Reverse Osmosis for Home Treatment of Drinking Water
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REVERSE OSMOSIS FOR HOME TREATMENT OF DRINKING WATER

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REVERSE osmosis (RO) is becoming a common home treatment method for contaminated drinking water. RO is probably best known for its use in desalination projects (turning seawater into drinking water). However, it is also effective for treating water quality problems in the home.

RO can reduce the amounts of organics, inorganics, bacteria and particulates that can be found in contaminated drinking water. Because the efficiency of removal of various contaminants can vary, homeowners should evaluate this when considering using RO for home treatment. Other home treatment methods may be better for a specific contaminant.

The first step toward solving a suspected water quality problem is to have your water analyzed by your local health department or a reputable laboratory. A water analysis will not only verify whether a water quality problem exists, but it is also essential to determine the most appropriate solution to the problem. State or local health officials can interpret water analysis results. Some laboratories may also provide this service.

Note that home water treatment is considered only a temporary solution. The best solutions to a contaminated drinking water problem are to either end the practices causing the contamination or change water sources.

REVERSE OSMOSIS

RO IS BASED ON THE process of osmosis. Osmosis involves the selective movement of water from one side of a membrane (a plastic film that looks similar to cellophane) to the other. To make the process work, pressure is applied to the contaminated water, forcing water through the membrane. Since contaminants do not move with the water as it moves across the membrane, purer water collects on the other side of the membrane. The purified water that accumulates on one side of the membrane can then be used or stored.

A specific amount of pressure is necessary to separate purified water and contaminants. This required pressure is based on the type and concentration of contaminants in the water. For example, producing purified water from sea water requires more than 10 times the applied pressure than regular tap water requires. Supplying even more pressure to the contaminated water than is required provides better separation and a higher production rate. Fig. 1 shows how reverse osmosis works.

The levels of most dissolved compounds and suspended matter present in water can be reduced by RO treatment. However, not all compounds can be efficiently removed by this process. The efficiency with which membranes reject the contaminant molecules depends on the pollutant concentration and chemical properties of the pollutant. Membrane type

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and operating conditions will also affect the degree of pollutant removal. Table 1 lists some potential water contaminants and their typical ranges of rejection with an RO system.

Efficiency of removal is often described using the term "rejection percentage," which is the percent of a particular contaminant that doesn't cross the membrane, i.e., is rejected by the membrane. However, rejection percentages do not tell the whole story. For example, the rejection percentage for nitrate can be as high as 90 percent with some systems, indicating the membrane is highly efficient in rejecting nitrate. However, for an incoming nitrate concentration of 110 milligrams per liter (mg/1) - an urealistically high level - 90 percent removal would still leave 10 percent of the nitrate in the purified water, or 11 mg/l. This is greater than the 10 mg/l maximum contaminant level for nitrate allowed in drinking water supplies. It is important to know not only rejection percentages, but also incoming pollutant concentrations to effectively reduce contaminant concentrations in the drinking water to safe levels.

Table 1:

Some Potential Drinking Water Contaminants and Their Typical Ranges of Rejection with an RO System

Contaminant	Rejection Range*
Sodium	87-93%
Calcium	80-97%
Magnesium	80-98%
Iron	90-98%
Cadmium	96-98%
Lead	96-98%
Nitrate	83-92%
Organic Halides	83-92%
Trihalomethanes	65-99%
Chlorine	13-91%
Total Dissolved Solids	95-99%

*Range of percentages of each contaminant removed.

RO SYSTEMS

BASIC COMPONENTS of an RO system should include a prefilter to remove fouling agents such as rust and lime; an RO module containing the membrane; an activated carbon postfilter to remove residual taste, odor and some compounds from the purified water; a storage tank; and various valves, including a shut-off valve that stops the water flow when the storage tank is full. The system must also provide for waste flow to drains. Prefilters containing activated carbon are commonly used to protect chlorine-sensitive membranes. All of these components can be purchased from the dealer.

OTHER USEFUL FEATURES that are available include an automatic membrane flush that periodically cleans the membrane; pressure gauges to help determine how effectively the unit is operating; and a sanitizing procedure to kill any bacteria that have accumulated the system.

A high conversion rate - the percentage of treated water obtained from incoming water - is another important consideration. Conversion rates can be quite variable and range from as low as 10 percent up to 50 percent.

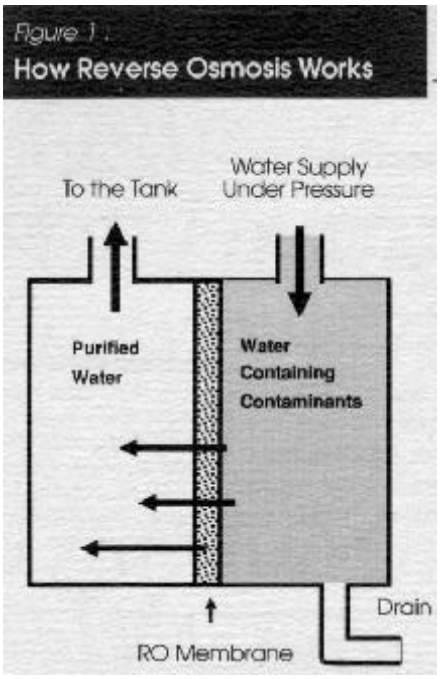
RO systems are typically installed as point-of-use (POU) devices. This means they are generally placed at a tap, usually in the kitchen. RO systems come in countertop or under-the-sink models. A separate faucet is often installed to bypass the RO unit so that the treated water is used for cooking and drinking purposes only. This increases the life of prefilters, postfilters and the membrane, thereby making treatment more economical. RO systems vary in capacity; however, 3 to 10 gallons per day is a common range.

Membrane selection, an important characteristic of RO systems that affects performance, is based on various water characteristics such as acidity, hardness, total dissolved solids and chlorine content. You can get information about water characteristics from a water analysis of a particular water source.

Another important characteristic influencing an RO system's performance is water pressure. The higher the water pressure, the better the rejection of pollutants and the more purified the water. Typical water pressure in most homes may be adequate for RO treatment, although booster pumps can be added if it is not. Doubling the net pressure across a membrane more than doubles the output flow rate of purified water. Keep in mind that home water pressures vary

significantly, thus changing the efficiency of the unit. In addition, water production and rejection rates in some units decrease as the storage tank fills, since this increases pressure on the purified water side of the membrane. Consequently, for maximum benefit, the tank should be emptied daily and sized accurately to fit the water use rates.

Water temperature will also influence the production rate of purified water. The higher the water temperature, the better the production rate. A drop in temperature from 75 degrees to 45 degrees cuts the production of purified water virtually in half.



OPERATION, MAINTENANCE AND COST

TO CONTINUALLY PERFORM WELL, RO systems, like all other home water treatment devices, require regular maintenance and replacement of various components. Prefilters and postfilters need to be replaced on a regular basis. The length of time between changing prefilters will depend on the water quality, especially the concentration of solids. The contaminant concentration, membrane rejection percentages, and efficiency of activated carbon removal determine when postfilters should be replaced. RO membranes should typically last for one to three years, depending on operating conditions, membrane type and prefilter performance.

Unfortunately, it is difficult to know when to replace the various components of an RO system. This is a major disadvantage of any home treatment system. Verification of a system's performance can only be determined by chemical testing. However, a professional who has access to your water analysis and who knows your water use rate can usually accurately determine when filters and membranes need to be replaced, presuming that contaminant concentrations do not increase over time.

A particularly major disadvantage of RO is the large amount of contaminated wastewater generated. This can be as much as 50 to 90 percent of the incoming water. This amount depends largely on the pressure difference across the membrane. The larger the pressure difference, the smaller the wastage rate.

The cost of RO systems ranges from $300 to $900 -expensive compared to some other treatment systems. Membrane replacement costs range from $70 to $140. Prefilter and postfilter costs vary, with an average price of about $20.

(NOTE: Dollar values are provided as a rough guide to compare costs of different systems. Current prices are likely to be higher than those quoted.)

CERTIFICATION AND VALIDATION

CERTIFICATION OF TREATMENT PRODUCTS is available from independent testing laboratories, such as the National Sanitation Foundation (NSF). Results from NSF tests provide good measures of the effectiveness of devices designed to treat water for both esthetic and health reasons. The Water Quality Association (WQA), a self-governing body of manufacturers and distributors, offers voluntary validation programs to its member. Validation is less stringent than certification. Note that certification or validation will not ensure effective treatment; all systems must be designed for each particular situation and maintained properly.

SUMMARY

RO IS A HOME WATER TREATMENT PROCESS that can effectively treat various contaminants from all major classes of drinking water pollutants, such as organic chemicals, inorganics, bacteria and particulates. If a water quality problem exists because several different contaminants are present, RO may be the most cost-effective method for their removal.

To determine the appropriateness and optimal operation of an RO system, it is necessary to have your water analyzed and your water use rate measured. As with all home treatment systems, it takes regular maintenance to ensure the quality of the purified water.

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For general water quality information and referrals, contact.

Your county Cooperative Extension Service office (listed under "County Government" in the white pages of your phone book).

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For questions about water testing, test interpretation and treatment systems, contact:

Your local health department (listed under city or country in the phone book).
Michigan Department of Public Health
Division of Water Supply 3
423 North Logan Street
P.O. Box 30195
Lansing Michigan 48909
(517) 335-9216

For further information on water quality and home water treatment, consult the following publications, available from your county Extension office:

E 2106 **Testing for contaminants: A Guide for the Home and Farm.**
WQ 02 **Guidelines for Testing of Private wells**
WQ 19 **Nitrate- A drinking water concern**
WQ 21 **A Guide to Home Water Treatment**
WQ 22 **Distillation for Home Water Treatment**
WQ 23 **Home water Treatment Using Activated Carbon.**