SERVICE IN ACTION

Drinking water treatment devices: filters

Joann Hallaway[1]/

No. 9.728

COLORADO STATE UNIVERSITY EXTENSION SERVICE

Quick Facts

Three major types of water treatment devices are available-filters, distillers and softeners.
Three kinds of filtering devices are available-those using carbon filters, fiber filters and reverse osmosis.
Carbon filtering devices include faucet mounts, pour-through, specialty, line by-pass and stationary.
Fiber filters contain spun cellulose or rayon to trap suspended sediment.
Reverse osmosis units use a membrane that separates water from impurities.

Concern about drinking water quality intensified in the early 1970s. Media accounts told of trace elements slipping through filters in municipal water treatment plants. Reports indicated toxic wastes had seeped into some wells. This concern prompted Congress to pass the Safe Drinking Water Act in 1974. The act mandated standards-maximum contaminant levels (MCL)-for inorganic chemicals; for example, arsenic, barium, chromium, coliform bacteria, nitrate and 12 secondary contaminants.

Secondary contaminants include foaming agents, chlorine, iron, manganese, odors and total dissolved solids. These substances in small quantities can impart a disagreeable odor and taste to water. One group of these contaminants, trihalomethanes (THMs)-chloroform for example have been found to be cancer-causing in some laboratory tests on rats. THMs are formed when the humic acid in organic matter reacts with chlorine used for disinfecting drinking water. This reaction occurs when the chlorine is added before the sedimentation stage in the water treatment process.

The Safe Drinking Water Act was amended in 1979 to require community water systems serving 10,000 or more persons to analyze for THMs when a disinfectant (chlorine) is added to the water. THMs are more likely to occur in areas using surface water because of the higher possibility of organic matter being found in surface water supplies than in deep ground wells. Approximately 55,000 of the 61,000 public water facilities in the United States meet the standards mandated by the Safe Drinking Water Act and administered by the Environmental Protection Agency. Home treatment of water provided by these systems should not be needed unless the water 1) is hard, 2) has disagreeable odors and/or tastes, or 3) has other minerals not removed to a satisfactory level by the water treatment. For persons concerned about the quality of drinking water or who dislike the way some water tastes or smells, a variety of water treatment devices are available.

Three major types of water treatment devices are available: filters, distillers and softeners. Filtering devices are discussed below. Distillers are discussed in Service in Action Sheet no. 9.729.

Filtering Devices

Three kinds of filtering devices are available. Carbon filters are found most frequently. The second kind uses fiber filters. The third and most expensive is a reverse osmosis unit.

Carbon filters. Carbon filtering devices use activated carbon (cartridges) that have a porous surface to absorb a variety of substances, including THMs, odors and disagreeable tastes. A filter's effectiveness depends on the amount of carbon in the unit and how long the water stays in the unit. The longer the water is in contact with the filter medium, the more time the carbon has to remove impurities. Those packed with a large volume of charcoal generally remove more organic material at the beginning of the cartridge life; performance decreases less rapidly over time than it does for those containers with a small amount of charcoal.

Five types of carbon-filtering devices include (See Table 1):

- faucet mount (Figures 1 and 3)
- pour-through, portable (Figure 2),

[1]/ Joann Hallaway, CSU associate professor, equipment and energy (11/1/83)

Table 1: Water filtering devices using activated carbon.

Type	Options	Installation'	Uses[2]	Price Range[3] Unit	Replacement
Faucet mount	"Remote" filter on counter Filter at faucet head (self contained) By-pass valve	To faucet head from which aerator has been removed	Removes odor. bad taste, some THMs and other chemicals	$20-$190	$4-$50 or more
Portable (pour through)	Pump Single or multi-layered filters Size of holding tank	If powered, to a 12 or 115 volt line No plumbing	Removes odor, bad taste, some THMs, chlorine in filter or if some bacteria if oxygen is bubbled through water	$10-$275	$2+
Specialty		In cold water line to refrigerator, standard ice maker, humidifier or water heater	Removes sediment, odor, bad taste	$12-$90 (Replace unit) $12-$16+	
Line by-pass	Two locations	In water line near where water enters house To cold water line with a pipe leading to a separate faucet at kitchen sink Shut off valve	Removes odor, bad taste, some THMs and other chemicals, sediment	$35-$150 or more	$8-$30
Stationary (under sink)	One or more cartridges By-pass faucet kit for some models Icemaker line	In cold water line under sink Adequate space for unit and around it to change filters	Removes odor, bad taste some THMs and other chemicals	$25-$400	$7.50-$40 or more

'A licensed plumber may be required for installation of some line by-pass and stationary devices.
[2]Results of tests on 31 filters by Gulf South Research Institute for EPA indicated the line by-pass models were the most effective group among those tested in removing THMs, harmless organic matter and other non-purgable organic carbons.
[3]Price differences reflect differences in size; cost of installation is included in price of some stationary units.

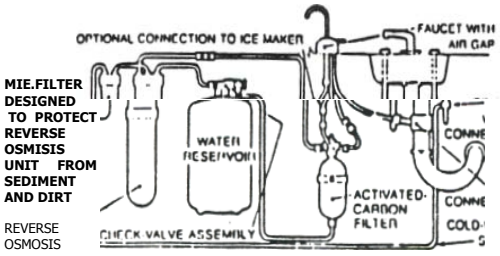

Figure 8: Installation of reverse osmosis unit.

Kind of contaminants to be removed. Water as it comes from the tap is not "pure" water. Water can form solutions with many substances. Undissolved substances remain suspended in the water. Impurities give water its distinctive taste, but impurities can include contaminants that can impart disagreeable tastes and odors to water and be harmful as well.

Before making the decision to purchase a water-filtering device, the water should be analyzed for impurities that affect health. The local health department (usually located at the county seat) or a private water-testing laboratory can perform these tests. Charges are based on the number and kind of tests performed. If taste, odor and THMs are the major contaminants, a device with a carbon filter could remove much of the objectionable odor and/or taste. Some carbon filter units remove more than 50 percent of the THMs. If sediment is present in high levels, a fiber filter may be needed. If a large number of impurities (excluding bacteria) or undesirable contaminants are present, a reverse osmosis unit may be the best type of filtering unit to purchase, although cost of these units and space needed for installation may preclude purchasing.

Location. Two choices are in-line (faucet mounted, line by-pass, stationary) or portables. In-line units vary in complexity of installation from removing an aerator in a faucet and attaching the filtering device to adding branch lines and valves for the accessories for reverse osmosis units. Some line by-pass and stationary models may require installation by a licensed plumber. The reverse osmosis units should be installed by a plumber.

- specialty, such as refrigerator ice maker filters and scale filters for water heaters and humidifiers (Figure 4),
- line by-pass (Figure 5), and
- stationary (Figure 6).

Faucet-mounted filters are attached to a faucet after the aerator is removed. These come in two basic designs. One has a by-pass valve that permits filtering only the water that is to be used for cooking and drinking. The second design has no by-pass valve; all water flowing through the faucet is filtered. Some models are placed on a counter and have a hose running from the faucet to a charcoal filter. They are not permanently attached to a faucet.

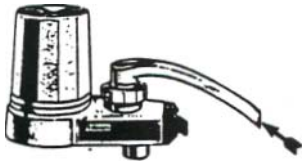

Figure 1: Faucet mount filter.

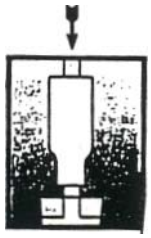

Figure 2: Pour-through filter.

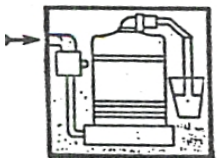

Figure 3: Faucet by-pass filter

Pour-through (portable) filters freshen water on recreational vehicles, boats or at campsite, if one starts with water suitable for drinking (potable water). (See Figure 2.) This type, if not powered, is the simplest of all filters. Water, poured through the filter, flows into a container. A few models are powered and operate on 115-volt current; others operate on a 12-volt line or battery. Powered units increase rate of filtration. Some of those operating on a 12-volt battery can filter up to 1¼ gallons (4.7 liters) in two minutes.

Specialty-type filtering devices such as icemaker and scale filters are placed on the cold water supply line to appliances. Icemaker filters are attached to the cold water supply line to refrigerators or standard ice makers. Scale filters are connected to the supply line to water heaters or humidifiers. A line by-pass filter may be installed in one of two locations. The first location is beneath the sink where it is attached to a line leading to a faucet at the kitchen sink (see Figure 7). The second location is in the water line after it enters the

Figure 4:Refrigerator icemaker filter.

The latter requires installation of a valve in the water line ahead of the filter in order for the water that is drawn from the regular faucet to be shut off.

A stationary water filter is installed in the cold water line under the sink. (See Figure 6.) All cold water flowing through the pipe to the kitchen is filtered.

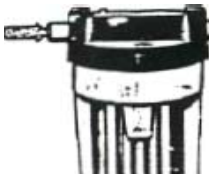

Figure 6: Stationary

Figure 5: Line by-pass filter.

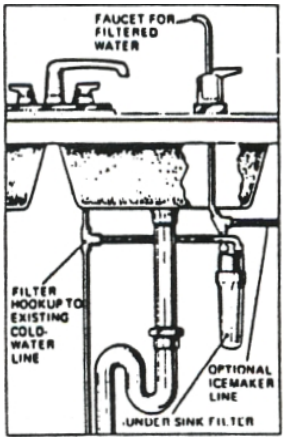

Figure 7: Line by-pass arrangement.

Fiber filters. Fiber filters designed to take out turbidity (suspended sediment) contain spun cellulose or rayon. The tightly wrapped fibers form a cylinder around a tubular opening. Line pressure forces water through the wrappings to the inner opening that leads to the faucet. The fibers trap silt. Filtered water passes to the opening that leads to the faucet.

Reverse osmosis units. Unlike other types of devices that reduce impurities in the water, reverse osmosis removes water from the impurities. It does this by forcing water through a specially constructed, semi-permeable, nonporous synthetic (usually cellulose acetate) membrane that separates soluble and suspended particles from the water. The process removes a wide variety of substances from the water. More than 75 percent of such minerals as sodium, calcium and chloride may be removed from the water. Reverse osmosis also may be effective in removing fluoride, nitrate and some forms arsenic. The membranes may last a year. Effective membrane life depends on quality of water entering the unit.

Reverse osmosis units are expensive because of the number of accessories needed to operate them. (See Figure 8.) Installation is in-line. A pre-filter is needed to remove dirt and sediment. If a backflush system is employed to prevent a buildup of contaminants on the membrane, the purchase price is increased.

Space available. In-line devices vary in space needed. Faucet-mounted units require clearance for the unit above the sink or space on a counter. Under-sink mounted units require clearance space for the unit, branch lines and valves that may not be available if a large disposer is installed under the sink. The reverse osmosis units require space for the prefilter, the units, a water reservoir, valves and additional line connections. One square foot ($.3m^2$) or less space (area and clearance) is needed for portable units.

Maintenance. All except a few models of filtering units require replacement of the filtering medium. Except for specialty devices, the frequency of cartridge replacement is lower for the larger, more expensive units than for the smaller units. Effective life of the filtering medium varies with amount of water filtered and quantity of impurities in the water. Some of the higher priced units contain a back-washing system that manufacturers claim eliminates the need for replacement cartridges. Water at 145°F (63°C) is necessary for the back-washing system to be effective.

Features. The number of cartridges in carbon filtering units varies from one in most faucet-mounted units to one or more in stationary, under the-sink units. The form and quantity of carbon used also varies. Types of carbon are granular, powder in block and powder in pad. Tests by a private testing organization indicated the powder in-a-pad type was less effective than other types. Granular is most frequently used. The cartridges in faucet-mounted units are smaller and contain less carbon than in under-the-sink units. The design of the cartridge for the under-the-sink units should force the water to travel the length of the cartridge for good filtration. Time for effective filtration varies.

Effective-use periods for the cartridges in faucet-mounted units varies from one to twelve months. The larger amounts of carbon in the under-the-sink units may effectively remove contaminants for six months to a year or longer. Depletion indicators (to replace the cartridge) for carbon are found on a few models. For most filtering units, metering the number of gallons of water treated would be more precise than the manufacturer-suggested observations of: 1) color change in the cartridge, 2) reduced water flow, or 3) return of bad taste or odor as depletion indicators. Metering is seldom practical outside of testing laboratories.

Integral or optional by-pass valves provide a means of obtaining unfiltered water for non-drinking and non-cooking uses. An optional bypass faucet kit may cost $35 or more.

Some filters also may contain silver. Manufacturers claim silver discourages growth of bacteria within the filter. The Environmental Protection Agency has concluded that silver compounds in water filters have little bacteriostatic effect. Allowing water to run through the filter for at least 30 seconds before filling a container helps to remove bacteria that may have accumulated within the filter.

Cost. Carbon filtering devices vary in price from $10 to $400 or more. For some models, cost of installation by a licensed plumber must be added to the purchase price. Replacement cartridges range in price from $3 to $50 or more. Reverse osmosis units vary in price from $300 to $900. Installation cost may be included in the purchase price.

References

[1]Environmental Protection Agency, Criteria and Standards Division, Office of Drinking Water (WH-550). "Third Phase/Update, Home Drinking Water Treatment Units Contract." March 1982.

[2]"Home Filters to 'Purify Water." Changing Times. 35:44-47, February 1981.

[3]1ngersoll, John H. "Water Filters-Should You Install One?" Popular Mechanics. 156:73-81, July 1981.

[4]Roberts, Racquel. "Make Your Water Safe to Drink." The Family Handyman. 32:30-34, November 1982.

[5]"Water Filters." Consumer Reports. 48:68-73, 102, February 1983.