in minute quantities (stage 2). Water leaving the carbon filter enters stage 3, the RO membrane housing, where the real "work" is done.

The RO membrane is a thin-film composite designed to allow water molecules to pass though it, while blocking essentially all dissolved solids. To give you an idea of the scale involved, a human hair is about 75 µ (microns, one-millionth of a meter) in diameter. The sediment filter typically blocks anything below 5 µ in size, the carbon block filter goes down to about 0.01µ, and the RO membrane removes almost everything down to 0.0001µ, or 0.000000004 inch!

When water enters the membrane housing, it splits into two paths, some passing through the membrane, purifying it, and the rest diverted to carry away the solids rejected by the membrane, preventing it from becoming rapidly fouled. Pure water leaving the membrane housing often is passed through a secondary carbon "polishing" filter — stage 4 — and then collected for use. The "flush water" passes through a flow restrictor, which creates the back-pressure needed to push the water through the membrane, and then is disposed of or used for humidification or irrigation of less-sensitive plants.

If the incoming water supply is chlorinated, it is considered wise to upgrade to a five-stage system, adding a second carbon block filter prior to the membrane to ensure complete extraction of the chlorine, which can be damaging to the membrane materials.



Integral to the management of the water flow through a system is the hydraulic cutoff. Many greenhouse systems are connected to a storage tank via a float valve; when the tank is full, it stops the flow of pure water. When the back-pressure from the tank reaches ⅔ of the incoming water pressure, the hydraulic cutoff stops all flow of water, so the flush water does not run continuously.

Maintenance of an RO system is pretty simple — the sediment filter should be replaced every six months, the carbon filters at 12 months, and the membrane and polishing filter every two years. The cost is not exorbitant either; including the purchase price and the periodic cost of replacement parts, most will find the average cost to be about $0.04–0.05 per gallon.

So now let's look at some of the practicalities of the use of RO systems.

Most systems used in a hobby greenhouse will be rated at 60 or 100 gallons (227–378 L) per day, which seems like a great deal of water, but that's a bit deceptive. One hundred gallons per day is equivalent to roughly a cup (236 ml) per minute, and nobody is watering their collection at that rate! Add to that the fact that RO membrane capacities are typically rated at water pressures in the 60–65 pounds per square inch (psi) range and at a water temperature of 77 F (25 C), and that any reduction in either results in slower pure-water production. A 10 F (5.6 C) and 10-psi reduction cuts the output by 30%. Because of those factors, it is necessary to have some sort of water storage capability so that one has a sufficient volume on hand for watering.

The hobbyist with a few plants might manually fill up some milk jugs and have plenty to pour on the plants, whereas a larger greenhouse grower might have a tank of several hundred gallons, and a separate pump to use for irrigation. The trick is to estimate the amount of water you use per watering, consider the frequency of watering, and select the storage volume and refill capacity to match it. For example, if you use 40 gallons (151 l) of water every other day, you'd probably do well with a 55-gallon (208 l) drum for storage (often free from a local car wash), which is refilled by a 60-gallon per day (227 l) RO system. Connect the system to the tank with a float valve and it will refill automatically, and you'll always have plenty of pure water for your plants.— *Ray Barkalow is an engineer and scientist, and a hobby orchid grower for over 40 years. He has owned and operated First Rays Orchids since 1994, He can be reached at raybark@firstrays.com.*