Description of Water-Treatment Options for Household Wells

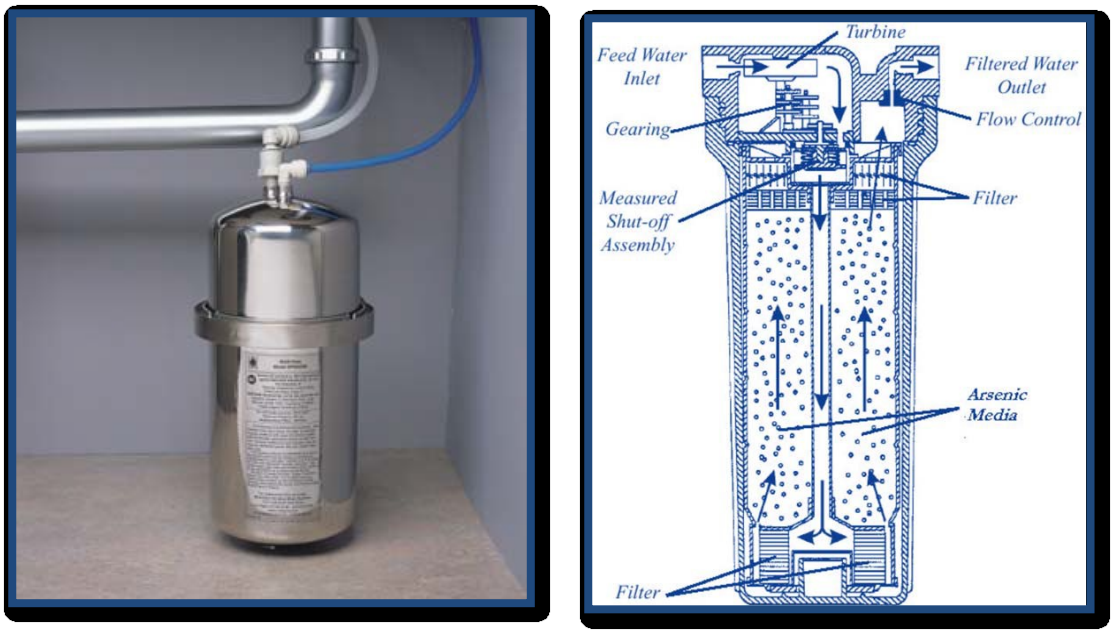
Treating water at a single tap: Point-of-use (POU) systems

1. POU Adsorptive Media

Arsenic is removed by passing water though a cartridge of adsorptive media where the arsenic "sticks" to the surface of the media. All media products have a limited capacity for arsenic removal. Once the capacity is reached, the media must be thrown away and replaced with new media.

Years ago, activated alumina was the main adsorptive media available to reduce arsenic. During the past 10–12 years, however, many new adsorptive media products, mainly iron based, have been introduced into the market place. Other names for iron-based adsorptive media include granular ferric oxide (GFO), and granular ferric hydroxide (GFH). In addition to iron-based products, other available products include iron-modified activated alumina, iron-modified anion resins, and several titanium-based granular media.

Iron-based adsorptive media will remove both As(3) and As(5), but the capacity for As(3) removal is less than for As(5). The estimated life (gallons of treated water) of the media for POU systems is usually based upon As(3) removal, and most systems will automatically shut off after the limit of As(3) removal is reached.

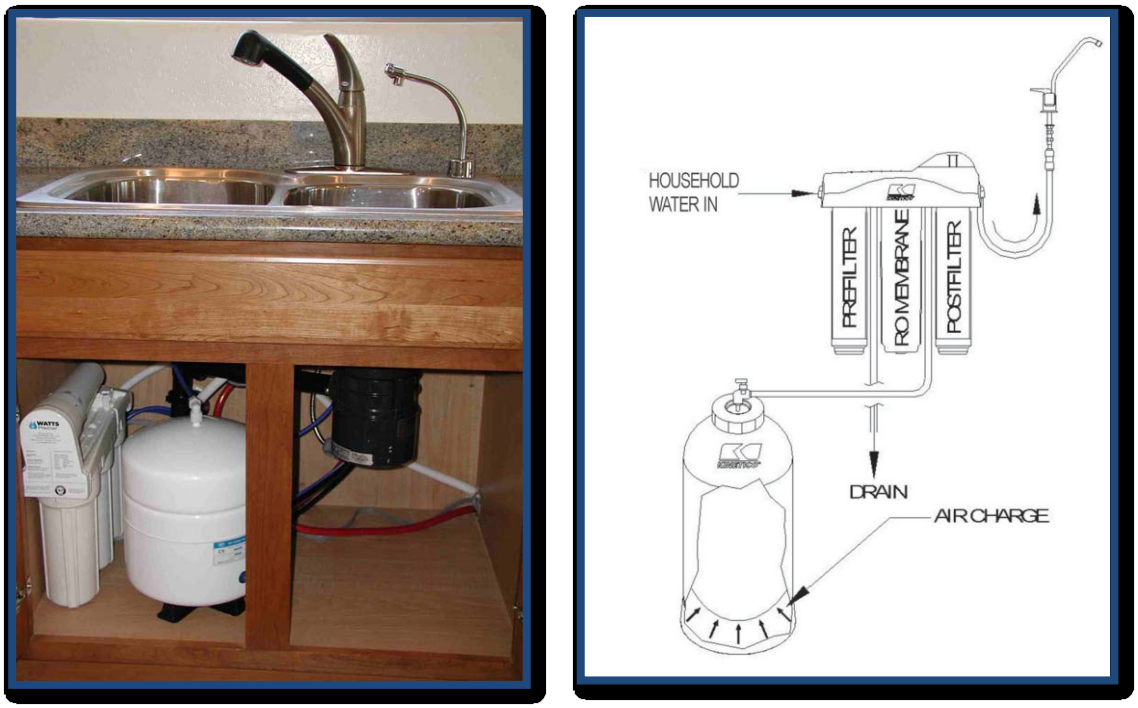


Single-tap adsorptive media system
(USEPA, 2003)

2. **POU Reverse Osmosis**

Reverse osmosis systems remove arsenic by forcing water, under pressure, past a special membrane. The water molecules migrate through the membrane, which blocks the passage of arsenic and many other contaminants. Treated water on the other side of the membrane flows to a small pressure storage tank until needed. The untreated water and contaminants (reject water) is disposed of into a sewer or septic system.

When operating at typical tap pressures, reverse osmosis devices commonly remove more than 95% As(5) but only 50–60 % of As(3). Water recovery is typically 10–25%, with 75–90% going to waste. In other words, for every gallon of water that is treated, 7–9 gallons are unused and must be disposed of.

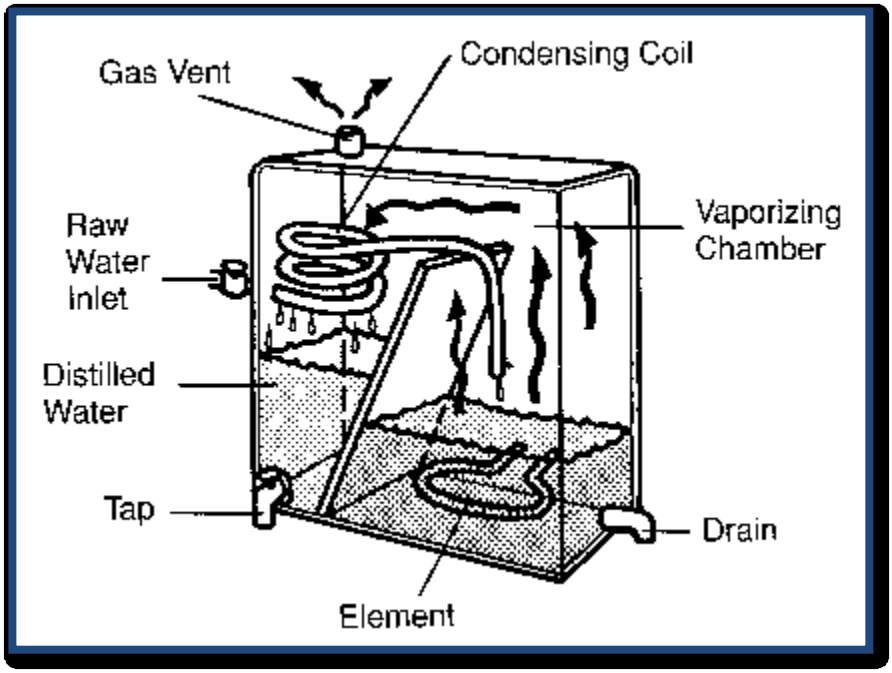


Single-tap reverse-osmosis system
(USEPA, 2003)

3. POU Distillation

In the distillation process, water is heated to boiling in an enclosed system where the steam is collected, cooled, and condensed back into a liquid free of the arsenic. Distillation, although effective, is not widely used because of it high energy cost (electricity) and the heat that it produces, especially during the summer. The process also requires periodic cleaning of the boiling chamber to remove the residual minerals.

Distillation will remove 95% of both As(3) and As(5). The process can also remove other contaminants, including heavy metals, bacteria, and some viruses. However, compounds that volatilize near the boiling point of water can be carried over in the steam and end up in the treated water.



Single-tap distillation system
(Dvorak, 2008)

Treating water for the whole house: Point of entry (POE systems)

4. POE Adsorptive Media

POE adsorptive media systems are similar to POU systems except they are significantly larger in size in order to treat all of the water used in the home. Arsenic is removed by passing the untreated water though a large tank (or two) of adsorptive media where the arsenic "sticks" to the surface of the media. All media products have a limited capacity for arsenic removal. Once the capacity is reached, the media must be thrown away and replaced with new media.

Years ago, activated alumina was the main adsorptive media available to reduce arsenic. During the past 10–12 years, however, many new adsorptive media products, mainly iron based, have been introduced into the market place. Other names for iron-based adsorptive media include granular ferric oxide (GFO), and granular ferric hydroxide (GFH). In addition to iron-based products, other available products include iron-modified activated alumina, iron-modified anion resins, and several titanium-based granular media.

Because the removal capacity for As(3) is substantially less than for As(V) and because of the large amount of media that must be replaced when exhausted, a pre-oxidation system to convert As(3) to As(5) is usually a necessity for well waters having As(III). Pretreatment is discussed in a later section.

Whole-house

Adsorptive Media

dual-tank system

(USEPA)

5. POE Reverse Osmosis

A POE reverse osmosis system operates in the same manner as a POU reverse osmosis system; arsenic is removed by passing untreated water, under pressure, past a special membrane. The untreated water molecules migrate through the membrane which blocks the passage of arsenic and many other contaminants. The contaminants on the untreated side of the membrane (reject water) are disposed of into a sewer, septic tank or other available waste disposal system. Treated water on the other side of the membrane flows to pressure storage tank until needed.

When operating at typical pressures, RO devices commonly achieve greater than 95% As(V) removal but only 50–60% As(3) removal. Water recovery for POE RO systems is generally higher than for POU systems, and will range from about 50 percent to 75 percent. In other words, for every gallon of water treated, 1-.5 gallons goes to waste and must be disposed of.

Reverse-osmosis systems remove most of the dissolved constituents in water, and so the pH of the treated water may decrease. In some homes, changes in pH could lead to corrosion of the plumbing system and could possibly increase the levels of lead and copper in the treated water.

Whole-house reverse osmosis system

6. POE Anion Exchange

POE anion-exchange systems are similar to a water-softening systems except that they remove the negatively charged As(5) ion rather than the positively charged ions, such as calcium and magnesium (the hardness ions) and iron. A POE anion-exchange system consists of a large tank of anion resin that exchanges the chloride (Cl^-) ion on the resin with the As(5) anion. The anion resin will also remove other anions such as sulfate, nitrate, bicarbonate (alkalinity), and even uranium. After the removal capacity of the resin is reached, the resin is regenerated by passing a salt solution (brine) through the resin tank to reverse the process; As(5) and other anions on the resin are released and replaced with chloride. The brine solution, which contains the arsenic and other anions, must be disposed of. The common methods of disposal of the brine solution for household wells are a septic tank or sewer, if accessible.

If the arsenic in the well water is As(3), oxidation of the As(3) is required because As(3) is not removed by anion resins. Because pre-oxidation coupled with the need of brine disposal adds to the complexity of the system, POE anion exchange is not a commonly used treatment solution for household wells.

Because anion exchange systems remove the bicarbonate anion, the pH of the treated water may decrease. In some homes, changes in pH could lead to corrosion of the plumbing system and could possibly increase the levels of lead and copper in the treated water.

Whole-house
Anion-exchange system
(USEPA)