

Home Water Treatment Systems

Consumers buy home water treatment units for many different reasons. Some may be concerned about chemicals or particles that affect the taste or appearance of their drinking water. Others may be concerned that their water contains harmful organisms, such as bacteria, or chemical pollutants, such as pesticides or industrial solvents. Whatever your reason for buying a home water treatment unit, you first should consider two points: if you use public drinking water that meets national/state standards, home treatment seldom is needed for health protection; and no single unit will solve all varieties of water problems. Before you buy a water treatment unit, have your water analyzed. A water analysis will help identify bacteria, minerals, or other pollutants that are present.

Interpretation of the test results will help you determine whether the water needs to be treated and, if so, the type of treatment needed. The intended use of the water (whether for drinking, laundry, or all household uses) will also help determine the extent of treatment required. Do not assume that installation of water treatment equipment similar to that of your neighbors will be the answer to improving your household water quality. Different water supply sources, amounts and types of household uses, and many other variables affect the selection of the proper water treatment system. Common water quality problems and suggested corrective procedures are described in the following table.

Problem	Typical Corrective Procedures
Fine sand, clay, other particles	Remove using a mechanical filter
Bacterial contamination	Remove the source of contamination or treat using chlorination or other forms of disinfection
Hydrogen sulfide gas (rotten egg odor)	Remove using chlorination and a sedimentation filter or an oxidizing filter followed by activated carbon filter
Odor and taste problems other than rotten egg odor	Remove using activated carbon filter
Suspended iron and manganese particles	Remove using a mechanical filter
Small amounts of dissolved iron	Remove using a water softener
Higher amounts of dissolved iron and manganese	Remove using a potassium permanganate regenerated oxidizing filter
Very high amounts of dissolved iron	Remove using a chlorinator followed by a mechanical filter
Hardness	Treat using a water softener
Acidity	Treat using a neutralizing filter
Volatile organic chemicals, trihalomethanes, certain pesticides and radon	Remove using an activated carbon filter
Heavy metals (lead, mercury, arsenic, cadmium)	Remove using reverse osmosis unit or a distiller
High total dissolved solids, sodium, sulfates, nitrates	Remove using reverse osmosis unit or a distiller

AVAILABLE WATER TREATMENT SYSTEMS

After you have decided that you want additional treatment for your home water supply, you need to select a unit that is technically suited to the problem. Included below are descriptions of common types of water treatment units with explanations of how the units work as well as information on limitations and maintenance.

ACTIVATED CARBON AND MECHANICAL FILTERS

Activated carbon filters (also called carbon filters) treat general taste and odor problems, including chlorine residue. When water flows through carbon filters, contaminants adsorb or stick to the surfaces of the carbon particles. Activated carbon filters are reported to be the best method available for removing specific organic chemicals, including some pesticide residues. Studies have also shown that GAC (granular activated carbon) adsorption is an effective method for radon removal. Mechanical filters trap, through a straining process, sand, dirt, and other suspended particles to reduce turbidity in water.

General Description

Carbon filter devices are available in several sizes and designs. Small units fit on kitchen taps and treat only 100 to 300 gallons effectively before a filter change is necessary. Large under-sink units, often called in-line filters, are designed to treat up to 1500 gallons. On such a unit the canister is connected to the cold water line. Other styles are available that treat all household water. An extra filter cartridge or canister is often included with the initial purchase. Check on availability of filters and cost of replacement filters at time of purchase; they may be available from the same dealer, at plumbing supply stores, or by mail order. Design greatly influences efficiency. Variations include use of powdered carbon or blocks of carbon instead of granular carbon. Those filters containing more carbon will usually treat more water before replacement is necessary. Mechanical filters are frequently combined with activated carbon filters. Small mechanical filters, using spun cellulose, attach to a tap or can be installed under a sink.

Filters to treat all the water supplied to the house may use sand or gravel.

Limitations

Activated carbon filters do not remove nitrate, bacteria, or metals. Concerns about the growth of harmful bacteria in these filters has been raised in the past. However, recent research by the U.S. Environmental Protection Agency indicates that the types of bacteria found in water samples obtained from this type of filter create no health hazard if the filter is properly maintained. As a precaution, however, activated carbon filters are recommended for use only on microbiologically safe water.

Maintenance

Setting up a regular maintenance schedule for filter replacement is necessary, because there is no easy method for detecting that a filter is no longer working effectively. The frequency of filter cleaning or replacement depends largely on the level of pollutants in the water supply and the quantity of water flowing through the filter. A mechanical filter may become clogged if not cleaned or replaced periodically, resulting in loss of water pressure and a reduction in flow. Filters using sand or gravel require automatic or manual backwashing to remove trapped particles.

WATER SOFTENERS

Water softeners remove the hardness minerals calcium and magnesium. Water exceeding 121 milligrams per liter or 7 to 8 grains per gallon hardness may interfere with the cleaning action of soaps and detergents, and cause scale buildup in hot water pipes, water heaters, and plumbing fixtures.

General Description

The most common way to soften household water is to use a cation exchange water softener. A synthetic resin with a strong attraction for calcium, magnesium, and other positively charged metal ions (cations) is first saturated with sodium cations from a salt (sodium chloride) solution. As the water passes through the resin, the sodium exchanges with calcium and magnesium. Softeners are automatic, semiautomatic, or manual depending on the system

for regeneration of the resin. Each type is available in several sizes and is rated on the amount of hardness it can remove before regeneration is necessary.

Limitations

Individuals on a sodium-restricted diet should consult a physician before using softened water. A possible solution is to have drinking and cooking water lines bypass the water softener. Water softening units also remove small amounts of iron. However, using a softener to remove iron in naturally soft water is not advised. Refer to the iron filter section of this publication.

Maintenance

When the resin is filled to capacity with calcium and magnesium, it must be recharged. Fully automatic softeners regenerate on a preset schedule and return to service automatically. Regeneration is usually started by a time clock, although some units start regeneration by water-use meters or hardness detectors. Semiautomatic softeners have automatic controls for everything except for the start of regeneration. Manual units require manual operation of one or more valves to control backwashing, brining, and rinsing. In many areas, there are companies that provide a water softening service. For a monthly fee the company installs a softener unit and replaces it periodically with a freshly charged unit. The replacement schedule depends on the water hardness and the amount of water used.

IRON REMOVAL EQUIPMENT

Iron filters remove iron and manganese that can cause staining of clothes and plumbing fixtures. Ferric iron usually appears as rust colored particles floating or settling in the water. Ferrous iron is in the dissolved form and cannot be seen in water. When water containing ferrous iron is exposed to air, the iron oxidizes and ferric iron is formed. Water with a high iron or manganese content is not considered a health problem, but can be very objectionable in taste, odor, or appearance if iron is present in amounts greater than 0.3 milligrams per liter or manganese is present in amounts greater than 0.05 milligrams per liter. Iron bacteria are nuisance

organisms often associated with soluble iron in water. Because they cause a slime buildup, they can be quite objectionable with iron concentrations as low as 0.1 milligrams per liter ferrous (soluble) iron. The presence of iron bacteria is indicated by a gelatinous slime on the inside wall of the toilet flush tank and gelatinous 'rusty slugs' being discharged at the tap. High dosages (200 to 500 milligrams per liter) of chlorine (known as shock chlorination or disinfection) are required to control iron bacteria. Shock chlorination must include the well and pumping system.

General Description and Maintenance

Five types of iron-removal equipment are available:

Iron Filter. Iron filters are only useful for removal of ferrous (soluble) iron and manganese; ferric iron will plug them. They look like water softeners but contain a bed of natural or synthetic manganese green sand. Manganese dioxide oxidizes iron and manganese and the oxidized particles are then filtered out in the lower part of the bed.

The filter bed must be backwashed frequently to remove the accumulation of iron particles. For backwashing, a flow rate more than double the normal service flow rate is usually required. The exhausted manganese must be recharged by adding potassium permanganate. Acid water below a pH of 6.8 will pick up manganese from the green sand and cause loss of oxygen-exchange capacity. Therefore, neutralization treatment may be necessary. Also, the slime produced by iron bacteria will clog the filter.

Water Softener. Water softeners contain a zeolite mineral in the resin that will remove soluble iron on an ion-exchange basis (the same way calcium and magnesium are removed in water softening). Depending on the kind of zeolite used and the regeneration process, up to 5 milligrams per liter of soluble iron can be removed. The slime produced by iron bacteria will clog the zeolite and reduce its effectiveness.

Polyphosphate Feeder. These units can handle up to 3 milligrams per liter of iron in solution. They contain a phosphate compound which coats the soluble iron and prevents its oxidation when the

water is exposed to air. The compound is not effective against ferric iron that has already oxidized.

Polyphosphate is only effective in cold water. Heating the water will release the iron so that oxidized iron accumulates in the water heater. The heated water will be rusty and unsatisfactory for home use.

Chlorinator and Filter. Chlorination followed by filtration through a sand filter can remove any quantity of iron in any form. The chlorine oxidizes and precipitates the iron and the filter strains out the particles. Carbon filtration maybe required to remove excess chlorine residue.

This method also destroys iron bacteria. When the bacteria cannot be permanently eliminated by shock chlorination, continuous chlorination is required.

Aerator and Filter. An alternative to chlorination for iron removal is that of aeration followed by filtration. An aerator introduces oxygen into the water, thereby causing ferrous iron to precipitate through oxidation. Aeration equipment for household use has become more available in recent years.

Limitations

Iron removal from your water supply can involve complex choices. Careful planning is needed when iron removal equipment is used in conjunction with other water treatment equipment. The type of iron removal equipment chosen depends on the type and quantity of iron in the water, the characteristics of the water supply, other water treatment equipment in use, and the user's requirements for cost, ease of use, and maintenance.

NEUTRALIZERS

This system treats corrosive (acidic) water by increasing alkalinity, resulting in a pH near 7.0. Reducing corrosivity may also lower the concentration of harmful metals, such as copper and lead, that may be dissolved from pipe walls and fittings.

General Description

Passing the water through granular calcite (marble, calcium carbonate, or lime) is the most common method of home treatment. A mix of calcite and

magnesium oxide also is used. If the water is very acidic or if a high flow rate is needed, a system to chemically feed soda ash, sodium carbonate, or caustic soda (sodium hydroxide) may be necessary.

Limitations and Maintenance

Neutralizers using soda or sodium compounds increase the sodium content of water which may be a health concern. Using calcite to neutralize water increases calcium, which increases water hardness. These factors must be considered in your treatment choice. All systems require routine maintenance to replenish the chemical used to neutralize the water.

DISTILLATION UNITS

Distillation removes most impurities from water, including minerals such as nitrate, sodium, and sulfate, and many organic chemicals.

General Description

Distillation units boil water to create steam which is then condensed and collected as purified water. Most impurities remain in the heating chamber and must be periodically removed. Units vary from the kitchen countertop size to larger units.

Limitations

Removal of minerals produces water that can have a bland taste. Because a kitchen location close to point of use is preferred for smaller units, counter or cabinet space must often be given up. Also, distillers are expensive to operate. Some distillers allow contaminants with a boiling point lower than water (e.g. some pesticides and volatile solvents) to vaporize with the water and recondense with the treated water, which means they remain in the treated water. Others have a volatile gas vent that releases these products to the atmosphere.

Maintenance

Design of the unit is important because minerals and other contaminants accumulate in the boiling chamber and can interfere with the operation of the unit. Hard water can cause scaling in a distiller. Some units are easily cleaned by hand while others require washing with a strong acid.

REVERSE OSMOSIS

A reverse osmosis unit substantially reduces most suspended and dissolved matter from water.

General Description

Contaminants are removed by forcing water through a membrane having microscopic holes that allow water molecules, but not larger compounds, to pass through. Water flushes away the contaminants held by the membrane. Membranes are made of a variety of materials that differ in effectiveness for different chemicals. Be sure to study water test data and identify the chemicals to be removed.

Limitations and Maintenance

Although reverse osmosis removes many organic chemicals, it does not remove all. For instance, it will not remove chloroform. And it does not remove 100 percent of most chemicals. These units waste large amounts of water. Most units will discharge up to 50% or more of total water as waste. The membrane can develop problems from precipitate buildup and scaling. A softener must be installed ahead of the reverse osmosis unit if hard water is used. Otherwise, the minerals will quickly plug the membrane filter. Frequently, mechanical and/or activated carbon filters are installed before the reverse osmosis unit to remove turbidity and improve taste and odor. This can result in improved overall water quality and extend the life of the reverse osmosis membrane. The reverse osmosis membrane will need periodic replacement according to the manufacturer's recommended schedule. Occasional cleaning and flushing of the whole reverse osmosis unit may be required.

DISINFECTION METHODS

Chlorination

Both municipal systems and households can disinfect water by adding chlorine. Household systems commonly use liquid chlorine bleach injected into the water by one of several types of pumps. Chlorination does not remove nitrate or other chemicals, but may oxidize organics and some minerals such as iron. Chlorine metering pumps must be calibrated and maintained carefully. Using a carbon filter after chlorination will remove any excess chlorine and chlorine-based chemicals that may form.

Other Methods

Other methods of disinfecting water include boiling, distilling, pasteurizing, treating with ultraviolet light, and treating with ozone. Chlorination, distillation, or boiling for 15 minutes are the usual methods used to purify water for household use. Disinfection by ozonation or ultraviolet light methods are replacing chlorination in some water treatment plants, and are becoming more popular for home use. Some filtration units with silver-coated activated charcoal blocks are being sold for removal or killing of bacteria. Before purchasing such a unit, evaluate it carefully and check for sufficient test data and certification to assure its effectiveness.

HOUSEHOLD WATER TREATMENT SYSTEMS

When single water quality problems are identified, one water treatment device may be adequate. In many cases, however, more than one problem is present, requiring a combination of water treatment devices. A household treatment system should take into account the most practical and effective device to treat each problem, the order these devices should be placed in the system, and the intended use of the water - for drinking, laundry, or all household uses.

SPECIFIC SELECTION OPTIONS TO CONSIDER

In addition to buying a treatment unit that is technically suited to address your water problem, you may wish to take time to comparison shop for costs; cancellation and refund policies; installation methods; and warranties.

Installation. Home water treatment units are installed in different ways. Some units, installed under the kitchen sink, treat all cold water going into the tap. Other units only treat water diverted from the cold water line and deliver it to a separate faucet. Some units are mounted on the faucet, while others rest on the counter top. Be sure to ask your salesperson which method of installation is required for your water treatment unit and who is responsible for the installation. If the unit must be installed by a professional, ask whether the cost of installation is included in the purchase price.

Warranty. Take time to carefully read warranties which accompany the unit. What parts and costs are covered? If you have problems, can you get a replacement or a refund? Also, ask where repairs can be done. If the unit needs to be repaired by the manufacturer, how long do repairs usually take and who pays the shipping charges.

PROTECT YOURSELF FROM DECEPTIVE SALES PRACTICES

Although most sellers of water treatment units are legitimate, some are unscrupulous. As part of their sales pitches, some dealers may falsely claim that the drinking water in your area contains a harmful level of chemical contaminants, such as chlorine or lead. Although certain communities may experience various levels of water contamination, your particular community may not. Always verify the dealer's claims about your drinking water with your local or state department of health before purchasing any product. Some dealers also may claim that certain government agencies require or recommend widespread use of water filters in homes or restaurants, or that the government approves a particular unit. This is not true. If you see an EPA registration number on a product label, it merely means that the manufacturer has registered its product with the EPA. A registration number does not mean that the EPA has tested or approved the product or substantiated the manufacturer's claims. Some sellers advertise in the local media, offering a free in-home test of your drinking water if you call. Although in-home testing may be a legitimate sales tool, some promoters use unsophisticated tests to convince you of the need to purchase their product. For example, they may test only for acidity/alkalinity, water hardness, iron, manganese, and color. None of these indicate the presence of harmful contaminants. Others may test only for chlorine, which, although present in your drinking water, may not be at harmful levels. Be aware that water filters sometimes are sold as part of prize promotions, which may not be legitimate. Some companies send out postcards saying that you have been selected to receive a prize, and, to receive further details, instruct you to call a telephone number, usually toll-free. If you call, you may discover that you must purchase a water treatment unit to be eligible for a prize, which may be of little or no value. Sometimes sellers will request your credit card

number, saying they need to verify your eligibility for a prize or to bill your account. Be cautious about giving your credit card number over the telephone to someone you do not know. Many consumers who have purchased water treatment units from telephone salespersons have found later that the units do not remove contaminants from the water and that they cannot cancel their orders or return the products to obtain refunds. If you are considering purchasing a water treatment device from a manufacturer unfamiliar to you, contact your state consumer affairs office or your local Better Business Bureau to learn if it has received any complaints against the company. In addition, you can contact the National Sanitation Foundation, which operates a voluntary certification program for water treatment products. Although this organization cannot rate or recommend a particular brand of water treatment unit, it may be able to provide you with useful information about various water treatment devices and technologies. The address of the National Sanitation Foundation is provided with those of other resources listed below.

FOR FURTHER INFORMATION

For information about the quality of your drinking water, you should contact your local water department or your county or state public health agencies. For additional information about water quality or treatment, see the organizations listed below.

For background on federal regulation of drinking water, contact:

* The United States Environmental Protection Agency
Office of Drinking Water
Washington, DC 20460
Safe Drinking Water Hotline
1-800-426-4791 (National Toll Free), or
202-382-5533 (Washington, DC area)

For more information on specific water treatment devices, write or call:

* The National Sanitation Foundation
3475 Plymouth Road
Post Office Box 1468
Ann Arbor, Michigan 48106
313-769-8010

* The Water Quality Association
4151 Naperville Road
Lisle, Illinois 60532
312-369-1600

For information about bottled water, contact:

* Food and Drug Administration
United States Department of Health and
Human Services
5600 Fishers Lane
Rockville, Maryland 20857
301-443-4166

* International Bottled Water Association
113 North Henry Street
Alexandria, Virginia 60532
703-683-5213

To resolve problems concerning a water treatment unit, first try settling your dispute with the company that sold you the product. If you are not satisfied, contact the state consumer protection agency or state Attorney General.

* SC Department of Consumer Affairs
P.O. Box 5757
Columbia, SC 29250
1-800-922-1594
803-734-9458

You also can contact your local Better Business Bureau (BBB). To find the BBB office nearest you, check your telephone directory, or write:

* The Council of Better Business Bureaus
4200 Wilson Boulevard, Suite 800
Arlington, Virginia 22203

To report a complaint about possible sales misrepresentations, write to:

* The Federal Trade Commission
Division of Marketing Practices
Washington, DC 20580

Although the FTC cannot intervene in individual disputes, it is interested in learning about home water treatment sales practices you believe to be deceptive.

HELPFUL TERMS TO KNOW

ACIDITY - A condition of water when the pH is below 7. See pH.

ALKALINITY - A condition of water when the pH is above 7. See pH.

BACKWASHING - The process of reversing the flow of water to restore or clean a filter.

FLOW RATE - The quantity of water available or needed, commonly measured in gallons per minute, per hour, or per day.

HARDNESS MINERALS - Minerals dissolved in water that increase the scaling properties and decrease cleansing action - usually calcium and magnesium.

ION EXCHANGE - Process whereby one mineral is substituted for another.

NEUTRALITY - A condition of water when the pH is at 7 (neither acid or alkaline). See pH.

OXIDATION - Causes the impurities to precipitate, and this reduces water impurities, such as iron, manganese, hydrogen sulfide, and many organics.

PEAK USE RATE - The flow rate necessary to meet the expected maximum water demand in the system.

pH - A measure of the acidity or alkalinity of water. Below 7 is acid, above 7 is alkaline.

REGENERATION - Process which restores the ion-exchange material (zeolite or resin beads) to usable condition.

SHOCK CHLORINATION - Using high dosages of chlorine (200 to 500 milligrams per liter).

SOFTENING - The process of removing hardness caused by calcium and magnesium minerals.

QUICK REFERENCE TO COMMON WATER TREATMENT DEVICES

Device	Primary Use	Limitations
Carbon Filter	Removes chlorine, some organic chemicals, resin, general taste and odor problems	Does not remove nitrate, bacteria, or metals. Periodic replacement of activated charcoal required
Mechanical Filter	Removes sand, dirt, and causes of turbidity	Requires regular cartridge replacement or backwashing (depending on type) to maintain effectiveness
Water Softener	Replaces water hardness minerals (calcium, magnesium) with sodium	Removes calcium and magnesium with sodium (consult physician if sodium in diet is a health concern)
	Improves cleaning action of soaps, detergent	Softened water can be more corrosive than unsoftened water
	Prevents scale deposits in pipes, equipment	Periodic backwashing and regeneration required
Iron Filter	Removes iron and manganese that can cause staining of clothes and plumbing fixtures	Periodic backwashing, addition of potassium permanganate required (frequency dependent on water usage, iron content)
	Prevents odor caused by iron, manganese	
Neutralizer	Treats corrosive or acidic water	May increase sodium or alter water hardness