# A Guide To Home Water Treatment

ALTHOUGH most drinking water in the United States is considered safe, there is increasing concern about the quality of drinking water as more and more pollutants are found in groundwater supplies. Worry about the possible health problems resulting from these contaminants is causing consumers to wonder what they can do to ensure the quality of their own water supply.

The most strongly recommended and best solutions to the problem of a contaminated water source are either ending the practices causing degradation of the water source, or changing water sources. These options may not always be practical or may take months or years to complete. In the meantime, other solutions may be necessary.

One viable alternative for people with contaminated drinking water may be to install a home water treatment system. Note that home water treatment is considered only a temporary solution. Treatment systems can be quite expensive, require regular monitoring and maintenance, and no one system can be used for all contaminants. They may also become less effective if the degree or type of contamination changes over time. As a result, it may be recommended that bottled water be used for drinking and cooking purposes.

THIS BULLETIN provides a guide for consumers who want to know about home water treatment systems. The first step for homeowners or renters with suspected water quality problems is to have their water chemically analyzed by their local health department or a private laboratory. Public health professionals can help interpret the results. It is important to remember that the presence of a contaminant does not always mean that the water needs to be treated. A water quality professional will use the chemical analysis to determine which, if any, water treatment system is appropriate.

Many water quality problems - ex., bad odor or taste - are esthetic- rather than health-related. Although these types of problems are important and may also be resolved using home water treatment systems, the information in this bulletin focuses on contaminants that may lead to adverse health effects.

A VARIETY OF WATER TREATMENT processes are available to the homeowner. The systems differ in the types of chemicals removed, location within the home, and operating and maintenance requirements. Two broad categories of home water treatment units are point-of-use (POU) and point-of-entry (POE) systems. POU systems are installed near the point of use, normally in the kitchen at the end of a faucet, plumbed in-line under the sink, or placed on a counter top. These systems typically treat the 3 to 5 gallons per day that the average family uses for drinking and cooking. POE units are larger, more expensive, and usually placed in the basement. They treat water as it enters the home, generally excluding water to outdoor taps.

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**Table 1**
**Characteristics of Typical Home Treatment Systems**

| Treatment | Type* | Capacity | Initial Cost** | Contaminants removed |
|---|---|---|---|---|
| Activated carbon | POU, POE | variable | $20-600 | volatile organic compounds, pesticides, radon, some metals (lead, mercury), chlorine |
| Ion exchange | POE | 3-16 gal/min | $400-1500 | hardness (calcium and magnesium), some metals (iron) |
| Reverse osmosis | POU | 3-10 gal/day | $500-900 | microorganisms, asbestos, fibers, metals, nitrate, some organics |
| Distillation | POU | 5-11 gal/day | $300-1200 | microorganisms, metals, nitrate, some organics |
| Chemical oxidation | POU, POE | variable | $300-400 (ozonator) | microorganisms, some organics |
| UV radiation | POU. POE | variable | $300-600 | microorganisms |

*POU = point-of-use system, POE = point-of-entry system,
**Dollar values current at the time this bulletin was prepared are provided as a rough guide to compare cost of different, systems. Actual prices may be higher than those quoted,

POU or POE treatment systems are most economical if they are sized and operated to supply treated water only in quantities needed. POE devices offer the best protection from both esthetic- and health-related contaminants. However, POU devices are generally cheaper. POE devices are often preferable when water is hard or contains iron. These compounds can discolor fixtures and clothes, or lead to excessive buildup of scale in water piping.

SEVERAL PROCESSES ARE AVAILABLE for home water purification. These include activated carbon, ion exchange, reverse osmosis, distillation, chemical oxidation and ultraviolet radiation treatment. These processes purify water by removing contaminants or transforming them into less objectionable compounds.

A major disadvantage of all the processes is that verification of performance can usually only be determined by expensive chemical analysis. Therefore, filter replacement or maintenance may not take place when it is really needed. If the filter is not functioning properly, the water may contain unacceptable levels of contaminants. It is also not possible to know for sure the degree to which contaminants have been removed from the water unless the water has been appropriately tested.

Home treatment systems are not regulated by federal, state or local laws. Regulatory authorities generally consider home systems temporary solutions. This is because no system is capable of removing all possible contaminants and, in some cases, the potential for malfunction or improper maintenance is too great for these systems to be considered long-term

solutions. Thus, to best protect public health, health officials recommend permanent solutions such as a new water source or cleanup of the old source.

## CERTIFICATION AND VALIDATION

CERTIFICATION OF TREATMENT PRODUCTS is available to manufacturers through independent testing laboratories, one of the most prominent of which is 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. Homeowners interested in particular systems can contact the NSF to determine if these devices have been certified for the use tended.

The Water Quality Association (WQA), a self-governing body of manufacturers and distributors, offers voluntary validation programs and advertising guidelines to its members. However, certification, registration or validation may be misleading. For example, manufacturers may be certified by an organization that uses test conditions ideal for contaminant removal, but not representative of all home conditions.

## TREATMENT PROCESSES

*Activated Carbon*

ACTIVATED CARBON (AC) is commonly used to remove organic contaminants from water. Common organic contaminants are pesticides, industrial solvents such as trichloroethylene, and components of gasoline such as benzene. The contaminants interact with the large surface area of the AC in a process called adsorption. AC also effectively removes radon and many natural organic compounds that can cause unpleasant tastes and odors.

AC treatment systems use replaceable cartridges containing granular or powdered block carbon. Cartridges with the most carbon remove the most contaminants and last the longest, thus increasing the time between cartridge replacement. Tests show that under-the-sink models have more carbon, are more convenient, and perform better than faucet and countertop models. Cartridge life expectancy can be maximized, and replacement costs minimized, with systems that allow dispensing of unfiltered tap water for purposes other than drinking or cooking.

The following considerations are important when purchasing AC filters:

- Efficiency of contaminant removal
- Ease of cartridge replacement
- Effectiveness of attached sediment filters, which prevent cartridge clogging
- Amount of pressure loss at the faucet caused by the filter
- Risks associated with possible bacterial growth on AC.

***Ion Exchange***

ION EXCHANGE WORKS by exchanging a compound in the water for a chemical on the filter resin. It is effective for treating ions or charged contaminants. Most inorganic compounds can be removed by ion exchange; however, most common organic compounds cannot effectively be removed. Ion exchange is most commonly used to remove compounds that are esthetic- rather than health-related.

Water softeners are the best known examples of ion exchange systems. Water softeners soften water by removal of calcium and magnesium, which make water hard. These hardness ions in water are exchanged for the sodium ions attached to the resin surface.

The water softener will no longer be effective when all sodium ions on the resin have been replaced by hardness ions. When this occurs, it is time to recharge the resin with sodium. This is accomplished by flushing the resin with high concentrations of salt (sodium chloride).

For people with high blood pressure and heart disease, consuming water from home water softeners that contain the exchanged sodium ions may pose some health risks. These people should check with their doctors to determine whether consuming water from a home softener will exceed the amount of sodium that they are allowed.

Ion exchange systems have also been developed to remove nonhardness chemical ions such as nitrate and metals. In these cases, recharging the resins can only be done at special facilities, making this form of treatment expensive.

***Reverse Osmosis***

REVERSE OSMOSIS (RO) is a membrane separation process that uses a very thin membrane to allow water, but not various undesirable chemicals, through. RO membranes can remove all major types of contaminants, including bacteria, metals, nitrate and organics. However, there are some organic chemicals that may not be removed very efficiently.

An RO system works by applying a high pressure to the contaminated water, forcing pure water through the membrane. Pure water collects on one side of the membrane while pollutants accumulate on the other side. The pollutants are periodically flushed to the sewer or septic system. RO membranes should last at least one year before they need to be replaced.

The typical RO system consists of a sediment filter that protects the RO membrane, the RO module, activated carbon (AC) prefilters to remove chlorine for chlorine sensitive membranes,

AC postfilters; to remove some organics, a tank for water storage, and provisions for waste flow to drains. Because of the small volume of water they treat, RO units are typically located at the point of use under the sink or on the countertop.

Pretreatment with water softeners is often recommended for extremely hard water. Prefilters and postfilters must be replaced regularly.

An important factor to consider regarding RO is the large volume of water that is wasted. This can range between 25 and 60 gallons per day, depending on the amount of treated water needed and the pressure drop across the membrane.

***Distillation***

DISTILLATION RELIES ON EVAPORATION to accomplish water purification. It removes inorganic compounds, such as lead and nitrate, as well as some organics that do not easily evaporate and so are left behind in the distillation process.

During distillation, the water is heated to form steam. The steam then cools and condenses to form purified

water. Unevaporated contaminants are left behind and periodically flushed to the septic or sewer system.

Distillers are POU systems and may be countertop, wall mounted, or placed on carts. Systems can be manual, or partially or fully automated. Some models can separate volatile organic compounds before distillation takes place.

An advantage of using distillation on water supplies that have not been chlorinated is that disinfection occurs during boiling. However, care must be taken to avoid bacterial recontamination of the condensed purified water in the storage container.

Problems associated with distillation include loss of beneficial minerals from water, and possibly flat-tasting water. Operating costs may be higher than other forms of home treatment. The heat produced by a distiller may be beneficial in the winter, but a disadvantage in the summer.

***Chemical Oxidation***

CHEMICAL OXIDATION WORKS by chemically changing the pollutant to a less objectionable compound. Chemical oxidants also act as disinfectants by killing bacteria and viruses. Chlorine is a common oxidant added to most public water supplies for disinfection purposes.

There are several strong oxidizers that may be practical for home water treatment of a bacteria-contaminated water supply. These include hypochlorite or hypochlorous acid, and hypobromite or hypobromous acid. All are available in powder or liquid form. Automatic feeders add the chemicals directly to water in the pipes. They can be either point-of-use or point-of-entry systems. Adequate contact time is essential to make sure disinfection takes place.

Chlorinated oxidants can transmit an unpleasant taste to the water and may produce potentially harmful chlorinated organics (trihalomethanes) by reacting with natural organic materials present in the water.

Ozone is another chemical oxidant. It can destroy bacteria in drinking water without creating the taste and odor problems common with chlorine. In addition, many organic compounds can be partially or completely oxidixed by ozone without the formation of chlorinated compounds.

The effectiveness of an oxidant can be influenced by water temperature, acidity, concentration of oxidant, contact time with the oxidant prior to water use, and other factors. Pretreatment may be required for turbid water (water heavy with sediments).

***Ultraviolet Radiation***

ULTRAVIOLET (UV) RADIATION DISINFECTS drinking water by killing microorganisms. Unless sufficient levels are applied, however, UV radiation may merely retard growth or impede reproduction of bacteria and viruses rather than destroy these organisms.

**BUYER'S CHECKLIST**

1. Have a water analysis performed by a qualified laboratory.

2. Discuss your results with health professionals to Their recommendations.

3. Research different products on the marker. Compare initial, operating and maintenance costs, contaminant removal efficiency, and company reputation and service record.

4. Read manufacturer's claims and warranties carefully to make sure that the capacity and life expectancy of a given system meet your needs.

5. Understand the operation and maintenance requirements when the unit is installed. Find out where to obtain replacement filters and who will service the equipment when problems arise.

UV systems are placed directly into water lines at convenient locations for POU or POE treatment. If it is combined with other technologies, UV should be used last. The other devices can remove dissolved and undissolved materials that inhibit the disinfection process, and UV can kill any bacteria left in the system.

A UV disinfection system consists of a prefilter, which removes sediment, and a UV-emitting lamp. Good UV-disinfection designs should provide:

- Maintenance with easy tube and lamp removal
- Flow rates that provide adequate contact time between radiation and bacteria
- Easy visual inspection of the lamp and tube.

The primary advantage of UV treatment is that no disinfecting chemicals are added to the water. Taste and odor problems are less likely to arise when chlorine is not added. Chlorine, however, does provide residual disinfecting power downstream of the application point while UV does not.

***Bottled or Bulk Water***

BOTTLED OR BULK WATER may be a viable alternative to home water treatment if it is needed only for a short period of time. Examples are when a homeowner is pursuing a new source of water or installating a home water treatment system.

Bottled water is regulated as a food by the U.S. Food and Drug Administration (FDA). The FDA concerns itself mostly with sanitation and labeling but is also responsible for ensuring that bottlers comply with Primary and Secondary Drinking Water Standards. Only those bottlers working in more than one state are regulated by the FDA. In Michigan, the Department of Public Health (MDPH) regulates bottled water sources, and the Department of Agriculture (MDA) regulates labeling and quality.

Bulk water, which is delivered to the home and stored in large tanks, is available in some Michigan communities and may provide a more convenient alternative than bottled water for some people.

**SUMMARY**

THERE ARE MANY STRATEGIES for dealing with a water contamination problem. The best approach for each situation will depend on what contaminants are present and at what levels; the homeowner's budget constraints; and, willingness to maintain a system. If water treatment is the option homeowners choose, they should remember that this is not a long-term solution, since no one system can work for all contamination problems and none are maintenance-free. The homeowner or renter should take the time to learn about the water source and the treatment systems available in order to intelligently and appropriately resolve the problem.

*This material is based upon work supported by the U.S. Department of Agriculture, Extension Service, under project number 89-EWQI-1-9144. The publication was developed by the Community Assistance Program in Environmental toxicology, a program in Michigan State University's Center for Environmental toxicology and Department of Resource Development that is supported in part with a grant from the Charles Stewart Mott Foundation.*

**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),

**Center for Environmental Toxicology**
Michigan State University East
Lansing, Michigan 48824
(517) 353-6469

**Institute of Water Research**
Michigan State University
East Lansing, Michigan 48824
(517) 353-3742

**FOR questions about water testing, test interpretation and treatment systems, contact.**

**Your local health department** (listed under city or county in the phone book).

**Michigan Department of Public Health** Division of Water Supply
3423 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-2016, **"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 22, **"Distillation for Home Water Treatment"**

WQ 23, **"Home Water Treatment Using Activated Carbon"**

WQ 24, **"Reverse osmosis for Home Treatment of Drinking Water"**

Newl:90 5M-KDP-HP, Price 600
FILE: 28.362 (Water & Water Quality)