

WHOLE-HOUSE WATER FILTRATION

BY BRENT EHRLICH

As Americans, we tend to take our water for granted. We turn on the faucet and out comes safe, drinkable water . . . but how safe is it? Increasing demands on our water supply by industry and agriculture, combined with dwindling water sources, are putting a strain on our nation's water supply. Even with some of the best water-quality controls in the world, as many as 7 million Americans become sick from contaminated tap water in the United States each year, according to the National Resources Defense Council. And some of these contaminants can be deadly. The parasite *Cryptosporidium* found its way through Milwaukee's municipal water system in 1993, killing more than 100 people and making 400,000 residents sick.

Milwaukee now has some of the toughest municipal water standards in the country, and disasters like that are rare, but home buyers are becoming increasingly concerned about water quality. Whether the water comes from a municipal source or a well, builders should be prepared to answer questions about a home's water quality.

Drinking water is never 100% pure. It contains minerals and gases, sediment, bacteria, and even disinfectants. Some minerals are necessary for our health, some sediment is harmless, and most bacteria won't hurt you. But there are many contaminants that are dangerous, and too much of a good thing, like disinfectant, can be harmful as well.

For municipal water, builders can find out about its quality by obtaining an Annual Water Quality Report (also known as Consumer Confidence Report) from the water utility. The report lists the following:


- The source of the water
- Any contaminants found in the water (with levels supplied as an average or range)
- The source of contaminants
- The EPA Maximum Contaminant Levels (MCLs) for potentially harmful contaminants
- Any violations of drinking-water safety rules or MCL levels and an explanation of what was done to fix the problem
- An explanation of the dangers of *Cryptosporidium*

If a house is going to use a well, ensuring safe water is critical to the sale of the home. Certified well drillers will disinfect a well with chlorine after construction to make certain the water is drinkable, but lenders may require specific water tests before they will approve a loan. After that first test, owners are responsible for the quality of their own water, and homeowners should have their wells tested every year by an accredited laboratory. (For a listing of state-certified drinking-water laboratories see Epa.gov/safewater/labs/index.html.) Tests range from around \$15 for a coliform bacteria test to around \$50 for a radon test. A thorough test for bacteria,


radon, and a range of harmful contaminants will cost around \$150. The pH and hardness of the water should be tested as well. A pH of <7 can leach copper and lead from plumbing, and hard water can damage appliances, including water filters, and should be treated. State and local water officials will be able to help determine what kind of test you need based on regional geography and local conditions such as agricultural runoff.

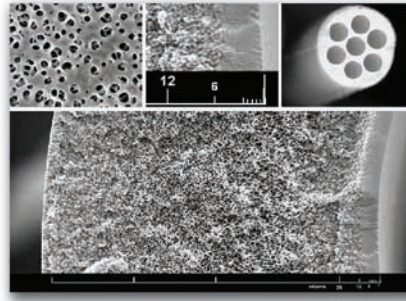
WHAT IS IN OUR WATER?

Drinking water is never 100% pure. It contains minerals and gases, sediment, bacteria, and even disinfectants. Some minerals are necessary for our health, some sediment is harmless, and most bacteria won't hurt you. But there are many contaminants that are dangerous, and too much of a good thing, like disinfectant, can be harmful as well. Water can contain everything from arsenic to radon to pesticides, so here are some common contaminants to watch out for:

 **Cryptosporidium** is a nasty parasite found in water throughout the United States, often where water has been contaminated by sewage or runoff from farms. *Cryptosporidium* survives in cyst form and is a tough bug to kill. It causes cramps, nausea, and diarrhea, and can be dangerous to those with compromised immune systems; it can cause fever and infection. Chemical disinfectants don't do a thorough job of eliminating *Cryptosporidium*

either. Boiling water for at least one minute is the most certain way to kill the bug, but reverse osmosis filters, ultraviolet disinfection, and filters that remove particles <1 micron are all effective.

 **Lead** is a toxic metal found in old paint, plumbing fixtures, and in nature. When swallowed or inhaled, lead is dangerous. It can harm infants' and children's physical and mental development, and cause kidney disease and high blood pressure in adults. While exposure to lead normally comes from ingesting paint chips and dust, the EPA estimates that up to 20% of human exposure to lead may come from drinking water. Lead does occur naturally, but municipal water systems remove most lead from the source water. The real problem occurs when the water comes in contact with old lead pipes on the way to the home from the water treatment plant or inside the home itself. Section 1417 of the Safe Drinking Water Act banned installation of lead pipes and lead solder after 1998, but older homes may still have significant lead problems. If a home has lead pipes, a test should be done on the water flowing from the tap to make certain the lead content is below 15 parts per billion (ppb) or 0.015 mg/L. When hot or acidic water runs through the plumbing, even more lead can leach out of pipes, solder, and brass, so the EPA suggests an optimum pH of 7 or higher for all incoming water, and people who know they have lead pipes should run



HF UF WATER-FILTRATION SYSTEMS USE A HOLLOW FIBER MEMBRANE THAT RESEMBLES A CROSS SECTION OF A BUNCH OF STRAWS (LEFT) TO FILTER WATER. THE HOLLOW FIBERS HAVE BILLIONS OF PORES ALONG THEIR SIDES (ABOVE). NATURAL WATER PRESSURE PUSHES WATER TO THE INSIDE OF THESE "STRAWS," LEAVING CONTAMINANTS ON THE OUTSIDE. THESE ULTRAFILTRATION MEMBRANES CAN PURIFY WATER DOWN TO ABOUT 0.05–0.02 MICRON AND WILL REMOVE MOST BACTERIA, VIRUSES, AND *CRYPTOSPORIDIUM*.

their water until cold before drinking. If lead is a problem in a home, then point-of-use (POU) filters (such as those mounted under the counter/sink) certified for lead removal should be installed. Whole-house filtration for lead may not be the ideal solution, because it tends to treat water at the point of entry, and then filtered water can become contaminated on its way to the faucet.

🌀 **Nitrate** (NO_3) is one of the main sources for nitrogen, which plants need to grow. Found in most soils, nitrate is one of the main components of fertilizer. Nitrate is not particularly dangerous to children and adults, but it can be deadly to babies less than 3 months old. Babies this age have bacteria in their intestines that change nitrate into toxic nitrite (NO_2). The nitrite then reacts with the blood to form methemoglobin, which does not carry oxygen. Babies can die from methemoglobinemia or "blue baby disease," as they are starved of oxygen. After babies turn 6 months old or so, their digestive systems develop and methemoglobinemia is no longer a concern. Nitrate is more of a problem in rural farm communities, and people in these areas need to check with their water utility for nitrate levels or have their well water tested at a certified lab. Even without children in the house, high

nitrate concentration indicates a problem with the water that could be caused by fertilizers, animal waste, or septic problems, so nitrate is often a marker for contamination by bacteria and pesticides. The EPA has put a limit of 10 mg/L for nitrate, and the National Sanitation Foundation (NSF) recommends removing it using a reverse osmosis (RO) filter.

🌀 **Turbidity** is the amount of sediment found in water. In many cases, the water's cloudiness may be no more than harmless sediment, but like nitrate, turbidity can indicate the presence of other problems, such as harmful organisms. More importantly, cloudy water can interfere with the performance of disinfectants and filters. UV light (see filter types below) is less effective when it has to cut through murky water, and sediment clogs filters, limiting their life span and hurting performance. Turbidity is measured by how much light passes through a sample of water, and is measured using nephelometric turbidity units (NTUs). Most people won't notice turbidity at <5 NTUs, but the EPA has set the standard for drinking water at 1 NTU, so if you see cloudy drinking water, have it tested.

🌀 **Chlorine** is one of the most effective disinfectants we have and has been used for years to improve the safety of

water throughout the world. Most water treatment plants use chlorine for disinfection but some are now using chloramine, a mixture of chlorine and ammonia. The EPA has set a safe limit of 4 mg/L for both chlorine and chloramine, but these disinfectants can cause problems of their own. Chlorine and chloramine react with organic matter in water and create a by-product called trihalomethane (THM). THM is a group of VOCs that include bromoform and chloroform. These VOCs become airborne during dishwashing, laundry, and showers, and in high concentrations can cause kidney and liver damage and potentially cancer. The EPA regulates THM as well, with limits that should not exceed 0.08 mg/L. While potentially dangerous, chlorine and THMs are easy to remove with the use of a whole-house carbon filter certified for chlorine and VOC removal. Chloramine, on the other hand, does not create as much THM, but it is more difficult to remove because of its added ammonia, so most carbon filters will not remove chloramine. A catalytic carbon filter will filter both chlorine and chloramine. Check with the local water utility to find out which disinfectant is used in your area. For more information on chlorine see the May 2006 issue of *Green Builder Magazine*.

SIZE OF CONTAMINANT	ST Microscope	Scanning Electron Microscope	Optical Microscope	Visible to Naked Eye			
	Ionic Range	Molecular Range	Macro Molecular Range	Micro Particle Range	Macro Particle Range		
	0.001 m	0.01 m	0.1 m	1.0 m	10 m	100 m	1,000 m
	DISSOLVED SALTS	COLLOIDS		GIARDIA CYSTS	HUMAN HAIR		
		VIRUS		SUSPENDED SOLIDS		BEACH SAND	
			BACTERIA		PIN POINT		
			PARASITES				
	REVERSE OSMOSIS (Hyperfiltration)						
	NANOFILTRATION						
	ULTRAFILTRATION						
	MICROFILTRATION						
	GRANULAR MEDIA						

DRINKING WATER IS RARELY 100% PURE. IT CAN CONTAIN MINERALS, GASES, SEDIMENT, BACTERIA, AND EVEN DISINFECTANTS. EACH DIFFERENT TYPE OF WATER FILTRATION SYSTEM OFFERS A RANGE OF COVERAGE FOR THESE CONTAMINANTS, WITH REVERSE OSMOSIS OFFERING THE MOST PROTECTION AND GRANULAR MEDIA OFFERING THE LEAST.

FILTRATION, WHO NEEDS IT?

The vast majority of municipal water is safe to drink. But is the water going to be good for you? Tanya Lubner, the Water Quality Association’s director of education notes that “there’s a difference between EPA standards and ideal levels of contaminants.” The EPA uses two ratings for contaminants: maximum contaminant level (MCL), a measure of what the EPA allows in municipal water systems due to “real world” concerns, and maximum contaminant level goal (MCLG), the ideal level. Arsenic, for instance, has an MCLG of zero, but has an accepted MCL of .01 mg/L.

So do your customers need water filtration? “It depends on your starting water quality and what you want to filter out,” says Lubner. Water filters are available that can remove nearly any contaminant, but it is impossible to find just one that removes them all. The trick is finding out what’s in your water and finding the filter(s) that will remove the most dangerous contaminants. In some rural areas, nitrate filtration and purification might be important, but in an urban setting, chlorine/chloramine and VOCs may be more of a problem. And lead should be a concern for everyone.

Make sure to have the local water tested by an independent, certified laboratory. Then, you and your customers can compare filters and purchase the most effective unit without throwing money down the drain on unnecessary filtration. Make certain to buy a filter that has been independently certified by Underwriters Laboratories (UL), National Sanitation Foundation (NSF), or Water Quality Association for the contaminant(s) you need to remove.

POINT-OF-ENTRY VERSUS POINT-OF-USE FILTERS

The two main types of water filters are whole-house, point-of-entry (POE) filters installed where water enters the house, and point-of-use (POU) filters installed near the faucet. True whole-house water filtration will require both types. POE filters can protect a home from VOCs and chlorine, which can be released during dishwashing, laundry, and showering, but POU filters cannot. POE filters can be expensive. Units start at about \$1,000 but can go as high as \$5,000 for complete filtration; replacement filters range from \$150 to \$2,500. Fortunately, these filters normally last up to 10 years. For both POE and POU fil-

ters, most systems include a prefilter that eliminates sediment or contaminants that can damage the filter. Because these filter systems need to be plumbed into the incoming water line, builders can expect to tack on another \$250 to the price for plumbing fees.

POE filters can do a thorough job of filtering out contaminants, but because lead can leach into the water from household plumbing after POE filtration, it may be necessary, especially in older homes, to filter water again before drinking. Many POU filters are certified to remove lead and many other drinking-water contaminants. These filters start at around \$50, with replacement cartridges at less than \$20. But you get what you pay for. Small filters will not last long nor do a thorough job. Larger under-counter filters—like the reverse osmosis (RO) GE Merlin or the activated carbon Everpure H-1200—will do a very thorough job removing contaminants and their filters have long lives. Most under-counter models have their own dedicated faucet and require a plumber.

Most home buyers seem to be interested in POE filtration because they provide pure water to their families, but note

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MANUFACTURED FILTER SYSTEMS

GE HOMESPRING

The Homespring is a whole-house filtration system that uses a two-stage process. The first stage uses either a steel mesh (for water not on a municipal system) to remove large particles or a granular activated carbon (GAC) filter to prefilter the water and remove unwanted taste and odors, such as chlorine. The second stage uses hollow fiber ultra-filtration (HF UF) to remove particles (0.02 micron or larger) as well as turbidity, bacteria, viruses, and cysts from the water. Because the filter does not remove all total dissolved solids (TDS), it won't change the pH of a home's water and won't leach lead and copper or damage plumbing. Homespring can deliver 11 gallons of water per minute with little change in water pressure (pressure drop) and, according to GE, is the first POE water-filtration system certified as a "microbiological water purifier" by the Water Quality Association (WQA). The system is also certified to NSF/ANSI Standard 42 (chlorine, taste, odor, and particulates) and NSF/ANSI Standard 53 (*Cryptosporidium*, *Giardia*, lead, and others) for drinking water.

Homespring can treat municipal water, untreated well water, and lake water sources, and can even provide decentralized water treatment. The units are tall (74 inches) but can be installed on their sides. Dale Puskas of GE said that installation is straightforward and that the filter "needs to be placed as close to the water meter as possible, so you don't lose pressure. And the back flush is pretty powerful, so it has to be located near a drain." Homespring needs electricity just for the timer that triggers the back flush (which cleans the filter periodically), so you will need a power source nearby. The membrane will last up to 10 years, but the GAC should be changed yearly. Cost depends on many factors so GE recommends contacting them at www.Homespring.com; 866-418-7412.



AQUACERA RS-CITY

The Aquacera RS-City is a two-canister filter/softener that combines GAC filtration with a new, salt-free water softener technology called Filtersorb SP. Traditional water softeners work by exchanging calcium and magnesium ions with sodium or potassium. These methods lead to increased salt concentrations that are carried into drinking water and into the environment. According to Aquacera, the Filtersorb SP works as a catalyst, changing magnesium and calcium carbonate into microscopic crystals that do not dissolve back into the water or attach to surfaces. For iron-heavy water, the catalyst changes the iron into particles that are trapped by the second canister, which will need to be back flushed manually to remove these particles. The system earned a Gold Seal from the WQA and is certified to NSF/ANSI-61 for drinking-water system components/health effects.

The second canister in the RS-City is made of a NSF/ANSI Standard 42-certified blend of coconut shell and bituminous GAC that reduces chlorine, chloramines, THMs, polycyclic aromatic hydrocarbons (PAHs), chloramine by-products, VOCs, and industrial chemicals for hard, city water. Aquacera delivers 10–12 gpm and is simple to install. There are two 8x44-inch canisters connected together that are plumbed directly into the incoming water, with no back-flush plumbing necessary. Additional canisters can be added to remove other contaminants. The RS-City costs about \$2,500 for the model designed for a home with up to three occupants. The carbon filter should last about 3–5 years and costs around \$150 to replace, but Aquacera is not certain how long the Filtersorb SP media will last, so replacement cost hasn't been determined. According to Aquacera, tests have shown no breakdown of the catalyst after 6 years of use, with no change in performance.

Doultonusa.com; 888-664-3336.



GE MERLIN

The GE Merlin reverse osmosis (RO) filter uses a three-stage process: a carbon block filter that reduces sediment and chlorine which can damage the RO membrane (a sediment version is available for well water), the RO membrane, and a final GAC filter. The Merlin has a larger surface area than most RO systems, so it can produce 748 gallons per day (gpd) compared with 10–50 gpd for a standard RO unit. The Merlin is normally installed under-counter, with a dedicated faucet for drinking water and drain for backwash, but it can be installed as a POE system if a tank and pump are added. The Merlin is WQA Gold Seal-listed but is for use with potable water only. It reduces arsenic, barium, cadmium, chromium, copper, fluoride, nitrate, nitrite, radium 226/228, selenium, and TDS as specified by NSF/ANSI 58. Like other RO systems, the resulting filtered water can have a pH <7 and can leach lead and copper from pipes, so if the Merlin is used as a POE, a neutralizing agent can help protect the plumbing and occupants. Most people will use the Merlin as a POU filter, which will provide clean drinking water but will not reduce THMs throughout the house. Water pressure is important for the Merlin, with a minimum water pressure of 40 psi needed for proper shutoff, but a booster pump is available if necessary. Installation takes about an hour for the under-counter model, compared with four hours for a conventional RO unit. Skilled do-it-yourselfers could probably install the unit themselves, but a plumber is recommended. The carbon filter will last about 6 months and the filters should be changed regularly. A clogged prefilter can reduce pressure and hurt the filter's performance. The RO membrane will last between 2 and 4 years. The Merlin costs about \$800, with replacement filters costing \$40 for the prefilter, \$150 for the RO filter, and \$35 for the postfilter. Gewater.com/residential/home/merlin.jsp; 866-439-8272.



AQUACORE AC-11

Aquacore AC-11 uses hollow fiber ultrafiltration (HF UF) to filter out particulates as small as .02 micron, effectively removing bacteria, cysts, viruses, and turbidity (meets NSF/ANSI Standards 42

and 53). The filter does not remove TDSs, so the filtered water will not become acidic, damage plumbing, or leach lead and copper, but it will not remove contaminants like chlorine. The membrane is made up of a network of hollow fibers, each with multibore fiber that has seven capillaries, which Aquacore claims makes them stronger and more efficient than single-bore models. Aquacore can produce 10 gallons per minute with little pressure drop, but it will need to be back flushed regularly and uses about two gallons a day for this. The flushing cleans the unit and prolongs the filter's life and is controlled by electronics that automatically determine when to flush and how much water to use. It will even flush the system if it has been inactive. A prefilter that removes particles <50 microns should be added.

Installation should be as close to the water meter or pressure tank as possible and plumbed close to a drain because of the high-pressure back flush. Cost is about \$3,500 for the AC-11 with replacement filters at about \$2,600, but these advanced membranes are capable of filtering over a million gallons of municipal water, according to Aquacore. Aquacore.com; 888-657-7788.



AQUASANA RHINO EQ-300 AND EQ-300-85

The Aquasana Rhino EQ-300 is made for municipal water systems and uses a four-stage filter system: a 5 micron prefilter removes larger particles; a KDF membrane filters out chlorine, mercury, and some biological contaminants; a bituminous GAC further reduces chlorine; and a fine-particle coconut carbon finishes off the filtration. The end result is removal of >90% of VOCs and synthetic organic compounds (SOCs) as well as chlorine. The EQ-300 is UL-rated for removal of MTBE (a toxic additive to gasoline), lindane, and atrazine. The EQ-300 filters water at 7–8 gallons per minute, so there is very little pressure drop; however, if you are building a home larger than 3,200 square feet, then an additional filter is needed to maintain water pressure.

The EQ-300-85 is Aquasana's filter for well water and uses KDF-85 that removes a higher concentration of iron, most commonly found in wells, along with hydrogen sulfide. The system reduces pesticides and herbicides as well but will not filter out biological contaminants. The unit is 47 x 11 inches and has to be installed vertically and out of direct sunlight. The unit costs about \$1,000 and the main filter should last 3 years before replacement. The carbon prefilter should be replaced twice a year or more, as water quality demands. Replacement cost for the main filter is about \$600 and about \$5 for the prefilter. Aquasana.com; 866-237-4658.



Jack Barkeir

EVEN WITH SOME OF THE BEST WATER-QUALITY CONTROLS IN THE WORLD, AS MANY AS 7 MILLION AMERICANS BECOME SICK FROM CONTAMINATED TAP WATER EACH YEAR. TODAY, A NUMBER OF WHOLE-HOUSE AND POINT-OF-USE WATER-FILTRATION SYSTEMS LIKE THE ONE SHOWN HERE CAN OFFER CLEAN WATER, AT A PRICE.

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that filtration makes appliances last longer, too. Many whole-house filters remove iron and calcium and reduce the buildup of scale and minerals on critical parts of appliances. The money spent up front on a water filter could be partially recouped by increasing the life span of appliances, from ice machines to dishwashers.

TYPES OF FILTERS

⊙ **Carbon.** Activated carbon is the most common and least expensive filter media. Made from bituminous coal, wood, or coconut shells (the most popular type for water treatment), carbon is “activated” through the use of steam or other means to create a porous surface with a slight electrical charge that attracts contaminants by absorption. Activated carbon is so porous that one teaspoonful has the surface area the

size of a football field. Because of this large surface area, the longer the water stays in contact with the carbon, the better the filtration. Activated carbon performs well when removing VOCs, chlorine/THMs, and even radon, but it does not filter arsenic, some toxic metals, or nitrate. Carbon filters will not remove biological contaminants either. Plus, mold can even grow on these filters if they are not maintained properly or changed when recommended.

The two main types of carbon filters are carbon block and granular activated carbon (GAC). Water flows more slowly through carbon block, so it tends to do a more thorough filtering job. GAC that is not in block form works very well, but channels can form through the media and compromise the filtering ability. Some carbon-block filters can remove particles as small as 0.5 micron, making them effective at filtering out *Cryptosporidium*, but most GAC are not recommended for biological contaminants.

Never run hot water through a GAC. Hot water releases trapped contaminants, making the water coming out of the filter more polluted than the water entering it. This is not much of a problem for POE systems located on cold water lines, but it can be for POU filters such as pitchers or faucet-mounted models. GAC is relatively inexpensive, and minerals that our bodies need are not trapped by the filter. But the filter normally has to be replaced every 6–9 months, and durability depends on water clarity.

⊙ **Kinetic Degradation Fluxion (KDF).** KDF water filters use copper-zinc granules attached to a mesh that allows water to flow through. These filters use a chemical reaction called redox (oxidation/reduction) that exchanges particles with contaminants, converting them into harmless by-products. For instance, chlorine is changed into chloride. KDF can remove chlorine, lead, hydrogen sulfide, and even bacteria (but not cysts), and KDF is certified for drinking water by the NSF Standard 61. KDF is added to

many filters and is even mixed in with GAC to extend the life of the filter by removing chlorine and improving heavy metal removal. KDF comes in two forms: KDF 55 removes or reduces chlorine, heavy metals, and bacteria; KDF 85 removes or reduces iron, hydrogen sulfide, and bacteria. While nearly maintenance free, KDF filters need to be replaced every 8-12 months and can be damaged by high sediment levels.

tank for the water, a drain for wastewater, and a separate water faucet (due to "aggressive" water). Because the flow rate of whole-house RO systems can be as low as a gallon per minute, you might need a pump to fill the tank and another pump to pump water throughout the home. There will be electricity costs for these pumps as well, and RO systems can waste up to 75% of the water going through the filter. That quantity of water can be tough on septic systems and the

Cryptosporidium. HF UF systems generate about 10 gallons per minute without the use of electricity, but they do need to be backwashed to clean the membrane unit. Unlike RO systems that waste large amounts of water, HF UF filters are about 97% efficient. HF UF models are good performers but they do not filter out total dissolved solids (TDS), so contaminants can remain in the water. Plus they can be expensive, ranging from \$2,500 to \$5,000.

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☉ **Reverse Osmosis.** Reverse osmosis (RO) filters offer very complete water filtration. The membrane used in RO has remarkably small pores (.0005 micron), so purified water is allowed to pass through the filter while contaminants are left behind. A water pressure of about 45 psi is necessary to push the water through the filter. RO filters are particularly good at removing total dissolved solids (TDS). So, RO filters remove salts, metals, lead, nitrate, and asbestos, but even these RO filters need backups. They do not effectively filter radon, and their membranes can be damaged by sediment and chlorine. RO systems normally use a prefilter and a GAC filter, and if there are high levels of biological contaminants in the water, an ultraviolet (UV) purification system should be considered. Hard water can also damage the RO membrane, so it may be necessary to install a water softener if you are building in an area with high calcium or magnesium.

Most RO systems are under-counter models, but whole-house and under-sink units consist of a prefilter, filter, a storage

environment. A POE RO unit can end up costing well over \$5,000, whereas POU ROs will come in under \$800.

POE RO units are good at filtering out salts, but they cannot remove dissolved carbon dioxide. This can result in acidic, "aggressive" water with a pH that can drop as low as 5 (well below the EPA recommended pH of 7). This can strip copper and lead from a home's plumbing. While this may not be a problem for POU models, POE RO filters should add a neutralizer to keep the water's pH in the nonacidic range.

☉ **Hollow Fiber Ultrafiltration (HF UF).** HF UF systems use a hollow fiber membrane that resembles a cross section of a bunch of straws. The hollow fibers have billions of pores along their sides. A home's water pressure pushes filtered water through to the inside of these "straws" and leaves contaminants on the outside. There is little drop in water pressure during this process, so no holding tank is necessary. These ultrafiltration membranes are used to purify water down to about 0.05-0.02 micron and will remove most bacteria, viruses, and

☉ **Ultraviolet (UV) Light.** UV light is not a filter and cannot remove particulates. Instead, it is an effective water purification method. Using an intense UV light from low-pressure mercury vapor lamps located inside a protective sleeve, these purifiers destroy 99% of bacteria, viruses, molds, and cysts as water passes by. UV is typically combined with other filters to remove VOCs, heavy metal, or other contaminants. These units require a prefilter because particles in the water can block the UV rays and make the purification less effective. UV lights are relatively maintenance free, but the bulb should be replaced every year and the sleeve cleaned a few times a year.

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