# What Are Manganese Greensand Filters?

Manganese Greensand is capable of reducing iron, manganese and hydrogen sulfide from water through oxidation and filtration. Manganese Greensand is formulated from a glauconitic greensand which is capable of reducing iron, manganese and hydrogen sulfide from water through oxidation and filtration. Soluble iron and manganese are oxidized and precipitated by contact with higher oxides of manganese on the greensand granules. The hydrogen sulfide is reduced by oxidation to an insoluble sulfur precipitate. Precipitates are then filtered and removed by backwashing. When the oxidizing capacity power of the Manganese Greensand bed is exhausted, the bed has to be regenerated with a weak potassium permanganate ($KMnO_4$) solution thus restoring the oxidizing capacity of the bed. 1½ to 2 ounces of potassium permanganate, in solution, per cubic foot of Manganese Greensand is considered sufficient for normal regeneration. It is required to vigorously backwash and regenerates the bed when it is placed in service and before its oxidation capacity is totally exhausted. Operating the bed after oxidation capacity is exhausted will reduce its service life and may cause staining.

## Advantages of Manganese Greensand Filters:

- Iron reduction over a wide pH range
- Effective reduction of hydrogen sulfide in addition to iron and/or manganese
- No harmful effects from a chlorine feed
- Low attrition for long bed life

# What Are Pyrolox Iron Filters?

A Naturally mined ore, Pyrolox is a mineral form of manganese dioxide which has been used in water treatment for more than 75 years. Pyrolox is a granular filtration media for hydrogen sulfide, iron and manganese reduction. Pyrolox functions as a catalyst, but it remains relatively unchanged. Pyrolox works on a principle whereby the hydrogen sulfide, iron and manganese are oxidized and trapped on the media while simple backwashing cleans the bed. No chemical regeneration is required, nothing is imparted into the drinking water and Pyrolox has a high capacity for low contaminant concentrations. Pyrolox can be used in conjunction with aeration, chlorination, ozone or other pretreatment methods for difficult applications. Chlorine or other oxidants accelerate the catalytic reaction.

## Advantages of Pyrolox Filters:

- Effective reduction of iron, sulfur and manganese
- Durable material with long service life and low annual attrition of bed
- No chemical regeneration required, only periodic backwashing

## Conditions for Operation for Pyrolox Iron Filters:

- Water pH range: 6.5 - 9.0
- Due to its heavy weight, Pyrolox filters must be backwashed properly to insure bed expansion and service life.

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# Water Tech Resource Guide

## System Flow Rates for Various Sizes of Pyrolox Filters:

| Model No.* | Media (Cu.Ft.) | Service Flow Rate** (GPM) | Backwash** (GPM) | Fleck Valve Head | Tank Size (Dia." × H.") | Pipe Size (in.) | Approx. Ship. Wt. (lbs) |
|---|---|---|---|---|---|---|---|
| **W-MFI744P** | 0.3 | 1.3 | 7 | 5600 | 7 × 44 | ¾ | 75 |
| **W-MFI844P** | 0.5 | 1.7 | 7 | 2510 | 8 × 44 | 1 | 95 |
| **W-MFI940P** | 0.6 | 2.2 | 12 | 2510 | 9 × 40 | 1 | 100 |
| **W-MFI1040P** | 1.0 | 2.7 | 17 | 2510 | 10 × 40 | 1 | 155 |
| **W-MFI1054P** | 1.0 | 2.7 | 17 | 2510 | 10 × 54 | 1 | 165 |
| **W-MFI1252P** | 1.5 | 3.9 | 17 | 2510 | 12 × 52 | 1 | 245 |
| **W-MFI1354P** | 2.0 | 4.6 | 25 | 2750 | 13 × 54 | 1 | 285 |
| **W-MFI1465P** | 2.5 | 5.3 | 25 | 2750 | 14 × 65 | 1 | 435 |
| **W-MFI1665P** | 3.0 | 7.0 | 30 | 2850 | 16 × 65 | 1.5 | 465 |
| **W-MFI2162P** | 4.0 | 12.0 | 49 | 2850 | 21 × 62 | 1.5 | 635 |
| **W-MFI2472P** | 6.0 | 15.7 | 60 | 3150 | 24 × 72 | 2 | 905 |

## How does a Water Softener work?

A typical water softener has four major items:

1. Resin Tank
2. Resin
3. Automatic Valve or Controller
4. Brine or Salt Tank

Hard water flows over resin in the resin tank. Resin is in the form of tiny beads that have a special chemical property. At low concentration of sodium in typical hard water, the resin beads adsorb (combine with them) the hardness of water and replace it with an equivalent amount of sodium in water. As hardness is removed the water becomes "soft". The resin has a fixed capacity of the amount of hardness it can remove. Once that happens the resin can no longer remove the water hardness and the resin is called "saturated" or exhausted.

Fortunately, the same resin when exposed to high sodium chloride (common salt) or potassium chloride concentration, the process is reversed; it adsorbs the sodium and releases the hardness. This property is utilized in regenerating the exhausted resin. This is done by temporarily stopping the softening process and exposing the resin to a concentrated salt solution from the brine tank. The entire process is controlled by the controller valve which works either on a set time of regeneration (normally set at 2 AM) or by a metered valve inside the controller preset to a calculated volume of water that can be softened before regeneration is required. During bed regeneration, the controller rinses the resin to remove all residual salt not adsorbed by the resin with the entire cycle lasting less than 1 hour.

The softening process adds a very small amount of sodium or potassium in the water which comes from the exchange process. It is not directly added from the brine tank. For example, water with 10 grain hardness will have a sodium addition of 80 ppm in the water after softening.

## Sizing and Selection Information for Designing a Water Softener:

**Step 1: Calculate Total Hardness as GPG**

Usually chemical analyses report for calcium (Ca) and magnesium (Mg) in terms of parts per million (ppm) as calcium carbonate (CaCO3). However, in some cases, the analysis is reported in terms of the elements themselves. If this is the case, proceed as follows:

Calcium (as Ca)_____ × 2.50 = _____ppm Ca as CaCO3. (A)
Magnesium (as Mg) _____× 4.10 = _____ppm Mg as CaCO3. (B)
A _____ + B_____ = _____Total Hardness PPM as CaCO3

Total Hardness PPM as CaCO3 _____ ÷ 17.1 = _____ GPG (grams per grain) as CaCO3.

**Step 2: Calculate Cubic Feet of Resin Required**

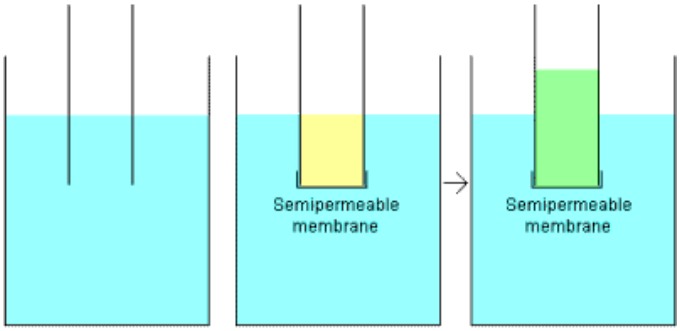
_____ Gallons per Day × _____Total Hardness (GPG) = _____ Grains per Day

_____ Grains per Day ÷ 30,000 = _____ Cubic Feet of Resin Required for System

Note: Above calculations are based on daily regeneration and maximum resin capacity. Regeneration based on 15 lbs. of salt per cubic foot of resin.

# How does reverse osmosis work?

To understand "reverse osmosis," it is probably best to start with normal osmosis. According to Merriam-Webster's Collegiate Dictionary, **osmosis** is the "movement of a solvent through a semipermeable membrane (as of a living cell) into a solution of higher solute concentration that tends to equalize the concentrations of solute on the two sides of the membrane." That's a mouthful. To understand what it means, this picture is helpful:




On the left is a beaker filled with water, and a tube has been half-submerged in the water. As you would expect, the water level in the tube is the same as the water level in the beaker. In the middle figure, the end of the tube has been sealed with a "semi-permeable membrane" and the tube has been half-filled with a salty solution and submerged. Initially, the level of

the salt solution and the water are equal, but over time, something unexpected happens -- the water in the tube actually rises. The rise is attributed to "osmotic pressure."

A **semi-permeable membrane** is a membrane that will pass some atoms or molecules but not others. Saran wrap is a membrane, but it is impermeable to almost everything we commonly throw at it. The best common example of a semipermeable membrane would be the lining of your intestines, or a cell wall. Gore-tex is another common semipermeable membrane. Gore-tex fabric contains an extremely thin plastic film into which billions of small **pores** have been cut. The pores are big enough to let water vapor through, but small enough to prevent liquid water from passing.

In the figure above, the membrane allows passage of water molecules but not salt molecules. One way to understand **osmotic pressure** would be to think of the water molecules on both sides of the membrane. They are in constant Brownian motion. On the salty side, some of the pores get plugged with salt atoms, but on the pure-water side that does not happen. Therefore, more water passes from the pure-water side to the salty side, as there are more pores on the pure-water side for the water molecules to pass through. The water on the salty side rises until one of two things occurs:

- The salt concentration becomes the same on both sides of the membrane (which isn't going to happen in this case since there is pure water on one side and salty water on the other).
- The water pressure rises as the height of the column of salty water rises, until it is equal to the osmotic pressure. At that point, osmosis will stop.

Osmosis, by the way, is why drinking salty water (like ocean water) will kill you. When you put salty water in your stomach, osmotic pressure begins drawing water out of your body to try to dilute the salt in your stomach. Eventually, you dehydrate and die.

In reverse osmosis, the idea is to use the membrane to act like an extremely fine **filter** to create drinkable water from salty (or otherwise contaminated) water. The salty water is put on one side of the membrane and pressure is applied to stop, and then reverse, the osmotic process. It generally takes a lot of pressure and is fairly slow, but it works.

## Activated Carbon Filters:

These filters are used to reduce chlorine, organics, color, tannin, and objectionable tastes and odors from water. Automatic backwashing system removes the trapped contaminants within the filter bed and washes them down the drain. **Our Household Carbon Filters** (10"-12" Diameter) **use NSF approved coconut shell based carbon.**

## Benefits of Using a Carbon Filter:

- Carbon Systems Significantly Reduce the Following Contaminants
  - Chlorine
  - Chlorine By-Products (Trihalomethanes-THMs): Group of organic chemicals-suspected carcinogenic.
  - Bad Tastes & Odors
  - Turbidity (Cloudy Water)
  - Herbicides, Pesticides, & Insecticides
  - Volatile Organic Chemicals (VOCs): Organic Chemicals that turn into vapor.

# Water Tech Resource Guide

## About Calcite:

**Calcite is a crushed and screened white marble media which can inexpensively be used to neutralize acidic or low pH waters to a neutral, less corrosive effluent.**

Calcite is a naturally occurring calcium carbonate media. One of the advantages of Calcite is its self-limiting property. When properly applied, it corrects pH only enough to reach a non-corrosive equilibrium. It does not overcorrect under normal conditions. Upon contact with calcite, acidic waters slowly dissolve the calcium carbonate to raise the pH which reduces potential leaching of copper, lead and other metals found in typical plumbing systems. Periodic backwashing will prevent packing, reclassify the bed and maintain high service rates. Depending on pH, water chemistry and service flow, the Calcite bed will have to be periodically replenished as the calcite is depleted.

As the Calcite's calcium carbonate neutralizes the water, it will increase hardness and a softener may become necessary after the neutralizing filter.

## Advantages of Calcite Filters for Neutralization:

- **Calcite is a Naturally Occurring Material**
- **Low Uniformity coefficient for maximum contact for controlled pH correction.**
- **Inexpensive**
- **Slower Reacting for controlled pH correction**

## About Multi-Media Sediment Filtration

These filters contain several types of media and gravel under bedding. Multi-media filtration is a proven design concept; the coarse media layers in the top of the tank trap large particles, and successively smaller particles are trapped in the finer layers of media deeper in the bed. The result is a highly efficient filtering since removal takes place throughout the entire bed. Multi-Media depth filters typically remove particles 5-15 microns in size or larger. All media included in our filters are carefully selected according to particle size, so the media retains its stratification during backwash and rinse. Automatic backwashing system removes the trapped contaminants within the filter bed and washes them down the drain.

# Factors Affecting RO Membrane Performance

Reverse osmosis (RO) technology can be a complicated subject, particularly without an understanding of the specific terminology that describes various aspects of RO system operation and the relationships between these operating variables. This section defines some of these key terms and provides a brief overview of the factors that affect the performance of RO membranes, including pressure, temperature, feedwater salt concentration, permeate recovery, and system pH.

---

### Definitions

- **Recovery:** the percentage of membrane system feedwater that emerges from the system as product water or "permeate". Membrane system design is based on expected feedwater quality and recovery is fixed through initial adjustment of valves on the concentrate stream. Recovery is often fixed at the highest level that maximizes permeate flow while preventing precipitation of super-saturated salts within the membrane system.

- **Rejection:** the percentage of solids concentration removed from system feedwater by the membrane.
- **Passage:** the opposite of "rejection", passage is the percentage of dissolved constituents (contaminants) in the feedwater allowed to pass through the membrane.
- **Permeate:** the purified product water produced by a membrane system.
- **Flow:** Feed flow is the rate of feedwater introduced to the membrane element, usually measured in gallons per minute (gpm). Concentrate flow is the rate of flow of non-permeated feedwater that exits the membrane element. This concentrate contains most of the dissolved constituents originally carried into the element from the feed source. It is usually measured in gallons per minute (gpm).
- **Flux**: the rate of permeate transported per unit of membrane area, usually measured in gallons per square foot per day (gal/ft2/day).
- **Dilute solution:** purified water solution, RO system product water.
- **Concentrated solution**: brackish water solution such as RO system feedwater.

## Effect of pressure

Feedwater pressure affects both the water flux and salt rejection of RO membranes. Osmosis is the flow of water across a membrane from the dilute side toward the concentrated solution side. Reverse osmosis technology involves application of pressure to the feedwater stream to overcome the natural osmotic pressure. Pressure in excess of the osmotic pressure is applied to the concentrated solution and the flow of water is reversed. A portion of the feedwater (concentrated solution) is forced through the membrane to emerge as purified product water of the dilute solution side (please see Figure 1).

As shown in Figure 2, water flux across the membrane increases in direct relationship to increases in feedwater pressure. Increased feedwater pressure also results in increased salt rejection but, as Figure 2 demonstrates, the relationship is less direct than for water flux.

Because RO membranes are imperfect barriers to dissolved salts in feedwater, there is always some salt passage through the membrane. As feedwater pressure is increased, this salt passage is increasingly overcome as water is pushed through the membrane at a faster rate than salt can be transported.

However, there is an upper limit to the amount of salt that can be excluded via increasing feedwater pressure. As the plateau in the salt rejection curve (Figure 2) indicates, above a certain pressure level, salt rejection no longer increases and some salt flow remains coupled with water flowing through the membrane.

---

## Effect of temperature

As Figure 3 demonstrates, membrane productivity is very sensitive to changes in feedwater temperature. As water temperature increases, water flux increases almost linearly, due primarily to the higher diffusion rate of water through the

membrane. Increased feedwater temperature also results in lower salt rejection or higher salt passage. This is due to a higher diffusion rate for salt through the membrane.

## Effect of temperature (cont.)

The ability of a membrane to tolerate elevated temperatures increases operating latitude and is also important during cleaning operations because it permits use of stronger, faster cleaning processes. This is illustrated by the comparison of the pH and temperature ranges of thin-film composite (TF) membrane and a cellulose acetate (CA) membrane in Figure 4.

---

## Effect of salt concentration

Osmotic pressure is a function of the type and concentration of salts or organics contained in feedwater. As salt concentration increases, so does osmotic pressure. The amount of feedwater driving pressure necessary to reverse the natural direction of osmotic flow is, therefore, largely determined by the level of salts in the feedwater.

Figure 5 demonstrates that, if feed pressure remains constant, higher salt concentration results in lower membrane water flux. The increasing osmotic pressure offsets the feedwater driving pressure. Also illustrated in Figure 5 is the increase in salt passage through the membrane (decrease in rejection) as the water flux declines.

---

## Effect of recovery

As shown in Figure 1, reverse osmosis occurs when the natural osmotic flow between a dilute solution and a concentrated solution is reversed through application of feedwater pressure. If percentage recovery is increased (and feedwater pressure remains constant), the salts in the residual feed become more concentrated and the natural osmotic pressure will increase until it is as high as the applied feed pressure. This can negate the driving effect of feed pressure, slowing or halting the reverse osmosis process and causing permeate flux and salt rejection to decrease and even stop (please see Figure 6).

The maximum percent recovery possible in any RO system usually depends not on a limiting osmotic pressure, but on the concentration of salts present in the feedwater and their tendency to precipitate on the membrane surface as mineral scale. The most common sparingly soluble salts are calcium carbonate (limestone), calcium sulfate (gypsum), and silica. Chemical treatment of feedwater can be used to inhibit mineral scaling.

---

## Effect of pH

The pH tolerance of various types of RO membranes can vary widely. Thin-film composite (TF)membranes are typically stable over a broader pH range than cellulose acetate (CA) membranes and, therefore, offer greater operating latitude (please see Figure 4).

Membrane salt rejection performance depends on pH. Water flux may also be affected. Figure 7 shows that water flux and salt rejection for Thin Film membranes are essentially stable over a broad pH range.

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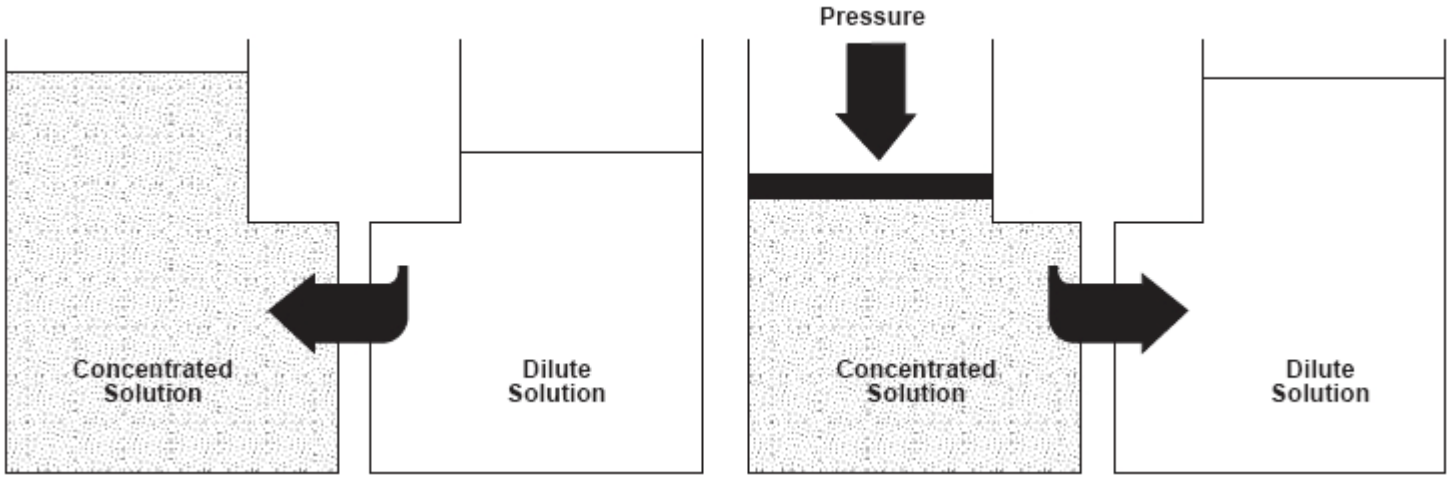
As illustrated in Figure 4, the stability of TF membrane over a broad pH range permits stronger, faster, and more effective cleaning procedures to be used compared to CA membranes

**Figure 1 - Overview of Osmosis/Reverse Osmosis**




| Osmosis | Reverse Osmosis |
|---|---|
| Water diffuses through a semi-permeable membrane toward regions of higher concentration to equalize solution strength. At equilibrium, the height difference between the concentrated and dilute sides corresponds to the osmotic pressure differential between the two sides. | With applied pressure in excess of osmotic pressure fluid flow reverses direction thereby creating the term "reverse osmosis". |

**Figure 2 - Effect of Feedwater Pressure on Flux and Salt Rejection**

**Figure 3 - Effect of Feedwater Temperature on Flux and Salt Rejection**

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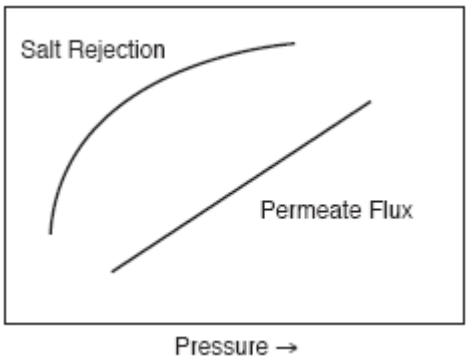


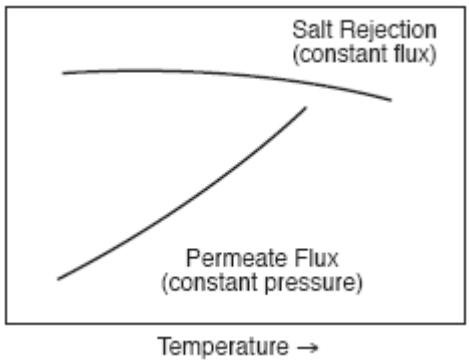


**Figure 4 - Comparison of Operating and Cleaning Parameters for Thin-Film Composite Membrane and a CA Membrane**

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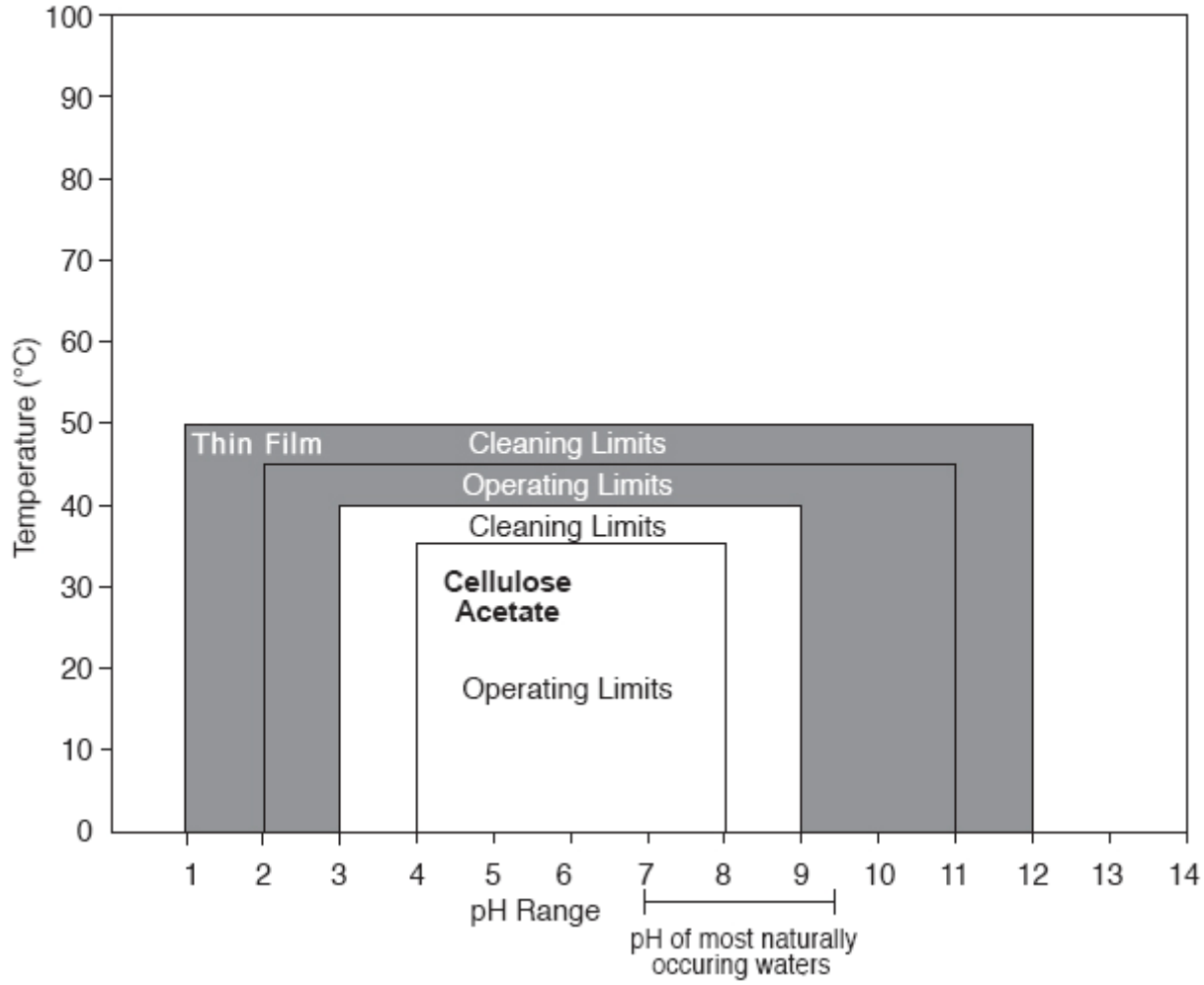


**Figure 5 - Effect of Increasing Salt Concentration on Flux and Salt Rejection**

**Figure 6 - Effect of Increased Recovery on Flux and Salt Rejection**

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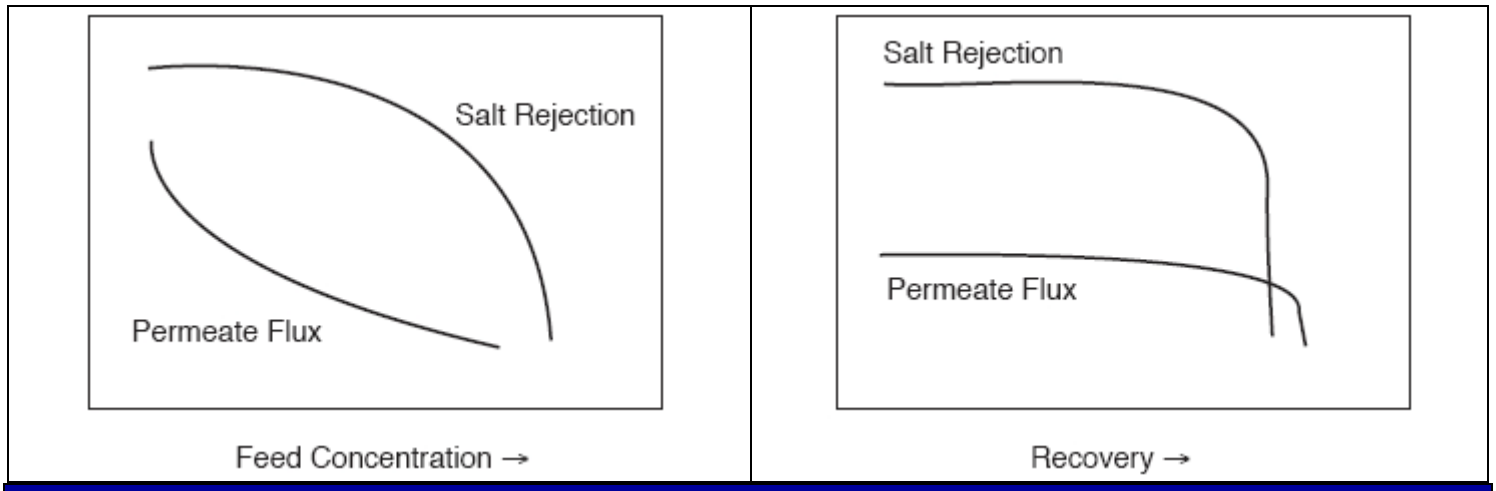
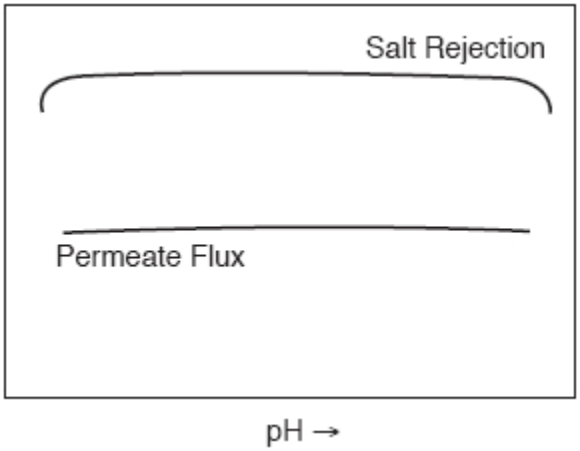



**Figure 7 - Effect of Feedwater pH on Water Flux and Salt Rejection**




# Mistakes to Avoid in Design & Operation of Reverse Osmosis Systems

## Introduction

Reverse Osmosis technology has evolved into a widely used process for the purification of water. Well designed and properly operated systems give a trouble-free performance over long periods of time. Membranes in these systems have a long useful life. On the other hand mistakes made during the design or operation of reverse osmosis systems can lead to ongoing problems and reduced membrane life.

This article reviews some common mistakes made during the design and operation of reverse osmosis systems.

# Water Tech Resource Guide

## Membrane Performance

There is one simple but extremely important fact in keeping the membranes at their peak performance:

**"Keep The Membrane Surface Clean".**

All impurities in water are removed at the membrane surface. The dynamics of this separation step must ensure that concentrated materials are not accumulating at the membrane surface. If concentrations are allowed to build up near the membrane, precipitation of low solubility substances will follow resulting in a decline in membrane performance.

## Water Analysis

Understanding the water analysis and the potential problems caused by the sparingly soluble substances are crucial for the success of a reverse osmosis system. Many reverse osmosis systems have been designed and sold with no or incomplete water analysis. Some of these mistakes are difficult to fix in the field and may even require discarding the existing system and starting all over again.

---

## Recovery

Recovery is defined as the ration of the permeate flow to feed flow.

% Recovery = (Permeate Flow ÷ Feed Flow) x 100

In residential systems the recovery is expressed in terms of ratio of brine flow to permeate flow. For example, the brine: permeate flow ration may be 5:1. This can be converted into recovery as follows:

Feed flow = Permeate Flow + Brine Flow
% Recovery = (Permeate Flow x 100) ÷ Feed Flow
or = 100 ÷ 6 = 16.7%

It is recommended that for most tap waters the recovery for each membrane be maintained between 10 to 15%. Operating membranes at higher than recommended recovery will result in premature fouling of the membrane surface.

## Membrane Flux

All membranes have one common limitation. They can only produce a maximum flow of a certain maximum permeate flow for a given amount of water. This limit is controlled by the quality of feed water and not by the make of the membrane. For example, a maximum permeate flow for most tap water applications is 25 gallons per square foot per day. When membranes are operated at flux rates higher than this value, fouling occurs.

## Feed Flow

A minimum feed flow rate must be maintained throughout the membrane. Feed velocity helps to reduce build-up of concentrated materials at the membrane surface. When several membranes are being used, the arrangement of these membranes is crucial in maintaining proper flow velocities. This arrangement must be checked against other related factors such as higher pumping costs, recycle flow, etc.

### System Shut-Down

The fouling tendency of feed water when flowing through membranes is quite different than that of stagnant water at shut down. Certain suspended solids may settle on the membrane surface during stagnant periods. On the other hand silica is found to crystallize during shut down. A proper flush cycle can eliminate these problems.

### Residential Systems

Residential reverse osmosis systems need to take into consideration all of the parts described above. In addition, there are some other factors that require special attention in residential systems. Most of these concerns are due to an improper selection of some key components in the manufacturing of these systems.

- **Flow Restrictors**: Poor quality flow restrictors may cause systems to run at higher recoveries resulting in shorter membrane life.
- **Prefilters**: Sediment and carbon filters used in the pretreatment of the residential systems must not shed fibers or release carbon fines.
- **Check Valves**: A faulty check valve can cause a back pressure on the permeate side of the membrane element resulting in a physical damage to the membrane.

### Summary

Mistakes in the design and operation of reverse osmosis systems can be avoided by following the recommendations outlined in this paper. There are no short cuts in providing systems that give trouble free performance with a long useful membrane life.

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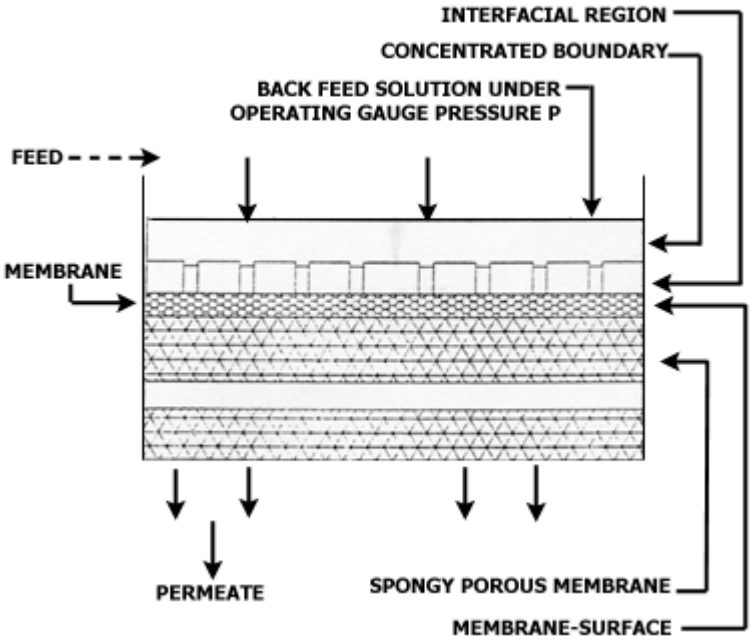
# Water Tech Resource Guide

## Diagrams and References

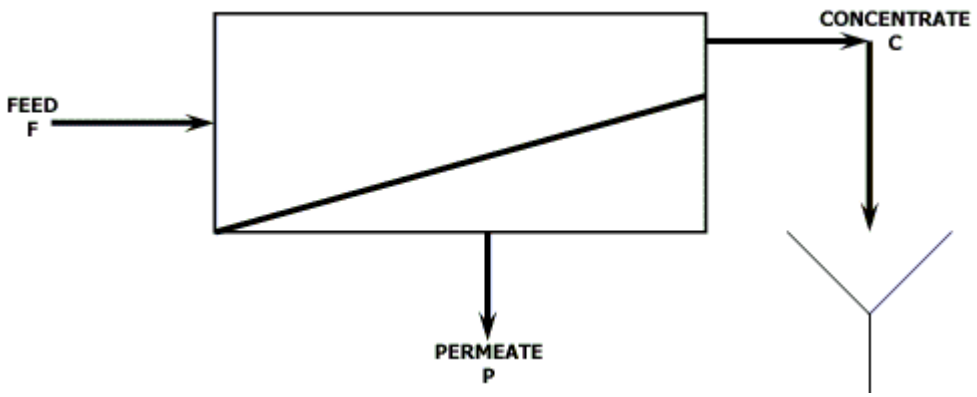
### Concentration Polarization




- Increase in Solute Diffusion
- Possible Saturation/Precipitation
- Decrease in Net Pressure

### Recovery

% Recovery = (Permeate ÷ Feed) x 100




| % Recovery | Concentrate Concentration |
|---|---|
| 50 | x 2 Feed Conc. |

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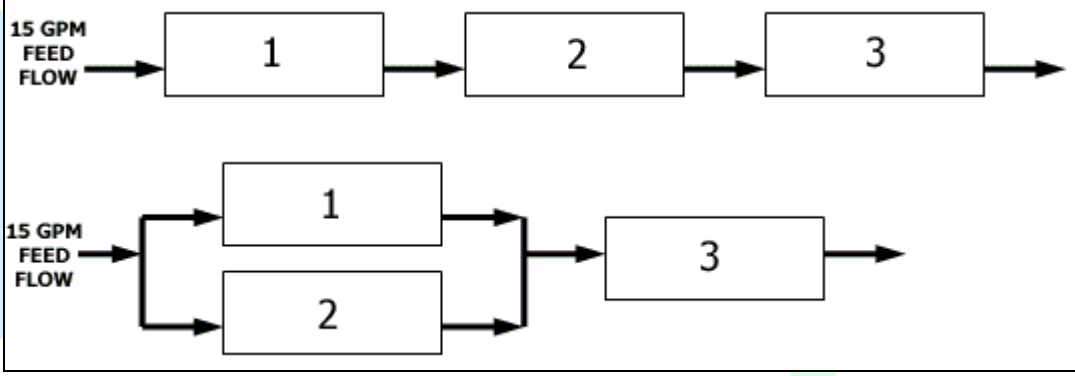
| | |
|---|---|
| 75 | x 4 Feed Conc. |
| 90 | x 10 Feed Conc. |

Concentrate Conc. = (100 ÷ [100-R]) x Feed Conc.
R = % Recovery

**Feed Flow**

**Higher Feed Flow Helps to Reduce Membrane Fouling**

**Example:**




## Reverse Osmosis System Design: Concentrate Recycle Loop

The main purpose of a concentrate recycle loop in a reverse osmosis system is to reduce the amount of concentrate or waste water flowing to the drain. Recycle loops are also used to maintain an optimum flow velocity across the membrane surface and reduce individual membrane recovery.

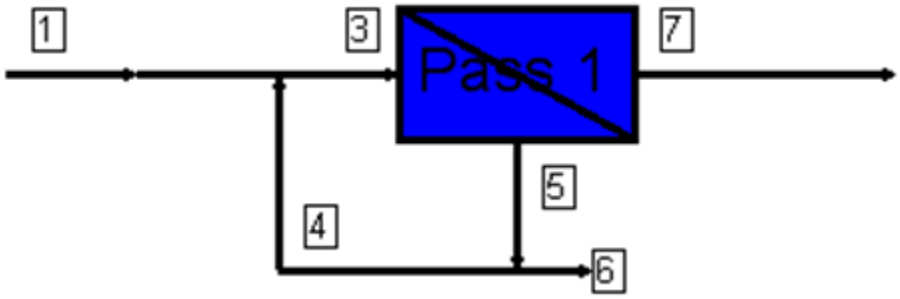
A recycle loop takes a portion of the concentrate flow which would have otherwise gone to drain and returns it to the feed of the RO pump in a continuous loop. Reducing the concentrate flow to drain achieves a higher system “recovery” percentage. Pump sizing needs to take the additional flow coming from the concentrate recycle loop into consideration.

Careful attention must be paid to the feed water analysis. Concentrating the waste stream to a higher degree can only be done to a certain point before fouling will occur in the membranes. This fouling point will vary with each individual feed water line.

# Water Tech Resource Guide

The examples shown below are for the same system operating at 70% recovery, the first example with recycle and the second without:

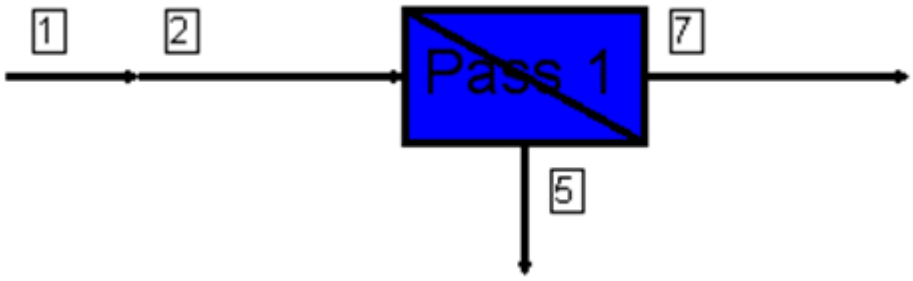
## 1. System Design Overview with Recycle Loop




| Pass 1 | | | |
|---|---|---|---|
| **Stream #** | **Flow (GPM)** | **Pressure (psig)** | **TDS (mg/l)** |
| 1 = Feed | 6.00 | 0.00 | 914.82 |
| 3 = Pump Flow | 9.00 | 218.37 | 1650.21 |
| 4 = Recycle Flow | 3.00 | 179.92 | 3087.03 |
| 5 = Concentrate Flow | 4.80 | 179.92 | 3087.03 |
| 6 = Final Drain Flow | 1.80 | 179.92 | 3087.03 |
| 7 = Permeate Flow | 4.20 | -- | 5.98 |
| 7 = Permeate/1 = Feed | **% Recovery** | 70.0 | |

**Design Warnings:** -None-

## 2. System Design Overview Without Recycle Loop




| Pass 1 |
|---|

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# Water Tech Resource Guide

| Stream # | Flow (GPM) | Pressure (psig) | TDS (mg/l) |
|---|---|---|---|
| 1 = Feed | 6.00 | 0.00 | 914.82 |
| 3 = Pump Flow | 6.00 | 210.50 | 930.59 |
| 5 = Concentrate/Drain Flow | 1.8 | 179.92 | 3088.81 |
| 7 = Permeate Flow | 4.20 | -- | 4.83 |
| 7 = Permeate/1 = Feed | **% Recovery** | 70.0 | |

**Design Warnings:**

**CAUTION:** The concentrate flow rate is less than the recommended minimum flow. Please change your system design to increase concentrate flow rates. (Product: TW30-4040, Limit: 3.00gpm minimum, design only produces 1.8 gpm)

**WARNING:** Maximum element recovery has been exceeded. Please change your system design to reduce the element recoveries. (Product: TW30-4040, Limit: 25.00%, design indicates 100%-70% = 30%)

**Example 1:** Without recycle the concentrate to drain would have been 4.8 GPM. A flow of 3 GPM is being returned to the feed in a recycle loop. This reduced the drain flow to 1.8 GPM and made the overall system recovery of 70% possible.

**Example 2:** 70% recovery without recycle in this system is too high as indicated with System Design Warning.

## Question

How does antiscalant work for a reverse osmosis water treatment application?

## Answer

An antiscalant is a pretreatment injected into the feedwater before the feedwater enters the RO membranes. Its presence delays the reaction between calcium magnesium and bicarbonate. This results is scale not forming as the water is being purified by the RO. As the duration of the water in the membrane system is relatively short during the treatment, scale formation is prevented.

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## Question

What is the difference between Flocon 260 Antiscalant/Dispersant and Coagulant?

## Answer

Flocon 260 Antiscalant is used to keep water hardness from precipitating during reverse osmosis treatment of

water. The antiscalant also contains a dispersant which prevents iron or aluminum in water from reacting with the antiscalant and making it ineffective.

Coagulant, on the other hand, works just the opposite. It is used to cause the suspended solids that may be present in water to coagulate and settle out. By coagulation we mean that the very fine particles of suspended matter come together to become a larger cluster which will settle more easily than the smaller suspended particles. The fine suspended particles in the water normally have an electrical charge. The coagulate facilitates the removal of the charge, allowing the particles to coagulate and settle. In short, coagulant is used to remove suspended solids.

In membrane process, coagulants are used only in rare situations. Many coagulants can be harmful for the membranes. Coagulants are commonly used in municipal water treatment systems.

In short: Antiscalant is used for hardness, which is dissolved in the water, and coagulant is used for suspended solids.

## Question

Can excessive Antiscalant foul the membranes?

## Answer

Excessive antiscalant can cause fouling of the membrane. This fouling can be cleaned by flushing the membranes with water at a pH of 2-3.

## Question

Antiscalant (organo-phosphonate) and AM-88 (sodium meta-bisulphite for dechlorination) are sometimes both used for pretreatment. In this case, are there any chemical reactions which would cause fouling of the membrane?

## Answer

There is no chemical reaction between the two chemicals.

## Question

We are dosing a cationic coagulant before sand filter in our seawater desalination RO pretreatment system. Meanwhile, Flocon 260 (anionic) is dosed after sand filter. I wonder whether these two chemicals may react and result in fouling on RO membrane.

## Answer

Flocon 260 is typically not compatible with cationic polymers. If we knew the exact polymer you are using, we would be able to give a definite answer. There are alternative antiscalants that may be used (FLOCON 40), but in order to determine whether this will work, we will need a complete water analysis. The FLOCON 40 does not offer much scale control for most of the 'sulfite' scales.

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## Question

What is the dose rate and method of injection for Flocon antiscalants?

## Answer

### Dose Rate

The amount of Flocon required to inhibit scale formation depends on the degree of supersaturation of the insoluble salts at the point of highest concentration in the system. The degree of supersaturation in turn depends on the concentration of the ionic species in the feedwater, the overall salinity of the feed, the temperature of the feedwater, the percentage of the feedwater recovered as permeate and the type of membrane used for the application.

| FLOCON Solution Concentration* % | Amount of Solution to be Injected per 1,000 Gallons of Feed Water, In Gallons | |
|---|---|---|
| | 3 ppm | 5 ppm |
| **100** | 0.003 | 0.005 |
| **50** | 0.006 | 0.010 |
| **20** | 0.015 | 0.025 |
| **10** | 0.030 | 0.050 |

*** Use soft water or RO permeate to mix with Flocon.**

### Dose Method

Flocon should be added to a membrane system prior to the final cartridge filter. If media filtration or activated carbon is used, Flocon should be applied after these treatment stages.

Flocon should be delivered by dosing pump from a dilution tank, direct from the drum or from a bulk storage facility, into the feedwater at a rate that is determined by the size of the membrane system, the recommended dose

rate and the delivery range of the dosing pump. It is recommended that the dosing pump be adjusted by the stroke length, while maintaining stroke frequency at a high level as possible to achieve even distribution of the Flocon in the membrane system feedwater.

**CAUTION - Biological Activity:**
Flocon contains a preservative that is effective up to a dilution of 1 part Flocon to 15 parts of system permeate water. General periodic cleaning of the dosing system is recommended as part of the planned maintenance program.

## Water Softeners and Softening Resins

### Question
How long is the backwash time for a Water Softener?

### Answer
Minimum backwash time is 5 minutes. Generally the backwash time is factory set at 10 minutes. If the water is not clear then the backwash time can be as long as 20 minutes.

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### Question
How long is the brine and slow rinse for a Water Softener?

### Answer
This depends on the salt dosage selected for the softener. The default setting is 60 minutes.

| Salt Dosage, lb/cu.ft. | Brine and Slow rinse Time, minutes |
|---|---|
| 5 | 60 |
| 10 | 80 |
| 15 | 100 |

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### Question
How long is the Rapid rinse for a Water Softener?

### Answer
Rapid rinse is typically 10 minutes minimum.

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### Question
How long does the brine refill take for a Water Softener?

## Answer

This time is a minimum of 4 minutes.

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## Question

What is the total time to regenerate a water softener?

## Answer

The total to regenerate is between 1.5 to 2 hours.

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## Question

Would soft water be preferred over hard water as a feed for a residential RO system as calcium has a higher molecular weight than sodium?

## Answer

Hardness is easily precipitated as a scale on the membrane surface as the pure water is removed by the membrane. For residential membranes, the removal of the hardness may prolong the membrane life if the soft water is used.

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## Question

How often should I change the resin in a water softener?

## Answer

Softening Resin Life (Approximate):

No chlorine: 8 years

Chlorine: 3-4 years

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## Question

How do you dispose of the resin in a water softener?

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## Answer

Softener Resin Disposal:  It is a non-hazardous product that you can throw out with regular trash.

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## Question

I have a brine tank that is at a low level, how much salt do I need to add and how often does it need to be added?

## Answer

The brine tank should be filled with salt to slightly above the water level. The tank is self filling, so no additional water needs to be added. Check the tank regularly, and add salt as necessary to maintain the proper level of salt.

## Question

Are Lead and Arsenic Removed by Thin Film Reverse Osmosis Membranes?  What are the rejection rates?

## Answer

There is not a list of rejection rates for these heavy metals, but we can give you some general guidelines. However, we recommend that you run the experiments under your unique set of conditions and ions/counter ions.

Rejection of lead by thin film RO membranes has been reported to be quite high, >99%.

The rejection of arsenic depends on its oxidation state. The +3 acid, arsenious, is not rejected particularly well in neutral solutions, 70 to 90%, but is well rejected as the pH approaches or exceeds the pKa of 9.2. The +5 arsenic acid is well rejected in neutral solution.

## Question

How can I remove the Silica from the water before passing it through the membranes?

## Answer

There is no easy method. The conventional method used is lime soda softening but this is very expensive. In reverse osmosis no attempt is made to remove silica before the membranes. Instead the recovery and other operating conditions are adjusted to prevent silica super saturation and precipitation.

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## Question

For a GMP pharmaceutical water pretreatment system to be used for large scale WFI production, what are the options for removal of chloramines?

## Answer

Currently, the only two options for removal of chloramines are break-point chlorination, and utilization of catalytic carbon beds.

# Feed Water Quality for Reverse Osmosis Systems: Q & A

## Question

Is there a general rule of thumb regarding the Maximum TDS Concentration Treatable using RO? I realize that there are many variables; however, I am just looking for a general number above which another treatment technology should be considered.

## Answer

The maximum is 50,000 ppm. For TDS values higher than this, the treatment process normally used is evaporation.

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## Question

Do your Brackish membrane elements work in TDS of 4000?

## Answer

Yes, Brackish Water Elements will typically work in a TDS of up to 10,000. There are many variables which will affect membrane performance, but typically 10,000 TDS is fine for a Brackish element.

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## Question

At what concentration of chlorine will the Thin Film Membrane Fail?

## Answer

Maximum chlorine concentration should not exceed 0.1 ppm for a maximum of 1000 hours.

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## Question

What is the conversion from conductivity to resistivity and vice versa?

## Answer

Resistivity is expressed as the inverse of conductivity. In other words resistivity = 1/conductivity. Conductivity of 1 micromhos-cm [or micro Siemens] = 1,000,000 ohms of resistivity or 1 megaohm. Conductivity of 10 micro ohms-cm= 100,000 ohms or 0.1 megaohm. Etc.

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## Question

What are the maximum levels of hydrogen sulfide, iron, and manganese that can be present in water in order to use a Pyrolox Filter?

## Answer

Hydrogen Sulfide = up to 10 ppm

Iron = up to 20 ppm

Manganese = up to 5 ppm

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## Question

What analysis must be done in order to determine an acceptable chlorine level? What is the maximum level?

## Answer

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Maximum acceptable level for chlorine for thin film membranes is 0.1 ppm. However, the total cumulative chlorine tolerance of the membrane is 1000 ppm-hours [ppm x hours of exposure].

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### Question

What values need to be considered when designing an RO membrane?

### Answer

You need to consider the TDS for design purpose. The salinity [conductivity based] is a quick but indirect and approximate method of estimating the TDS. Conductivity works on the conductance of ions from the dissolved solids. The conductivity of an ion varies with its charge etc. So the same amount of TDS can give different conductivities depending on the types of dissolved solids. The conversion of conductivity to TDS is done using a make-up "standard" TDS solution that may be widely different in the water you are testing.

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### Question

What is the chlorine value of tap water in the USA? How can you reduce/eliminate the chlorine?

### Answer

In the USA and Canada, the amount of chlorine in water is 0.2 to 1 ppm. Chlorine can be removed by using an activated carbon system or cartridges.

## Reverse Osmosis Membranes Questions & Answers

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### Question

Is it possible to recover an old membrane after a long time of inactivity and without water (dry)? If it is possible, how we clean it and with which product ?

### Answer

Most likely the membrane is damaged and will not work. You may try cleaning with AM-11.

# Water Tech Resource Guide

## Question

We are considering charging $N_2$ thru the permeate of an RO array in an attempt to reduce overall pressure drop by killing organic growth from the surface of the membranes. To some degree we do reduce the delta by 10-12psi, but does this harm conventional Thin Film membranes if this procedure is done frequently over time?

## Answer

As long as there is no shock to the membranes, such as sudden pressurization and depressurization, there is no adverse effect on the membranes.

## Question

Can a membrane be flushed with a water temp of 80 degrees C? If not, what is the maximum temperature possible?

## Answer

The elements of a membrane cannot withstand temperatures above the rated maximum of 45 degrees C. Anything higher than the maximum would destroy the elements of the membrane. If a higher temperature is needed, we recommend Filmtec's "Heat Sanitizable" membrane.

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## Question

How can I remove the black growth on the unused Cellulose Acetate membranes?

## Answer

The black growth at the end sections of the unused membrane elements is MOLD. The mold can be removed by soaking the membrane in water solution containing 0.2 weight percent Glutaraldehyde. Adjust pH to 5.5 for a period of 30 minutes.

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## Question

What is the lifetime of an M-T1812A50 Membrane? Can we use AM-11 to clean our filter?

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## Answer

AM-11 is generally used for cleaning larger membranes but some companies use them also to clean smaller residential membranes. It is difficult to predict the effectiveness of these chemicals, because each fouling situation is different. You will have to try these for your situation to determine the economic viability of cleaning small membranes.

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## Question

Is it possible to store Filmtec 8040 membranes in formaldehyde after pulling them out of our RO unit that will be down for a long period of time?

## Answer

As long as formaldehyde is not used in the first 24 hours of running the elements, storing these elements in formaldehyde is acceptable. A solution of 0.5% is recommended. No other aldehyde is acceptable for this purpose.

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## Question

Will membranes operate at a temperature greater than 45°C (113°F)?

## Answer

Thin Film Membrane Elements are not designed to support the temperature higher than 45°C (113°F). It does not mean that the elements cannot exceed the maximum temperature limit of 45°C. However, a greater potential for element damage exists as the temperature increases above 45°C, and the warranty is void. In order to operate or clean at high temperatures, high-temperature or heat-sanitizable elements with different materials of construction are recommended. We currently offer Filmtec heat-sanitizable elements that can be heat-sanitized up to 85°C (185°F).

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## Question

How long can I expect commercial membranes to last in my system?

## Answer

Membrane life is a function of feed water source, pretreatment, frequency of cleaning, system design, and operating conditions. For economic analysis, a 5 year life is normally used.

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## Question

What is the difference between Thin Film & CTA Membranes?

## Answer

CTA (Cellulose Triacetate) membrane is a paper by-product membrane bonded to a synthetic layer. CTA membranes are made to allow contact with chlorine in the water. These require a small amount of chlorine in the water source to prevent bacteria from forming on it. CTA membranes have a rejection rate of 85-95%.

TFC (Thin Film Composite) membrane is made of a synthetic material, and requires chlorine to be removed before the water enters the membrane. Chlorine will cause irreversible damage to a thin film membrane element - for this reason, carbon filters are used as pre-treatment in all residential reverse osmosis systems using TFC membranes. A Thin Film membrane has a higher rejection (95-98%) and longer life than the CTA membrane.

---

## Question

How Often is Membrane Cleaning Recommended?

## Answer

For commercial membranes (2"Dia. and Larger): Generally, it is recommended to clean an RO plant when a 10% decrease in normalized flux can be observed. For orientation, cleaning frequency can be in the range of 4/year with an SDI of less than 3. With an SDI of 5, the cleaning frequency could double. However, cleaning frequency will depend on the specific situation. Residential membranes (1.8" Diameter and Smaller) are typically not cleaned, as the cost of cleaning is greater than the cost of replacement.

---

## Question

Can Thin Film RO membranes tolerate chlorine?

## Answer

Chlorine will oxidize the surface of thin film composite polyamide membranes, causing the membrane to lose its ability to repel or reject salts.

Thin film membranes can tolerate up to 1000 ppm-hours of chlorine. Traces of metals will accelerate oxidation. Therefore chlorine should be removed from the RO feed water.

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## Question

What is the difference between tap & brackish water membranes?

## Answer

There is no difference in the membrane material. Brackish water membranes have an outer shell of fiberglass whereas Tap water have a tape wrap. The construction allows Brackish water membranes to be operated at higher pressures required to treat brackish water.

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## Question

What are the differences of different types of membranes? Are all membranes of the same type (e.g. TFC) from different manufacturers the same? (example: an oil filter by Toyota is different from that of Mitsubishi).

## Answer

You are right. These are very similar in construction and performance. Like other products, the main difference is in the reputation and reliability of the manufacturer. However, because there are different manufacturers, membranes do come in several end type configurations depending on the manufacturer. When ordering vessels, you will need to specify what brand of membrane you plan on using so the appropriate end adapters can be built in. When replacing membranes with a different brand, you should check the membrane specifications to make sure the end configuration is compatible for direct replacement.

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## Question

Why is the performance different in different flow rated residential membranes? (24 gpd, 36 gpd, 100 gpd, etc.) The membranes look the same even the number of times rolled up.

## Answer

The useful area of the membrane material is different in the two sizes. They look the same because of the difference in membrane area is made up by other fabrics.

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## Question

What is the difference between dry and wet membranes?

## Answer

When the thin-film membranes manufactured they are dry. These dry membranes have an indefinite shelf life, when stored properly. Membranes become wet when they are flushed or tested with water. Once wet, the membranes can not be dried. The wet membranes must be preserved to prevent the growth of micro-organisms on them. This is done usually by using a 1-2% solution of sodium metabisulfite. For more details look for information on storing membranes.

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## Question

What are the proper storage conditions & shelf-life for membranes?

## Answer

**Membrane Storage**
Store membranes in a cool area out of direct sunlight. Membrane storage temperature limits are 22°F-113°F (-5.5°C to 45°C)

Preserve in a solution of 2% AM-88 Membrane Preservative, and 20% AM-225 Glycerine. This will not prevent freezing below 32°F, but the crystals are soft and the membrane is not damaged.

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Keep new elements in original packaging.

Examine the preservative in preserved elements every 3 months. If not clear, remove and re-preserve. The pH of the preservative should not drop below 3.

Storage time for preserved elements is 6 months to 1 year.

Storage time for dry (new) elements is unlimited, and these can withstand temperatures below 22°F.

**Membrane Shipping**
Preserve the element in the plastic bag using the recommended procedure. Make sure the plastic bag does not leak and the element is properly identified.

Make sure the preservative solution is correctly labeled.

Protect the element package from physical damage.

**System Shut-Down**
Clean the membranes in the system using the cleaning procedure.

Circulate the preservative solution.

Shut down the system and close valves to prevent air entering the system.

Check preservative once a month.

## Ultraviolet Systems Questions & Answers

### Question

Should I shut my system off when I am not using it?

### Answer

No, the UV system should be left on whether you are using the water or not. The lamps age regardless of the amount of the water drawn through the system. By leaving the unit on, you will eliminate the potential problem of having contamination pass through the system while the unit is off.

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# Water Tech Resource Guide

## Question

Do I need to disinfect my municipal water supply?

## Answer

Our municipalities work very hard to provide safe, disinfected water for their customers. This is quite evident when you consider the difficulties involved in providing safe drinking water through a vast distribution network. If you use water that comes from a municipal water supply and wish to provide your family with an added "peace of mind", then we believe a UV system acts as an inexpensive insurance policy against the possibility of drinking bacteriologically contaminated water.

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## Question

Why do I need to disinfect my water supply?

## Answer

Disinfection is recommended for all water supplies that are not protected by a municipal water source (ex. A private well). Unfortunately, due to the uncertainties that exist with our current water supplies, we can no longer rely on the fact that our water supplies 'may be safe'. By providing your own disinfection, you are taking the responsibility of ensuring the safety of your water supply for you and your family.

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## Question

How does the UV light actually kill microorganisms?

## Answer

UV does not kill microorganisms like chlorine does, but instead UV inactivates them. UV light at a specific wavelength of 254 nm is readily absorbed by the genetic material of microorganisms. The DNA strand is coded with a specific sequence of something called base pairs. The sequence of these base pairs codes for certain characteristics. UV light at 254 nm is readily absorbed at the point on the microorganism's DNA strand which codes for reproduction. A microorganism that cannot reproduce, cannot make colonies and therefore cannot infect when consumed. In other words, the microorganisms have been sterilized or neutered. They will eventually die off.

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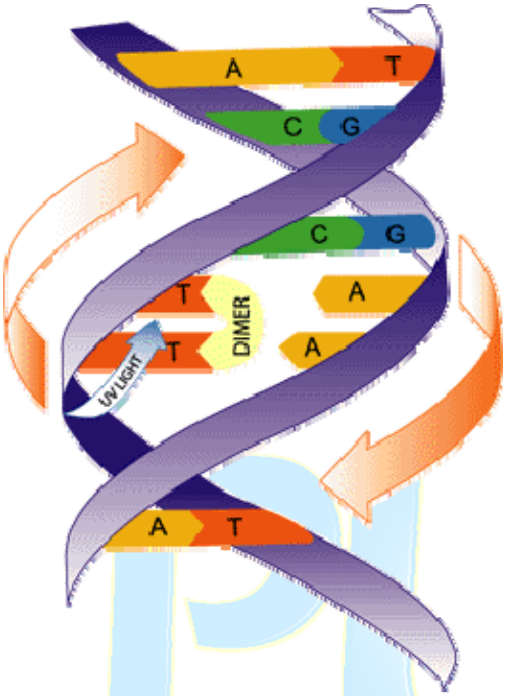
The picture on the left shows a DNA strand of a microorganism. You can see where the UV light is absorbed and how a blockage is formed, causing the microorganism to become sterile.




## Question

Does UV inactivate Cryptosporidium (Beaver fever) and Giardia?

## Answer

Cryptosporidium and Giardia are what is called a protozoan cyst. Protozoa can be described as microscopic, single celled microorganisms which live in water and are quite a bit larger in comparison to other microbes. The majority of protozoan cysts are parasitic. Both Cryptosporidium and Giardia are parasitic. These organisms are in a dormant phase when in water but when they enter a host (being any kind of mammal) they release colonies and begin to breed, ultimately causing severe diarrhea and dehydration over a prolonged period of time.

Cryptosporidium and Giardia were not microorganisms of concern until approximately 10 years ago when Milwaukee was hit with a waterborne disease epidemic. Milwaukee drinking water is surface water, which had become contaminated with high concentrations of Cryptosporidium at the time. Over 100,000 people came down with Cryptosporidiosis and over 400 people died. The USEPA recognized that they needed to consider these organisms and include them within their drinking water guidelines. Testing was done and it was found

that chlorine was NOT effective against either of the protozoa. Testing was then conducted using UV technology with initial failure due to improper test procedures. Ultimately it was proven that UV is in fact very effective against Cryptosporidium and Giardia. The dose levels required to inactivate these cysts are actually quite low; less than 10 mJ/cm² for 99.9% reduction of both Cryptosporidium parvum and Giardia lamblia.

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## Question

Will a UV system kill all microorganisms in my water?

## Answer

All PURfx systems are rated for a 4-log inactivation of bacteria, viruses and protozoan cysts under specific conditions. This rating is at a specific flow rate, and water quality. It is a good idea to have your water microbiologically tested prior to installing a UV system. We do suggest that if your water has bacteria counts in excess of 1000 CFU/10 mL that you do a bit of research with regards to what could be causing such high bacteria counts and that you oversize your UV in order to ensure a high UV dose being delivered to your water supply.

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## Question

Is UV effective against E. coli?

## Answer

Yes, E. coli requires a UV dose of between 6 -10 mJ/cm² to achieve a 4-log inactivation. This is well within the capabilities of PURfx UV systems.

## Question

How do I clean the quartz sleeve?

## Answer

If the quartz becomes stained, remove the sleeve from the reactor chamber and clean the OUTSIDE with a commercially available scale remover, such as Lime-Away or CLR. If the inside of the quartz sleeve does become wet, ensure that it is thoroughly dried before putting the PURfx system back together.

## Question

My lamp is still glowing blue; do I still need to replace it?

## Answer

The UV light that is inactivating microorganisms in water is non-visible light, therefore the blue light that you see coming off a UV lamp is not what's doing the work. A UV lamp can be described as a low pressure mercury vapor lamp, which means it fires via mercury vapor. Over the course of a year that mercury is being used up resulting in a slight decrease of UV intensity. At the end of one year a PURfx UV lamp has decreased in it's intensity by approximately 20%. We strongly recommend that UV lamps be changed on an annual basis.

## Question

What is recommended maintenance for a UV System?

## Answer

# Commercial Reverse Osmosis System Questions & Answers

## Question

What is the difference between element & system recovery?

## Answer

Element recovery: This refers to a single membrane element recovery rate. Element recovery = Permeate flow rate of single element / feed flow rate to the single element x 100%.

System recovery: This refers to a cumulative recovery rate. System recovery = cumulative permeate flow rate of membrane elements in a system / feed flow rate to the system x 100%

For example: Suppose there are two parallel pressure vessels and each pressure vessel contains 6 membrane elements. Feed flow to the system is 100 gpm. Since there are two pressure vessels in parallel, feed flow to each vessel is 50 gpm. The first element in each vessel would see 50 gpm of feed. Suppose the first element produces

5 gpm of permeate water and the whole system produces 50 gpm of permeate water. Then, the first element recovery = 5 gpm / 50 gpm x 100% = 10% while the system recovery = 50 gpm / 100 gpm x 100% = 50%

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## Question

How do I know when to replace elements?

## Answer

Determining when to replace elements is dependent on the type of problem, whether they are fouled, scaled, or damaged.

**Fouled or Scaled Elements**
Thin Film membrane elements can be very effectively cleaned due to their tolerance for wide range of pH and temperature. However, if cleaning is delayed, it becomes increasingly difficult to remove foulants or scales from the membrane surface. Cleaning will be more effective if it is tailored to the specific fouling problem.

Knowing when to replace them is dependent upon what you can tolerate. If your system cannot meet the water quality and/or permeate flow specifications even though you change operating conditions or cleanings do not restore the performance, then it is probably a time to replace the membranes.

Some foulants/scales are nearly impossible to clean off: e.g. aluminum, oil, grease, calcium, barium, or strontium sulfate scale, calcium phosphate. So if an element is fouled or scaled with these, it will need to be replaced.

**Oxidized or Mechanically Damaged Elements**
Such elements cannot be restored as the membrane has been irreversibly damaged. The elements need to be replaced. Elements with moderate telescoping may be still usable.

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## Question

What is shimming?

## Answer

The placement of shims on the adapter within the vessel minimizes movement of the individual membrane elements is called "shimming". This reduces wear-out and mechanical abrasion and subsequent o-ring leakage.

## Question

Will membranes operate at a temp. greater than 45°C (113°F)?

## Answer

Thin Film Membrane Elements are not designed to support the temperature higher than 45°C (113°F). It does not mean that the elements cannot exceed the maximum temperature limit of 45°C. However, a greater potential for element damage exists as the temperature increases above 45°C, and the warranty is void. In order to operate or clean at high temperatures, high-temperature or heat-sanitizable elements with different materials of construction are recommended. We currently offer FilmTec heat-sanitizable elements that can be heat-sanitized up to 85°C (185°F).

## Question

What system recovery should I run at?

## Answer

FAQ Summary:

A general rule is the system can be operated at recoveries of 50% for single stage, 75% for two stage, and 80-85% for three stage systems. % recovery is defined as the ratio of permeate flow to feed flow rate. Parameters such as operating temperature, source of feed, composition of feed, feed concentration, and pH can have an effect on the overall % system recovery and % recovery of individual element. In all cases though, % system recovery is often set to maximize permeate flow while preventing precipitation of super-saturated salts within the membrane system.

## Question

What is pressure drop and why is high pressure drop problematic?

## Answer

Pressure drop is the loss of pressure from the feed end to the concentrate end of a module or a pressure vessel. Under normal operation condition, the pressure drop for a commercial RO membrane element is about 4 to 5 psi (0.3 bar) per element.

(Typical pressure drop through a new home drinking water element is 1 psi at 50 psi feed pressure.)

Pressure drop increases with the extent of fouling. A high pressure drop is problematic because it may lead to telescoping and inefficient operation, and thus a decline in system performance. The maximum allowable pressure drop is 60 psi (4 bar) per 6-element array.

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## Question

How long can I expect commercial membranes to last in my system?

## Answer

Membrane life is a function of feed water source, pretreatment, frequency of cleaning, system design, and operating conditions. For economic analysis, a 5 year life is normally used.

PURfx UV systems require the lamp to be changed on an annual basis (provide they are not installed in a seasonal home). It is suggested that the quartz sleeve be cleaned during the lamp change provided the home is supplied with high quality water (no iron, hardness etc.) otherwise the sleeve should be maintained on a regular basis.

Please NOTE: If the PURfx system you have is monitored (ie. Has a sensor) you must ensure that you clean the sensor eye as well as the quartz sleeve.

All new lamps come with a pair of o-rings. Please replace existing o-rings with the new ones.

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## Question

Is UV light harmful?

## Answer

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You never want to expose your skin or eyes to the light from a UV system. UV light is non-visible however it can be harmful, similar to the harmful effects of UV light from the sun. UV lamps can actually cause a severe sunburn-like effect if skin is exposed for long periods of time.

Always ensure that you are wearing some type of protective glasses (ie. Safety glasses or sunglasses) when working on a UV system and the lamp is exposed. You want to make sure that you do not touch the UV lamp with your fingers as the oil from your hands will form a residue on the lamp and can potentially block UV light.

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## Question

What does "log inactivation" mean?

## Answer

Log inactivation is the inactivation of microorganisms on a logarithmic scale. Microorganisms must be considered on a logarithmic scale due to their high numbers.

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## Question

What is UV dose?

## Answer

UV dose is the energy that is coming off the UV lamp over a specific time period. Therefore, UV dose (or fluence) is a product of UV intensity and time. Dose is usually measured in milli joules per square centimeter. Each PURfx system is rated to disinfect your water at specific flowrate, under specific water quality conditions to give a UV dose of 30 mJ/cm2 at the end of the lamp life (which is one year).

If you were to run say 10 USGPM through a 5 USGPM PURfx system (ie. S5Q-PA) then you would only be receiving HALF the dose that the system is rated at because you doubled the flow. It works the other way as well. If you were to have a 12 USGPM PURfx system installed (ie. S12Q-PA) but you were only running 6 USGPM through it then you would be receiving double the UV dose as you are increasing the water's exposure time to the UV light.

The UV industry standard for dose is 30 mJ/cm2 at the end of lamp life (EOL) however different validation protocols will specify different dose values. Please refer to the compliance page for more information on the various validation dose requirements.

## Question

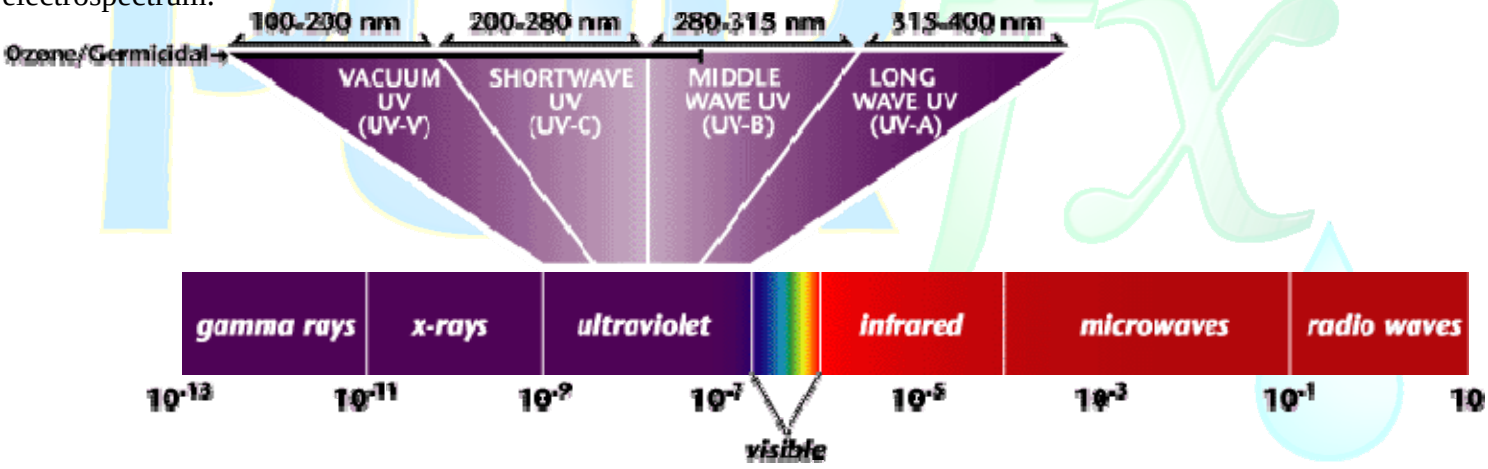
What is UV light?

## Answer

UV light is part of the electromagnetic spectrum, shining at a specific wavelength.

All light is given off at different wavelengths. For example if you see a rainbow, you will notice that the colors are always in a specific order from red all the way to blue. You are able to see each color due to their individual wavelength. These wavelengths are part of the visible portion of the electromagnetic spectrum.

UV light is at a wavelength of 254nm (nanometers), and is not visible to the naked eye. This portion of the electromagnetic spectrum is termed UV-C light or a germicidal wavelength. At this 254nm microorganisms undergo a genetic alteration which ultimately results in inactivation. Below is a representation of the electrospectrum:




UV System manufacturers are able to harness this wavelength of light in UV lamps, which will ultimately disinfect your water.

## Question

Will UV change the taste and/or odor of my water?

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## Answer

No. With chemical disinfection, such as chlorination, the taste and odor of your water will change (depending on chlorine levels water can smell and taste of bleach) and disinfection by-products will be produced. A few examples of chemical disinfection by-products (DBP) are trihalomethanes and haloacetic acid. Both of these DBP's can be carcinogenic when ingested at high levels. The pH and conductivity of drinking water also changes when chlorine is added.

UV is a physical type of disinfection. This means that the UV will have an effect on the microorganisms in the water only. The water will not change chemically, nor will the taste and odor change. The water may elevate in temperature if the water has been left stagnant in the UV reactor (ie. During times of little or no use - during the night).

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## Question

I have colour in my water causing a low UVT, how do I remove it?

## Answer

If you have high colour in your water it is most likely a concentration of tannins. High tannin levels are found in most surface water supplies and some groundwater or simply in waters where large quantities of vegetation have decayed. Unfortunately tannins cannot simply be removed from water by a physical means of filtration.

Tannins can be described as a colloidal suspension as it carries a negative charge and therefore will not simply fall out of solution like turbidity does. Tannins are water soluble, organic compounds formed in the decomposition of organics. It can cause a slight yellowish color to the water and will rapidly decrease the level of UVT in your water as the tannin level increases.

The most efficient way to remove tannins from drinking water is by way of an anion exchange system. Hardness is removed from water via a cation exchange system or softener, as the hardness compounds need to be exchanged with sodium ions in order for the hardness to be removed. Tannin removal systems work the same way but with a slightly different resin than a softener. Softeners exchange cations for cations (positively charged ions, like calcium and magnesium in exchange for sodium ions) and tannin removal systems exchange anions for anions (negatively charged ions like tannins in exchange for chloride ions).

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## Question

# Water Tech Resource Guide

What is UVT?

## Answer

UV transmittance at 254 nm (which is the wavelength of light that UV lamps operate at) is a measure of the fraction of incident light transmitted through the water column. The UV transmittance is the ratio of the light entering the water to that exiting the water. The UVT is usually reported for a pathlength of 1 cm. As UV absorbance increases, the UV transmittance decreases (USEPA UVDGM 2003).

UVT is measured using a spectrophotometer. High levels of color &/or tannins will cause a decrease in the UVT level. If the water cannot transmit the UV light, than the UV cannot disinfect efficiently

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## Question

Does my water require pretreatment before my UV?

## Answer

Yes, you must have your water tested prior to installing a UV systems. Many people feel that if they can fill a glass with water and the water looks clear then that must mean that it is. This is not true. There is more to water than what the naked eye can see. Water flowing through a UV system needs to be free from hardness, iron, turbidity, manganese and color (which can be called tannins). The following is what R-Can recommends for the PURfx UV systems:
Hardness < 7 gpg (grains per gallon)
Iron < 0.3 ppm (parts per million)
Manganese < 0.05 ppm
Turbidity < 1 NTU
UVT > 75%
Tannins < 0.1 ppm
If these levels are exceeded scaling can occur, causing a decrease in the UV system's efficiency as well as an alarm condition if the system is monitored. We always recommend to our customers that they install a 5 micron filter prior to the UV in order to knock down any turbidity that may be present in the water.

We do recommend that if you are drawing from a lake or from some other SURFACE water supply (lakes, rivers, dug well etc.) that a water analysis is ALWAYS done prior to the installation of a UV.

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# Water Tech Resource Guide

## Question

How do I disinfect water lines in my home?

## Answer

A UV system is there to protect your water from pathogenic microorganisms, BUT there is the potential for harmful microorganisms to already be present in the water lines. The water lines then need to be disinfected upon installation of the UV system.

A simple way to introduce a disinfectant (chlorine) into the lines is via the filter. Once the PURfx system has been plumbed in simply remove the cartridge from the filter housing and fill the housing halfway with household bleach (bleach contains 5.25% chlorine). With the PURfx system ON, turn the water on and ensure that at each and every tap a chlorine smell is detected. Leave the bleach in the lines for at least one hour. Drain the chlorine from the lines.

Detailed Disinfection Procedure

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## Question

What is a solenoid valve and can I hook one up to a UV System?

## Answer

A solenoid valve is an electrically-activated mechanical valve that opens and closes when power is applied to it. This kind of valve can be installed and wired into a PURfx system which is monitored. If the UV intensity were to drop below the recommended level the solenoid would then be activated and automatically shut down the flow of water. This will keep contaminated water from getting through the UV system. A solenoid can be hooked up to a PURfx system either by dry contacts (the Platinum, SUV and SUVAM systems all come equipped with dry contacts), or directly into the PURfx system (Silver and GOLD series can be hooked up directly to a solenoid; outside power does NOT need to be brought to the solenoid).

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## Question

Where do I install UV in relation to other treatment equipment?

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## Answer

The UV must be the very LAST piece of water treatment equipment.

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## Question

Will a UV system restrict my water pressure?

## Answer

No, PURfx systems are designed with inlet/outlet ports correctly sized for the specific application. As an example, the 8 USGPM system comes with 3/4" ports. The typical pressure drop on this system would be 2-3 psi.

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## Question

Will UV change the taste and/or odor of my water?

## Answer

No. With chemical disinfection, such as chlorination, the taste and odor of your water will change (depending on chlorine levels water can smell and taste of bleach) and disinfection by-products will be produced. A few examples of chemical disinfection by-products (DBP) are trihalomethanes and haloacetic acid. Both of these DBP's can be carcinogenic when ingested at high levels. The pH and conductivity of drinking water also changes when chlorine is added.

UV is a physical type of disinfection. This means that the UV will have an effect on the microorganisms in the water only. The water will not change chemically, nor will the taste and odor change. The water may elevate in temperature if the water has been left stagnant in the UV reactor (ie. During times of little or no use - during the night).

# Residential RO Systems/Membranes Questions

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## Question

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Can I use Copper Tubing for the RO Product Water?

## Answer

No. Due to RO product water being very pure, it can leach the minerals from copper tubing which will cause a metallic taste in the water or ice, and cause the copper tubing to develop pinhole leaks over time.

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## Question

How Far Can A Line Be Run From the RO System?

## Answer

If using 1/4" Poly tubing: Approximately 20-25 Feet.
Use 3/8" Poly tubing for longer distances.

Tubing for RO product water should always be POLY tubing, not copper.

---

## Question

What does each filter do in a residential RO System?

## Answer

Our AAA series residential reverse osmosis systems are 5-stage systems.

Stage 1 is a 5 Micron Sediment filter, to remove suspended solids such as dirt, dust and rust from the water. This helps to extend the life of the membrane and filters downstream by removing any particles which can clog and damage them.

Stage 2 & 3 are GAC (granular activated carbon) filters to remove chlorine, taste and odor from the water. It is important to have these upstream from the RO membrane in a system, as they remove the chlorine which will damage the membrane if it comes into contact.

Stage 4 is the RO (reverse osmosis) Membrane which removes 98% of the total dissolved solids in the water. This is where the purification takes place.

Stage 5 is a GAC (granular activated carbon) "polishing filter" which the water passes through right before going to the faucet. This helps to improve the flavor of the water, and to remove any taste or odor that the water may have developed while in the storage tank.

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## Question

Do I need a booster pump for my residential RO system?

## Answer

Water pressure is necessary to force the water through the membrane and to flush the rejected solids out of the element, and is directly related to production and quality of filtration. Low pressure can result in low production, low rejection, and premature fouling of the membrane.

The ideal pressure for an RO System is approximately 60 PSI. Generally anything between 40 PSI and 60 PSI is considered acceptable. If your water pressure is below 40 PSI, a booster pump is required to boost the water pressure.

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## Question

Can I use the RO water for my icemaker or refrigerator?

## Answer

Yes. The RO treated water can be run to an icemaker. This can be done by installing a 1/4" tee in the line between the final polishing filter and the faucet. 1/4" POLY tubing should be run to the icemaker.

All tubing for RO water should be POLY tubing. Copper tubing should not be used.

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## Question

Why am I getting very little output from my RO?

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## Answer

Please check the following:

- If the water pressure is below 40 psi, a booster pump may be necessary.
- If the water pressure is above 40 psi, first try to re-tap the tap supply line. This can be done by tightening the self-piercing valve clockwise until it is fully turned, then turn it counterclockwise until it stops. There should open enough space in the line for proper water flow.
- Straighten or repair the tubing
- Check that pre-filters are not clogged. If they are, they will need to be replaced. If membrane is fouled, it will need to be replaced.

---

## Question

How often do I need to change my filters?

## Answer

There is no definite answer to this question, as the feed water conditions and system maintenance will affect filter life. Below is a guideline:

| | |
|---|---|
| Sediment and Carbon Prefilters: | Every 3-6 Months |
| Carbon Post Filter: | Every 3-6 Months |
| | |
| Membrane Element: | Every 12 Months |

---

## Question

# Water Tech Resource Guide

Why is there no water in my storage tank?

## Answer

| Possible Cause | Remedy |
|---|---|
| Filter cartridges have failed | Replace filter cartridges as indicated |
| Cartridges upside down | Install carbon block filter right side up as indicated on the filter. |
| No pressure in storage tank | Check pressure with gauge. Refill or reduce pressure to max. 8 psi. |
| Automatic shut-off malfunctioning | Check lines to valve for correct hook-up and check for water running into drain. Replace if necessary |
| Kinked lines | Straighten lines if necessary |

## Question

Why is the water backing up to the air gap faucet?

## Answer

| Possible Cause | Remedy |
|---|---|
| Line is clogged | Clean out the line |
| Line is too long | Must be as short and straight as possible |
| Drain is clogged | Disconnect the drain line and clean out with probe or by flushing |

## Question

Why is my faucet spout dripping?

## Answer

Possible Cause: The hande is sticking or worn.
Remedy: Replace the faucet.

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# Water Tech Resource Guide

## Question

Why is Water Leaking from the Filter Housings?

## Answer

| Possible Cause | Remedy |
|---|---|
| Filter sumps are loose | Retighten the filter sumps to the caps |
| Burr on edge of filter housing | Remove burr with emory cloth or sand paper |
| O-Ring in filter bowl is missing, damaged, or not seated properly | Replace or position correction |

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