

Water Treatment Basics

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Water treatment Overview

- Physical treatment
 - Filtration
 - Reverse Osmosis
 - Adsorption
 - Heating
 - Ultraviolet light
- Chemical treatment
 - Involves adding a solid liquid or gas to alter water chemistry
 - Chlorination, ozonation, water softeners, acid neutralizing filters,
- Point of use (POU) – single faucet
- Point of entry (POE) – whole house

Virginia
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REVISED 1999



Housing

PUBLICATION 356-481

Household Water Treatment

by: Kathleen Parrott, Blake Ross, and Janice Woodard*

Foul taste, smell, or color of your household water may prompt you to investigate water treatment equipment. The publicity about water pollution problems may cause you to question the safety of your water supply. Or mineral scale buildup may cause you to invest in early replacement of plumbing fixtures and water-using appliances.

Before you attempt a quick and possibly costly or ineffective remedy, take a first important step: 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.

Keep in mind that no single water treatment device treats all problems, and that all devices have limitations. Common water quality problems and suggested corrective procedures are described in the table on page 2.

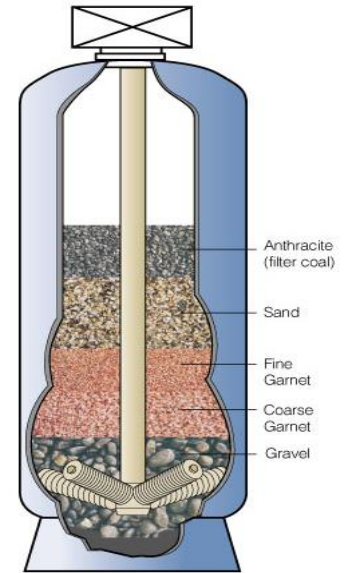
carbon filters, contaminants adsorb or stick to the surfaces of the carbon particles. Activated carbon filters are reported to be the best method available for removing specific organic chemicals, including some pesticide residues. Studies have also shown that GAC (granular activated carbon) adsorption is an effective method for radon removal.

Mechanical filters trap, through a straining process, sand, soil, and other suspended particles in water. Mechanical filters reduce turbidity in water.

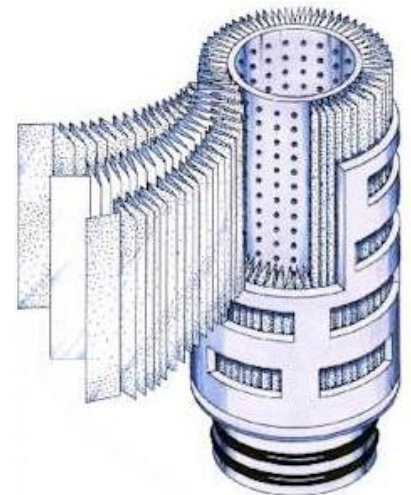


Filtration

- Several types of filters
- Used for a variety of constituents
 - Suspended solids (sediment) most common
 - Can remove particulate iron and manganese (can see particles or imparts color to water)
- **MUST** match filter to target constituent(s) and integrate with other treatment components



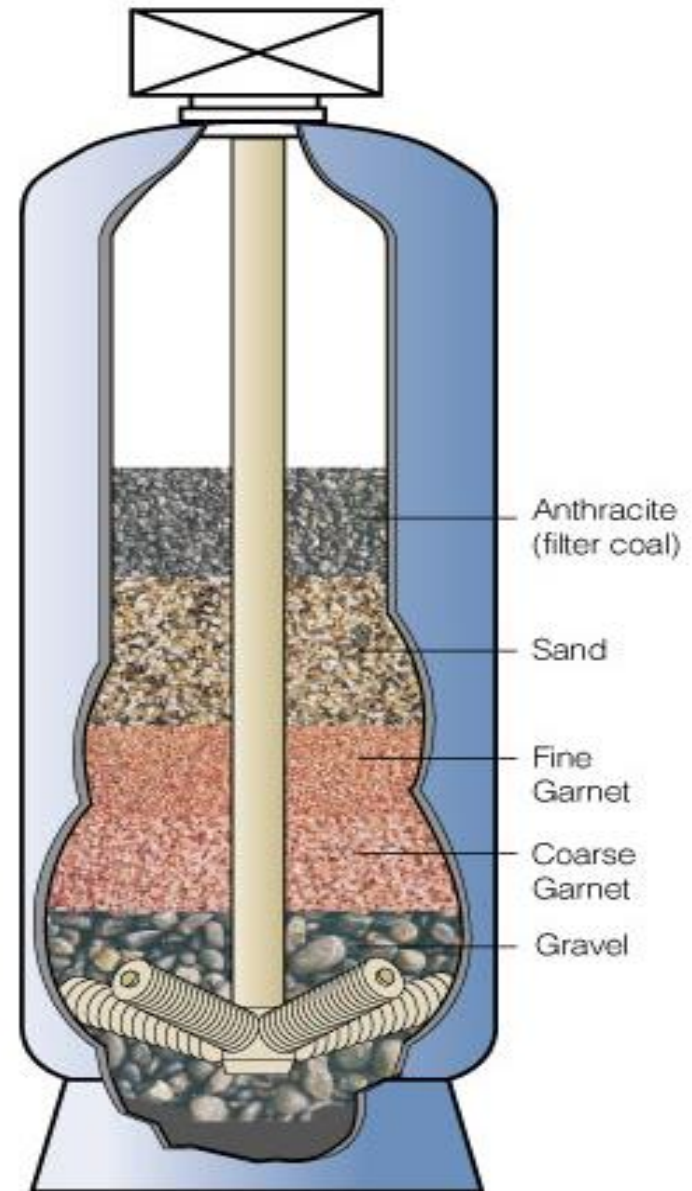
Media filter



Pleated Cartridge Filter

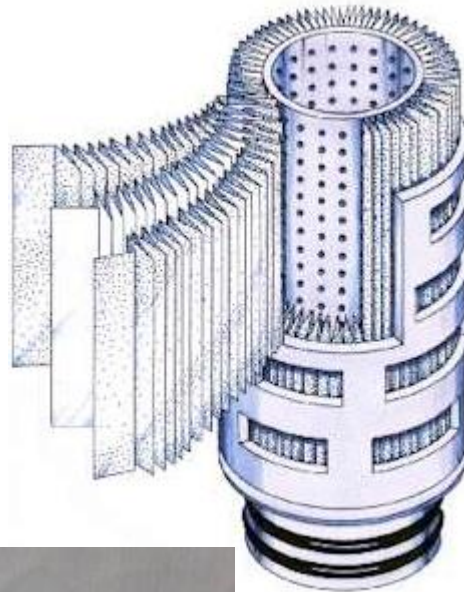
Filters: Media

- Removes suspended solids
- Often used as prefilter when constituents in raw water will harm or reduce effectiveness of other treatment devices
- “Media” can be variety of materials
- Sizing based on pore size and flow rate
- Maintenance involves periodic backwashing
- POE



Filters: Cartridge

- Primarily for suspended solids
- Sized by pore opening and flow rate
- Maintenance involves periodically replacing cartridges
- POU or POE



Pleated

<http://www.filtersfast.com/ProdImages/rs6-lg.jpg>

http://www.viledon-filter.co.uk/p/liquid/Cartridge_Filter_s40.jpg



Cartridge Filter Housing, Filter, Wrench

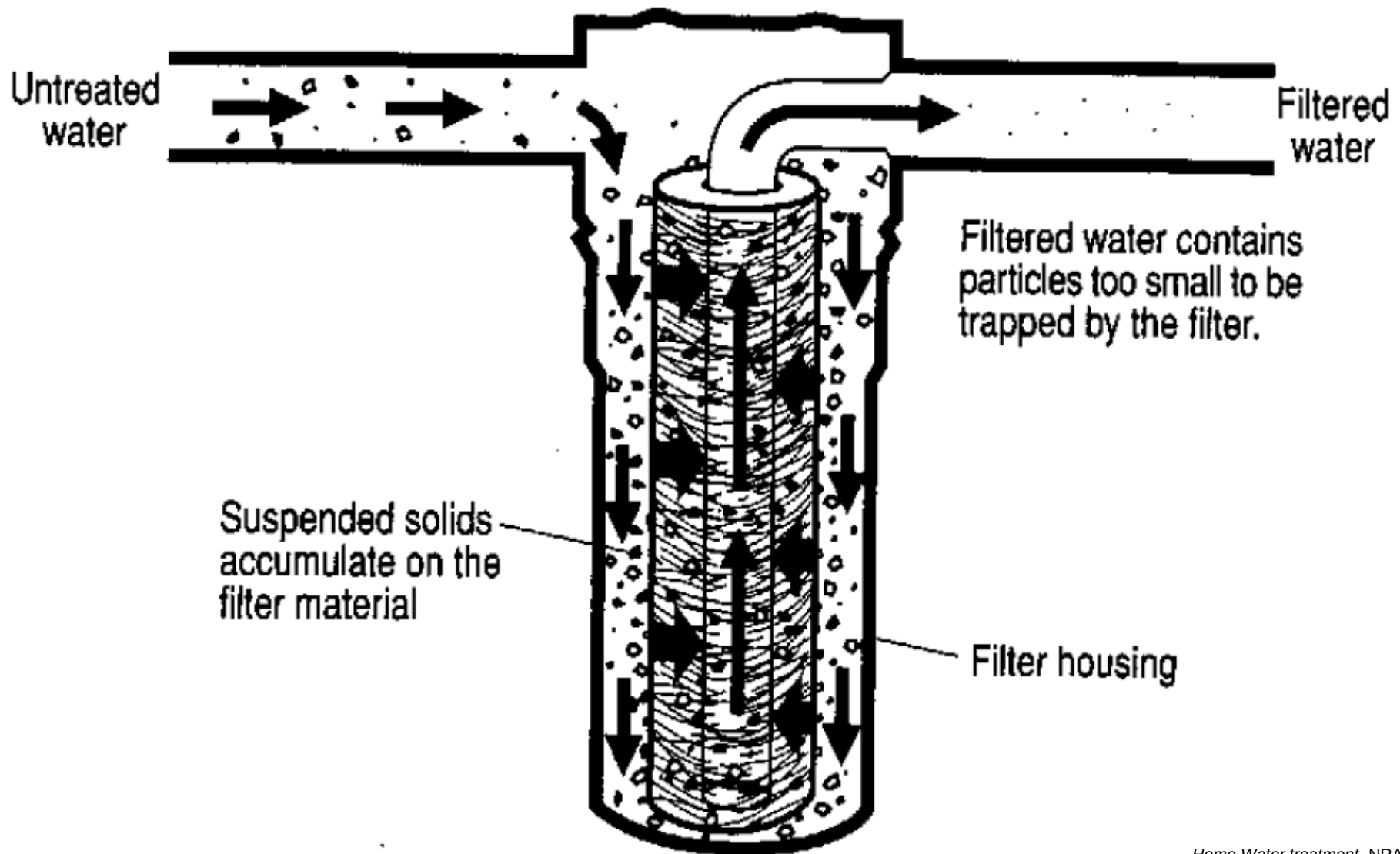
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“Spun or Wound”

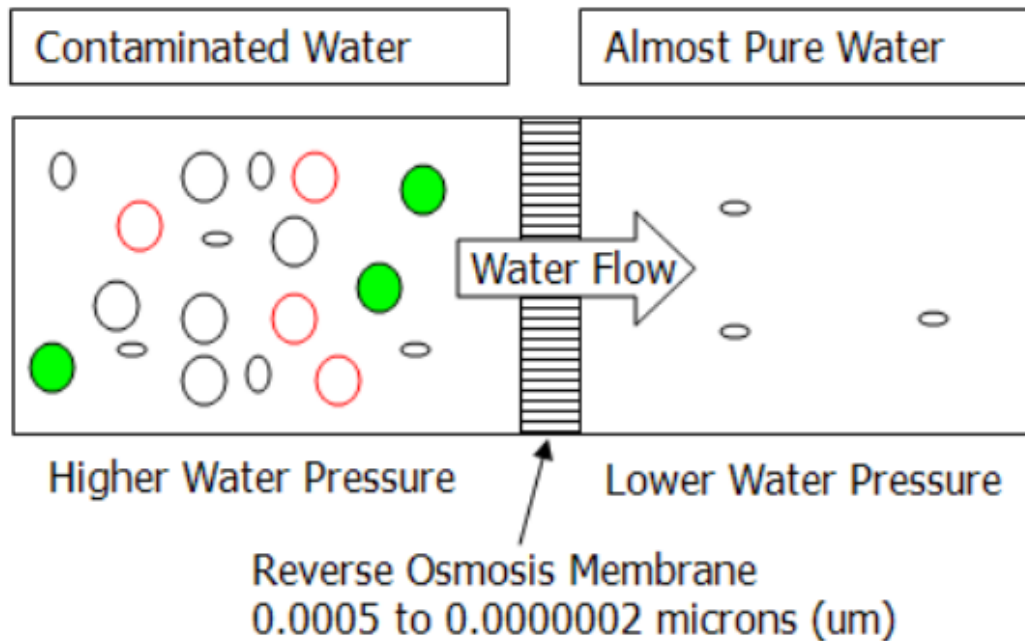
<http://www.bestfilters.com/images/ProductImages/bfsf5020425.jpg>

Filters: Cartridge Filter Schematic



Reverse Osmosis – RO

- Effective for a variety of contaminants
- Analogous to a filter
- Relies on pressure to force water thru a membrane
- POU

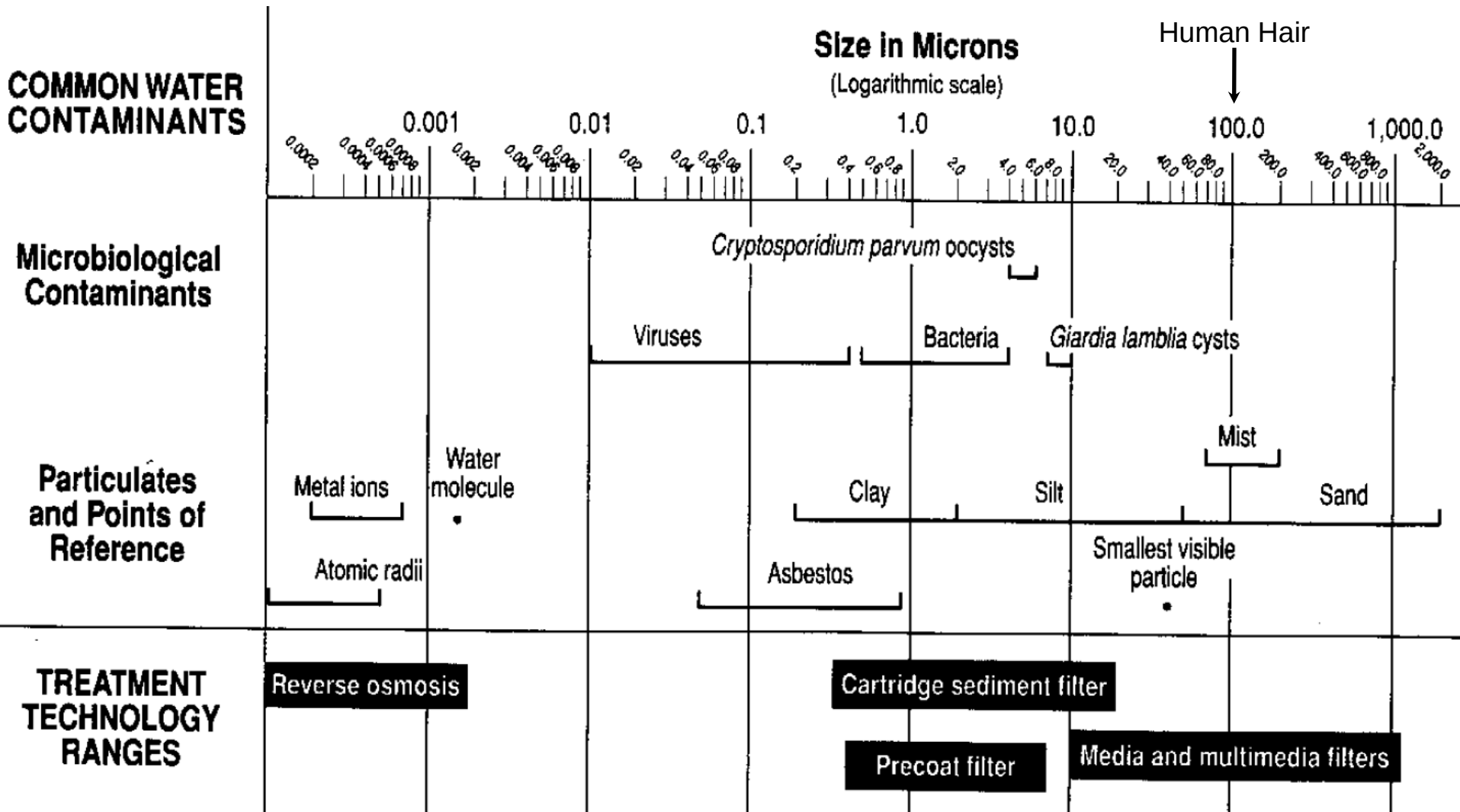


<http://www.reverseosmosiscanada.com/>



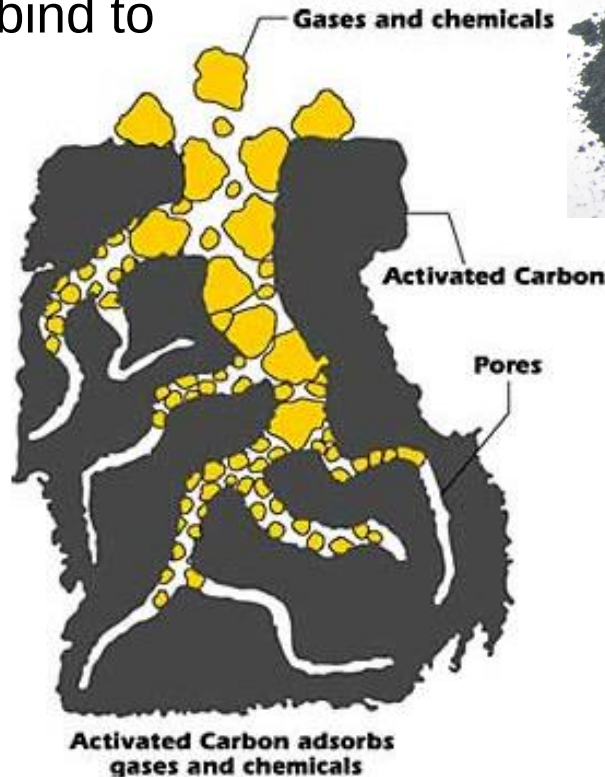
http://www.water-right.com/residential/reverse_osmosis/eclipse/eclipse.html

Filtration Size Spectrum

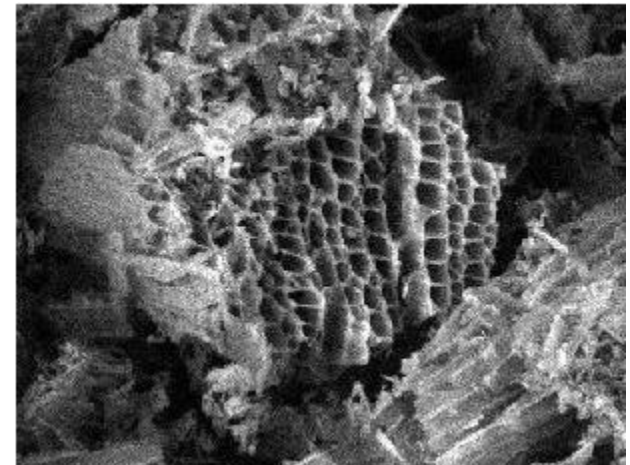


Filters: Activated Carbon

- Adsorption – contaminant binds to carbon
- Honeycomb-like structure provides enormous area for contaminants to bind to
- Effectiveness declines over time
- Granular carbon most common in home treatment uses
- POU



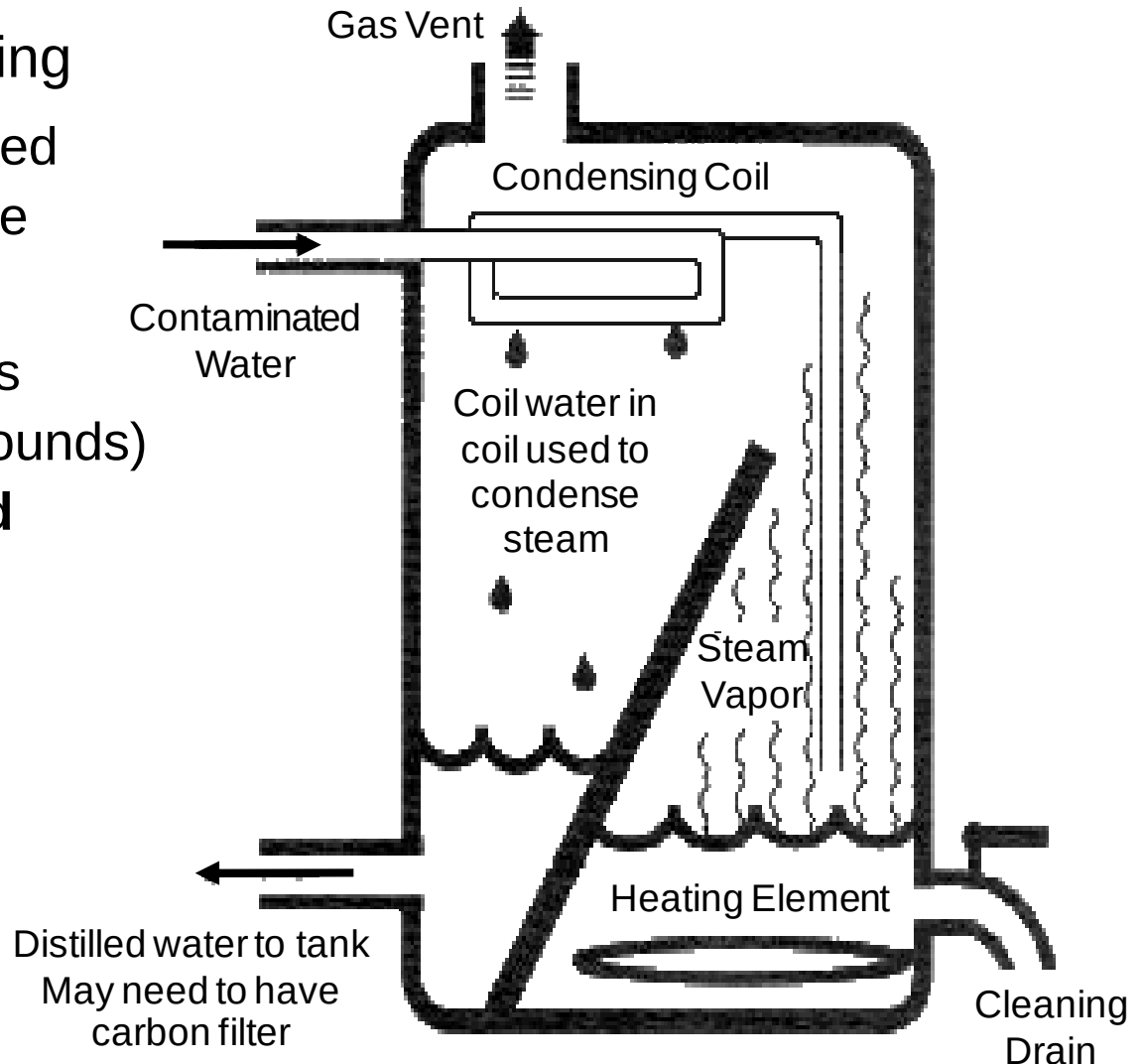
[tp://upload.wikimedia.org/wikipedia/commons/2/2d/Activated_Carbon.jpg](http://upload.wikimedia.org/wikipedia/commons/2/2d/Activated_Carbon.jpg)



www.cee.vt.edu/ewr/environmental/teach/wtprimer/carbon/cccoal1.jpg

Heating – Distillation

- Boiling and condensing
- Removes most dissolved constituents and can be effective for bacteria
- Low boiling point VOCs (volatile organic compounds) **may NOT be removed**
- Limited capacity
- POU

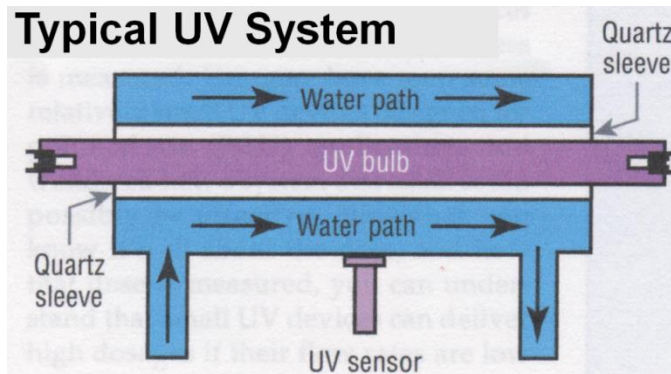


Bacteria Treatment Options

- Remove source of contamination.
May not be possible with springs and cisterns, some wells.
- If treatment required...
 - Both physical and chemical options available
 - UV radiation, chlorination, ozonation
 - Typically POE



Sanitary Well Cap



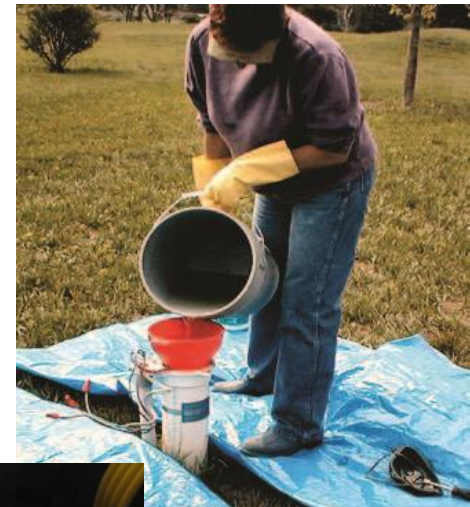
Chlorine Injection

Bacteria – Shock Chlorination

- Involves adding chlorine to the well/spring box/cistern
- Not a long-term solution – does not address **source**
- Should be done anytime well is “opened”
- Must know volume of water to be treated

THE SHOCK CHLORINATION PROCESS

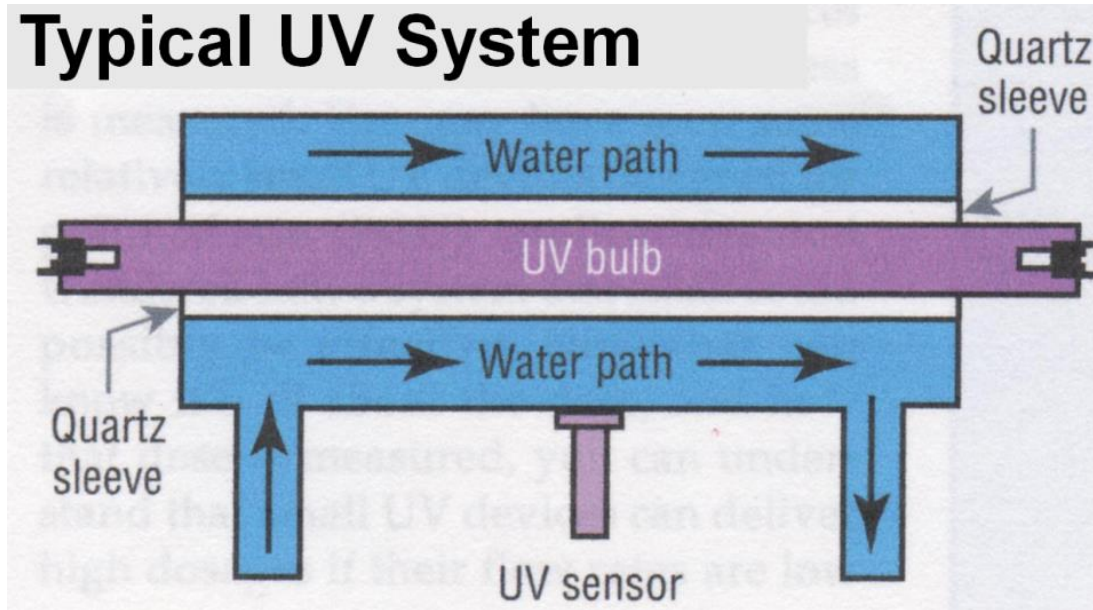
1. CLEAN AND OPEN WELL CASING
2. CALCULATE, MIX AND POUR
3. CIRCULATE
4. CLOSE AND LET STAND
5. FLUSH
6. RETEST



Bacteria – Ultraviolet systems (UV)

- Disrupts bacteria/pathogen “life cycle”

Typical UV System



Advantages

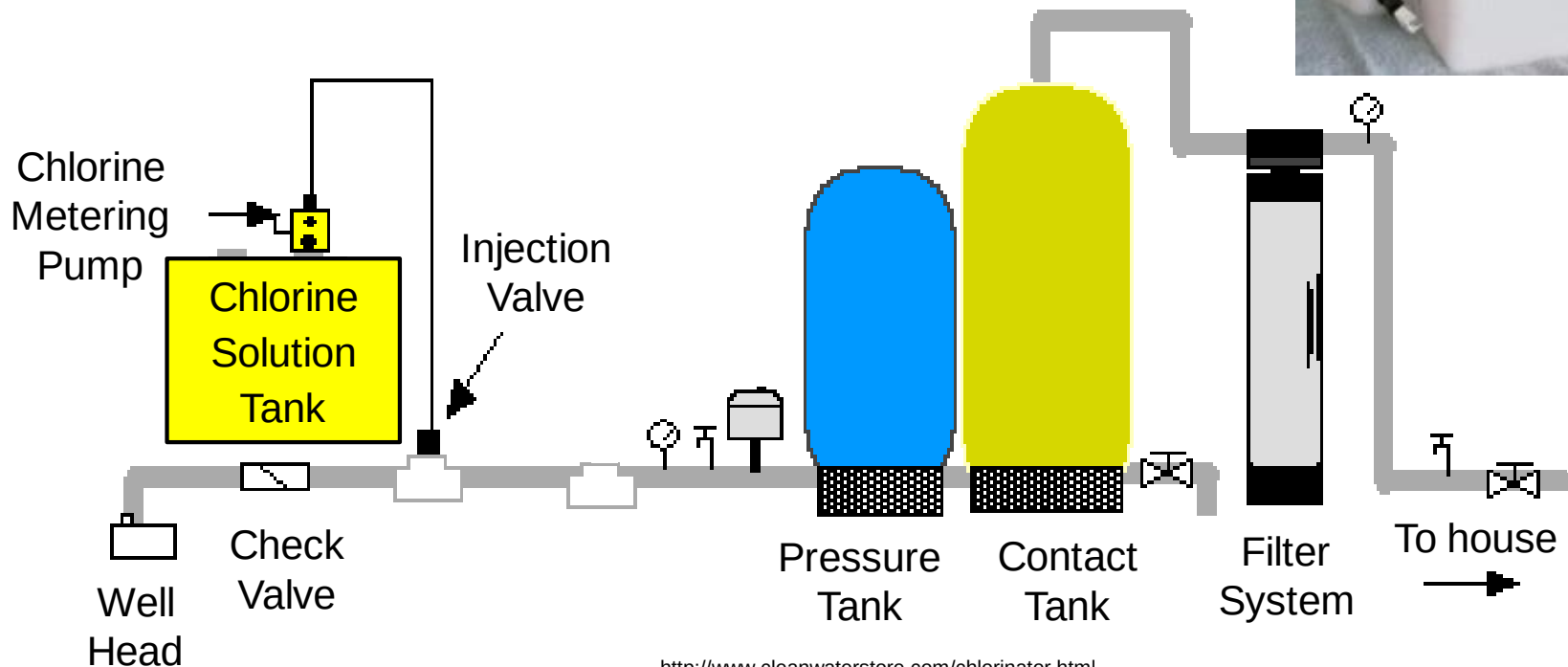
- Automatic
- Low contact time
- Low cost to operate
- More effective than chlorine
- Compact and easy to maintain
- No taste or odor

Disadvantages

- Not effective in turbid (cloudy, muddy water)
- Bulb housing can become coated, lessening light penetration
- Bulbs wear out
- No way to test effectiveness (i.e., can't test for residual chlorine levels)

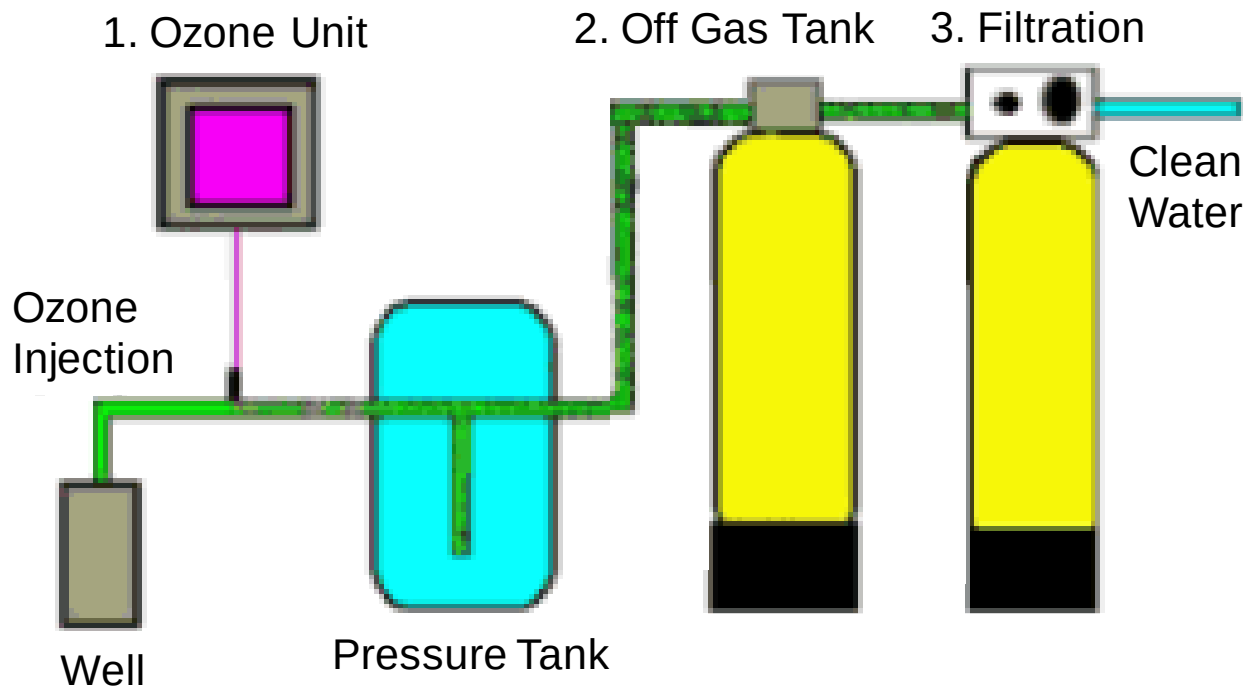
Bacteria – Chlorine Injection

- Continuous disinfection
- Requires “contact” time
- High maintenance
- POE



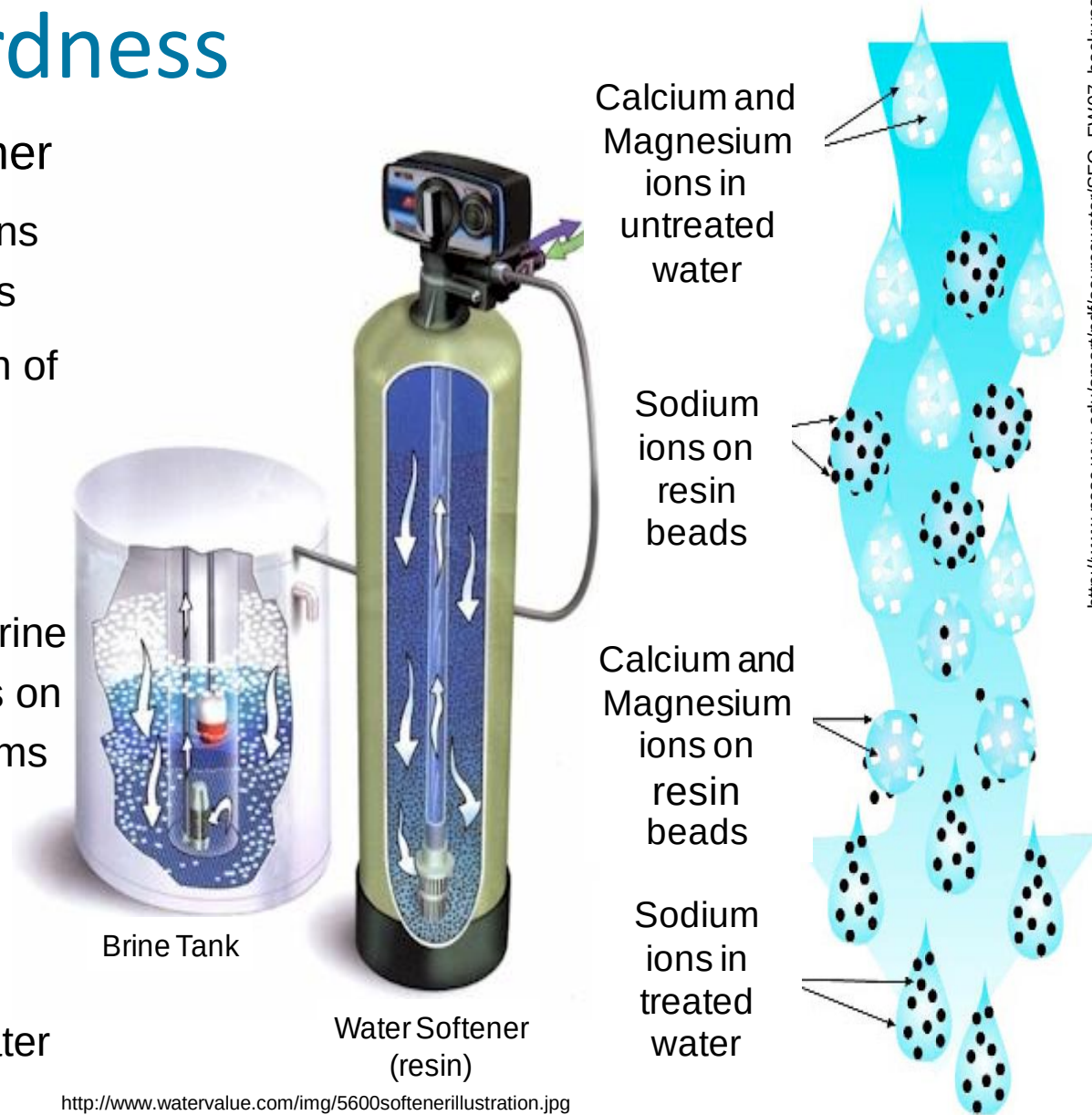
Bacteria – Ozonation

- Inject O_3 – powerful oxidant
- Treat bacteria and dissolved Fe, Mn
- POE



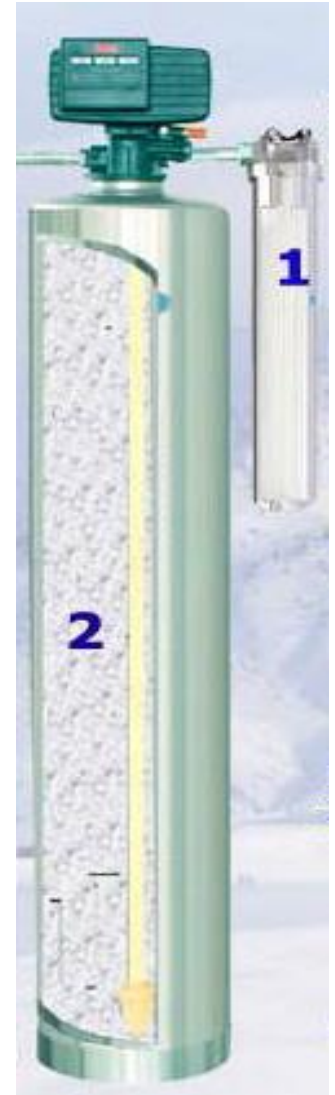
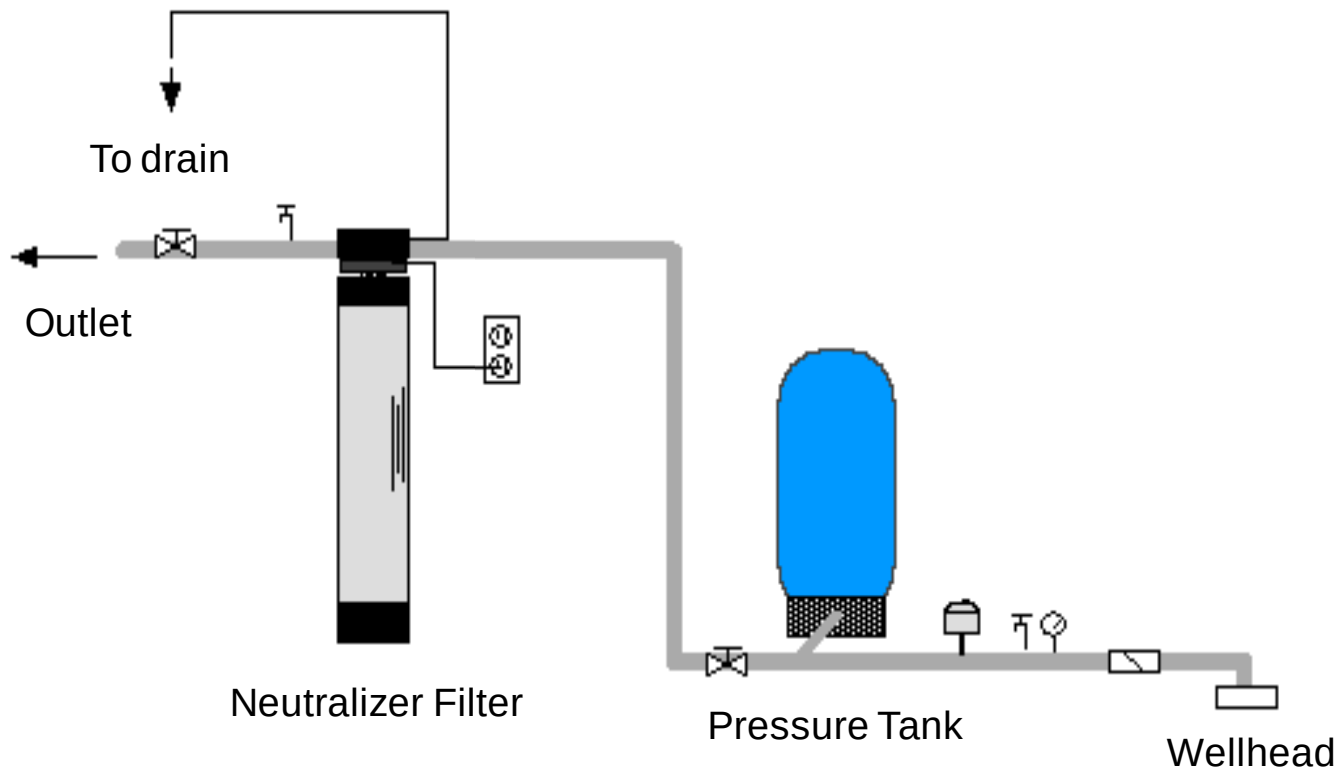
Removing Hardness

- Ion exchange water softener
 - Calcium and magnesium ions exchanged with sodium ions
 - Increases salt concentration of treated water
 - Recharge cycle should be based on usage **NOT** time
 - Discharge and dispose of brine properly – differing opinions on discharging to septic systems
 - Components
 - Resin tank
 - Brine tank (recharge resin)
 - POE – can by pass cold water

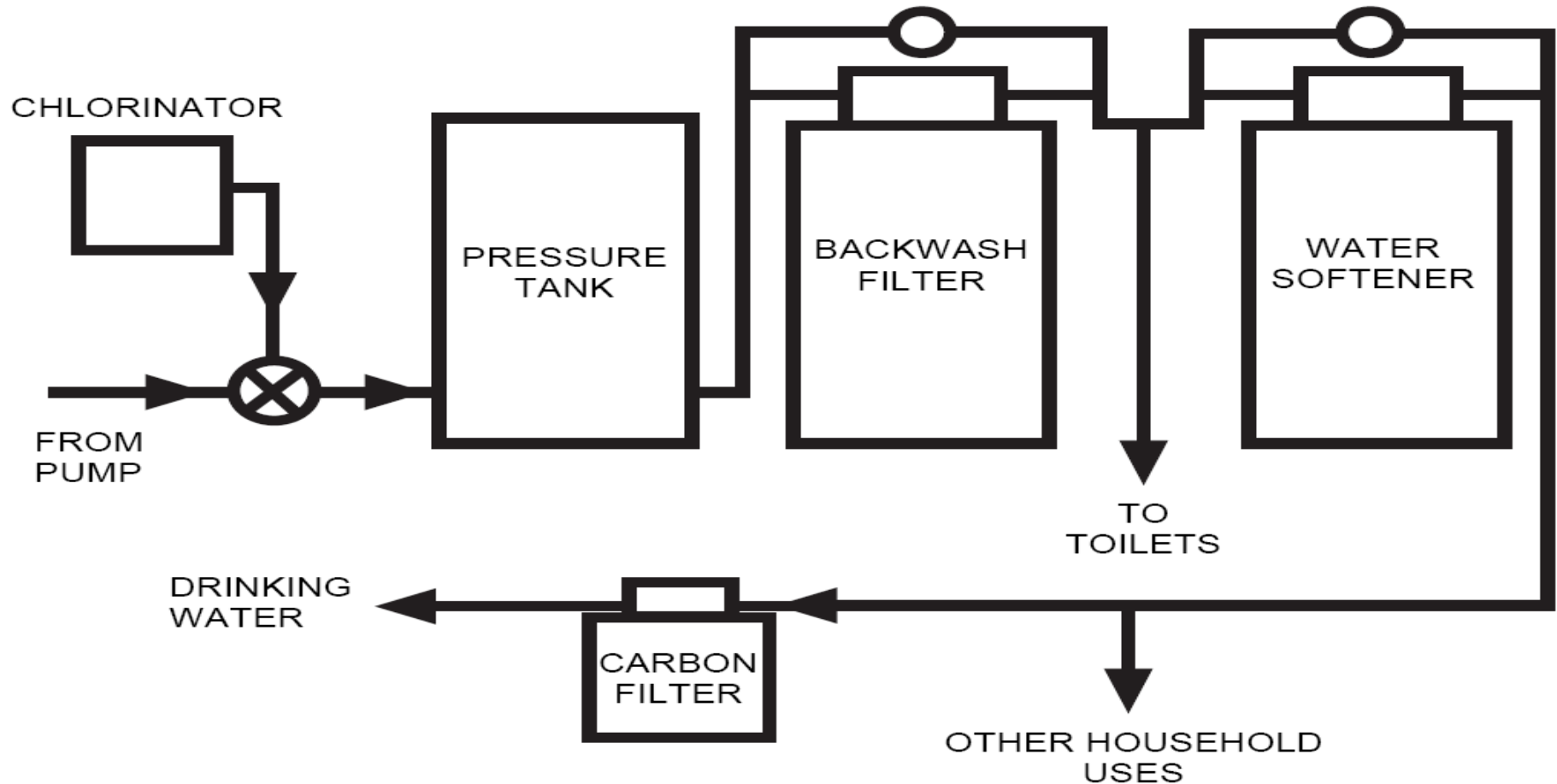


Raising pH: Acid Neutralizing 'Filter'

- Uses calcite or calcite/magnesium oxide mixture depending on pH
- POE
- Increases hardness



Treatment systems can be complex



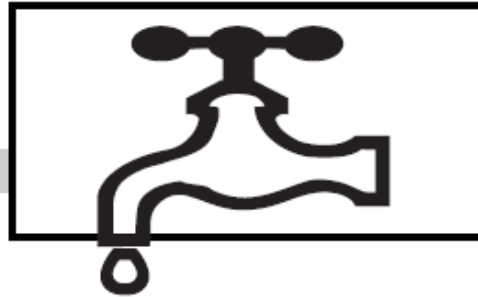
Example – Removing dissolved iron:

Chlorination to oxidize iron, filtering to remove oxidized iron, softening for hardness, carbon filter to remove chlorine residual

Resource

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Housing

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HOUSEHOLD WATER QUALITY

Home Water Quality Problems—Causes and Treatments

*Blake Ross, Kathleen Parrott, and Janice Woodard**

Many areas have water containing impurities from natural or artificial sources. These impurities may cause health problems, damage equipment or plumbing, or make the water undesirable due to taste, odor, appearance or staining. Water-related problems will be found primarily in homes serviced by a private water supply, although occasionally, they will be found in water from municipal water supplies. Those impurities which cause health problems should be attended to immediately; other problems caused by water impurities can be corrected if they are a nuisance. Before beginning any treatment plan, have water tested by an independent laboratory to determine the specific impurities and level of contamination. This will help you select the most effective and economical treatment method.

SYMPTOMS

Intestinal disorders.

Water may or may not have “off” taste or odor.

PROBABLE CAUSES

Contamination due to surface runoff containing fertilizer, pesticides, or manure. Unprotected plumbing cross connections. Sewage infiltration.

SUGGESTED TREATMENTS

Disinfect water supply with strong chlorine solution and install automatic chlorinator if appropriate. Install check valves or other protection at cross connections and maintain air gaps between faucets and any possible source of contamination

Home Water Quality Problems – Causes and Treatments: 356-482

SYMPTOM

Reddish-brown stains in sinks, toilets, tubs, dishwashers, and dishes. Reddish-brown stains or yellowing of laundry, especially after using chlorine bleach. Water tastes metallic. Brown sediment in standing water. (See also *reddish slime*.)

Corroding water pipes. Water dripping from corroded iron or galvanized pipe has a rusty color. Corroded copper or brass pipes cause blue-green stains on plumbing fixtures. Laundry may have red, reddish-brown, or blue-green stains. Metallic taste.

Objectionable taste or odor other than hydrogen sulfide.

PROBABLE CAUSE

Dissolved iron in the water that is oxidized by air to form iron oxide, which is insoluble. (See also *iron bacteria*.)

Low pH, commonly called acid water; often caused by a high concentration of carbon dioxide.

Water softeners may increase the corrosiveness of acid water.

Decaying organic matter, pollution from surface drainage, insufficient chlorine being used to disinfect water.

SUGGESTED TREATMENTS

After determining type and amount of iron problem, select appropriate iron removal equipment such as chlorinator and sand filter, high capacity water softener or manganese green-sand filter. Choice of treatment for iron problems can be complex, depending on the level of iron in the water and the presence of other impurities.

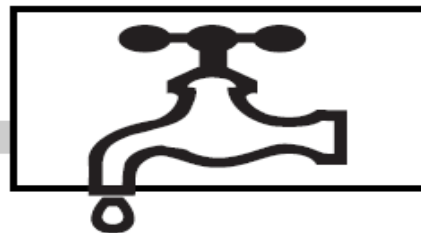
Depending on the acidity level, use appropriate treatment such as aeration, soda ash feeder, or neutralizing filter.

Install activated carbon filter or automatic chlorinator followed by activated carbon filter.

Water Treatment “talking points”

- Treatment devices should be certified
 - National Sanitation Foundation (NSF International) – www.nsf.org.
 - Water Quality Association – www.wqa.org
- Water treatment professional Training and Certification
 - WQA offers Certified Water Specialist (CWS) program levels 1 – 6
 - WQA “Find a Member” database <http://wqa.org/members.cfm?section=3>
- Are others that have used service/made a purchase satisfied? What would they do differently?
- Beware of scams and pressure sales pitches.
- Have water tested at a certified lab. Test regularly.
- Be an INFORMED consumer!!

Resource to help inform consumers



Questions to Ask When Purchasing Water Treatment Equipment

Until recently, the point-of-use water treatment industry focused on improving the aesthetic quality of drinking water. The industry has lately been thrust into the forefront of treatment of contaminated drinking waters that pose a serious health hazard. The response has been a plethora of companies and products promising to render the consumer's drinking water safe and contaminant free. The individual is left to sift through advertising claims and technical data to select the appropriate treatment method.

The following are questions the consumer should ask a water treatment professional to determine the system needed; background information follows many of the questions. These questions should be used as guidelines. The extent to which the manufacturer or distributor is willing to provide answers can assist the consumer in making an informed choice.

1. What exactly does the analysis of the water done by the treatment professional show? Are health hazards indicated? Should more testing be done?

Many water treatment companies include in their services free in-home testing of the water. Not all contaminants can be evaluated this way; for example, organics, which have been associated with serious health problems, must be analyzed in a laboratory with sophisticated equipment. The consumer must be wary of home analyses claiming to determine more than basic water quality constituents such as hardness, pH, iron, and sulfur.

2. How long has the company been in business, and is there a list of referrals the consumer can contact?

3. Have the product and the manufacturer been rated by the National Sanitation Foundation (NSF) or other third party organization? Was the product tested for the specific contaminant in question, over the advertised life of the treatment device (with more than 1 gallon of water), under household conditions (tap water, actual flow rates and pressures)?

The NSF, whose function is similar to Underwriter's Laboratory, sets performance standards for water treatment devices. Because companies can make unsubstantiated statements regarding product effectiveness, the consumer must evaluate test results of the device to determine if claims are realistic.

4. Does the water quality problem require wholehouse treatment or will a single-tap device be adequate?

Although less than one percent of tap water is used for drinking and cooking, some contaminants are as hazardous when inhaled or absorbed through the skin as when ingested. Treatment of all the water used in the household may be required. Reverse osmosis and distillation units are usually connected to a single tap; activated carbon devices can be installed on a single tap or where water enters the house. The device selected depends upon the type of contaminant in question.

5. Will the unit produce enough treated water daily to accommodate household usage? If a filter or membrane is involved, how often will it need to be changed, and how does the consumer know when that change should take place?

Additional Resources

Virginia Household Water Quality Program

540-231-9058

www.wellwater.bse.vt.edu

Water Quality Association

630-505-0160

www.wqa.org

National Sanitation Foundation

734-769-8010

www.nsf.org

Water Systems Council

202-625-4387

www.wellcarehotline.org

National Groundwater Association

800 551.7379

www.ngwa.org

Virginia Water Well Association

540-740-3329

www.vawaterwellassociation.org

American Ground Water Trust

603-228-5444

www.agwt.org

USEPA Safe Drinking Water Hotline

800-426-4791

www.epa.gov/safewater/hotline

Virginia Department of Health

Office of Drinking Water

804-786-6278

www.vdh.state.va.us/DrinkingWater

Local Health Departments

-in the phone book under Government