CSI
WATER TREATMENT SYSTEMS

Technical Information

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PURPOSE and CAPABILITIES: An ion exchange water softener is designed to remove (exchange) water hardness ions (calcium & magnesium) from water supplies using specialized softening resin as the catalyst and salt (sodium) as the regenerant. Water passes downwardly through the mineral bed where the ion exchange takes place. Softeners can easily remove upwards of 100 grains per gallon of hardness (depending upon the cubic foot capacity). They can also remove very high quantities (20 ppm+) of ferrous (clear water) iron and manganous (clear water) manganese. HOWEVER, making a softener work this hard may run you into problems of bed fouling and iron/manganese breakthrough. Additionally, the amount of salt required to regenerate resin where iron/manganese is concerned is four times that of hardness. Therefore, removing iron and manganese with a softener consumes a tremendous amount of salt and puts higher levels of sodium into the water . Standard cation exchange water softeners can also remove or reduce Aluminum, Copper {20%-90%}, Zinc, Radium, Barium, Beryllium, Cadmium, Chromium (+3), Lead {20%-90%}, Mercury (+2) {20%-90%}, Nickel and Thallium. **WARNING:** Although softeners can reduce the foregoing water constituents, do not make such claims regarding health-related contaminants. Attempting to handle such problems as those other than basic Hardness, Iron and Manganese requires special testing and equipment application. Always check with CSI before attempting anything other than standard applications!

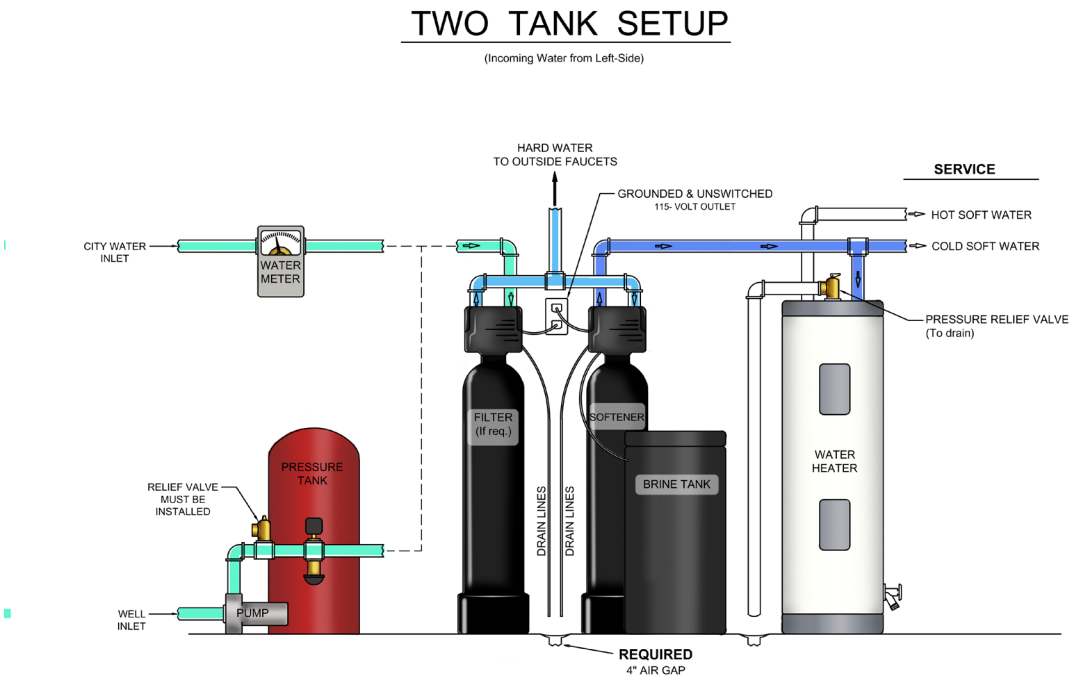
HARDNESS TABLE	
Soft	0 - 3.5 gpg
Moderately Hard	3.5 - 7.0 gpg
Hard	7.0 - 10.5 gpg
Very Hard	10.5+ gpg

NOTE: “gpg” means grains per gallon.

LIMITATIONS: Softeners cannot remove hydrogen sulfide, iron bacteria, tannins, foul tastes, odors & colors nor should they be used to remove anything other than very, very light sediment. Iron bacteria will eventually cause fouling and plugging of the bed. High levels of hydrogen sulfide and chlorine can damage the exchange capacity of the mineral beads. Various size units have different hardness, iron/manganese, service and backwash flow rates. Always consult the specification sheet in order to make a proper selection.

WATER TESTING: Always test the raw water supply for at least the following: 1) Hardness; 2) Iron; 3) Manganese; 4) pH; 5) Tannins; 6) Hydrogen Sulfide {if rotten egg odor is present}; 7) Total Dissolved Solids and 8) Chlorine {if on treated water supply}. Consult specification sheet to check for limitations.

INSTALLATION: Softeners should be installed on a level surface; on cold water line only; after filtration equipment; after outside sillcock lines; and, before the piping splits to the water heater. Below is a diagram of a typical installation.



Never elevate the mineral tank more than 1-2 feet above the brine tank so as not to cause problems with brine draw. Avoid installations in direct sunlight and where freezing may occur. Locate the unit near a 115V, unswitched outlet (except manual units that require no electricity) and near a drain. Where the drain line must be elevated above the system or runs for more than 20 feet, increase the drain line size to 3/4". NEVER decrease the size of the drain line! It is advisable (and code in most areas) that there be at least a 4" air gap between the drain and drain line. Check all local codes before installing equipment.

PROGRAMMING THE SYSTEM: After all plumbing has been completed according to the installation instructions, find the section in the instructions regarding programming the control valve. It is quite simple but you must first consult your water test results. You have determined the amount of hardness, iron, manganese, etc. Remember that iron and manganese must have special consideration. To calculate "Compensated Hardness," add the total of iron and manganese together and multiply by four (4). Add this answer to the amount of hardness (in grains per gallon) to arrive at compensated hardness. Use this number when programming either a Timeclock or Demand initiated control valve. It is always advisable to both disinfect the unit and test the system cycles. Consult the installation instruction manual.

REGULAR MAINTENANCE: All that's necessary for normal softener maintenance is to keep good quality softener salt in the brine tank. Where iron/manganese are also being removed, it is a good idea to occasionally use either a resin cleaner (Res-Care) or a bag of salt that has rust inhibitor in the formulation. Some prefer to use this type of salt instead of standard salt. That's fine, but it is more costly. If iron bacteria has entered the system, you will need to put the system through one or more regenerations using 5.25% sodium hypochlorite (standard household bleach). Adding a 1/4 cup of bleach to the system brine tank prior to regenerating will usually suffice. Do not use more bleach than this, as it can permanently damage the softening resin.

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PURPOSE and CAPABILITIES: Standard whole house (point-of-entry) water filters can be used to solve many different water problems for the home, business or farm. All work on the same principle of downflow treatment. Filtration media are granular in design so that the granules nest tightly together to provide for excellent compaction and filtration. After a period of time, they simply backwash (upwardly through the media to drain). The differences are the size of tank and media selection. See the Filter Media Selection Guide for the various media and their applications. Residential filter tanks are available in 9, 10, 12, 13, 14 and 16 inch diameters. All must have either a Vortech plate, “D” gravel or Garnet Sand underbed to insure a proper distribution system for both service and backwash modes.

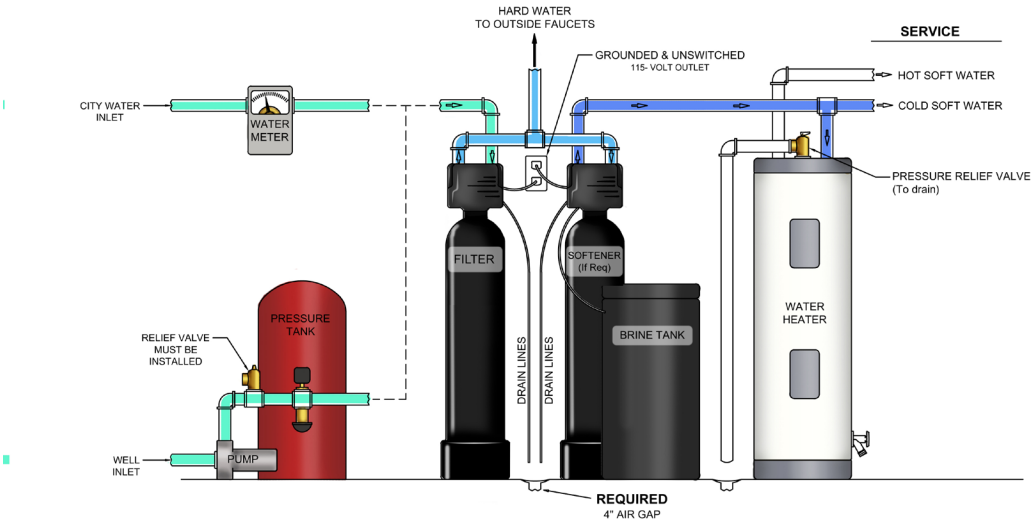
Various medias are available for handling problems such as Turbidity (sediment), Iron, Manganese, Hydrogen Sulfide, low pH, Taste, Odor, Color, Chlorine and Organics reduction. All but the Greensand Plus units operate without the use of chemicals. They simply backwash, rinse then return to service position.

A specialized filter is the Upflow System. It has no control valve, instead, a simple “INLET” / “OUTLET’ manifold. It works exactly the opposite of the standard “downflow” filters. Water enters the unit first running down the distributor tube then UP through the media. This means that it is not designed to handle sediment! Since the flow is upward, the granules do not compact to provide the desired straining effect needed for sediment removal. The only media that you would ever use in Upflow filters are Neutralizer and Activated Carbon. Again, refer to the Filter Media Selection Guide for more information on media selection. Always check with CSI before attempting anything other than standard applications!

LIMITATIONS: An automatic downflow filter must have sufficient water flow rate supplied to it for proper backwashing to take place. It is, therefore, critical to test the output capacity of the pumping or water supply system before making a selection. It is often the case that filters require more water for backwash than they can offer in treated, service flow. Another limitation is that of service flow. If you attempt to get too much water through a filter, one of two things will happen. First, the water may not be completely treated leaving stains, odors, etc. in the finished service water. Secondly, there may be tremendous pressure drop across the filter bed if too much water is forced through the filter. Proper sizing is critical! Check the individual specifications sheets for backwash requirements and service flows.

FILTER SETUP

(Incoming Water from Left-Side)



HOW TO DETERMINE PUMP CAPACITY

1. Open any faucet and run until pump turns “on.”
2. Close faucet and let pump fill pressure tank and turn “off.”
3. Open any faucet and collect all water discharged until pump turns “on.”
4. When pump turns “on,” immediately close faucet and start timing pump cycle.
5. When pump turns “off,” record cycle time to refill pressure tank (in “seconds”).
6. Measure total number of “gallons” collected in step #3.
7. Divide the number of “gallons” collected in step #3 by the number of “seconds” in step #5.
8. Multiply the answer derived in step #7 by “60.”
9. The answer in step #8 is the average pumping capacity of the system.

(Note: Make certain no other water is being used during this test)

Example

Number of “gallons” collected during draw-down (step #3) = 9
Number of “seconds” in pump cycle to refill tank (step #5) = 72
GPM = (gallons collected / seconds in cycle) X 60
GPM = (9 / 72) X 60
GPM = .125 X 60
GPM = 7.5
(Simply select a filter requiring 7.5 gpm, or less, backwash)

WATER TESTING: Always test the raw water supply for at least the following: 1) Hardness; 2) Iron; 3) Manganese; 4) pH; 5) Tannins; 6) Hydrogen Sulfide {if rotten egg odor is present}; 7) Total Dissolved Solids and 8) Chlorine {if on treated water supply}. Consult specification sheet to check for limitations.

INSTALLATION: Filters should be installed on a level surface; on cold water line only; typically after outside sillcock lines; before softeners; and, before the piping splits to the water heater. Above is a diagram of a typical installation. Avoid installations in direct sunlight and where freezing may occur. Locate the unit near a 115V , unswitched outlet (except manual units that require no electricity) and near a drain. Where the drain line must be elevated above the system or runs for more than 20 feet, increase the drain line size to 3/4 “. NEVER decrease the size of the drain line! It is advisable (and code in most areas) that there be at least a 4” air gap between the drain and drain line. Check all local codes before installing equipment.

PROGRAMMING THE SYSTEM: After all plumbing has been completed according to the installation instructions, find the section in the instructions regarding programming the control valve. It is quite simple but you must first consult your water test results. You have determined the pH, amount of iron, manganese, etc. It’s typical to set filters to backwash from every 3 to 6 days. It is always advisable to both disinfect the unit and test the system cycles. Consult the installation instruction manual.

REGULAR MAINTENANCE: All that’s necessary for normal filter maintenance is regular backwashing. If iron bacteria has entered the system, you will need to remove the control valve and add 1/2 cup 5.25% sodium hypochlorite (standard household bleach), leave it sit for at least 30 minutes then backwash. If this doesn’t sufficiently clean the medium, a replacement bed will be necessary. You’ll need to replace and/ or replenish media according to the **Filter Media Selection Guide.**

Filter Media Guide

Media	Ship Wt. (lbs)	Description	Handles...	Used in...
SmartBlend SB75 SB10	 45 61	Granular / White-Black / Blend of Filter Ag Plus and Katalox Light / Max life expectancy about 8-10 years but is dependent upon pH	Sediment Iron (clear & red) Manganese (clear & red) Sulfur Particles	Nitro and Nitro Pro Reactr and Hydroxr Sidekick
Neutralizer NE50 NE75 NE10	 50 64 85	Granular / White / Sacrificial to water with pH, 7.0 / Max pH correction to 7.2 / Lowest pH application 5.8 / Must be replenished about every 6 months to 1 year	Sediment (downflow) pH correction	WF Filter Upflow and Optimizer
Neu-Cor™ NC75 NC10	 62 82	Granular / Semi-round / White & Off-white / 70%-30% Blend of Neutralizer & Corosex® must be replenished on a regular basis since both components are sacrificial to low pH / Use on pH levels as low as 5.0	Sediment (downflow) pH Correction	WF Filter Upflow and Optimizer
Corosex® CX75 CX10	 79 103	Semi-round / Off-White / Magnesium Oxide / Extremely reactive to pH dissolving rapidly adding alkalinity / NEVER use 100% Corosex® in a filter as it will "cement" / 30% Corosex® - 70% Neutralizer is best blend for correcting low pH / Will raise pH from lows around 5.0 to as high as 9.0+ / Must be replenished frequently / consult factory with specific application questions	Sediment (downflow) pH Correction	WF Filter Upflow and Optimizer
Coconut Shell Carbon CN75 CN10	 22 30	Black / High carbon-low ash content. Practical for ordinary taste, odor and chrlorine loads. Will impart a high "polish" to the filtered water.	Taste/Odor/Chlorine	WF Filter Upflow and Optimizer
Activated Carbon AC75 AC10	 21 28	Granular / Black / Wide application for removal of organics and some inorganics / Must be replaced on a regular basis / Life expectancy varies based on use	Sediment Taste/Odor/Color Chlorine/Iodine	WF Filter Upflow and Optimizer
Catalytic Carbon CC75 CC10	 26 34	Granular/Black / enhanced activated carbon that has a higher catalytic power which produces an increased electron transfer for better absorption.	Sulfur Removal Chloramines	WF Filter Nitro and Nitro Pro City Softener
Filter Ag® FA75 FA10	 21 28	Granular / Off-White / Wide application for removal of sediment / Life expectancy is unlimited	Sediment	WF Filter
Filter Ag Plus FP75 FP10	 37 50	Light tan to white, 5 micron filtration	Sediment	WF Filter
Birm® BM75 BM10	 37 29	Granular / Gray / Must not be used on waters with a pH < 6.8 / Must have dissolved oxygen present at a level of at least 15% of iron & manganese ppm / Max iron & manganese level 10 ppm / Estimated life about 8-10 years	Sediment Iron (clear & red) Manganese (clear & red)	WF Filter, Reactr
Greensand Plus GP75 GP10	 63 85	Granular / Black / Must not be used on waters with a pH <6.8 / Must be regenerated with potassium permanganate on a regular basis / Max iron & manganese level 10ppm/ Max H2S level 3ppm / Estimated life about 8-10 years	Sediment Iron (clear & red) Manganese (clear & red) Hydrogen Sulfide	IF Filter
GT10	42	Arsenic Media	Arsenic III and V	WFA Filter
"D" Gravel DG20 DG50	 20 50	Semi-Round / Brown / #20 Flint / Used as underbed for all media in all filters providing for excellent flow distribution in both service and backwash modes / Permanent unless fouled but can be cleaned and re-used.	Underbed	All Non-Vortech Filter Tanks

Filter Media and Gravel are shipped in convenient reusable buckets.

The following information is **not** intended to replace attending technical training programs or reading of installation instructions. It should be viewed as a general discussion about the product, its application, limitations and key factors to remember before purchase.

The Nitro & Nitro Pro Single Tank Aeration Systems

How The **Nitro & Nitro Pro Works**
The Nitro™ and Nitro Pro™ single tank aeration systems use a chemical process called oxidation to convert clear ferrous iron/manganous manganese and sulfur gas to physical particles (precipitants) that can be mechanically filtered by the SmartBlend™ filter media. They each accomplish this by maintaining a head of air in the top portion of the media tank and as raw water enters the unit, it falls through the head of air exposing the contaminants to oxygen. Using ambient air as an oxidant allows treatment of contaminants without the use of chemicals and/or regenerates like salt, chlorine or potassium permanganate. The precipitants are then periodically backwashed out of the Nitro™ filter to drain (usually every 6 days), cleaning and reorienting the filter bed. This is accomplished automatically by use of the Signature 2 control valve.

All Signature 2 control valves are now equipped with Bluetooth™ technology to provide operating history information and ease of programming functions through the LegacyView™ app available for both Android™ and iOS™ (Apple) devices.

The Nitro Pro™ has the added feature of being able to add the OXY-08NP Oxyclean Option to automatically introduce chlorine or hydrogen peroxide through the media bed during the backwash cycle without the use of a chemical feed pump. This can help to prevent fouling of the media bed by iron/sulfur bacteria or tannins. Oxyclean NP chemical injection is accomplished with the use of the TWEDO™ (Twin Electronic Drive Operation) function (patents pending) included on the Nitro Pro™ Signature Series 2 control valve. This industry-first operation decouples the main piston drive from the Oxy-clean valve (brine valve) which is opened during chemical draw. The Oxyclean Option is recommended whenever the iron level is above 3 ppm and/or there are known or suspected iron/sulfur bacteria or tannin issues.

The included Smart Blend™ filter media is comprised of a proportioned mixture of two (2) different types of media: (1) Filter Ag Plus™ & (2) Manganese Dioxide media. The Filter Ag Plus media does an excellent job of physically filtering out turbidity and suspended solids (down to between 3-5 micron in size) and is very light, so it is easily backwashed. The Manganese Dioxide media is added mainly to act as an insurance policy against iron, manganese & sulfur odor bleed through, especially during periods of high water demand or fluctuating contaminant levels, both of which, reduce contact times. The Manganese Dioxide media will use the existing dissolved oxygen in the water to maintain a regenerated state and assist in the oxidation process. It will also correct low pH from a low of 6.0 to above neutral 7 with no replenishing of media required.

Due to the counterproductive increasing of the pH when treating sulfur, a special “S” unit has been developed which utilizes Catalytic Carbon as the primary media bed with specially formulated foam cubes impregnated with KDF™ media placed on top. This media combination gives an increased capability for sulfur gas reduction when iron levels are low.

Oxygen from the air pocket in the top of the media tank will slowly be depleted over time and will need to be replenished by the Signature Series 2 control valve. This is accomplished automatically one of two ways; either by (1) the Air Replenish Cycle, where by the control valve replenishes the air without going through a full backwash and rinse (this saves THOUSANDS of gallons of water per year over the competition) or (2) the Backwash Cycle, which will replenish the air as part of a full backwash and rinse cycle. This also cleans the media bed of any accumulated precipitants and re-orients the media bed in the event that channeling has occurred. Air draw for the Air Replenish Cycle is provided by an external air educator that pulls free air in and injects it directly into the top of the media tank. This helps minimize ferric iron build up within the control valve body. The Nitro™ or Nitro Pro™ can be used on any type of pumping system (sub-mersible, constant pressure, jet pump, etc.) as air draw for the Air Replenish Cycle will occur as long as the inlet pressure is at least 30 psi. The programming function for the initial set up (which can be set using the manual buttons on the control valve face or with your device through the Legacy View App) will allow the Time of Day, AM or PM, Days Between Backwash & Days Between Air Replenish to be set. The different cycle steps for each are as follows:

Nitro / Nitro Pro Cycle Steps

Air Replenish Cycle Only

Step 1 – Air Release - 6 min.-non-adjustable
Step 4 – Air Replenish - 20 min.-adjustable
Step 5 – Rapid Rinse - 5 min.-adjustable

Nitro Full Backwash/Rinse Cycle

Step 1 – Air Release - 6 min.- non-adjustable

Step 2 – Backwash - 10 min.- adjustable
Step 3 – Rest - 5 min.- adjustable
Step 4 – Air Replenish - 20 min.- adjustable
Step 5 – Rapid Rinse - 5 min.- adjustable

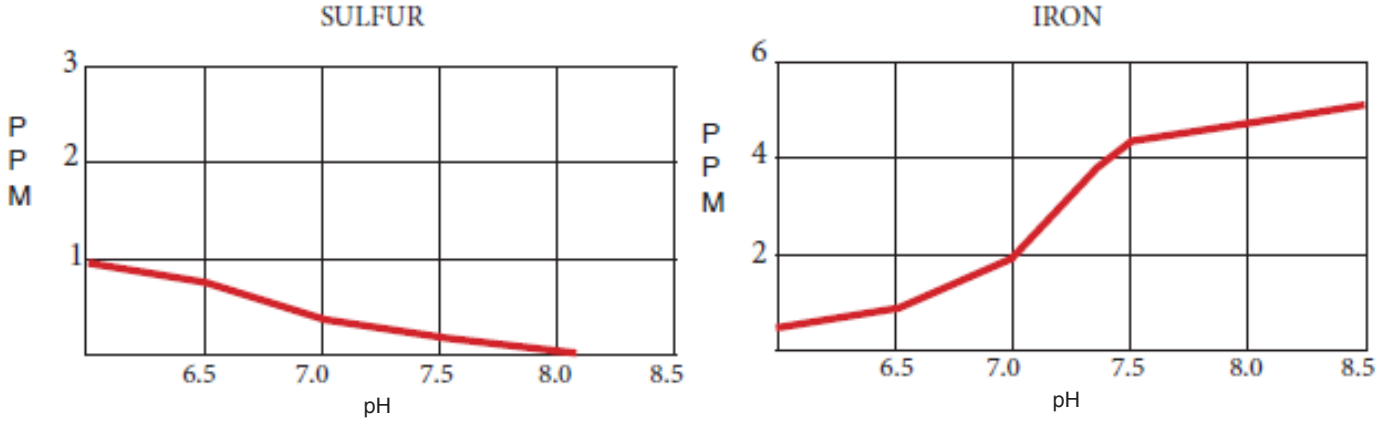
Nitro Pro Full Backwash / Rinse Cycle

Step 1 – Air Release – 6 min. – non-adjustable
Step 2 – Oxyclean NP Injection – 15 seconds – non-adjustable
Step 3 – Short Rinse – 1 min. – non-adjustable
Step 4 – Rest – 20 min. – non-adjustable
Step 5 – Backwash – 10 min. – adjustable
Step 6 – Rest – 5 min. – adjustable
Step 7 – Air Replenish – 20 min. – adjustable
Step 8 – Rapid Rinse – 5 min. – adjustable

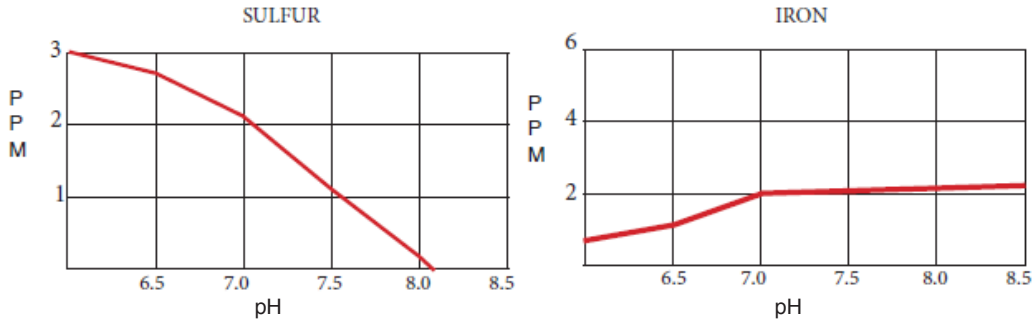
Nitro/Nitro Pro - Total Water Used During Cycle

Air Cycle Only	Nitro Full Backwash/Rinse	Nitro Pro Full Backwash/Rinse
NTF15/NTP15 – 31 gals.	NTF15 – 106 gals.	NTP15 – 111 gals.
NTF25/NTP25 – 41 gals.	NTF25 – 146 gals.	NTP25 – 153 gals.

Nitro™/Nitro Pro™ Contaminant Reduction Limitations



Nitro™ "S" /Nitro Pro™ "S" Contaminant Reduction Limitations



As you can see from the above limitation chart, the pH of the untreated water is the determining factor regarding the quantity of iron and sulfur gas the Nitro & Nitro Pro can handle comfortably. The higher the pH level is (up to about 8.0-8.3 maximum), the more quickly iron will oxidize and precipitate so it can be filtered*. When dealing with sulfur gas the direct opposite is true. The lower the pH level, the more quickly sulfur will oxidize and precipitate.

* Note: If the pH approaches 8.3 or above, iron can become colloidal which will be too small of a particle to be physically filtered and can cause the water to be discolored. If pH is being raised artificially with a chemical feed pump injecting soda ash prior to the filter, caution must be taken not to get the pH level too high. If lowering of the pH level is desired (for more effective treatment of sulfur gas), use of a chemical feed pump injecting citric acid or distilled white vinegar prior to the filter works well.

In cases where manganese treatment is also involved, the iron to manganese ratio in relation to the raw water pH must be considered. As a rule of thumb, at a pH of 7.0, an iron to manganese ratio of at least 10 to 1 is desired. This means if you have 1 ppm of manganese, you will want to have at least 10 ppm of iron to effectively get the manganese to oxidize and precipitate along with the iron. For other iron to manganese ratios and required pH levels, please see the following table:

If the Iron to Manganese ratio is:	Then the pH must be at least:
10:1	7.0
5:1	7.8
1:1	8.3
0:1	8.5

Of course, if the filter will be followed by a water softener to reduce the hardness, the above manganese rule is not as critical as the softener will reduce any residual manganese that may possibly get through.

Nitro™ / Nitro Pro™ Sizing

To properly size the Nitro™ or Nitro Pro™, the well pump capacity in gallons per minute (gpm) must be known. The most critical component during sizing is assuring there is adequate flow to properly backwash and clean the filter system. Service flow rate considerations are secondary.

Sizing Step 1 – Calculate the average well pumping capacity using the test procedure in the Filter Technical Information Guide.

Sizing Step 2 – Choose the Nitro™ or Nitro Pro™ model(s) that can be backwashed with the available well pump flow rate (see specs below).

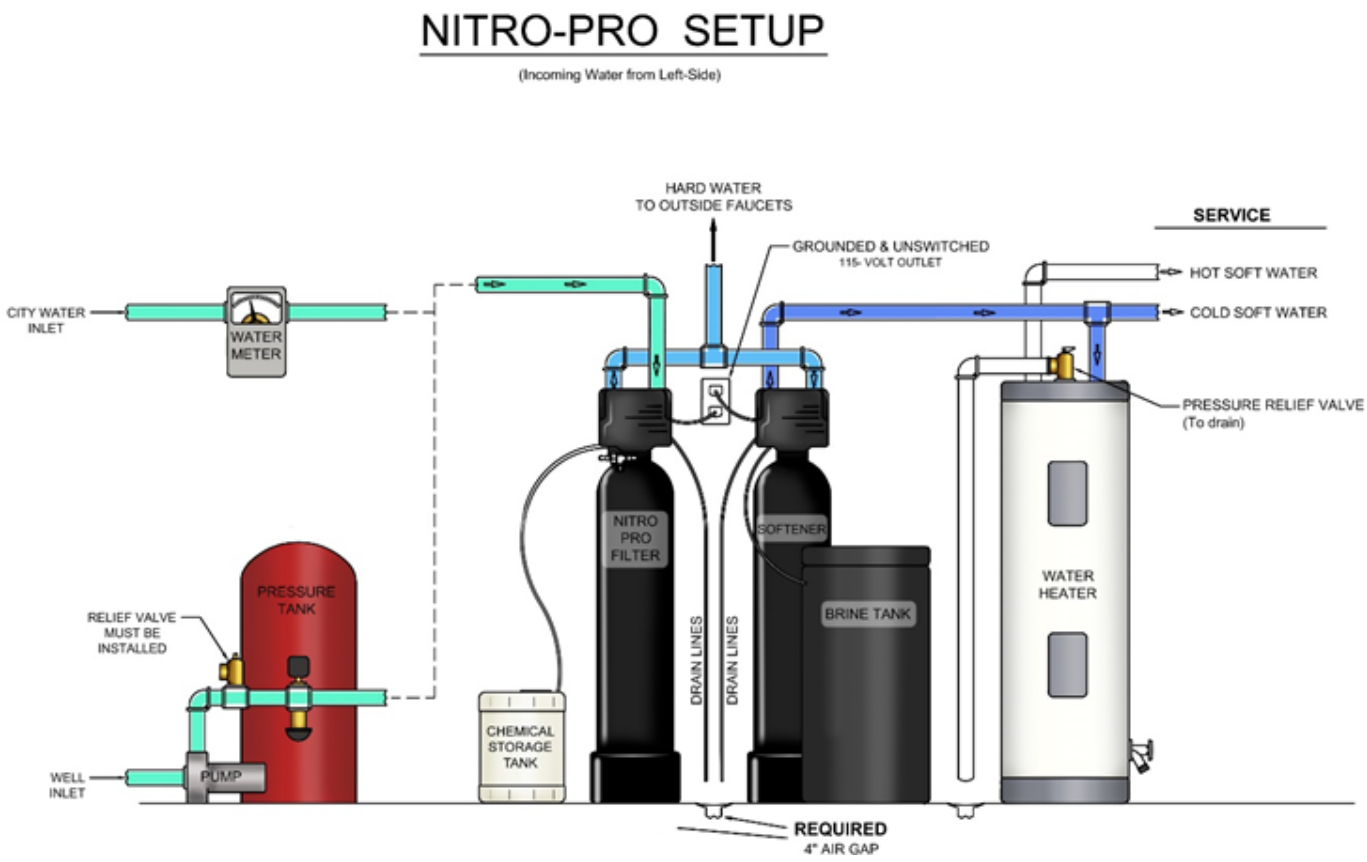
Sizing Step 3 – Choose the Nitro™ or Nitro Pro™ model that will give the service flow rate desired (see specs below).

General Specifications	NTF15 / NTP15	NTF25/NTP25
Filter Media Type	SMART BLEND™	
Filter Media Capacity (cu ft)	1.5	2.5
Mineral Tank (Vortech ™)	10 X 54	13 X 54
Service Flow Rate - Continuous (gpm)	5	8
Service Flow Rate - Intermittent (gpm)	7	10
Backwash Flow Rate (gpm)	5.0	7.0
Gallons Used / Backwash	106	146
Space Required	10 X 10 X 62	13 X 13 X 62
Approximate Shipping Weight (lbs)	145	221

Nitro™ / Nitro Pro™ Required Maintenance

The simplicity and cost saving economics of single tank aeration technology doesn't come without a couple of tradeoffs. The first is the fact that the control valve is, for the most part, constantly in a head of air. This can create maintenance issues not experienced by older generation type iron filters. The most pronounced issue is the potential drying out of the rubber seals and also iron accumulation in the valve spacers, both of which can cause potential control valve piston jams. This condition WILL cause damage to the control valve and system failure!! Due to this inherent problem in ALL similarly designed single tank systems on the market, it is REQUIRED to replace the control valve seals & spacers annually. For this reason, every new Nitro™ / Nitro Pro™ system includes one seal & spacer kit (Part # 20561X253) for the first change out.

Typical Nitro™ / Nitro Pro™ Installation



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The Sidekick™ Single Tank Aeration System

How The Sidekick™ Works

The Sidekick™ single tank aeration system uses the same chemical oxidation process as the Nitro™/ Nitro Pro™ to convert clear ferrous iron, manganous manganese and sulfur gas to precipitants that can be physically filtered. Each system accomplishes this by maintaining a head of air in the top portion of the media tank and as raw water enters the unit, it falls through the head of air exposing the contaminants to oxygen. The precipitants are then periodically backwashed out of the filter to drain (usually every 6 days). This is accomplished automatically by use of the Signature 2 Bluetooth™ equipped control valve. The Sidekick™ also has the added feature of being able to add the OXY-08NP Oxyclean Option to automatically introduce chlorine or hydrogen peroxide through the media bed during the backwash cycle without the use of a chemical feed pump. But this is where the similarity to the Nitro™ / Nitro Pro™ ends!!

Remember the annual seal and spacer kit replacement required for the Nitro™ / Nitro Pro™?
This is NOT REQUIRED for the Sidekick™!! In fact, due to the innovative design all iron, manganese & sulfur contamination passes through the Signature 2 control valve in an UNOXIDIZED state on their way to the Sidekick™ filter, where the actual oxidation occurs. This keeps the Signature 2 control valve internal parts clean & free of iron accumulation which is the number one cause of mechanical failure for ANY type of iron filter, not just a single tank system. Along with the optional Oxyclean Option that is available, there is the optional OXY-03 Ozone Complete to replenish with ozone instead of air, if desired. Ozone is comprised of three atoms of oxygen (O3) instead of two (O2) making it an extremely powerful oxidant in comparison. The Ozone Complete compact package includes an integral air dryer (evaporator) for maximum ozone production.

The included Smart Blend™ filter media is comprised of a proportioned mixture of two
(2) different types of media: (1) Filter Ag Plus™ & (2) Manganese Dioxide media. The Filter Ag Plus™ media does an excellent job of physically filtering out turbidity and suspended solids (down to between 3 - 5 micron in size). The Manganese Dioxide media is added mainly to act as an insurance policy against iron, manganese & sulfur odor bleed through, especially during periods of high water demand or fluctuating contaminant levels, both of which, reduce contact times. The Manganese Dioxide media will use the existing dissolved oxygen in the water to maintain a regenerated state and assist in the oxidation process. It will also correct low pH from a low of 6.0 to above neutral 7 with no replenishing of media required.
Due to the counterproductive increasing of the pH when treating sulfur, a special “S” unit has been developed which utilizes Catalytic Carbon as the primary media bed with specially formulated foam cubes impregnated with KDF™ media placed on top. This media combination gives an increased capability for sulfur gas reduction when iron levels are low.

Oxygen from the air pocket in the top of the media tank will slowly be depleted over time and will need to be replenished by the Signature Series 2 control valve. This is accomplished automatically one of two ways; either by (1) the Air Replenish Cycle, where by the control valve replenishes the air without going through a full backwash and rinse (this saves THOUSANDS of gallons of water per year over the competition) or (2) the Backwash Cycle, which will replenish the air as part of a full backwash and rinse cycle. This also cleans the media bed of any accumulated precipitants and re-orients the media bed in the event that channeling has occurred. Air draw for the Air Replenish Cycle is provided by an external air educator that pulls free air in and injects it directly into the bottom of the media tank. This eliminates any contaminant oxidation in and around the Signature 2 control valve body. Just like the Nitro™ or Nitro Pro™, the Sidekick™ can be used on any type of pumping system (submersible, constant pressure, jet pump, etc.) as air draw for the Air Replenish Cycle will occur as long as the inlet pressure is at least 30 psi. The programming function for the initial set up (which can be set using the manual buttons on the control valve face or with your device through the LegacyView app) will allow the Time of Day, AM or PM, Days Between Backwash & Days Between Air Replenish to be set.

Backwash & Days Between Air Replenish to be set. The different cycle steps for each are as follows:

Sidekick™ Air Replenish Only Cycle Steps

Step 1 – Air Release – 6 min. – non-adjustable
Step 7 – Air Replenish (or Ozone) – 20 min. – adjustable
Step 8 – Rapid Rinse – 5 min. - adjustable

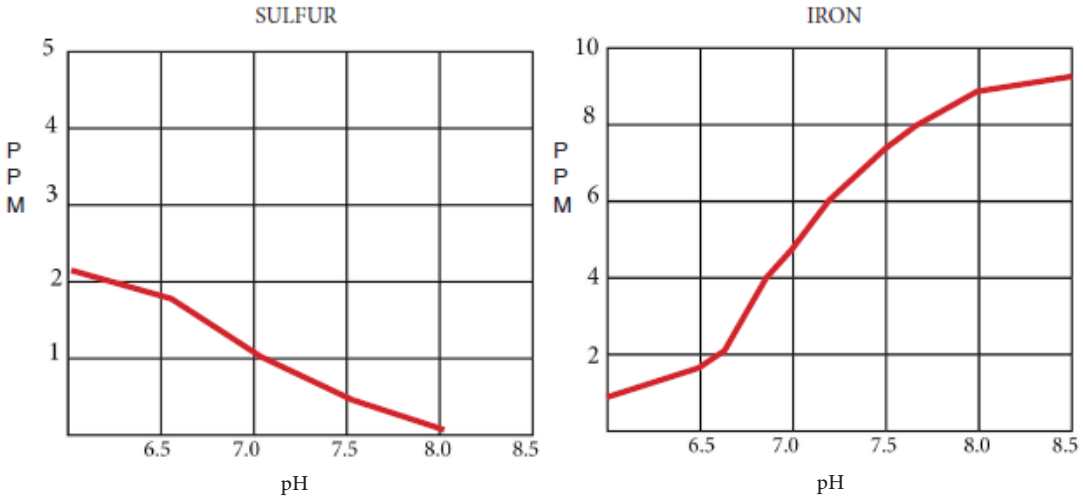
Sidekick™ Full Backwash & Rinse Cycle Steps

Step 1 - Air Release - 6 min.- non-adjustable
Step 2 – Oxyclean NP Injection – 15 seconds – non-adjustable
Step 3 – Short Rinse – 1 min. – non-adjustable
Step 4 – Rest – 20 min. – non-adjustable
Step 5 – Backwash – 10 min. – adjustable
Step 6 – Rest – 5 min. – adjustable
Step 7 – Air Replenish (or Ozone) – 20 min. – adjustable
Step 8 – Rapid Rinse – 5 min. - adjustable

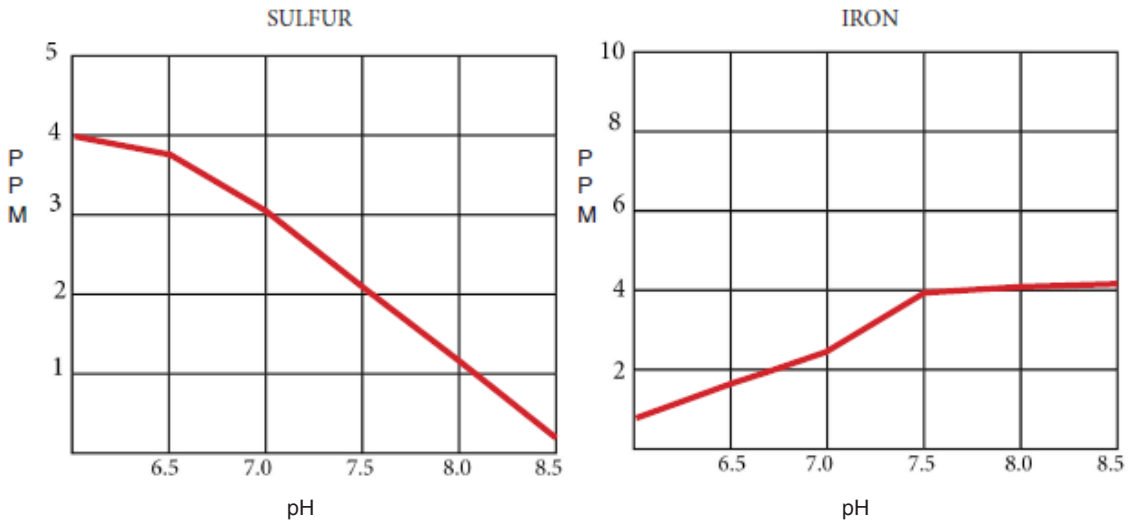
Sidekick™- Total Water Used During Cycle

Air Cycle Only	**Full Backwash/Rinse**
SK15 – 40 gals.	SK15 – 95 gals.
SK25 – 52 gals.	SK25 – 129 gals.

Sidekick™ Contaminant Reduction Limitations



Sidekick™ "S" Contaminant Reduction Limitations



As you can see from the above limitation chart, the pH of the untreated water is the determining factor regarding the quantity of iron and sulfur gas the Sidekick™ can handle comfortably. The higher the pH level is (up to about 8.0-8.3 maximum), the more quickly iron will oxidize and precipitate so it can be filtered*. When dealing with sulfur gas the direct opposite is true. The lower the pH level, the more quickly sulfur will oxidize and precipitate.

* Note: If the pH approaches 8.3 or above, iron can become colloidal which will be too small of a particle to be physically filtered and can cause the water to be discolored. If pH is being raised artificially with a chemical feed pump injecting soda ash prior to the filter, caution must be taken not to get the pH level too high. If lowering of the pH level is desired (for more effective treatment of sulfur gas), use of a chemical feed pump injecting citric acid or distilled white vinegar prior to the filter works well.

In cases where manganese treatment is also involved, the iron to manganese ratio in relation to the raw water pH must be considered. As a rule of thumb, at a pH of 7.0, an iron to manganese ratio of at least 10 to 1 is desired. This means if you have 1 ppm of manganese, you will want to have at least 10 ppm of iron to effectively get the manganese to oxidize and precipitate along with the iron. For other iron to manganese ratios and required pH levels, please see the following table:

If the Iron to Manganese ratio is:	Then the pH must be at least:
10:1	7.0
5:1	7.8
1:1	8.3
0:1	8.5

Of course, if the filter will be followed by a water softener to reduce the hardness, the above manganese rule is not as critical as the softener will reduce any residual manganese that may possibly get through.

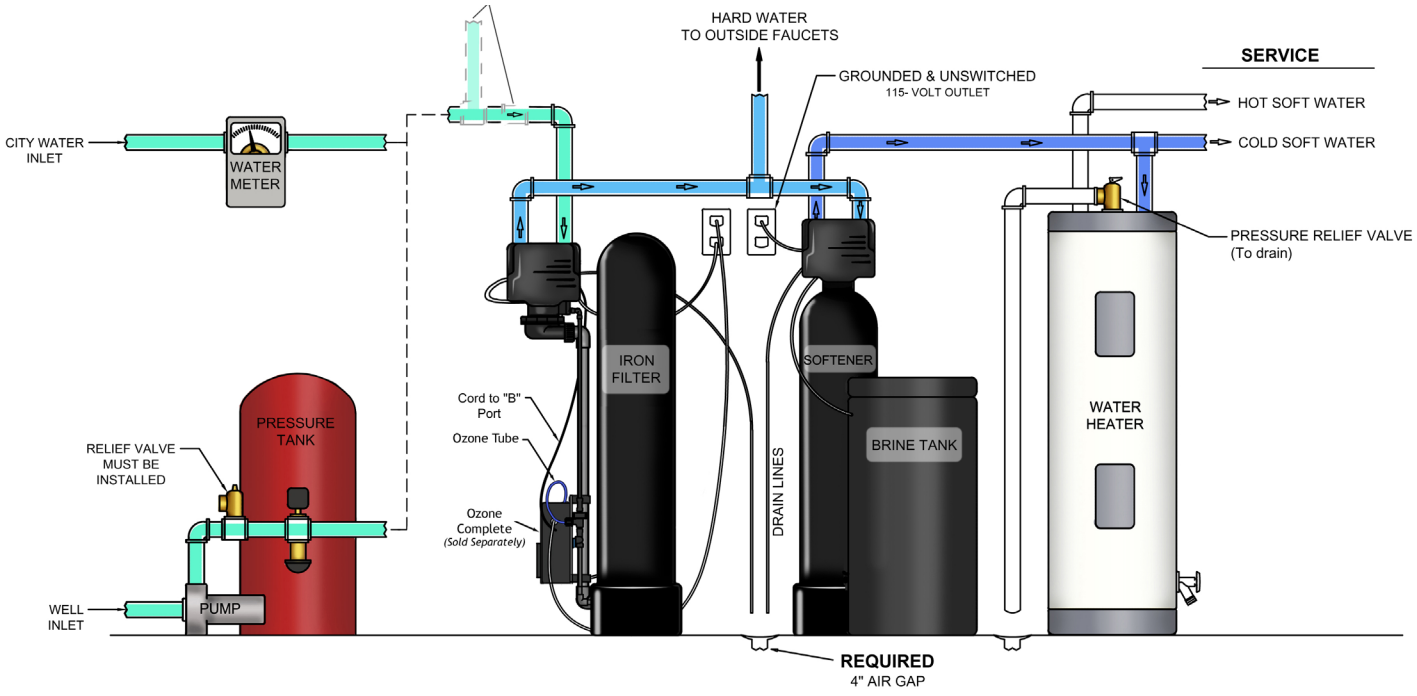
Sidekick™ Sizing

To properly size the Sidekick™, the well pump capacity in gallons per minute (gpm) must be known. The most critical component during sizing is assuring there is adequate flow to properly backwash and clean the filter system. Service flow rate considerations are secondary.

Sizing Step 1 – Calculate the average well pumping capacity using the test procedure in the Filter Technical Information Guide.
Sizing Step 2 – Choose the Sidekick™ model(s) that can be backwashed with the available well pump flow rate (see specs below).
Sizing Step 3 – Choose the Sidekick™ model that will give the service flow rate desired (see specs below).

General Specifications	SK15	SK25
Filtration (See "Filter Media" section for application)	Smart Blend™	
Filtration Media Capacity (CU. FT.)	1.5 cu. ft.	2.5 cu. ft.
Mineral Tank	10 X 54	13 X 54
Service Flow Rate - Continuous (GPM)	5	8
Service Flow Rate - Intermittent (GPM)	7	10
Backwash Flow Rate (GPM)	5.0	7.0
Gallons Used / Backwash	106	146
Space Required (D x W x H inches)	10 X 21 X 61	13 X 24 X 61
Approximate Shipping Weight	160	236

Typical Sidekick™ Installation



The following information is **not** intended to replace attending technical training programs or reading of installation instructions. It should be viewed as a general discussion about the product, its application, limitations and key factors to remember before purchase.

REACTR & REACTR VS Dual Tank Aeration Systems

How The **REACTR & REACTR VS Works**

The REACTR™ Water Treatment System is a revolutionary product that utilizes two tanks for its treatment process. The first tank, called the REACTR aeration tank assembly, injects ambient air into the water and provides excellent mixing of oxygen to oxidize contaminants into precipitants. Any excess free air that is not needed is automatically vented from the aeration tank by an integral weighted float system. Oxidized precipitants are then physically filtered by the SmartBlend™ filter media located in the REACTR automatic backwashing filter tank. Standard treatment is accomplished without the use of chemicals and/or regenerates like salt, chlorine and potassium permanganate. In cases where elevated iron levels (above 5 ppm), iron/sulfur bacteria or tannins are present in the raw water supply, the OXY-08R Oxyclean™ option can be added to automatically inject chlorine or hydrogen peroxide during the backwash cycle. This is a great preventative maintenance tool, as both the aeration tank and filter tank are cleaned and disinfected every time the filter backwashes. Every REACTR™ System is already configured for the Oxyclean™ option, so it can easily be added to the system at any time.

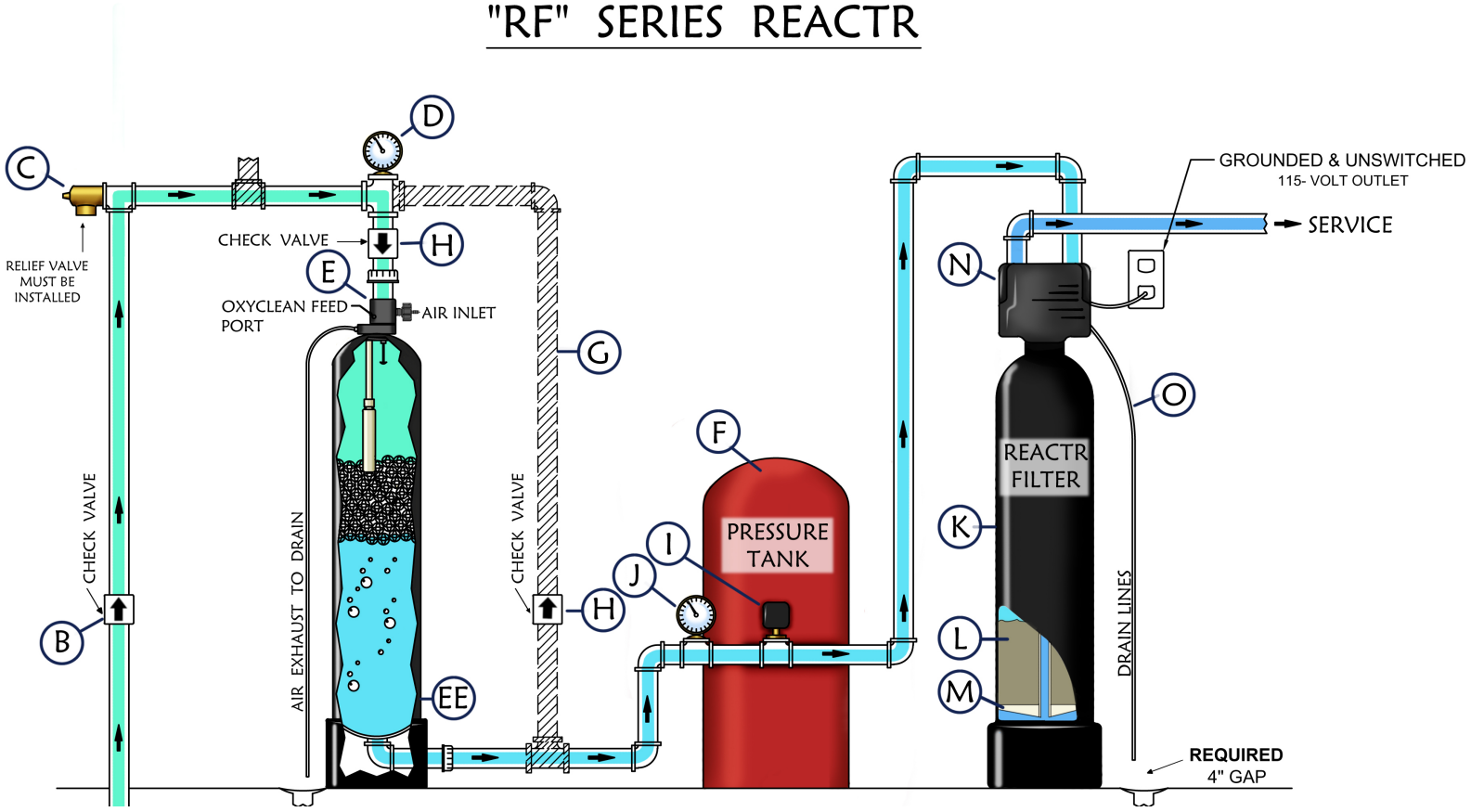
SmartBlend™ filter media is comprised of a proportioned mixture of two (2) different media: (1) Filter Ag Plus™ & (2) Manganese Dioxide media. The Filter Ag Plus media does an excellent job of physically filtering out turbidity (down to 3-5 micron in size) and suspended solids and is very light, so it is easily backwashed. The Manganese Dioxide media is added mainly to act as an insurance policy against iron/ manganese or sulfur bleed through, especially during periods of high water demand or fluctuating contaminant levels, both of which reduce contact times. The Manganese Dioxide also will correct low pH from 6.0 to above neutral 7.0 without replenishing.

Air induction for the REACTR™ is created by a Venturi/Nozzle assembly which is a primary component of the REACTR aeration tank intake manifold. To create suction (air draw), the V/N needs enough flow and at least a 20 – 30 psi differential pressure between the inlet and outlet of the V/N (more on this later in this section). Due to this fact, the REACTR™ aeration tank assembly MUST be installed between the well pump and existing pressure tank. The difference between the high head pressure from the well pump and system pressure (pressure tank pressure) creates this needed differential in pressure for air draw. Also, to assure adequate flow and inlet pressure, the system works best with standard submersible well pump applications. This presents a problem when dealing with a constant pressure (variable speed) well pump or a well pump producing low pressure and/or flow (shallow well jet pump).

In these applications, the REACTR VS™ System must be used (of course, a NITRO™/ NITRO PRO™ or Sidekick™ could also be used if contamination parameters are within system limitations). The REACTR VS™ System operates in exactly the same manner as the standard REACTR™ System except air is introduced to the water by use of an oil less air compressor, which forces air (oxygen) into the REACTR VS™ aeration tank assembly. The REACTR VS™ is uniquely designed to be a “plug & play” type system. Air compressor operation is controlled by the Signature Series or Signature 2 control valve through a small relay panel. On/Off signals from the relay panel are provided by electronic turbine meter inputs from the control valve. This makes the REACTR VS™ System a totally self-dependent system that does not require any special wiring or plumbing to install. The OXY-08VS Oxyclean Option can also be added to the system in cases of severe problem type waters to inject chlorine or peroxide into the system during backwash.

Let's take a look at a more detailed explanation of the operation and installation of the REACTR™ & REACTR VS™ Systems. As we discuss the functions, we will move from left to right on the diagram below. Please refer to the circled letters within the drawings of each component part or portion of the system we are discussing as shown alphabetically below.

FIGURE 1



REACTR™ Technical Information Guide

A. **Pump** – Since the REACTR™ requires both sufficient flow and pressure to operate, you should generally limit installations to only those jobs where you have a submersible pump that has been properly sized for the well. There are only a few exceptions to this general rule that we will discuss later, but for most all cases, limit your installations to submersible pumps. Generally, jet pumps do not provide both flow and pressure in combination to let the REACTR™ Manifold {E} work properly. If you do have a job that is to be treated where a jet pump is involved, either include a new submersible with the installation or use a REACTR VS™ system. A REACTR VS™ will also be needed for constant pressure (variable speed) well pump applications. Of course, a NITRO™/NITRO PRO™ or Sidekick™ could be used also if system limitations are met.

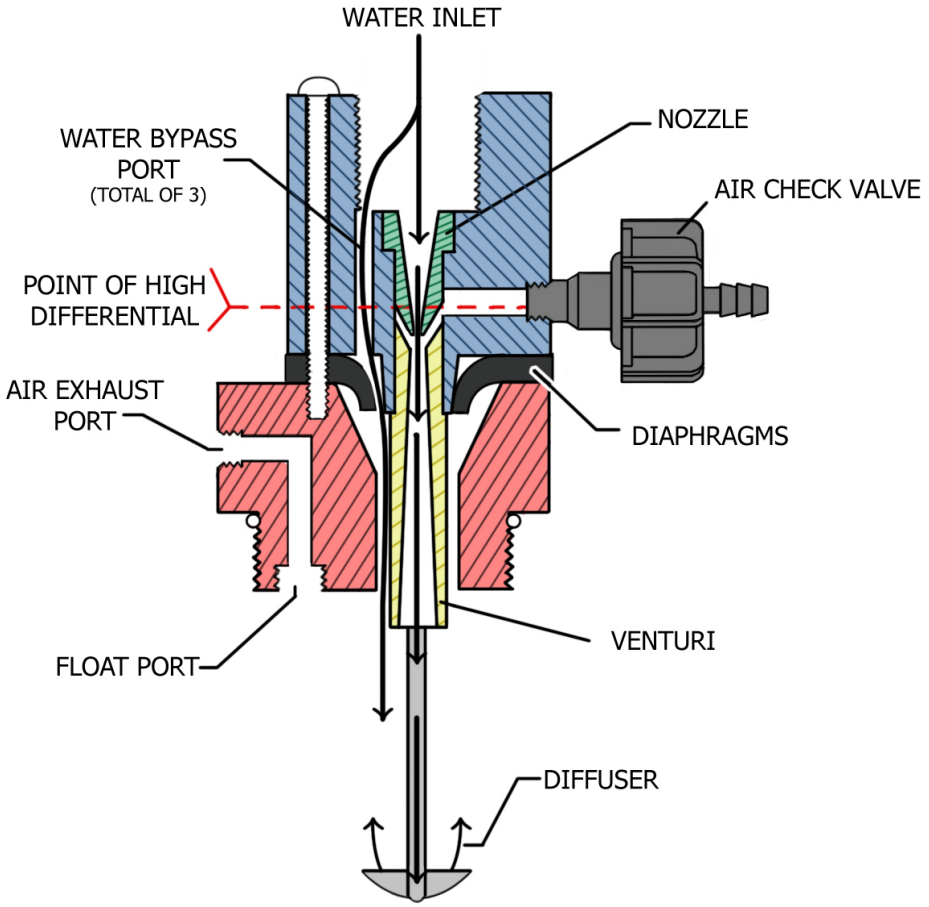
B. **Check Valve** – It is recommended that a check valve be installed above ground as a back-up to the well pump check. In the event the primary check valve fails, the above ground check will prevent a back flow of water down the well. This can cause a negative pressure situation which can collapse the REACTR™ tanks. This cannot be covered under the standard warranty if this occurs.

C. **Pressure Relief Valve** – This is an optional piece of equipment that should be installed between the pump and the REACTR™ tank. The relief valve will protect the system from an over pressure situation. A relief valve with a minimum 125 psi blow off should be used as well pump head pressures in excess of 75 psi is quite common.

D. **Pressure Gauge** – It is highly recommended that a gauge be installed at this location for the purpose of reading actual head pressure being delivered from the pump during the pump cycle. A gauge at this location will be invaluable if later troubleshooting of the system is required. Head pressure readings of between 65-110 psi at this location with the well pump running is normal.

E. **REACTR™ Tank Manifold** – The REACTR™ Tank Manifold is a special device designed and manufactured by CSI that brings air into the water system. This is where actual “treatment” of the water begins. This air starts the oxidation process of producing physical particles that will be trapped by the filter portion of the system. The relatively high pressure and flow delivered by the pump, compared with the lower system pressure (i.e. 30/50 psi switch setting), causes a point of low pressure and suction in the center of the REACTR™ Tank Manifold. This suction is what draws air into the system through the air intake valve check located on the side of the REACTR™ manifold.

FIGURE 2



The water flowing into the REACTR™ Tank Manifold is somewhat restricted in the nozzle section. When the nozzle receives sufficient pressure, suction is then created at the point the water leaves the nozzle and enters the opening of the venturi section. This is where the air is pulled into the water flow. If there is more than the required amount of water flow entering the nozzle (5 gpm), a certain amount will go around the nozzle through the bypass ports. This prevents an unnecessary loss of flow and pressure while the pump is operating. This occurs automatically and does not require adjustments. The bypass water then rejoins the main stream of flow at the end of the venturi, where it mixes with the water flow that received the air injection. This mixing point assures that all of the water comes into contact with the air.

The amount of differential pressure generally required to operate the REACTR™ manifold is 20 psi. Consider this number as a constant in all residential systems. You can actually determine the air draw into the system by following this example:

How to Calculate Air Draw

Simply determine the Head Pressure (gauge {D}) offered by the pump and subtract the constant of 20# differential required to operate the REACTR™ manifold. The answer you get will tell you the point at which the REACTR™ manifold will stop drawing air. This pressure number is the pressure seen on gauge {J} – system pressure. If Head Pressure (gauge {D}) is 65 psi on a 30/50 system …

65 psi (Gauge {D})
- 20 psi (Differential Constant)
45 psi (Will draw air to this system pressure)

In this case, air will be drawn by the REACTR™ manifold from 30 psi to 45 psi (on gauge {J}) or 75% of the pump cycle.

As a general rule, we want to have at least a 25% air draw at the REACTR™ manifold. The higher level of contamination in the water, the more air draw we need. You will find that most properly sized submersibles will easily give you from 50% to 100% air draw.

EE. **REACTR™ Tank** – This tank is critical to the operation of the REACTR™ System. All water and excess air that is taken into the water system by the REACTR™ manifold passes through this tank on its way to the pressure tank and then the REACTR™ Filter. There are certain dynamics that occur in this tank which move contaminants closer to a fully oxidized state. Let's discuss just how the REACTR™ tank works.

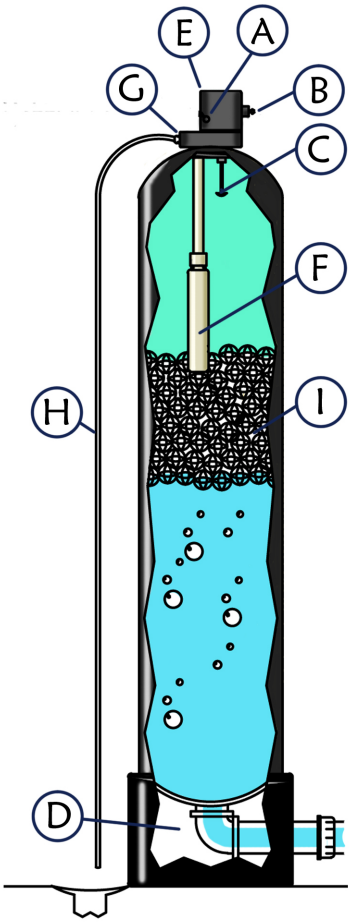


FIGURE 3

As water flows from the well pump and enters the REACTR™ tank manifold {E}, the nozzle/venturi section {A} creates a suction and draws air into the water through the air intake valve check {B}. The valve check body is constructed of Noryl™ plastic and is totally serviceable.

As more and more excess air is trapped in the top section of the REACTR™ tank, the water level moves lower in the tank. This is what we call the maturity level in the REACTR™ tank. When additional air is introduced into the REACTR™ tank thereafter, the water level falls and the weighted float inside the float guide {F} drops momentarily allowing a proportionate amount of air to escape from the REACTR™ tank manifold through the exhaust vent {G} and out the air vent line {H} to a drain. When sufficient air has vented to allow the water level to rise back to the maturity point, the water rising allows the float to become buoyant once again. The float then closes off the exhaust vent so that air is kept in the REACTR™ tank.

It is an important safety measure to run the exhaust vent line to a drain. Normally, there will be a very small amount of water discharged with the air as the system vents. However, in the event that the float malfunctions and stays "open", water will continuously run through this line until the float returns to shut-off or a repair is made. Always run this vent line to a drain to prevent flooding should a problem arise. The exhaust vent line can be run outside as long as measures are taken to prevent the line from freezing shut during cold weather. It is important to mention that if the REACTR™ is being used to treat hydrogen sulfide gas (H2S), the air will oxidize most of the gas to a particle of elemental sulfur. Consequently, very little odor, if any, will be experienced out of the air vent line.

To this point, the contaminants in the raw water have been forced through the nozzle/venturi section of the REACTR™ tank manifold where they are exposed to compression/decompression, a massive quantity of air, and forcefully at full pump flow, diffused through the head of air in the top of the REACTR™ tank. Notice the plastic air stripping balls {I} located in the REACTR™ tank. These balls do not perform filtration, but serve to accomplish two other functions. Precipitated contaminants (e.g. ferric and manganic hydroxides) will form a thin coating on the surface of the air stripping balls. As the water/contaminant mixture moves over the balls on its way to the bottom outlet of the REACTR™ tank, the coating of oxidized contaminants on the balls chemically assists yet unoxidized contaminants to move closer to a fully oxidized state by a chemical process called sorbing.

The second function of the air stripping balls is to further mix the dissolved oxygen with the water and to help hasten the oxidation of certain gases (e.g. hydrogen sulfide). Due to the large openings in these balls, the water is sheared as it passes through them, and allows for a thorough mixing of oxygen, water and the separation of excess gases. As we continue our discussion, please refer back to the REACTR™ System drawing.

F. **Pressure Tank** – All REACTR™ Systems will require a pressure tank, unless installed ahead of an atmospheric storage tank. In the case of an atmospheric storage tank, the system will need to be configured for clean water back wash or a change in pump wiring will need to be done to provide pump flow for backwashing purposes. (Contact the factory or your sales representative for details.) Due to the fact that all excess free air is being exhausted prior to the pressure tank, either a pre-charged diaphragm/bladder type or air-to-water lined galvanized tank may be used.

G. **Split System** – If a secondary service line (split system) is to be installed ahead of the REACTR™ tank to provide untreated water (e.g. irrigation, outside faucets, etc.), it is highly recommended that a bypass line be installed between the REACTR™ tank and the pressure tank. This will allow draw down from the pressure tank to bypass the REACTR™ tank until the pressure switch closes and turns the pump on providing true raw water to the secondary service line.

Note: In most irrigation applications, the well pump will be oversized to provide adequate flow for both the irrigation system and the home. In these cases, a REACTR™ Manifold with a larger venturi/nozzle size will probably be required (e.g. 10 gpm or 15 gpm). This will prevent high head pressure from developing when the irrigation system is not in use.

H. **Check Valve** – A one-way check valve should be installed at the two locations shown. This will prevent free air from escaping the REACTR™ tank into the secondary service line and also provide one-way passage of flow from the pressure tank when secondary service is operated.

I. **Pressure Switch** – This is any good quality pressure switch usually preset to the 40/60 psi range. Remember that the point at which the pressure switch senses pressure must always be located **AFTER** the REACTR™ tank so that it reads system and not pump head pressure.

Note: If it is ever desired to change the pressure switch setting (cut on/cut off), always drain the system and change the pre-charge in the pressure tank to 2 psi below the cut on pressure (e.g. 40/60 setting – pre-charge = 38 psi). This is extremely important as maximum draw down, pump run time and contact time will be achieved.

J. **Pressure Gauge** – This is the gauge that shows current system pressure. It is the difference between this gauge and gauge {D} that will show you differential pressure for any given water system.

K. **REACTR™ Filter Tank** – The filter tank serves several important functions. Its primary purpose is to trap the physical particles (e.g. ferric hydroxides and elemental sulfur) that have been produced by the oxidation process. We have simply taken unfilterable dissolved solids and converted them by an oxidation process to precipitated and filterable suspended solids. In most cases, the particles are trapped on the surface and in the top portion of the media bed {L}.

L. The media bed of the REACTR™ consists of a proportioned mixture of two (2) proven filter media known as SmartBlend™. The two medias are:

Filter Ag Plus™
Manganese Dioxide media

This media is coarsely blended by CSI and serves the following functions. The entire bed provides excellent mechanical filtration due to the angular/granular nature of the individual minerals.

Filter Ag Plus™ - Specifically, Filter Ag Plus™ is non-hydrous aluminum silicate. It's only function is that of mechanical filtration down to between 3-5 micron in size.

Manganese Dioxide - The Manganese Dioxide media is an active, insoluble catalyst that utilizes dissolved oxygen in water to convert clear iron/manganese & sulfur gas to a filterable state. It serves as an "insurance policy" in the filter bed during peak demand periods to remove traces of iron and manganese in the event that they were not fully oxidized prior to entry into the filter bed. It also will increase low pH from as low as 6.0 to above neutral 7.0 without replenishing.

Note : SmartBlend™ media is used for ALL applications

M. **Vortech™ Distributor Plate** – Beneath the SmartBlend™ filter media {L} is the Vortech™ Distributor plate. The purpose of the Vortech™ is to permit even flow of the water during both service and backwash modes. Also, the Vortech™ provides a vigorous backwash helping to clean the filter media bed. **No gravel underbedding required!**

N. **Filter Control Valve** – The Filter Control Valve is used for the automatic cleaning (backwashing) of trapped oxidized contaminants from the filter. The control valve does this by directing the flow of water backwards through the filter, thus purging the contaminants from the tank and also reorienting the filter bed. This backwash water is then directed out of the control valve drain line {O}. After the backwash cycle is complete, the control valve will then direct the flow downward through the filter tank (rapid rinse), re-compacting the mineral bed and flushing any "dirty" water from the bottom section of the filter. During the backwash cycle, water is available to the house but will be untreated. That is why the REACTR™ control valve is factory preset to activate the backwash cycle at 12:00 a.m. on a night it is scheduled. Backwash frequency can be estimated using the following formula:

Combined iron and manganese removal for
REACTR™ Filter = 15,000 ppm per cu. ft. of filter media

Example:

Model – RF15
Qty. of Media – 1.5 cu. ft.
Iron / Manganese Content – 5 ppm
Number of People in Family – 4
Estimated Water Usage – 75 gals. per person per day

Total iron / manganese removal before backwashing is required:
1.5 cu. ft. x 15,000 ppm / cu. ft. = 22,500 ppm

Estimated water usage:
4 people x 75 gpd = 300 gals. per day

Iron / Manganese removal per day:
300 gpd x 5 ppm = 1,500 ppm / day

Required backwash frequency :
22,500 / 1,500 ppm / day = 15 days

The required backwash frequency in this example is every 15 days. We want to backwash a minimum of every 6 days to assure orientation of the filter bed. Program the Signature Series or Signature 2 control valve for every 6 days in this example.

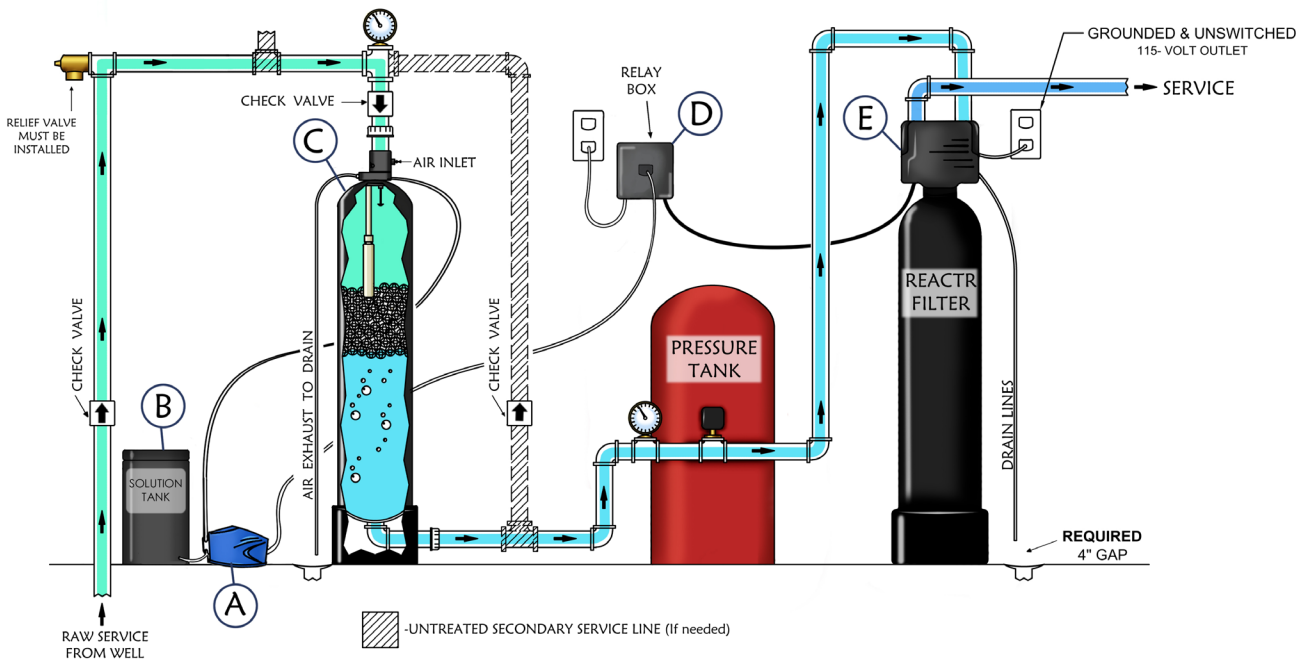
Note: For sulfur gas removal, frequency of backwash should be accomplished twice as often as for iron/manganese. Also, if tannins and/or bacteria versions of these contaminants are involved, the OXYCLEAN™ Option should be added to the system and backwash frequency increased to every 3 – 4 days.

The Signature 2 Valve is provided as the standard valve for the REACTR™ System. It includes Bluetooth™ technology that provides water usage/flow rate history (with a meter installed) and ease of programming through the free LegacyView™ App downloaded to your device (Android™ or iOS™). The Signature 2 control provides excellent backwash flow characteristics required for proper cleaning of the filter. It also features adjustable cycle length times (backwash, rest and rapid rinse) for versatility when well capacities may be at a minimum. Also, the Signature 2 control will motor to each position to provide full flow for the entire cycle duration. This provides for a better backwash and will help keep oxidized contaminants from collecting inside the valve by keeping water velocities high. It also has 9-volt battery back-up to keep time of day current if power fails or motor the valve to an off position if power fails during the backwash cycle to shut off water going to drain. For more information about operation and service of the Signature 2 control valve, please consult the REACTR™ Installation & Operations Manual.

O. **Drain Line** ¬– During any backwash cycle, water will automatically be directed through the REACTR™ filter and out the drain line. A 1/2" I.D. by 5/8" O.D. clear drain line attached to the drain line hose barb is normally used. DO NOT use flimsy tubing that will kink, reducing drain line flow. Only semi-rigid drain tubing should be used. By removing the drain line hose barb, a 1/2" drain line can also be hard plumbed in PVC or copper. The drain line should be kept as short as possible and the diameter of the line should never be decreased to less than that of the hose barb provided with the filter. Decreasing the diameter will result in a back pressure situation due to friction loss and can result in insufficient backwashing. A 4" air gap should also be maintained to prevent a possible siphoning of water standing in the drain back into the filter.

FIGURE 4

OXYCLEAN OPTION FOR REACTR



The OXYCLEAN™ Option – Please refer to the above diagram before we begin studying the function of the OXYCLEAN™.

The OXYCLEAN™ is an optional piece of equipment that can be added to any new or previously installed REACTR™ System. The OXYCLEAN™ is designed to introduce chlorine or hydrogen peroxide automatically during the backwash cycle for cleaning and disinfecting of the entire system.

In cases of iron bacteria or tannins that can cause fouling of the filter media or heavy iron (over 5 ppm) that can cause pipe plugging problems, the OXYCLEAN™ Option can drastically reduce service calls associated with these situations.

The OXYCLEAN™ Option includes the following items:

A. **OXCYLEAN™ Feed Pump** – The OXYCLEAN™ Feed Pump is designed to deliver chlorine or peroxide into the system during the backwash cycle. It is of a peristaltic design, so ball type check valves that usually require maintenance are not required. Pump RPM and tubing size is factory designed to deliver eight (8) ounces of solution in a typical ten (10) minute backwash cycle. Consequently, there are no settings or adjustments required for the pump during or after installation. Because of the peristaltic design, the pump is totally self-priming and will only require a short run time to fill the outlet tubing on initial installation. The pump is designed to set on the floor adjacent to the solution tank. This will provide flooded suction to the pump, although the pump may be elevated, if need be. The OXYCLEAN™ pump is designed for 120 V / 60 Hz power and is plugged into the front of the OXYCLEAN™ relay panel. Note: It is recommended that the Oxyclean Pump Tubing be replaced every 1 – 2 years. One (1) extra pump tube is included.

B. **OXYCLEAN™ Solution Tank** – The OXYCLEAN™ Solution Tank is designed to store chlorine or peroxide for the OXYCLEAN™ pump. It has a five (5) gallon capacity and includes a compression type bulkhead fitting where the OXYCLEAN™ pump inlet tubing (lower fitting) is to be connected. Fill the OXYCLEAN™ Solution Tank with straight 5.25% - 8.0% laundry bleach or 7.0% hydrogen peroxide. Do not dilute with water. Chlorine bleach can lose its strength over a period of time, so it is suggested to fill the solution tank with two to three gallons of bleach as this will last approximately six to eight months, depending on the frequency of backwash. A gravity overflow elbow is installed and 1/2" I.D. x 5/8" O.D. tubing should be attached and run to a drain.

C. **OXYCLEAN™ Injection Check Valve** – There are two (2) 1/4" MNPT plastic pipe plugs that are threaded into the manifold base on every REACTR™ system shipped. Depressurize the system, remove one of the pipe plugs and carefully thread the OXYCLEAN™ Injection Check Valve (included with the installation kit) into the 1/4" port. Tighten the check valve by HAND ONLY!! The outlet tubing (upper fitting) from the pump should then be connected to the injection check valve.

D. **OXYCLEAN™ Relay Control Panel** – A relay control panel is included to provide 120V power to the OXYCLEAN™ pump when signaled by the Signature 2 control valve during backwash. The relay panel should be wall mounted in close proximity to the REACTR™ System. The 120V power cord from the relay panel should be plugged into a 120V wall receptacle with the patch cord connected to the "B" output port located on the left side of the Signature 2 control valve.

E. **Signature 2 Control Valve** – Every REACTR™ System shipped is equipped with three output ports labeled "P", "B" & "S" located on the left under side of the REACTR™ Signature 2 control valve. With the relay panel plugged into the "B" output, the control valve is designed to provide 12 vdc power to the relay panel only during the backwash cycle (Cycle #1). To complete the OXYCLEAN™ installation, simply insert the patch cord from the OXYCLEAN™ relay panel into the "B" output port on the Signature 2 control valve and plug the OXY CLEAN™ feed pump power cord into the receptacle located on the front of the relay panel. Then plug the relay panel power cord into a 120V wall receptacle. Backwashing frequency should be set to every 3 – 4 days.

The cycle times on all REACTR™ Signature 2 control valves should be set to the following:

Oxyclean Cycle Time Settings	
Backwash	10 minutes
Rest Period	20 minutes
Rapid Rinse	16 minutes
Total	46 minutes

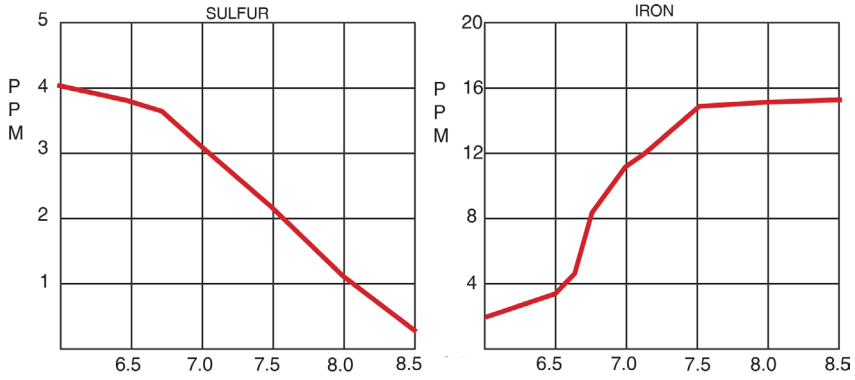
By setting the rest period to 20 minutes in length, we are able to achieve the contact time needed for chlorine disinfection. Setting the rapid rinse cycle to 16 minutes will assure that all chlorine or peroxide residual is flushed from the system.

Equipment Selection Procedure

We have reviewed how the REACTR™ works and discussed the various contaminants that can be present in a given water supply. Let's proceed with the proper method for selecting the correct sized equipment for the job. Please review the specification charts below and the contaminant matrix chart for REACTR™ capabilities.

General Specifications	RF15-S2	RF20-S2	RF25-S2	RF30-S2	RF40-S2
Filter Media Type	SmartBlend ™				
Filter Media Capacity (cu ft)	1.50	2.00	2.50	3.00	4.00
REACTR™ Tank (polyglass)	10 X 54	10 X 54	10 X 54	16 X 40	16 X 40
Mineral Tank (Vortech™)	10 X 54	12 X 52	13 X 54	14 X 65	16 X 65
Service Flow Rate-Continuous (gpm)	5	6	8	9	11
Service Flow Rate-Intermittent (gpm)	7	8	10	11	13
Backwash Flow Rate (gpm)	5.0	6.0	7.0	10.0	15.0
Gallons Used / Backwash	100	120	140	200	300
Space Required (DxWxH inches) REACTR™ Tank	10 X 10 X 62	10 X 10 X 62	10 X 10 X 62	16 X 16 X 51	16 X 16 X 51
Space Required (DxWxH inches) Filter Tank	10 X 10 X 62	12 X 12 X 60	13 X 13 X 62	14 X 14 X 73	16 X 16 X 74
Approximate Shipping Weight (pounds)	165	236	270	311	394

REACTR™ Contaminant Reduction Limitations



Step 1: Perform a water analysis for concentrations of iron, manganese, sulfur (if rotten egg odor is detected), pH, hardness and tannins. Are all levels within the range of performance of the REACTR™? If not, contact your distributor or CSI for assistance.

Step 2: Determine the actual pumping capacity of the water system using the following test procedure. There are two reasons why the actual pumping capacity must be known before selecting equipment;

A. REACTR™ Manifold – The REACTR™ Manifold must receive an adequate flow of water in order for it to work properly. The flow requirement is a minimum of 5 gpm.

B. Backwashing – The filter bed must receive an adequate flow of water in order to lift the contaminants from the filter bed during backwash. The requirements are shown under the “Backwash Flow Rate” section of the specifications chart.

Well Pump Capacity Test Procedure

To properly size any type of water treatment equipment, the well pump output in gallons per minute (gpm) must be known. To properly calculate the average well pump output, use the following test procedure;

1. Make certain there is no water being used.
2. Open any faucet and run water until well pump starts.
3. Close faucet and let pump fill pressure tank and stop.
4. Open any faucet and collect ALL water discharged until pump starts (a 5 gallon bucket works well for this).
5. When well pump starts, IMMEDIATELY close faucet and START TIMING PUMP CYCLE in Seconds (you will need a sweep second hand on your wristwatch or a stopwatch).
6. When pump stops, record cycle time in seconds to refill pressure tank.

7. Measure the total number of gallons collected in Step #4.
8. Divide the number of gallons collected in Step #4 by the number of seconds in Step #5.
9. Multiply the answer derived in Step #8 by 60.
10. The answer in Step #9 is the average pumping capacity of the system in gpm.

Example

Number of gallons collected during draw-down (step #4) = 9
Number of seconds in pump cycle to refill pressure tank (step #6) = 72
GPM = (gallons collected ÷ seconds in pump cycle) x 60

GPM = (9 ÷ 72) x 60
GPM = .125 x 60
GPM = 7.5

If completing the information sheet for factory testing, enter this number under **Pump Capacity GPM.**

Model # Series	Backwash Requirements
RF15-S2	5.0 gpm
RF20-S2	6.0 gpm
RF25-S2	7.0 gpm
RF30-S2	10.0 gpm
RF40-S2	15.0 gpm

Now that the flow rate has been determined and you understand its importance, a REACTR™ System can be selected. Below is a chart showing flow rate ranges and the REACTR™ by model number series that would be proper.

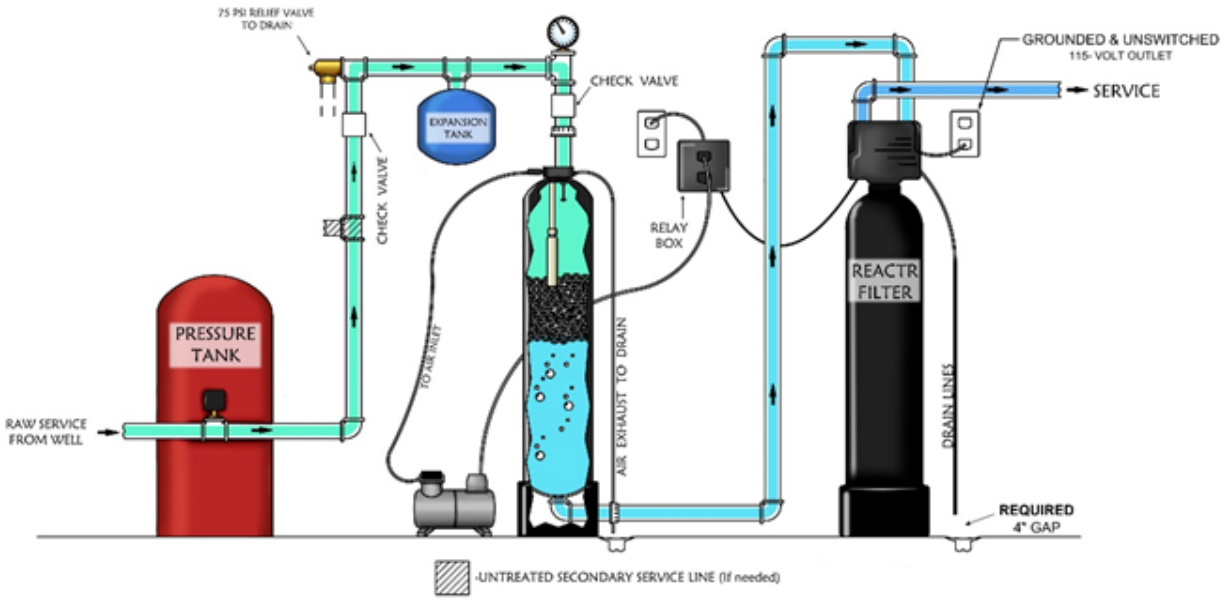
Calculate Pump Flow Rate (gpm)

Model #	Minimum	Maximum
RF15-S2	5.0	10.0
RF25-S2	7.0	14.0
RF30-S2	10.0	20.0
RF40-S2	15.0	25.0
*(2) RF25-S2	14.0	28.0
*(2) RF30-S2	20.0	40.0
*(3) RF15-S2	15.0	30.0
*(3) RF25-S2	21.0	42.0
*(3) RF30-S2	30.0	60.0

* In Parallel

Note : It is advisable to contact your distributor or CSI when dealing with flow rates above 10 gpm.

"VS" SERIES REACTR



General Specifications	RF15VS-S2	RF20VS-S2	RF25VS-S2	RF30VS-S2	RF40VS-S2
Filter Media Type	SmartBlend ™				
Filter Media Capacity (cu ft)	1.50	2.00	2.50	3.00	4.00
REACTR™ Tank (polyglass)	10 X 54	10 X 54	10 X 54	16 X 40	16 X 40
Mineral Tank (Vortech™)	10 X 54	12 X 52	13 X 54	14 X 65	16 X 65
Service Flow Rate-Continuous (gpm)	5	6	8	9	11
Service Flow Rate-Intermittent (gpm)	7	8	10	11	13
Backwash Flow Rate (gpm)	5.0	6.0	7.0	10.0	15.0
Gallons Used / Backwash	100	120	140	200	300
Space Required (DxWxH inches) REACTR™ Tank	10 X 10 X 62	10 X 10 X 62	10 X 10 X 62	16 X 16 X 51	16 X 16 X 51
Space Required (DxWxH inches) Filter Tank	10 X 10 X 62	12 X 12 X 60	13 X 13 X 62	14 X 14 X 73	16 X 16 X 74
Approximate Shipping Weight (pounds)	175	246	280	321	404

Installation Tips – Please consult the REACTR™ Installation and Operations Manual for specific details on installation and service procedures. Call your distributor or CSI with any questions you may have.

A. Do a full water analysis.

B. Check the water closet of a flush type toilet for signs of bacterial growth (e.g. iron bacteria).

C. Refer to the REACTR™ Matrix Chart for contaminant limitations.

D. Do a pump capacity test using the procedure discussed earlier.

E. Size the REACTR™ System for the backwash flow requirement.

F. If more service flow is required, consider:

1. Use multiple residential systems in parallel.
2. Add a large diaphragm / bladder type pressure tank after the REACTR™ (stored treated water).
3. Consider a small commercial system.

G. The REACTR™ Filter will need to be loaded in the field. Always load media at the approximate location of installation, if possible.

H. Always plug the end of distributor tube with a cork or similar method to prevent media from entering tube.

I. Fill the mineral tank 1/3 with water before adding media to filter tank. Add water occasionally while filling media to help soak material.

J. Do not use petroleum based plumber's dope or O-ring lubricant on PVC/plastic parts or O-ring connections. Only Teflon based tape/paste and silicone O-ring lubricants are acceptable!

K. If sweat soldering copper pipe, protect control valve bypass and all plastic parts from heat damage.

L. If installing REACTR™ tank using PVC pipe, solvent weld adapter before threading into REACTR™ manifold to prevent cement from entering the venturi/nozzle section.

M. Never connect the drain line directly to a soil line! At least a 4" air gap is required to prevent waste water back flow into the REACTR™ filter.

N. If the drain line needs to be elevated and/or exceeds 20 feet in length, increase drain line inner diameter to at least 3/4".

O. Always install the REACTR™ System before water softening equipment.

Side Effects of Aeration – The following is an excerpt from the What You Should Know About Your New REACTR™ Water Filter System brochure that is included with every unit. We encourage the installing contractor to make certain the customer reviews this information before installation.

The REACTR™ uses the air we breathe to naturally reduce the effects of iron, manganese and sulfur gas. By introducing oxygen to water, contaminants chemically change to a physical particle that can be mechanically filtered out of the water. This natural process called Oxidation, is usually accomplished in other systems by using chemicals such as chlorine or potassium permanganate. Since the REACTR™ does not use chemicals to treat the water, maintenance and chemical byproducts associated with these types of systems are eliminated. The energy required to operate this system is provided by using extra power that is available in your well pump to inject free air into the water. There are several normal side effects that may or may not occur when water is treated in this manner:

1. **Cloudy or milky appearance to the treated water** – This side effect is usually more pronounced when the iron, manganese and sulfur gas levels are low. Since the REACTR™ uses oxygen for the treatment of these contaminants, it can be expected to have some amount left over in the treated water. The higher the contamination levels are, the less oxygen there will be. It is the oxygen that gives the cloudy or milky appearance. Once the faucet is opened and the water is drawn, pressure is released and allows the oxygen to escape. This usually will take from a few seconds to a minute depending on the amount of oxygen and the pressure. This noticeable side effect tells you the system is working properly and will actually enhance the palatability of the water. It's oxygen that gives water it's fresh, crisp taste.

2. **Sputtering or slight coughing from the hot water side faucets** – This is a normal phenomenon that usually occurs first thing in the morning. As the high oxygenated REACTR™ water is exposed to heat in the hot water tank a small amount of oxygen will separate. The longer the water is allowed to sit in the hot water tank, the more this will be noticed.

   Usually, this will only occur if the hot water is allowed to sit idle for eight (8) hours or more. Consequently, when hot water is drawn after an extended period of no use, a slight sputtering or coughing may be experienced for a few seconds. If this causes the hot water to splash out of the sink, the problem is reduced by simply turning on the cold water first and blending in the hot for several seconds. If there is a large amount of free air noticed on the cold water side, there is a possible malfunction of the system and your CSI Dealer should be contacted to service the unit.

Summary – We have attempted to review the most pertinent technical information as it relates to understanding the REACTR™ Water Treatment System. This system will provide many years of service for the removal of the water contaminants we have discussed. Proper analysis, equipment selection and installation procedures are the critical keys to successful operation. Please refer to the REACTR™ Installation and Operations Manual for complete particulars on the proper steps for installation and troubleshooting.

The following information is **not** intended to replace attending technical training programs or reading of installation instructions. It should be viewed as a general discussion about the product, its application, limitations and key factors to remember before purchase.

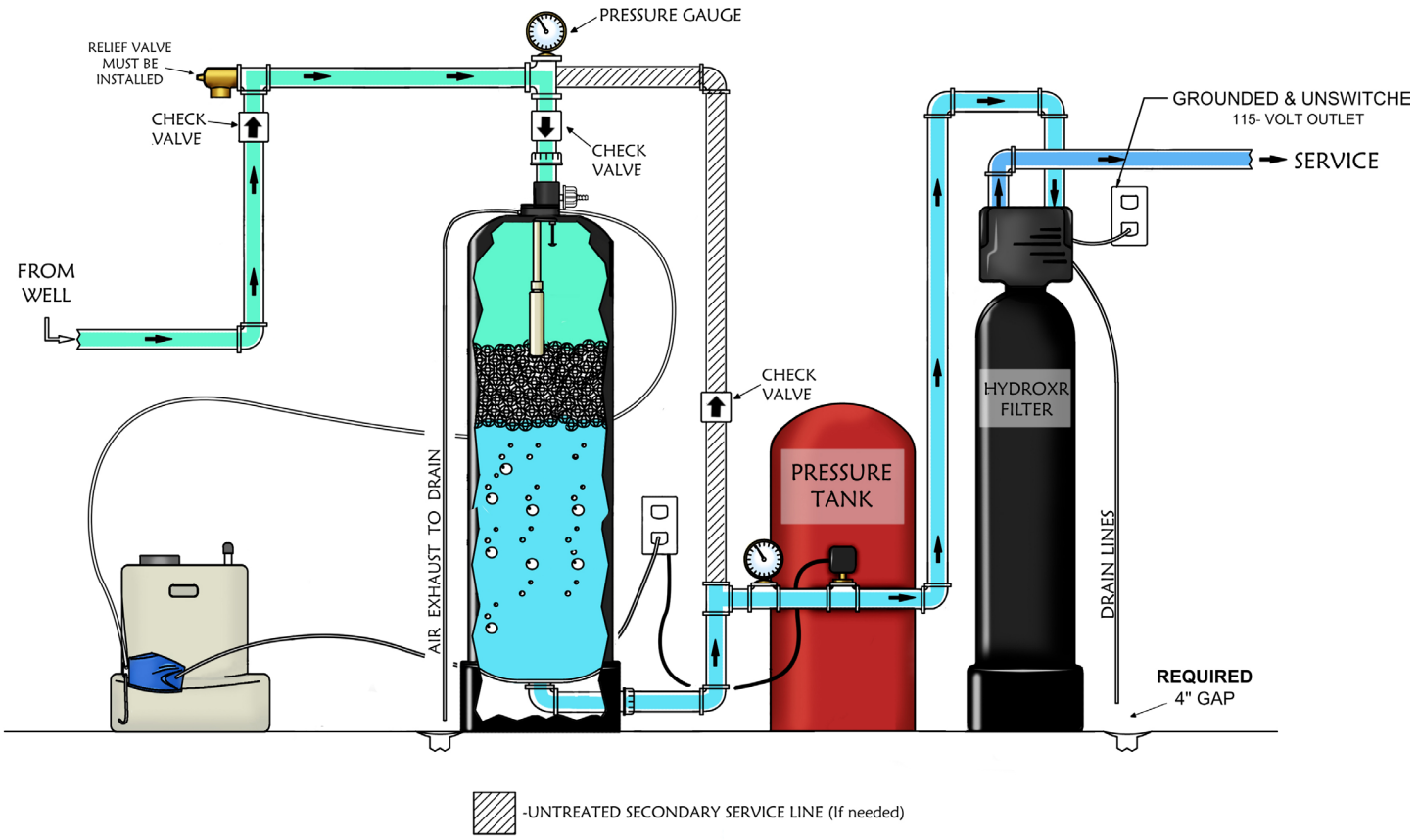
How the Hydroxr & Hydroxr VS Works

The Hydroxr™ Water Treatment System is very similar to the Reactr™ System in that it utilizes two tanks for its treatment process. The first tank, called the Hydroxr™ aeration tank assembly, injects ambient air into the water & provides excellent mixing of oxygen to oxidize contaminants into precipitants. As with the Reactr™ aeration manifold, excess free air is vented by an integral weighted float system. What separates the Hydroxr™ System from other aeration systems, and gives it an almost unlimited capability, is that it also injects Hydrogen Peroxide into the aeration manifold by use of an included chemical feed pump. This feed pump is wired directly into the existing well pump pressure switch. This will activate the feed pump whenever the well pump is turned on by the pressure switch. The Hydroxr aeration tank assembly is also larger (80 gallon capacity compared to 10 gallons for the Reactr) which provides 8 times more contact time for oxidation & disinfection. Ambient air has a limited amount of oxygen available and consequently, is only capable of oxidizing a certain quantity of contaminants before all of the oxygen is depleted. This is especially true with hydrogen sulfide gas as oxygen demand for oxidation is extremely high. Throw on top of that, the almost certain possibility of bacterial forms of iron, manganese & sulfur that usually accompanies extreme levels of these contaminants, standard aeration type products will not perform very well. Even a Reactr™ System, Nitro Pro™or SideKick™ with the Oxyclean Option added will not be capable of consistently treating such waters. A more powerful oxidant must be used to add oxidation capability & disinfect for bacteria continuously to provide reliable results. In the past, chemical feed systems (sometimes called chlorination/de-chlorination systems) were used to inject chlorine into the water continuously to oxidize contaminants & disinfect. This type of system requires high maintenance & the chlorine used can combine with organics in the water to create chemical byproducts called trihalomethanes (a known carcinogen). This is one of the reasons backwashing carbon filters are generally used for this type of system. The carbon will reduce trihalomethanes along with the chlorine taste & odor. The advantage of hydrogen peroxide over chlorine is that it will not create these byproducts and is actually a stronger oxidant. It is safer than chlorine, as it is essentially super oxygenated water (H2O2) & has no taste or odor. Due to these reasons, we do not need to be concerned about removing any peroxide residual. In fact, we want to carry a modest residual into the plumbing system to help protect against any bacterial re-infestation. This allows for use of a more cost effective & virtually permanent filter media for the included backwashing filter.

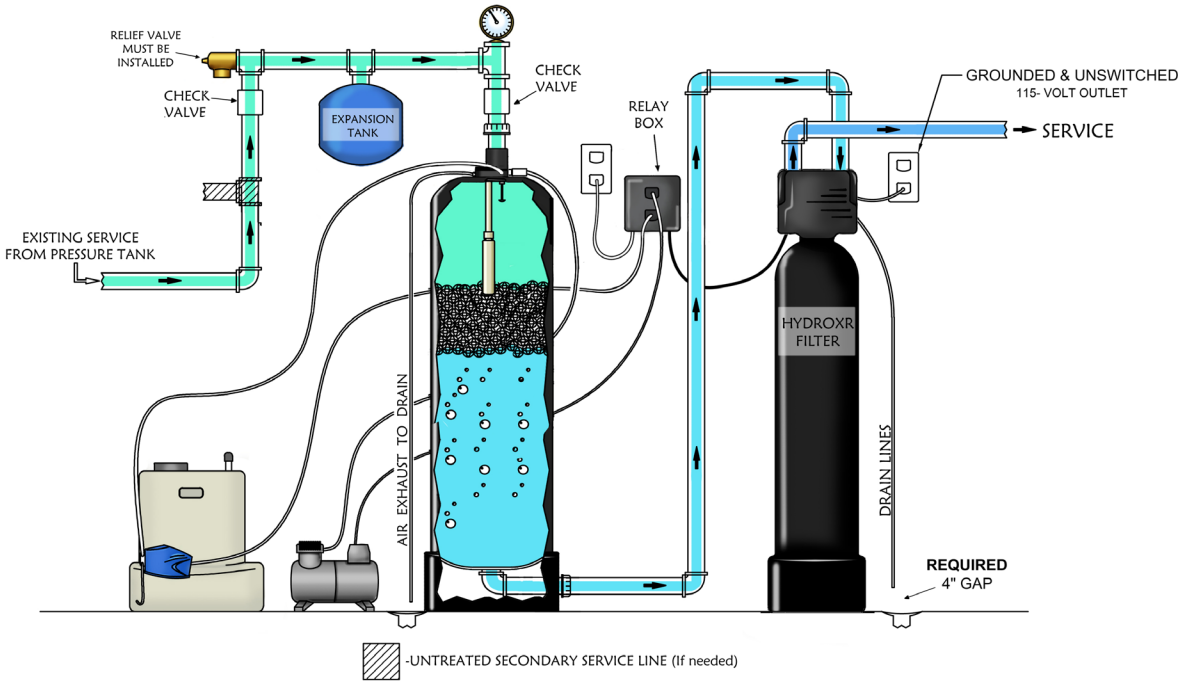
The filter media used for the Hydroxr™ filter tank assembly is called SmartBlend™. This media is an even proportioned mixture of Filter Ag Plus™ & Manganese Dioxide. These two medias will not only physically filter but also will assist in the chemical treatment of iron, manganese & sulfur gas. This is particularly helpful when treating extreme levels of contaminants. The physically filtered oxidized precipitants are periodically backwashed out to drain. Due to the severity of the water conditions the Hydroxr™ & Hydroxr VS™ will be treating, adequate contact time is critical. Use of a service line flow control installed on the outlet line from the filter is advised. The flow control should be sized for the continuous service flow rate of the system & will assure too much flow does not pass through the filter. Generally, due to the severe water conditions the Hydroxr™ filter will be exposed to, the Signature Series or Signature 2 control valves should be programmed to backwash the filter every 3-4 days.
Just like the standard Reactr™ aeration manifold assembly, air induction is created by a Venturi/Nozzle assembly within the aeration manifold. The same dynamics of flow & differential pressure pertain to the Hydroxr™ aeration manifold, & consequently, the Hydroxr™ aeration tank assembly MUST be installed between the submersible well pump & existing pressure tank. This again presents a problem for systems utilizing a constant pressure (variable speed) well pump or a well pump producing low pressure and/or flow (shallow well jet pump).

In these applications, the Hydroxr VS™ System must be used. The Hydroxr VS™ system operates in exactly the same manner as the standard Hydroxr™ System except air is introduced into the water by use of an oil less air compressor, which forces air (oxygen) into the Hydroxr VS™ aeration tank assembly. The Hydroxr VS™ is uniquely designed to be a “plug & play” type system. Both air compressor & chemical feed pump operation are controlled by the Signature Series or Signature 2 control valve through a small relay panel. On/Off signals from the relay panel for both the air compressor & feed pump are provided by electronic turbine meter inputs from the control valve. Just like the Reactr VS™ system, this makes the Hydroxr VS™ system a totally self-dependent system that does not require any special wiring or plumbing to install.

Hydroxr System



Hydroxr VS System



Hydrogen Peroxide Feed Rates & Solution Strengths

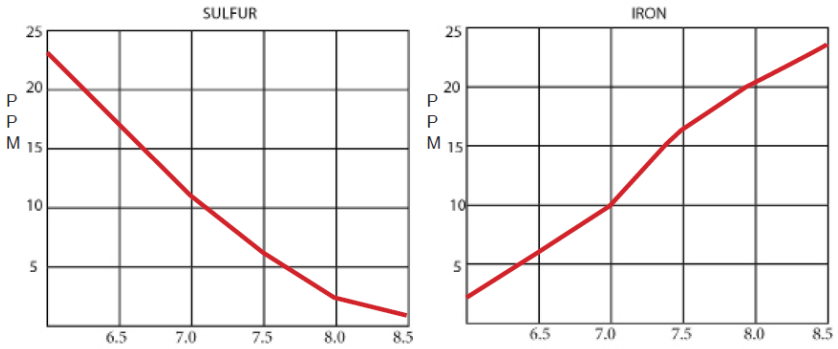
The included peroxide feed system is totally assembled at the factory. The only requirement is to install the injection fitting into one of the two ¼" FNPT ports at the base of the aeration manifold & connect the included tubing from the outlet of the feed pump to the injection fitting. For the standard Hydroxr™ system, the feed pump will then be wired to the well pump pressure switch, so feed pump voltage must match well pump voltage. This will operate the feed pump when the well pump operates. It is recommended to wire a receptacle to the pressure switch so the feed pump power cord can be plugged in. This will make feed pump change out much easier if needed. The Hydroxr VS™ System is equipped with a 115 volt feed pump which will plug into the feed pump receptacle on the front of the supplied relay panel. The feed pump is of a peristaltic design, which is required when pumping hydrogen peroxide due the potential for the solution to foam.

This solution foaming will vapor lock a standard positive displacement type chemical feed pump. Routine maintenance on the feed pump includes changing of the pump tube every year. This is an easy task and an extra tube is included with the system.

A solution of hydrogen peroxide & filtered water will need to be poured into the 15 gallon solution tank. It is recommended to use a peroxide strength of 7%. Hydrogen peroxide found in local drug stores is 3%. Above 7% strength is considered hazardous & can create liability concerns. 7% peroxide can be purchased from your CSI distributor, local farm coop stores or possibly from swimming pool chemical supply stores. CAUTION: Some farm coop stores stock 35% peroxide for farm use only and is extremely dangerous. Do not use any hydrogen peroxide that is over 7% strength! A certain quantity of peroxide (ppm) will be needed to oxidize & disinfect. This amount is dependent upon the oxidation that is accomplished by the air and the type of contaminants (eg.; iron, sulfur, manganese, tannin, etc.). A bottle of peroxide test strips is included with the system to periodically test the residual. These test strips will show both total peroxide (the amount in ppm that is being dispensed at the injection point) & free peroxide (the amount in ppm left over, or residual, after oxidation of contaminants has taken place). So, the quantity of contamination, well pump flow rate, amount of air draw, pH of the raw water, etc. will dictate how much peroxide will need to be injected. There are two ways that the quantity of peroxide injected can be controlled; (1) the feed pump has an adjustment knob called a stroke setting that will adjust how much solution is delivered by the feed pump, (2) the solution strength can be adjusted to provide either a stronger mixture or weaker mixture. The goal is to mix the solution strength such that the feed pump is able to be run at approximately 50% stroke setting (this provides plenty of up & down adjustment in cases of fluctuating levels of contamination) while providing a 2-5 ppm residual peroxide at the cold side kitchen sink faucet. The chart below is a guide for solution strength & feed pump stroke setting based on contamination level. Remember, this is just a starting point! The system will need to be run & peroxide residuals checked every 20 minutes or so, with adjustments made first with pump stroke setting to attain between 2-5 ppm of residual. If the feed pump stroke setting has to be adjusted below 30% or above 90%, then the solution strength will need to be adjusted. For this reason, it is advisable to start the system with the least amount of solution in the solution tank so there is room to make necessary adjustments.

Combined Iron, Manganese & Sulfur (H2S) ppm	Solution Strength (7% H2O2 / Water)	Feed Pump Frequency / Stroke Setting (%)
5 – 9	1 gallon H2O2 / 4 gallon water	63%
10 – 14	1 gallon H2O2 / 3 gallon water	66%
15 – 19	1 gallon H2O2 / 2 gallon water	53%
20 – 24	1 gallon H2O2 / 2 gallon water	64%
25 – 29	1 gallon H2O2 / 2 gallon water	77%
30 – 34	1 gallon H2O2 / 1 gallon water	59%
35 – 39	1 gallon H2O2 / 1 gallon water	67%
40 – 44	1 gallon H2O2 / 1 gallon water	75%
45 – 49	1 gallon H2O2 / 1 gallon water	84%
50 – 54	Straight H2O2	46%
55 – 59	Straight H2O2	50%
60 – 64	Straight H2O2	54%
65 – 69	Straight H2O2	58%
70 – 74	Straight H2O2	62%
75 – 79	Straight H2O2	67%
80 – 84	Straight H2O2	71%
85 – 89	Straight H2O2	75%
90 – 94	Straight H2O2	79%
95 - 100	Straight H2O2	84%

Hydroxr™/Hydroxr VS™ Contaminant Limitations



As with any oxidation/filtration type system, the untreated water pH is the determining factor regarding the quantity of iron, manganese & sulfur reduction the Hydroxr™ & Hydroxr VS™ can successfully treat. Of course, reduction levels are much higher than a typical aeration system such as Reactr™/Reactr VS™ due to the added oxidation/disinfection power of hydrogen peroxide.

Hydroxr™/Hydroxr VS™ Sizing

To properly size the Hydroxr™ or Hydroxr VS™ system, the well pump capacity in gallons per minute (gpm) must be known. The most critical component during sizing is assuring there is adequate flow to properly backwash & clean the filter system.
Sizing Step 1 – Calculate the average pumping capacity using the test procedure found in the REACTR Tech Guide.
Sizing Step 2 – Choose the Hydroxr™ or Hydroxr VS™ model(s) that can be backwashed with the available well pump flow rate (see specifications below)
Sizing Step 3 – Choose the Hydroxr™ or Hydroxr VS™ model that will give the service flow rate desired (see specifications below)

General Specifications	UTP15-S2	UTP20-S2	UTP25-S2	UTP30-S2	UTP40-S2
Filter Media Type	SmartBlend ™				
Filter Media Capacity (cu ft)	1.5	2.0	2.5	3.0	4.0
Mineral Tank (Vortech ™)	10 x 54	12 x 52	13 x 54	14 x 65	16 x 65
Service Flow Rate - Continuous (gpm)	5	6	8	9	11
Service Flow Rate - Intermittent (gpm)	7	8	10	11	13
Backwash Flow Rate (gpm)	5.0	6.0	7.0	10.0	15.0
Gallons Used / Backwash	100	120	140	200	300
Space Required **HydroxR ™** Tank	21 x 21 x 74	21 x 21 x 74	21 x 21 x 74	21 x 21 x 74	21 x 21 x 74
Space Required Filter Tank	10 x 10 x 62	12 x 12 x 60	13 x 13 x 62	14 x 14 x 73	16 x 16 x 74
Space Required Feed Pump System	17 x 17 x 28.5	17 x 17 x 28.5	17 x 17 x 28.5	17 x 17 x 28.5	17 x 17 x 28.5
Approximate Shipping Weight (lbs)	175	246	280	321	394

General Specifications	UTP15VS-S2	UTP20VS-S2	UTP25VS-S2	UTP30VS-S2	UTP40VS-S2
Filter Media Type	SmartBlend ™				
Filter Media Capacity (cu ft)	1.5	2.0	2.5	3.0	4.0
Mineral Tank (Vortech ™)	10 x 54	12 x 52	13 x 54	14 x 65	16 x 65
Service Flow Rate - Continuous (gpm)	5	6	8	9	11
Service Flow Rate - Intermittent (gpm)	7	8	10	11	13
Backwash Flow Rate (gpm)	5.0	6.0	7.0	10.0	15.0
Gallons Used / Backwash	100	120	140	200	300
Space Required **HydroxR ™** Tank	21 x 21 x 71	21 x 21 x 71	21 x 21 x 71	21 x 21 x 71	21 x 21 x 71
Space Required Filter Tank	10 x 10 x 62	12 x 12 x 60	13 x 13 x 62	14 x 14 x 73	16 x 16 x 74
Space Required Feed Pump System	17 x 17 x 28.5	17 x 17 x 28.5	17 x 17 x 28.5	17 x 17 x 28.5	17 x 17 x 28.5
Approximate Shipping Weight (lbs)	175	246	280	321	394

The following is not intended to replace attending technical training programs or reading of installation instructions. It should be viewed as a general discussion about the product, its application, limitations and key factors to remember before purchase.

PURPOSE and CAPABILITIES: Chemical feeding can serve a number of purposes including feeding chlorine for disinfection and oxidation of certain contaminants such as iron, manganese, hydrogen sulfide, tannins and organic complexes. It is also useful for controlling pH levels. Selecting the right chemical feed pump is critical for proper treatment. The following formula applies whether disinfecting, oxidizing or controlling pH:

$$\frac{\text{Well Pump Output (WPO) X Required Dosage PPM (RD) X 1440}}{\text{Solution Strength PPM (SS)}} = \text{FEED PUMP OUTPUT (Gallons Per Day)}$$

Well Output Rate - Use the following formula for determining pump capacity:

HOW TO DETERMINE PUMP CAPACITY
1. Open any faucet and run until pump turns “on.” 2. Close faucet and let pump fill pressure tank and turn “off.” 3. Open any faucet and collect all water discharge until pump turns “on.” 4. When pump turns “on,” immediately close faucet and start timing pump cycle. 5. When pump turns “off,” record cycle time to refill pressure tank (in “seconds”). 6. Measure total number of “gallons” collected in step #3. 7. Divide the number of “gallons” collected in step #3 by the number of “seconds” in step #5. 8. Multiply the answer derived in step #7 by “60.” 9. The answer in step #8 is the average pumping capacity of the system. (NOTE: Make certain no other water is being used during this test)
Example Number of “gallons” collected during draw-down (step #3) = 9 Number of “seconds” in pump cycle to refill tank (step #5) = 72 GPM = (gallons collected / seconds in cycle) X 60 GPM = (9 / 72) X 60 GPM = .125 X 60 GPM = 7.5

Dosage Required - The following are chlorine dosage requirements for common water constituents:

For Every	Chlorine Required .....
1 ppm Hydrogen Sulfide	3 ppm
1 ppm Iron	1 ppm
1 ppm Manganese	2-3 ppm
1 ppm Tannin	3-4 ppm

Simply multiply the required amounts of chlorine by the ppm presence of each contaminant and add them together. Also, remember that it is usually necessary to have a chlorine residual of say, 1 ppm after contact time. Whatever answer you determine, add “1 ppm” for the residual.

Solution Strength - The following are strengths of typical chemicals for feeding:

Chemical	Strength
8.0% Chlorine Bleach	80,000 ppm
12.5% Chlorine Bleach	125,000 ppm
Potassium Permanganate (1/4# per gallon water)	30,000 ppm
Polyphosphate (1# per 10 gallons water)	12,000 ppm
Soda Ash (.926# per 1 gallon water)	10% Solution (100,000 ppm)

SAMPLE CALCULATION:

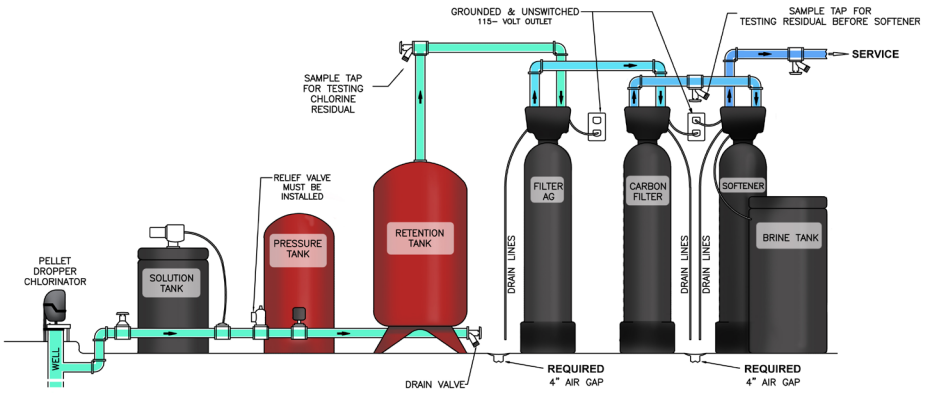
You've determined that the pump capacity was 10.5 gallons per minute. There are 2 ppm Iron; 4 ppm Hydrogen Sulfide; and, a 1 ppm Residual is desired. Simply multiply the 2 ppm Iron by its dosage requirement factor of 1 (2 X 1 = 2); multiply the 4 ppm Hydrogen Sulfide by its factor of 3 (4 X 3 = 12). Add the totals (2 + 12 = 14) then add the residual amount to that total (14 + 1 = 15) for the dosage required. If you are feeding 8.0% chlorine bleach full strength, you can now calculate the above formula to determine the number of gallons per day that will be fed in this example.

(10.5 gpm) X (15 ppm) X (1440) / (80,000) = 2.84 gallons per day

In this example, 2.84 gallons of chlorine bleach will need to be fed to insure that all contaminants are oxidized and a 1 ppm residual of chlorine is left over.

It is now necessary to choose a chemical feed pump that will deliver 2.84 gallons of chlorine in a 24 hour period. For example, choosing a 6 gpd with a maximum output daily would be a correct choice. However, a pump should not be set below 30% of its setting. To check your selection, simply divide the required output by the capacity of the pump... in this case, 2.84 / 6.0 = 47.3%. Therefore, the setting would be at 47% and above the 30% mark. If, however, you were diluting the chlorine (say 3 parts water to 1 part chlorine), you would need to select a 24 gpd since the daily output would be 11.36 gallons of solution. (8.52 + 2.84 = 11.36) Remember, proper sizing is critical! Check the individual specification sheets and contact your Distributor or CSI with questions.

CHEMICAL FEED SYSTEM



Tannin/Hardness Technical Information

The following is not intended to replace attending technical training programs or reading of installation instructions. It should be viewed as a general discussion about the product, its application, limitations and key factors to remember before purchase.

PURPOSE and CAPABILITIES: The Tannin/Hardness ion exchange equipment is designed to remove (exchange) water hardness ions (calcium & magnesium) and organic tannins from water supplies using a combination of specialized resins as catalyts using salt (sodium) as the regenerant. Water passes downwardly through the mineral bed where the ion exchange takes place. These systems can easily remove hardness and tannins when they occur in water (depending on the cubic foot capacity). They cannot remove iron, manganese, sulphur and other water constituents. Attempting to do so may cause problems of bed fouling and hardness/tannin breakthrough. Always check with CSI before attempting anything other than standard applications!

HARDNESS TABLE	
Soft	0 - 3.5 gpg
Moderately Hard	3.5 - 7.0 gpg
Hard	7.0 - 10.5 gpg
Very Hard	10.5 + gpg

Note: “gpg” means grains per gallon.

WATER TESTING: Always test the raw water supply for at least the following: 1) Hardness; 2) Iron; 3) Manganese; 4) pH; 5) Tannins; 6) Hydrogen Sulfide (if rotten egg odor is present); 7) Chlorine (if on treated water supply). Consult specification sheet to check for limitations.

RAW WATER LIMITATIONS	
Free Chlorine	0.1 ppm
Turbidity	5 units
Iron	0.50 ppm
Manganese	0.50 ppm
Hydrogen Sulfide	0.1 ppm

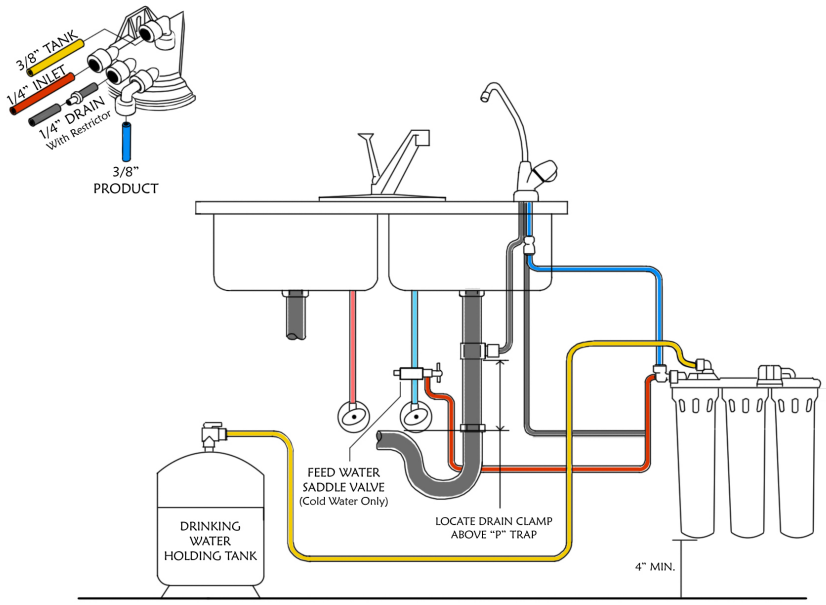
Note: “ppm” means parts per million - “gpg” means grains per gallon.

NOTE: For Limitations, Installation, Programming and Maintenance, refer to the Softener Technical Information Guide as Tannin/Hardness units have the same requirements.

The following is not intended to replace attending technical training programs or reading of installation instructions. It should be viewed as a general discussion about the product, its application, limitations and key factors to remember before purchase.

PURPOSE and CAPABILITIES: Reverse Osmosis systems are highly specialized water treatment devices that deal with contaminants at the molecular level. Influent water passes through a membrane that allows water to pass to a storage tank (service) and rejects the contaminants running them to a drain. They work very slowly to produce high quality water and must have significant water pressure in order to work properly. The TDS (total dissolved solids) are significantly reduced through R/O systems.

LIMITATIONS: An R/O system must receive water that is pretreated for best results. Iron, manganese, hydrogen sulfide, and hardness should be reduced to minimum levels. They are limited to small quantities of output water per day with TFC (Thin Film Composite) systems upwards of 25-35 gallons per day. Check the individual specification sheets for requirements and limitations.



WATER TESTING: Always test the raw water supply for at least the following: 1) Hardness; 2) Iron; 3) Manganese; 4) pH; 5) Tannins; 6) Hydrogen Sulfide (if rotten egg odor is present); 7) Chlorine (if on treated water supply); and, 8) TDS. Consult specification sheet to check limitations.

INSTALLATION: R/O systems are typically installed under the kitchen sink, in closets or basements with a treated line running to the kitchen sink faucet provided with each unit.

PROGRAMMING THE SYSTEM: There is nothing to program on an R/O system. Simply connect to source plumbing and drain line.

REGULAR MAINTENANCE: The membrane of an R/O system should be replaced at least every 12 months. The pre and post-filter elements should be replaced every 6 months. It is also advisable to completely drain the system (simply using the faucet) periodically to insure that the water in the storage tank is fresh. Complete maintenance details are included with each set of installation instructions.

Nitrate/Sulfate Technical Information

The following is not intended to replace attending technical training programs or reading of installation instructions. It should be viewed as a general discussion about the product, its application, limitations and key factors to remember before purchase.

PURPOSE and CAPABILITIES: Anion exchange Nitrate/Sulfate systems are designed to remove (exchange) nitrate and sulfate ions from water supplies using a very specialized resin as the catalyst and salt (chloride) as the regenerant. Water passes downwardly through the mineral bed where the ion exchange takes place. These systems can easily remove these constituents (depending upon the cubic foot capacity). They are not designed to remove hardness, iron or manganese! As a matter of fact, the water should be pretreated (if necessary) so that certain other contaminants are not present in the water to be treated. If they are not removed, you may run into some problems of bed fouling and nitrate/sulfate breakthrough. The amount of salt (per cubic foot of resin) required to backwash these systems is actually less than that required to regenerate a softener of a similar size (usually 10 lbs / cu ft of resin).

WARNING: Although these systems can reduce the foregoing water constituents, YOU MUST make certain that you take precautions for proper sizing, installation and water testing since these constituents (especially nitrates) can have serious health-related consequences!! Always check with CSI before attempting anything other than standard applications!

RAW WATER LIMITATIONS	
Free Chlorine	0.5 ppm
Turbidity	5 units
Iron	0.1 ppm
Manganese	0.1 ppm
Hydrogen Sulfide	0.1 ppm
Tannins	0.5 ppm
Hardness	Preferably less than 5 gpg

Note: “ppm” means parts per million - “gpg” means grains per gallon.

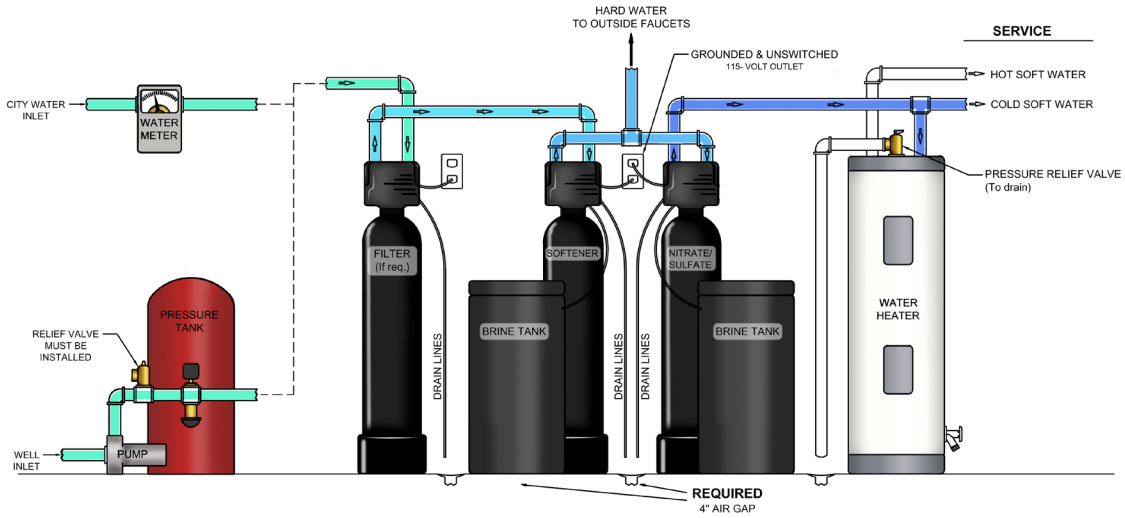
LIMITATIONS: Remember, Nitrate/Sulfate systems cannot remove hardness, iron, manganese, hydrogen sulfide, iron / manganese / sulfur bacteria, tannins, tastes, odors & colors nor should they be used to remove anything other than Nitrates and Sulfates. Presence of any of the above constituents can cause these systems to become less efficient or fail to remove nitrates and sulfates! Various size units have different service and backwash flow rates. Always consult the specification sheet in order to make a proper selection.
NOTE: It is possible for treated water pH to drop significantly after the Nitrate / Sulfate System. Installation of a neutralizer filter may be necessary.

WATER TESTING: Always test the raw water supply for at least the following: 1) Hardness; 2) Iron; 3) Manganese; 4) pH; 5) Tannins; 6) Hydrogen Sulfide (if rotten egg odor is present); 7) Chlorine (if on treated water supply); 8) Nitrates as N (nitrogen); 9) Nitrates as NO_3 (nitrate); and 10) Sulfates as SO_4 (sulfate)

INSTALLATION: Nitrate / Sulfate systems should be installed on a level surface, on cold water line only; after filtration and softeners; after outside sillcock lines; and, before the piping splits to the water heater. Note typical installation.

NITRATE SETUP

(Incoming Water from Left-Side)



Never elevate the mineral tank more than 1-2 feet above the brine tank so as not to cause problems with brine draw. Avoid installations in direct sunlight and where freezing may occur. Locate the unit near a 115V, unswitched outlet (except manual units that require no electricity) and near a drain. Where the drain line must be elevated above the system or runs more than 20 feet, increase the drain line size to 3/4". NEVER decrease the size of the drain line! It is advisable (and code in most areas) that there be at least a 4" air gap between the drain and drain line. Check all local codes before installing equipment.

PROGRAMMING THE SYSTEM: After all plumbing has been completed according to the installation instructions, find the section in the instructions regarding programming the control valve. It is quite simple but you must first consult your water test results. Refer to the **"Capacity/Regeneration"** box in order to determine the regeneration frequency for either Timeclock or Demand initiated control valves. Always check system cycles and consult the installation instruction manual.

REGULAR MAINTENANCE: All that's necessary for normal maintenance is to keep good quality softener salt in the brine tank. Should the system become fouled, it may be necessary to replace the resin. It is also wise to clean the brine tank about every other year.

Capacity/Regeneration

In order to properly size Nitrate/Sulfate systems, the amounts of each in the raw water must be known. They must be expressed as equivalents as calcium carbonate ($CaCO_3$). Use the test results and follow these steps:

Sulfate as SO_4 ppm X 1.04 = Sulfate ppm as $CaCo_3$
Nitrate as N ppm X 3.56 = Nitrate as $CaCO_3$
Nitrate as NO_3 ppm X 0.81 = Nitrate as $CaCO_3$

Add all $CaCO_3$ ppm quantities together and divide by 17.1 to find equivalent grains per gallon (gpg). Then, divide the total grain capacity of the unit by the gpg of $CaCO_3$ to determine how many gallons can be treated before regeneration.

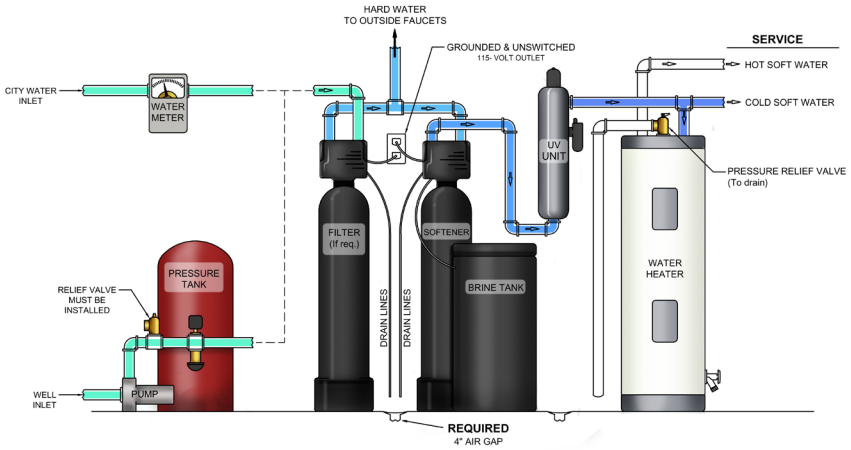
The following is not intended to replace attending technical training programs or reading of installation instructions. It should be viewed as a general discussion about the product, its application, limitations and key factors to remember before purchase.

PURPOSE and CAPABILITIES: Ultra Violet systems are highly specialized water treatment devices that disinfect water. Influent water passes through the cylindrical, stainless steel chamber where a certain wavelength of light destroys or deactivates many bacteria and viruses. It is recommended a service line flow control be installed so that proper contact time can be maintained to insure high disinfection rates.

LIMITATIONS: An Ultra Violet system must receive water that is pretreated for best results. Iron, manganese, hydrogen sulfide, and hardness should be reduced to minimum levels. They are not designed to kill forms of iron/manganese/sulfur bacteria nor cysts like Giardia lamblia. As a matter of fact, tannins and slime producing bacteria (iron bacteria) coat the quartz tube and reduce light penetration. See specification sheet for requirements and limitations.

TWO TANK SETUP

(Incoming Water from Left-Side)



WATER TESTING: Always test the raw water supply for at least the following: 1) Hardness; 2) Iron; 3) Manganese; 4) pH; 5) Tannins; 6) Hydrogen Sulfide (if rotten egg odor is present); 7) Chlorine (if on treated water supply); and, 8) TDS. Consult specification sheet to check limitations.

INSTALLATION: U/V systems are typically installed at the point-of-entry in a home or business where all water can be treated. It is strongly advisable to install a drain on the lower section of the plumbing for easy draining during cleaning. Make certain that it is connected to an uninterrupted power supply!

PROGRAMMING THE SYSTEM: There is nothing to program on a U/V system. Simply connect to source plumbing and power supply.

REGULAR MAINTENANCE: The U/V lamp should be replaced annually and the entire unit cleaned about every six months to prevent build-up on the quartz tube. It is also advisable to use a strong chlorine solution in the stainless steel housing each time the system is cleaned. If the unit has a failsafe feature, check the solenoid for proper operation. Complete details on preventative maintenance are included with each set of installation instructions.

Granular Activated Carbon Reduction Capability

CSI WATER TREATMENT SYSTEMS

Name of Contaminant	No Removal	Modest Removal	Good Removal	Excellent Removal
1.1.1-Trichloroethane			•	
1.1.2.2-Tetrachloroethane			•	
1.1.2.2-Tetrachloroethylene			•	
1.1.2-Trichloroethane			•	
1.1-Dichloroethane			•	
1.1-Dichloroethylene			•	
1.1.2.4-Trichlorobenzene				•
1.2-Dichlorobenzene				•
1.2-Dichloroethane			•	
1.2-Dichlorothylene			•	
1.2-Dichloropropane			•	
1.2-Diphenyl Hydrazline				•
1.3-Dibromochloromethane			•	
1.3-Dichlorobenzene			•	
1.3-Dichloropropane			•	
1.4-Dichlorobenzene				•
2.4.5-TP				•
2.4.6-Trichlorophenol				•
2.4-Dimethylphenol				•
2.4-Dichlorophenal				•
2.4-Dinitrophenol				•
2.4-Dinitrotoluene				•
2.6-Dinitrotouene				•
2-Chloroethyl Vinyl Ether			•	
2-Chloronaphthalene				•
2-Chlorophenol		•		
2-Methyl-4.6-Dinitrophenol				•
2-Nitrophenol			•	
4.4-DDD				•
4.4-DDE				•
4.4-DDT				•
4-Bromophenyl Phenyl Ether				•
4-Chlorophenyl Phenyl Ether				•
4-Nitrophenol			•	
Acenaphthene			•	
Acenaphthylene			•	
Acrolein			•	
Aldrin				•
Alhpa-BHC				•
Anthracene				•
Benzene			•	
Benzidine				•
Benza (a) Pyrene				•
Benza (b) Fluoranthene				•
Beta-BHC				•
Bis (2-Chloroethoxy) Methane				•
Bis (2-Chloroethyl) Ether				•
Bis (2-Chloroisopropyl) Ether				•
Bis (2-Ethylhexyl) Phthalate				•
Bix (Chloromethyl) Ether				•
Bromodichloromethane			•	
Bromofrom				•
Butyl Benzyl Phthalate				•
Carbon Tetrachloride			•	
Chloramines		•		
Chlordane				•
Chlorobenzene			•	
Chloroform			•	
Chrysene			•	
Di-n-octylphthalate				•
Dibutyl Phthalate				•
Dichlorodifluoromethane				•
Dieldrin				•
Diesel Fuel				•
Diethyl Phthalate				•
Dimethyl Phthalate				•
Dioxin				•
EDB				•
Endosulfan I			•	
Endosulfan II			•	
Endosulfan Sulfate				•
Endrin				•
Ethylbenzene			•	
Fluoranthene			•	
Fluorene				•

Name of Contaminant	No Removal	Modest Removal	Good Removal	Excellent Removal
Fuel Oil				•
Gasoline				•
Heptachlor				•
Heptachlor Epoxide				•
Hexachlorobenzene				•
Hexachlorobutadiene				•
Hexachlorocyclopentadiene				•
Hexachloroethane				•
Isophorone			•	
Kerosine				•
Lindane				•
Malathion				•
Methane		•		
Methoxychlor			•	
Methyl Bromide	•			
Methylene Chloride			•	
n-Nitroso-n-Propylamine			•	
n-Nitrosodimethylamine			•	
n-Nitrodoiphenyl Amine				•
Naphtalene			•	
Nitrobenzene			•	
Oil			•	
Parathion				•
PCB's				•
PCB-1016				•
PCB-1221				•
PCB-1232				•
PCB-1242				•
PCB-1248				•
PCB-1254				•
PCB-1260				•
Pentachlorophenol				•
Phenanthrene			•	
Phenol				•
Pyrene				•
TCA			•	
TCE			•	
Toluene				•
Total Organic Carbons			•	
Toxaphene				•
Toxic Herbicides			•	
Toxic Insecticides				•
Toxic Pesticides			•	
Trichloroethylene			•	
Trichlorofluoromethane			•	
Trihalomethanes (THM's)			•	
Unpleasant Colors			•	
Unpleasant Odors				•
Unpleasant Tastes				•
Aluminum	•			
Arsenic			•	
Asbestos	•			
Barium Sulfate	•			
Cadmium Oxide	•			
Calcium		•		
Chlorides	•			
Chlorine				•
Chromium Oxide		•		
Copper Oxide	•			
Fluoride	•			
Hydrogen Sulfide Gas (Sulfur)		•		
Iodine				•
Iron Oxide		•		
Lead Chromate	•			
Magnesium		•		
Manganese Oxide		•		
Mercury		•		
Nickel Oxide	•			
Nitrates	•			
Selenium		•		
Silver Chloride	•			
Sodium	•			
Toxic Heavy Metals		•		
Turbidity (Sediment & Scale)			•	
Zinc Oxide		•		

CSI WATER TREATMENT SYSTEMS

Water Use Estimates

Airports
Per Passenger = 3 - 5 gal. / day

Apartments
Based on 3 persons per apartment
Hot and Cold = 150 gal. / unit / day
Hot Only = 60 gal. / unit /day

Barber Shops
55 gal. / chair / day

Beauty Salons
270 gal. / station / day

Boilers
To determine daily makeup in gallons:
1. Multiply boiler h.p. by 4.25.
2. Then multiply by hours per day of operation.
3. Then multiply by the % operating rating.
4. Then subtract the % condensate returns.

Note: When ratings are given in pounds of steam per hour, divide by 500 to obtain GPM requirement. When ratings are given in BTU's divide by 12,000. For every 12,000 BTU's, there is an equivalent of 1 h.p.

Camps
Day (No meals) = 15 gal. / person/day
Resorts = 50 gal. / person/day
Tourist = 35 gal. / person/day

Cooling Water
To determine daily makeup in gallons:
1. Multiply the tonnage by four (this includes 2 gal. / hr / day / ton bleed off).
2. Then multiply by the number of hours per day of operation.

Dentist
4,000 gal. / month / chair

Dormitories
Hot and Cold = 40 gal. / person / day
Hot Only = 20 gal. / person / day

Dwellings
Boarding Houses
= 50 gal. / person / day
Luxury = 100-150 gal. / person / day
Multiple Family Apts.
= 40 gal. / person / day
Rooming Houses
= 60 gal. / person / day
Single Family
= 50-75 gal. / person / day

Factories
15 - 35 gal. / person/ shift

Hospitals
Meter reading preferred
Hot and Cold = 250 gal. / bed / day
Hot Only = 170 gal. / bed / day

Hotels
With Private Baths (2 persons)
= 60 gal. / day
Without Private Baths
= 50 gal. / person / day

Laundry
Hot and Cold = 2.5 x lb. capacity is equivalent to gallons per cycle

Lawns
25 gal. / square foot / season

Livestock & Poultry

Cow, Beef	= 12 gal. / animal / day
Cow, Dairy	= 20 gal. / animal / day
Goat	= 2 gal. / animal / day
Hog	= 12 gal. / animal / day
Horse	= 12 gal. / animal / day
Mule	= 12 gal. / animal / day
Sheep	= 2 gal. / animal / day
Chickens	= 10 gal. / each 100 / day
Turkeys	= 18 gal. / each 100 / day

Motels
With bed and toilet (no kitchen)
40 gal. / bed space / day

Nursing Homes
Hot and Cold = 100 gal. / bed / day
Hot Only = 50 gal. / bed / day

Office Buildings
Hot and Cold = 20 gal. / person / day
Hot Only = 3 gal. / person / day

Parks
Overnight with flush toilets
= 25 gal. / camper / day
Trailers with individual bath units
= 50 gal. / camper / day

Picnic Areas
With bath houses, showers and flush toilets = 20 gal. / picknicker / day
With toilet facilities only
= 10 gal. / picknicker / day

Schools
Elementary :
Hot and Cold = 13 gal. / student / day
Hot Only = 5 gal. / student / day
Junior High :
Hot and Cold = 20 gal. / student / day
Hot Only = 10 gal. / student / day
Senior High:
Hot and Cold = 35 gal. / student / day
Hot Only = 15 gal. / student / day

Service Stations
10 gal. / vehicle / day

Shopping Centers
300 gal. / 1,000 square foot / day

Stores
400 gal. / toilet room / day

Swimming Pools
10 gal. / swimmer / day

Theaters
Indoor = 5 gal. / auditorium seat / day
Drive-In = 5 gal. / car space / day

Trailer Parks
150 gal. / trailer / day

Workers
Construction = 50 gal. / person / shift
Office = 15 gal. / person / shift

Estimating Flow Rate Requirements

The following information describes estimated maximum GPM flows from certain typical fixtures and appliances. Estimates do not consider "water saving" devices. The "fixture count" columns are factors to be used to determine estimated flow rate requirement for homes, apartments and commercial facilities. Other types of equipment not listed below, but present on the premises must be also considered in the analysis.

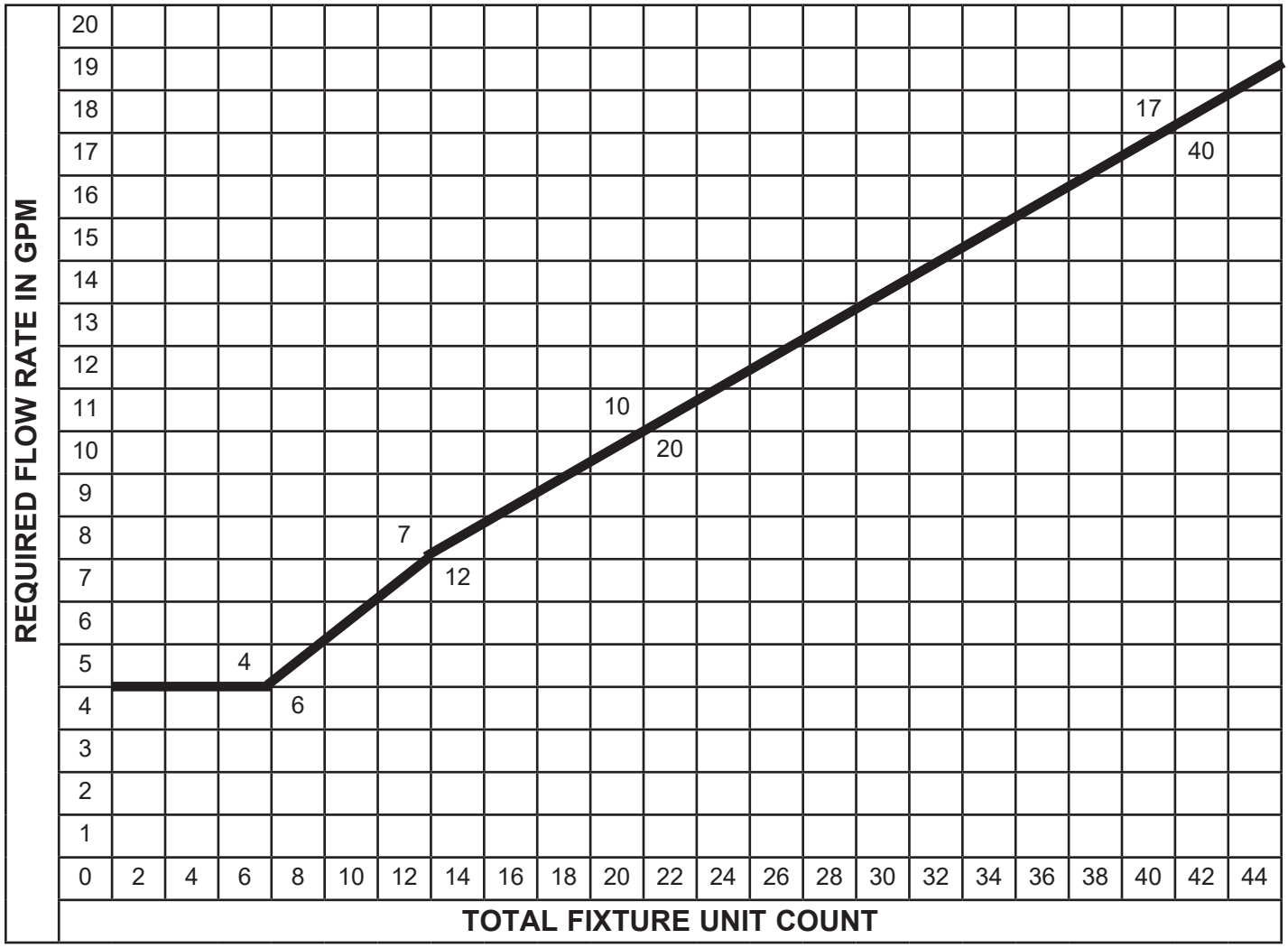
A FIXTURE / APPLIANCE	ESTIMATED FLOW RATE (gpm)	"RESIDENTIAL" FIXTURE UNITS	"PUBLIC" FIXTURE UNITS
Lavatory	4	1	2
Bathtub	6	2	4
Shower Head	5	2	4
Toilet (with flush tank)	3	3	5
Toilet (with flush meter)	15	6	10
Urinal (with flush tank)	3	---	3
Urinal (with flush meter)	10	---	5
Kitchen Sink	5	2	4
Dishwasher	2	1	3[1]
Laundry Tray / Service Sink	5	3	3
Automatic Clothes Washer	5	2	4[1]
Drinking Water Faucet / Water Fountain	.75	.25	.50

NOTE 1: Check with manufacturer of appliance or consult specifications manual for exact flow rate.

B OUTLETS	Flow RATES (gpm)	TOTAL USAGE (gallons)	NUMBER of BATHROOMS in the HOME			
			1	1 1/2	2-2 1/2	3-4
Shower / Bath Tub	5	35	35	35	53	70
Lavatory Sink	4	2	2	4	6	8
Toilet	4	5	5	10	15	20
Kitchen Sink	5	3	3	3	3	3
Automatic Washer	5	35	--	18	18	18
Dishwasher	2	14	--	--	3	3
Seven Minute *Peak Demand	--	--	45	70	98	122
Minimum Sized Pump Required	--	--	7 gpm	10 gpm	14 gpm	17 gpm
Minimum Treatment Equipment Reqd.	--	--	5 gpm	6 gpm	7 gpm	10 gpm

* Peak demand can occur several times during morning and evening.
NOTE 1: It is always better to have larger flow rate capacity treatment equipment if the pump capacity is available for backwashing.
NOTE 2: Chart B was adapted from *Ground Water Age* magazine, December 1991, page 22.

Plotting Service Flow Rates



In reading the above chart, use the vertical line to the right of the horizontal numbers. Use the line above the vertical numbers.

HOW TO USE THIS TABLE

The estimated flow rate requirement for plumbing fixtures used intermittently on a water supply line may be obtained by multiplying the number of each kind of fixture times its individual "fixture count" value as determined from Table A on the previous page entitled *ESTIMATING FLOW RATE REQUIREMENTS.* Add the sums together to get a grand total "fixture unit count."

Looking at the chart above, find the fixture count on the lower edge of the chart that most closely matches the number you calculated. At that point, go upward on the vertical line until you hit the curve on the chart. Follow the intersecting horizontal line to the left in order to determine the flow rate requirement for treatment equipment. The gpm flow rate that is discovered using this chart will be very adequate for the facility. You could actually use about 70% of the number as a minimum for equipment sizing.

Remember that "estimating" charts and tables are just that.....estimates. The more information you have, the better your calculations will be. Also refer to Table B on the previous page for more rules-of-thumb on treatment requirements in gpm based on number of bathrooms in the home.

Shock Chlorination Procedure

Shock Chlorination is the procedure for cleaning and sanitizing a well or spring with chlorine. Concentrations of chlorine used in shock chlorination are 100 to 400 times the amount of chlorine found in "city water." The highly chlorinated water is held in the pipes for 12 to 24 hours before it is flushed out and the system is ready for use.

Periodic shock chlorination may also be effective to reduce an **iron bacteria** problem.

For wells, the amount of chlorine needed to shock chlorinate a water system is determined by the amount of water standing in the well. Table 1 lists the amount of chlorine laundry bleach or powdered high-test hypochlorite (HTH) needed for wells. If in doubt, it is better to use more chlorine than less.

Table 1
Amount of chlorine needed for shock chlorination

Laundry bleach (about 8% Hypochlorite)

Depth of Water in well	Casing Diameter				
	4 inch	**6 inch**	**8 inch**	**10 inch**	**12 inch**
10 feet	1/2 cup	1 cup	1 1/2 cup	1 pint	2 pints
25	1 cup	1 pint	2 pints	3 pints	4 1/2 gallons
50	1 pint	1 quart	2 quarts	3 quarts	1 gallon
100	1 quart	2 quarts	1 gallon	1 1/2 gallon	2 gallons
150	3 pints	3 quarts	1 1/2 gallon	2 gallons	3 gallons

High-Test Hypochlorite (HTH 65-75% Hypochlorite)

Depth of Water in well	Casing Diameter				
	4 inch	**6 inch**	**8 inch**	**10 inch**	**12 inch**
10 feet	--	--	--	--	--
25	--	--	--	1/4 lb.	1/2 lb.
50	--	--	1/3 lb.	1/2 lb.	3/4 lb.
100	--	1/3 lb.	3/4 lb.	1 lb.	1 1/2 lb.
150	1/4 lb.	1/2 lb.	1 lb.	1 1/2 lb.	2 lbs.

Water Well Disinfection

To Shock Chlorinate a Well:

1. Pour the proper amount of chlorine bleach or powdered chlorine dissolved in a small amount of water directly into the well.

2. Connect a garden hose to a nearby faucet and wash down the inside of the well.

3. Re-circulate the chlorinated water into the well for a minimum of one (1) hour (2 to 3 hours is preferable).

4. Open each faucet one by one and let water run until a strong odor of chlorine is detected. If a strong odor is not detected, add more chlorine to the well.
   Note: Bypass all installed water treatment equipment.

5. Let the water stand in the water system for at least 12 to 24 hours.

6. Flush the system of remaining chlorine. Start by turning on outside faucets and letting them run until the chlorine smell dissipates. Let the water run on the ground to reduce the load on your septic system. Finally, run the indoor faucets until the system is completely flushed.

Shock chlorination of a spring is more difficult. If possible, divert spring water away from the spring box. Mix about 1/2 cup of household bleach in 5 gallons of water and scrub the walls of the spring box or holding tank or both. Return the flow of spring water back into the spring box and let the fresh water carry the chlorine through the pipeline to disinfect the plumbing.

Most water treatment equipment, such as water softeners and iron filters, should be bypassed. Check the manufacturer's literature before chlorinating treatment equipment and pressure tank to prevent damage from strong chlorine solutions. ***Do not*** chlorinate carbon or charcoal filters; doing so will use up their capacity. Rebedding of these type fixtures will be required.

Be Careful when handling concentrated chlorine solutions. Wear rubber gloves, goggles and protective apron. If chlorine accidently gets on your skin, flush immediately with clean water.

Never mix chlorine solutions with other cleaning agents or ammonia, because toxic gases are formed.

Do not use "fresh scent" bleach or other special laundry products to disinfect wells. Use the plain and usually least expensive laundry bleach.

Retest your water supply for bacteria after waiting 1 to 2 weeks. If shock chlorination does not eliminate a bacteria problem, continuous disinfection may be necessary.

Ref: OCES Ohio Cooperative Extension Service

Softener Regeneration Guide

The following will help you in determining how to program a Timeclock softener for regeneration. If you have a Demand system, this chart is not necessary as the control valve decides when to regenerate.

DETERMINE	EXAMPLE	YOUR CALCULATION
Hardness (in gpg) Iron & Manganese (in ppm - combined) Number of persons in the family Capacity of the softener (total grains)	20 2 4 32,000	_____ _____ _____ _____
STEP #1: Figure number of gallons used per day # of people x "75"	300	_____
STEP #2: Figure Compensated Hardness gpg of Hardness + (ppm Iron/Manganese x "4")	28	_____
STEP #3: Figure total grains used per day Step #1 answer x Step #2 answer	8,400	_____
STEP #4: Figure Days between Regenerations Softener Capacity / Step #3 answer	3.81	_____

NOTE: Always round "down" to the next lowest number of days between regeneration when programming. In the example above, the answer was 3.81 days between regenerations. For a 32,000 Grain Capacity Softner you would set the softener to regenerate every "3" days.

Problem Cause / Effect / Remedy Guide

PROBABLE CAUSE	GENERAL EFFECT	PROBABLE REMEDY
HARDNESS (calcium & magnesium)	Scale in pipes and water heaters; causes "soap curd" on fixtures, tile, dishes and laundry; low sudsing characteristics.	Removal by ion exchange softener.
IRON/MANGANESE	Causes discolored water; red, brown, orange or black stains on fixtures, appliances and laundry; dark scale in pipes and water heaters.	Low level (2ppm) removal by ion exchange softener when hardness is also present; best removed by oxidizing iron filter; aeration and/or chlorination followed by filtration in some cases.
IRON/MANGANESE/SULFUR Bacteria	Same general effects as above plus slimy deposits that form in pumps, pipes, softeners and toilet tanks.	Low level removal possible by oxidizing iron filter; best removed by chlorination followed by filtration.
HYDROGEN SULFIDE GAS	Foul rotten-egg odor; corrosion to plumbing; tarnishes silver and stains fixtures and laundry; ruins the taste of foods and beverages.	Best removed by aeration, scrubbing and filtration; also removed by oxidizing filters or chlorination followed by filtration.
TURBIDITY	Suspended matter in water; examples include mud, clay, silt and sand; can ruin seats, seals and moving parts in appliances.	Removal by backwashing sediment filters; extra fine treatment utilizing sediment cartridge elements.
ACID WATER (low pH)	Corrosive water attacks piping and other metals, red and/or green staining of fixtures and laundry.	Best corrected by neutralizing filters or soda ash feeding.
TASTE/ODOR/COLOR (organic matter)	Makes water unpalatable; can cause staining.	Depending on the nature of contaminant, aeration followed by filtration; carbon filtration; chlorination followed by filtration.
TANNINS/HUMIC ACID	Can impart an "iced-tea" color to water; causes light staining; can affect the taste of foods and beverages.	Removal by special ion exchange or oxidizing agents and filtration.
COLIFORM BACTERIA	Can cause serious disease and intestinal disorders.	Chlorination and filtration is most widely practiced; iodination, ozonation and ultraviolet treatment are used to a lesser degree.
ORGANIC HALIDES (e.g. Herbicides & Pesticides)	Can cause serious disease and/or poisoning.	Most are readily removed by absorption with carbon filters; some can also be removed by hydrolysis and oxidation.
NITRATES/CHLORIDES & SULFATES	Can cause health-related problems if quantities are high.	Removal by special ion exchange, deionization process or reverse osmosis.

Slot Opening Equivalents

The following chart details the opening sizes of slots for distributor systems and screens.

Inches	Microns	U.S. STD. Mesh *
.0002	5	--
.0006	15	1000
.0010	25	--
.0012	30	500
.0015	37	400
.0020	50	270
.0024	61	250
.0030	75	200
.0040	100	150
.0050	125	120
.0060	149	100
.0070	177	80
.0080	200	70
.010	250	60
.012	305	50
.014	355	45
.016	400	40
.020	500	35
.023	590	30
.028	710	25
.033	840	20
.039	1000	18
.047	1190	16
.055	1410	14
.066	1680	12
.094	2380	8
.111	2790	7
.132	3330	6
.157	4000	5

*Note: The higher the Mesh number, the “finer” job of filtration it will do.

Mathematical Conversions

To Convert From	To	Multiply By	To Convert From	To	Multiply By
Acre	Square Feet	43,560	Gallon (US liq)	Ounce (US fluid)	128
Acre-Foot	Cubic Yard	1613.333	Gallon (US liq)	Pint (US liq)	8
Angstrom	Nanometer	0.1	Gallon (US liq)	Quart (US liq)	4
Atmosphere	Foot of H_20	33.89854	Gallon (Brit)	Gallon (US liq)	1.200950
Bar	Atmosphere	0.9869233	Grain/Gal (Brit)	Milligram/liter	14.25377
Bushel	Cubic Foot	1.244456	Grain/Gal (US)	Milligram/liter	17.11806
Bushel	Gallon (US liq)	9.309177	Inch	Centimeter	2.54
Centimeter	Foot	0.03280840	Inch	Millimeter	25.4
Centimeter	Inch	0.3937008	Kilogram	Grains	15,432.358
Centimeter	Micrometer	10,000	Kilogram	Pounds	2.2046226
Centimeter	Millimeter	10	Liter	Cubic Feet	0.03531467
Chain(Gunter's)	Feet	66	Liter	Cubic Inches	61.02374
Cubic Foot	Cubic Cm	28,316.847	Liter	Gallons (US)	0.26417205
Cubic Foot	Cubic Inch	1,728	Liter	Milliliters	1,000
Cubic Foot	Gallon (US liq)	7.480519	Liter/Minute	Gallon (US)/Hr	15.85032
Cubic Foot	Liter	28.316847	Meter	Feet	3.2808399
Cubic Meter	Cubic Foot	35.31467	Meter	Inches	39.37007874
Cubic Meter	Cubic Inch	61,023.74	Micrometer	Millimeters	0.001
Cubic Meter	Gallon (US liq)	264.1721	Micrometer	Mils	0.03937008
Celsius (°C)	Fahrenheit (°F)	1.8	Micron	Micrometer	1
Fahrenheit (°F)	Celsius (°C)	0.5555556	Milligram/Liter	Grains/Gal (US)	0.05841783
Foot	Centimeter	30.48	Parts/Million	Milligram/Liter	1
Foot	Meter	0.3048	Pint (US liq)	Ounce (US liq)	16
Foot	Millimeter	304.8	Quart (US liq)	Ounce (US liq)	32
Foot of H_20	Atmosphere	0.0294998	Rod	Feet	16.5
Foot of H_20	Bar	0.0298907	Square Foot	Square Inches	144
Foot of H_20	Inch of Hg	0.882671	Square Mile	Acres	640
Gallon (US liq)	Cubic Feet	0.13368056	Square Yard	Feet	9
Gallon (US liq)	Cubic Inches	231	Tablespoon	Millimeter	14.79
Gallon (US liq)	Gallon (Brit liq)	0.8326742	Teaspoon	Millimeter	4.93
Gallon (US liq)	Liter	3.785412	Watt	BTU/Hour	3.41214

CSI WATER TREATMENT SYSTEMS

Table of Elements

Name	Sym	Num
Actinium	Ac	89
Aluminum	Al	13
Americium	Am	95
Antimony	Sb	51
Argon	Ar	18
Arsenic	As	33
Astatine	At	85
Barium	Ba	56
Berkelium	Bk	97
Berylium	Be	4
Bismuth	Bi	83
Boron	B	5
Bromine	Br	35
Cadmium	Cd	48
Caesium	Cs	55
Calcium	Ca	20
Californium	Cf	98
Carbon	C	6
Cerium	Ce	58
Chlorine	Cl	17
Chromium	Cr	24
Cobalt	Co	27
Copper	Cu	29
Curium	Cm	96
Dysprosium	Dy	66
Einsteinium	Es	99
Erbium	Er	68
Europium	Eu	63
Fermium	Fm	100
Flourine	F	9
Francium	Fr	87
Gadolinium	Gd	64
Gallium	Ga	31
Germanium	Ge	32
Gold	Au	79
Hafnium	Hf	72

Name	Sym	Num
Helium	He	2
Holmium	Ho	67
Hydrogen	H	1
Indium	In	49
Iodine	I	53
Iridium	Ir	77
Iron	Fe	26
Krypton	Kr	36
Lanthanum	La	57
Lawrencium	Lr	103
Lead	Pb	82
Lithium	Li	3
Lutetium	Lu	71
Magnesium	Mg	12
Manganese	Mn	25
Mendelevium	Md	101
Mercury	Hg	80
Molybdenum	Mo	42
Neodymium	Nd	60
Neon	Ne	10
Neptunium	Np	93
Nickel	Ni	28
Niobium	Nb	41
Nitrogen	N	7
Nobelium	No	102
Osmium	Os	76
Oxygen	O	8
Palladium	Pd	46
Phosphorus	P	15
Platinum	Pt	78
Plutonium	Pu	94
Polonium	Po	84
Potassium	K	19
Praseodymium	Pr	59
Promethium	Pm	61
Protoactinium	Pa	91

Name	Sym	Num
Radium	Ra	88
Radon	Rn	86
Rhenium	Re	75
Rhodium	Rh	45
Rubidium	Rb	37
Ruthenium	Ru	44
Samarium	Sm	62
Scandium	Sc	21
Selenium	Se	34
Silicon	Si	13
Silver	Ag	47
Sodium	Na	11
Strontium	Sr	38
Sulfur	S	16
Tantalum	Ta	73
Technetium	Tc	43
Tellurium	Te	52
Terbium	Tb	65
Thallium	Tl	81
Thorium	Th	90
Thulium	Tm	69
Tin	Sn	50
Titanium	Ti	22
Tungsten	W	74
Unnihexium	Unh	106
Unnilpentium	Unp	105
Unnilquadium	Unq	104
Unnilseptium	Uns	107
Uranium	U	92
Vanadium	V	23
Xenon	Xe	54
Ytterbium	Yb	70
Yttrium	Y	39
Zinc	Zn	30
Zirconium	Zr	40
Total Elements	**107**	

Softening & Sodium

Probably the number one question arising during a discussion of water softening is that of the "sodium" issue. It is greatly misunderstood due to all the bad press about too much salt (sodium) in the average American's diet today. Various studies contradict one another on the actual health-impact of sodium in the diet. We must have sodium to live...but how much is enough...how much is too much? We will not attempt to answer those questions. However, we can put the topic into perspective by showing where the sodium in one's life comes from daily.

The standard sodium ion exchange (softening) process uses sodium (salt) to exchange-out the hardness ions (calcium & magnesium). Therefore, when you remove the hardness ions, they are replaced with sodium ions. The amount of sodium produced in the softening process is quite small and should not present any health problems for a healthy person. As a matter of fact, the U.S. drinking water regulations have dropped sodium as a regulated component of water. However, if a person has a question about whether or not they should consume water softened by the sodium ion exchange process, they should consult with their own health professional.

The basic information below should put soft water sodium into perspective for you relative to sodium in foods. For example, if you drank 3 quarts of water that was 10 grains hard before softening you would only take-in 223 milligrams of sodium or about 4.3% of the average daily intake of sodium attributable to the water. This would be less than the amount of sodium contained in two slices of white bread.

FOOD	APPROXIMATE SODIUM CONTENT IN MILLIGRAMS
BREAKFAST	
1/2 cup canned tomato juice	270
1 egg (no salt added)	60
2 slices bacon	150
2 biscuits or toast	300
2 teaspoons margarine	100
LUNCH	
Luncheon meat, corned beef or ham (3 oz.)	900
Processed cheddar cheese (1 oz.)	420
2 slices white bread	300
1 cup milk	120
1 large olive	130
1 dill pickle	930
1 teaspoon mustard	60
Potato chips, about 10	200
DINNER	
Steak, 6 oz., no salt added	80
Green salad with 1 ounce French Dressing	450
Baked potato, salt added	240
Two pats margarine	100
Bread, 2 slices or equivalent	300
TOTAL SODIUM.....5,110 (Milligrams)	

TABLE 1 - Sodium Added to Water from Cation Exchange Softening

Initial Water Hardness	Sodium added by Cation Exchange Softening of Water	
Grains per Gallon	Milligrams Na+/gal.	Milligrams Na+/qt.
1	30	7.5
5	149	37
6	179	44
7	209	52
8	239	60
9	269	68
10	298	75
15	447	112
20	596	150
30	894	225
40	1,191	300

TABLE 2 - Sodium Intake from Softened Water Compared to Total Sodium Intake

Initial Water Hardness/ Grains per Gallons	Milligrams Na+ Per 3 qts. Softened Water	Milligrams Na+ from Food Water	Total Na+ Consumed Milligrams	% of Total from Softened
1	23	5,000	5,023	0.4%
5	112	5,000	5,112	2.2%
10	223	5,000	5,223	4.3%
15	335	5,000	5,335	6.5%
20	447	5,000	5,447	8.2%
30	670	5,000	5,670	12.5%
40	893	5,000	5,893	15.2%

To convert pressure (in pounds per square feet) to “Feet of Head” pressure, use the following formula: FT = 2.31 x psi

One U.S. gallon of water contains 231 cu inches and weighs about 8.333 pounds.

A cubic foot of water contains about 7.50 gallons and weighs about 62.5 pounds.

To find the pressure in “psi” of a column of water, multiply the height of the column in feet by .434.

One pound of water occupies 27.70 cubic inches.

One cubic foot of salt water weighs about 64.33 pounds.

One standard “barrel” of water contains 31.50 gallons.

Barrels per day (42 gallons) x .02917 = gallons per minute

Friction of liquids in piping increases as the square of the velocity.

Doubling the diameter of a pipe increases its capacity four times.

A “miner’s inch” of water is approximately equal to a supply of 12 gpm (9 in some states).

The gallons per minute which a pipe will deliver equals .0408 times the square of the diameter in inches, multiplied by the velocity of water in feet per minute.

To find the capacity of a pipe or cylinder in gallons, multiply the square of the diameter in inches by the length in inches then multiply by .0034.

The weight of water (in pounds) in any length pipe is obtained by multiplying the length in feet by the square of the diameter in inches then multiply by .340.

One common water pail will hold 2.27 U.S. gallons or about 19 pounds of water.

Sharp angles or sudden bends in pipes cause an increase in friction and, consequently, more power is necessary.

Where change of direction is desired, it should be made with long, easy curves or by using 45 degree elbows whenever possible.

About 80% of the earth’s surface is covered by water.

Around 97% of the earth’s water is contained in the oceans, 2% is in glaciers and icecaps; the remaining 1% is found in other surface waters, groundwater and living tissue.

Rainfall in the U.S. ranges from about 7-130 inches per year depending on geography, averaging out to about 30 inches.

About 52% of our fresh water is used for industrial processes; 40% for irrigation, and 8% for all other uses.

Man can survive for about 30 days without food but only about 7 days without sufficient water.

The average human contains about 10 gallons of water or around 65% of bodyweight.

Bone is about 20% water, the brain about 80%.

An average man needs about 2.50 gallons of water per day for proper health (from foods and beverages).

It is currently estimated that per capita consumption of water in the U.S. is 70-100 gallons per day for all uses.

Water boils at 212°F (100°C) and freezes at 32°F (0°C).

Most things contract when they freeze. Water, however, is one of the very few things that expands (by about 10%).

To find the circumference of a circle, multiply the diameter by 3.1416.

To find the circumference of a circle, multiply the radius by 6.283185.

To find the diameter of a circle, multiply the circumference by .31831.

To find the diameter of a circle, multiply the square root of the area by 1.12838.

To find the radius of a circle, multiply the square root of the area by 0.56419.

To find the area of a circle, multiply the square of the diameter by .7854.

To find the area of a circle, multiply the square of the circumference by 0.07958.

To find the surface of a sphere, multiply the square of the diameter by 3.1416.

To find the cubic inches in a sphere, multiply the cube of the diameter by .5236.

To find the U.S. gallon capacity of any size tank with given dimensions of the cylinder in inches, multiply the square of the diameter by the length then multiply by .0034.

Steam rising from water at its boiling point has a pressure equal to the atmosphere (14.7 psi).

The expansion of water from its freezing point to boiling is 1 gallon in each 23 or approximately 4.333%.

SOURCE: Water Well Handbook, Keith Anderson, pp. 39 & 254, 1989

Environmental Hotlines

Listed below are a number of agencies that may be of assistance to you in the event you have questions or need to report an emergency situation. Information was determined correct at the time of printing, however, for the most up to date information check with the EPA online at www.epa.gov

AGENCY	ADDRESS / TELEPHONE	
U.S. E.P.A. (Safe Drinking Water Hotline) For information on standards and contaminants		(800) 426-4791
E.P.A. Region I (ME,MA, NH, VT, RI & CT)	1 Congress St. Boston, MA 02114-2023	(888) 372-7341 (617) 918-1111
E.P.A. Region II (NY, NJ, PR & VI)	290 Broadway New York, NY 10007-1866	(877) 251-4575
E.P.A. Region III (VA, WV, PA, DE, MD & DC)	1650 Arch Street (3PM52) Philadelphia, PA 19103-2029	(800) 438-2474 (215) 814-5000
E.P.A. Region IV (FL, GA, NC, SC, KY, TN, MS & AL)	61 Forsyth Street, SW Atlanta, GA 30303-3104	(800) 241-1754 (404) 562-9900
E.P.A. Region V (IL, IN, MI, MN, OH & WI)	77 W. Jackson Blvd. Chicago, IL 60604	(800) 621-8431 (312) 353-2000
E.P.A. Region VI (TX, NM, OK, AR & LA)	1445 Ross Avenue Suite 1200 Dallas, Texas 75202	(800) 887-6063 (214) 665-6444
E.P.A. Region VII (NE, KS, IA & MO)	901 N. 5th Street Kansas City, KS 66101	(800) 223-0425 (913) 551-7003
E.P.A. Region VIII (MT, WY, UT, CO, ND & SD)		(800) 227-8917 (303) 312-6312
E.P.A. Region IX (CA, NV, HI, AZ)		(415) 947-8000 (866)-372-9378
E.P.A. Region X (AK, WA, OR & ID)	1200 Sixth Avenue Seattle, WA 98101	(800) 424-4372 (206) 553-1200
RCRA Superfund Hotline For general information on sites and hazardous waste laws		(800) 424-9346
National Institute for Occupational Safety Health For questions about workplace health hazards		(800) 35-NIOSH
National Response Center Hotline To report release of a spill or oil or hazardous waste		(800)424-8802
Consumer Products Safety Commission To report products with actual or potential Hazards		(800) 638-2772
National Pesticide Hotline For information on health risks of pesticides		(800) 858-7378

National Primary Drinking Water Regulations

National Primary Drinking Water Regulations (NPDWRs or primary standards) are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting levels of contaminants in drinking water.

National Secondary Drinking Water Regulations

National Secondary Drinking Water Regulations (NSDWRs or secondary standards) are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems, but does not require systems to comply. However, states may choose to adopt them as enforceable standards.

Definitions

Maximum Contaminant Level Goal (MCLG) --The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals.

Maximum Contaminant Level (MCL) -- The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.

Maximum Residual Disinfectant Level Goal (MRDLG) -- The level of drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbal contaminants.

Maximum Residual Disinfectant Level (MRDL) -- The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbal contaminants.

Treatment Technique (TT) -- A required process intended to reduce the level of a contaminant in drinking water.

***Note:** *This document addresses the United States Environmental Protection Agency Drinking Water Regulations in effect at its time of publication. These regulations are continually being reviewed and updated at the federal level. If there is any question as to validity of the current data, simply contact a state EPA office in your area.*

EPA National Primary Drinking Water Standards
MICROORGANISMS

Contaminant	MCL(mg/L)	Potential Health Effects from Exposure above the MCL	Treatment Methods
Cryptosporidium	Note: 1-1	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Absolute 1 micron filtration, Ultraviolet disinfection, Ozone, Chlorine disinfection
Giardia lamblia inactivation	99% Removal/ vomiting, cramps)	Gastrointestinal illness (e.g., diarrhea, disinfection, Ozone, Chlorine disinfection	Absolute 1 micron filtration, Ultraviolet
Heterotrophic plate count (HPC)	No more than 500 baterial colonies per mililiter	No health effects; it is an analytic method used to measure a variety of bacteria that are common in water. The lower the concentration of bacteria in drinking water, the better maintained the water system is.	Ultraviolet disinfection, ozone, hydrogen peroxide or chlorine disinfection
Legionella	Note: 1-2	Legionnaire's Disease, a type of pneumonia	same as above
Total Coliforms (including fecal coliform and E. coli)	Note: 1-3	Not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present	Ultraviolet disinfection, ozone, hydrogen peroxide or chlorine disinfection
Turbidity	Note: 1-4	Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease -causing organisms are present). These organisms can cause symptoms such as nausea, cramps, diarrhea, and headaches.	Coagulation/Filtration, Submicron Filtration, Ultrafiltration, Reverse Osmosis, Cartridge Filtration matched to Turbidity Particle size, or Distillation
Viruses (enteric)	99% Removal inactivation	Gastrointestinal illness (e.g., diarrhea, vomiting, cramps)	Ultraviolet disinfection, ozone, hydrogen peroxide or chlorine disinfection

Notes:

1-1. *Cryptosporidium* (as of 1/1/02 for systems serving more than 10,000 and 1/14/05 for systems serving less than 10,000) 99% removal.

1-2. *Legionella*: No limit, but EPA believes that if Giardia and viruses are removed/inactivated, *Legionella* will also be controlled.

1-3. Fecal coliform and E. coli are bacteria whose presence indicates that the water may be contaminated with human or animal wastes. Disease-causing microbes (pathogens) in these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms. These pathogens may pose a special health risk for infants, young children, and people with severely compromised immune systems. No more than 5.0% total coliform-positive in a month. Every sample that has total coliform must be anlayzed for either fecal coliforms or *E. coli* if two consecutive TC-positive samples, and one is also positive for *E. coli* fecal coliforms, system has an acute MCL violation.

1-4. Turbidity: At no time can turbidity (cloudiness of water) go above 5 nephelolometric turbidity units (NTU); systems that filter must ensure that the turbidity go no higher than 1 NTU (0.5) for conventional or direct filtration in at least 95% of the daily samples in any month. As of January 1, 2002, for systems servicing more than 10,000, and January 14, 2005, for systems servicing less than 10,000, turbidity may never exceed 1 NTU, and must not exceed 0.3 NTU in 95% of daily samples in any month.

RADIONUCLIDES

Contaminant	MCL(mg/L)	Potential Health Effects from Exposure above the MCL	Treatment Methods
Alpha particles	15 picocuries per Liter (pCi/L)	Increased Risk of Cancer	Ion Exchange, Reverse Osmosis, Distallation, & Electrodialysis
Beta particles & photon emitters	4 millirems per year	Increased Risk of Cancer	Ion Exchange, Reverse Osmosis, Distallation, & Electrodialysis
Radium 226 & Radium 228 (combined)	5 pCi/L	Increased Risk of Cancer	Cation exchange, Reverse Osmosis, Distallation, & Electrodialysis
Uranium	30 ug/L as of 12/08/03	Increased Risk of Cancer, kidney toxicity	Coagulation/Filtration, Submicron Filtration, Anion Exchange, Activated Alumina, Reverse Osmosis, Distillation, and Electrodialysis

Inorganic Chemicals

Contaminant	MCL (mg/L)	Potential Health Effects from Exposure Above the MCL	Treatment Methods
Antimony	0.006	Increase in blood cholesterol; decrease in blood sugar	Coagulation / Filtration, Submicron, Filtration, Reverse Osmosis, Ultrafiltration, and Distillation
Arsenic	0.010 as of 1/23/06	Skin damage or problems with circulatory systems, and may have increased risk of getting cancer	Coagulation / Filtration, Submicron, Filtration, Anion Exchange, Activated Alumina, Reverse Osmosis, Distallation, Electrodialysis, and Granular Ferric Oxide Media Filt.
Asbestos (Fibers > 10 micrometers)	7 million fibers per liter (MFL)	Increased risk of developing benign intestinal polyps	Coagulation / Filtration, Submicron, Filtration, Reverse Osmosis and Distallation
Barium	2	Increase in blood pressure	Cation Exchange, Reverse Osmosis, Distillation, and Electrodialysis
Berylium	0.004	Intestinal lesions	Coagulation / Filtration, Submicron, Filtration / Activated Carbon, Activated Alumina, Cation Exchange, Reverse Osmosis, Distallation and Electrodialysis
Cadmium	0.005	Kidney Damage	Coagulation / Filtration, Submicron, Filtration, Cation Exchange, Reverse Osmosis, Distallation and Electrodialysis
Chronium (total)	0.1	Allergic Dermatitis	Coagulation / Filtration, Cation Exchange, Reverse Osmosis, Distallation, Anion Exchange, and Electrodialysis
Copper	Note: 2-1 1.3 action level	Short Term Exposure: Gastrointestinal Distress Long Term Exposure: Liver or Kidney Damage	Cation Exchange (20% - 90%), Reverse Osmosis, Distillation and Electrodialysis
Cyanide	0.2	Nerve damage or thyroid problems	Chemical Oxidation / Disinfection at pH > 10, Anion Exchange, Reverse Osmosis, Distillation and Electrodialysis
Flouride	4.0	Bone disease (pain and tenderness of the bones); Children may get mottled teeth	Activated Alumina, Activated Carbon, Reverse Osmosis, Distillation and Electrodialysis
Lead	Note: 2-1 0.015 action level	Infants and Children: Delays in physical or mental development; children should show slight deficits	Cation Exchange (20% - 90%), Coagulation / Filtration, Submicron Filtration / Activated Carbon, Reverse Osmosis, Distillation and Electrodialysis
Mercury (inorganic)	0.002	Kidney damage	Submicron Filtration / Activated Carbon, Cation Exchange (20% - 90%), Reverse Osmosis, Distillation, Anion Exchange and Electrodialysis
Nitrate (measured as Nitrogen)	10	Infants below the age of six months who drink water containing nitrate or nitrite inexcess of the MCL could become seriously ill and, if untrated, may die. Symptoms include shortness of breath and blue-baby syndrom	Anion Exchange, Reverse Osmosis, Distillation and Electrodialysis
Nitrite (measured as Nitrogen)	1		Chemical Oxidation / Disinfection, Anion Exchange, Reverse Osmosis, Distillation and Electrodialysis
Selenium	0.05	Hair or fingernail loss; numbness of fingers or toes; circulatory problems	Coagulation / Filtration, Submicron Filtration / Activated Carbon, Activated Alumina, Anion Exchange, Reverse Osmosis, Distillation and Electrodialysis
Thallium	0.002	Hair loss; changes in blood; kidney, intestine or liver problems.	Cation Exchange, Activated Alumina, and Distillation

Note:
2-1. Lead and Copper are regulated by a treatment technique that requires systems to control the corrosiveness of their water. If more than 10% of tap water samples exceed action level, water systems must take additional steps.

Organic Chemicals

Contaminant	MCL (mg/L)	Potential Health Effects from Exposure above the MCL	Treatment Methods
Acrylamide	Note: 3-1	Nervous systems or blood problems	Control of water treatment chemicals and surfaces in contact with water
Alachlor	0.002	Eye, liver, kidney or spleen problems; anemia; increased risk of cancer	Activated Carbon, Aeration
Atrazine	0.003	Cardiovascular system or reproductive problems	Activated Carbon
Benzene	0.005	Anemia; decrease in blood platelets; increased risk of cancer	Activated Carbon, Aeration
Benzo(a)pyrene (PAHs)	0.0002	Reproductive difficulties; increased risk of cancer	Activated Carbon
Carbofuran	0.04	Problems with blood, nervous system, or reproductive system	Activated Carbon
Carbon tetrachloride	0.005	Liver problems; increased risk of cancer	Activated Carbon, Aeration
Chlordane	0.002	Liver or nervous system problems; increased risk of cancer	Activated Carbon
Chlorobenzene	0.1	Liver or kidney problems	Activated Carbon
2,4-D	0.07	Kidney, liver, or adrenal gland problems	Activated Carbon
Dalapon	0.2	Minor kidney changes	Activated Carbon
1,2-Dibromo-3-chloropropane (DBCP)	0.0002	Reproductive difficulties; increased risk of cancer	Activated Carbon
o-Dichlorobenzene	0.6	Liver, kidney, or circulatory system problems	Activated Carbon, Aeration
p-Dichlorobenzene	0.075	Anemia; liver, kidney or spleen damage; changes in blood	Activated Carbon, Aeration
1,2-Dichloroethane	0.005	Increased risk of cancer	Activated Carbon, Aeration
1,1-Dichloroethylene	0.007	Liver problems	Activated Carbon, Aeration
cis-1,2-Dichloroethylene	0.07	Liver problems	Activated Carbon, Aeration
trans-1,2-Dichloroethylene	0.1	Liver problems	Activated Carbon, Aeration
Dichloromethane	0.005	Liver problems; increased risk of cancer	Aeration
1,2-Dichloropropane	0.005	Increased risk of cancer	Activated Carbon, Aeration
Di(2-ethylhexyl) adipate	0.4	Weight loss, liver problems, or possible reproductive difficulties	Activated Carbon, Aeration
Di(2-ethylhexyl) phthalate	0.006	Reproductive difficulties; liver problems; increased risk of cancer	Activated Carbon
Dinoseb	0.007	Reproductive difficulties	Activated Carbon
Dioxin (2,3,7,8-TCDD)	0.00000003	Reproductive difficulties; increased risk of cancer	Activated Carbon
Diquat	0.02	Cataracts	Activated Carbon
Endothall	0.1	Stomach and intestinal problems	Activated Carbon
Endrin	0.002	Liver problems	Activated Carbon
Epichlorohydrin	Note: 3-1	Increased cancer risk, and over a long period of time, stomach problems	Control of water treatment chemicals and surfaces in contact with water

Note:

3-1. Each water system must certify, in writing, to the state (using third-party or manufacturers certification) that when it uses acrylamide and/or epichlorohydrin to treat water, the combination (or product) of dose and monomer level does not exceed the levels specified as follows: Acrylamide = 0.05% dosed at 1 mg/L (or equivalent); Epichlorohydrin = 0.01% dosed at 20 mg/L (or equivalent).

Contaminant	MCL (mg/L)	Potential Health Effects from Exposure above the MCL	Treatment Methods
Ethylbenzene	0.7	Liver or kidney problems	Activated Carbon, Aeration
Ethylene dibromide	0.00005	Problems with liver, stomach, reproductive system, or kidneys; increased risk of cancer	Activated Carbon, Aeration
Glyphosate	0.7	Kidney problems; reproductive difficulties	Activated Carbon
Heptachlor	0.0004	Liver damage; increased risk of cancer	Activated Carbon
Heptachlor epoxide	0.0002	Liver damage; increased risk of cancer	Activated Carbon
Hexachlorobenzene	0.001	Liver or kidney problems; reproductive difficulties; increased risk of cancer	Activated Carbon
Hexachlorocyclopentadiene	0.05	Kidney or stomach problems	Activated Carbon, Aeration
Lindane	0.0002	Liver or kidney problems	Activated Carbon
Methoxychlor	0.04	Reproductive difficulties	Activated Carbon
Oxamyl (Vydate)	0.2	Slight nervous system effects	Activated Carbon
Pentachlorophenol	0.001	Liver or kidney problems; increased cancer risk	Activated Carbon
Picloram	0.5	Liver problems	Activated Carbon
Polychlorinated biphenyls (PCBs)	0.0005	Skin changes; thymus gland problems; immune deficiencies; reproductive or nervous system difficulties; increased risk of cancer	Activated Carbon
Simazine	0.004	Problems with blood	Activated Carbon
Styrene	0.1	Liver, kidney, or circulatory system problems	Activated Carbon, Aeration
Tetrachloroethylene	0.005	Liver problems, increased risk of cancer	Activated Carbon, Aeration
Toluene	1	Nervous system, kidney, or liver problems	Activated Carbon, Aeration
Toxaphene	0.003	Kidney, liver, or thyroid problems; increased risk of cancer	Activated Carbon
2,4,5-TP (Silvex)	0.05	Liver problems	Activated Carbon
1,2,4-Trichlorobenzene	0.07	Changes in adrenal glands	Activated Carbon, Aeration
1,1,1-Trichloroethane	0.2	Liver, nervous system, or circulatory problems	Activated Carbon, Aeration
1,1,2-Trichloroethane	0.005	Liver, kidney, or immune system problems	Activated Carbon, Aeration
Trichloroethylene	0.005	Liver problems; increased risk of cancer	Activated Carbon, Aeration
Vinyl Chloride	0.002	Increased risk of cancer	Aeration
Xylenes (total)	10	Nervous system damage	Activated Carbon, Aeration

DISINFECTANT

Contaminant	MCL(mg/L)	Potential Health Effects from Exposure above the MCL	Treatment Methods
Chloramines (as Cl_2)	MRDL = 4.0	Eye/nose irritation; stomach discomfort, anemia	Activated Carbon
Chlorine (as Cl_2)	MRDL = 4.0	Eye/nose irritation; stomach discomfort	Activated Carbon
Chlorine Dioxide (as ClO_2)	MRDL = 0.8	Anemia; infants & young children, nervous system effects	Activated Carbon

DISINFECTANT BYPRODUCT

Contaminant	MCL(mg/L)	Potential Health Effects from Exposure above the MCL	Treatment Methods
Bromate	0.010	Increased risk of cancer	Call EPA for more info.
Chlorite	1	Anemia; infants & young children, nervous system effects	Call EPA for more info.
Haloacetic acids (HAA5)	0.060	Increased risk of cancer	Call EPA for more info.
Total Trihalomethanes (TTHMs)	0.080	Liver, kidney or central nervous system problems; increased risk of cancer	Activated Carbon

EPA National Secondary Drinking Water Standards

Contaminant	Secondary Standard	Treatment Methods
Aluminum	0.05 to 0.2 mg/L	Cation Exchange, Reverse Osmosis, Distillation, Electrodialysis
Chloride	250 mg/L	Reverse Osmosis, Distillation, Anion Exchange, Electrodialysis
Color	15 (color units) Note: 1	Anion Exchange, Reverse Osmosis, Activated, Carbon, Distillation, Filtration, Ozonation, Chloronation, Activated Alumina
Copper	1.0 mg/L	Reverse Osmosis, Distillation, Cation Exchange (20%-90%), Electrodialysis
Corrosivity	Non-corrosive	Calcite or Calcite/Magnesium Oxide (Magnesia), (5 to 1) Filter to raise pH, Soda Ash Chemical Feed, Sodium Silicate Feed, Reduce TDS via Reverse Osmosis (partial, split stream treatment), Coatings, Insulating Unions
Fluoride	2.0	Activated Alumina, Activated Carbon, Reverse Osmosis, Distillation
Foaming Agents	0.5 mg/L	Chlorination, Reverse Osmosis, Activated Carbon, Distillation, Ozonation
Iron	0.3 mg/L Note: 2	Filtration (oxidizing filters), Cation Exchange, Reverse Osmosis, Pressure Areation/Filtration, Chlorination - Precipitation/Filtration, Distillation, Electrodialysis
Manganese	0.05 mg/L Note: 3	Filtration (oxidizing filters), Cation Exchange, Reverse Osmosis, Distillation, Chlorination - Precipitation/Filtration, Pressure Areation/Filtration, Electrodialysis
Odor	3 threshold odor # Note: 4	Activated Carbon, Aeration, Oxidation
pH	6.5 - 8.5	pH may be increased by alkalies and may be decreased by acids, Ion Exchange, Neutralizing Filter (Calcite, Magnesia)
Silver	0.10 mg/L	Coagulation/Filtration, Submicron Filtration/Activated Carbon, Ion Exchange (Anion or Cation depending on complexed Ion Species)
Sulfate	250 mg/L	Reverse Osmosis, Distillation, Anion Exchange, Electrodialysis
Total Dissolved Solids (TDS)	500 mg/L	Reverse Osmosis, Distillation, Deionzation by Ion Exchange (Cation/Anion in two bed or mixed bed), Electrodialysis
Zinc	5 mg/L	Reverse Osmosis, Distillation, Cation Exchange, Electrodialysis

Notes:

1. Color - Color units are based on the APHA recommended standard of 1 color unit being equal to 1 mg/L of platinum or chloroplatinate ion.

2. Iron - Ferrous Iron (clear water iron) is readily converted to ferric iron (red water iron) in the presence of any air or oxidizing material; precipitating ferric iron must be prevented to avoid fouling and interference with effective reverse osmosis membrane rejection.

3. Manganese - Manganese must be maintained in the soluble manganous (Mn^{+2}) stated to avoid fouling and interference with effective reverse osmosis membrane rejection.

4. Odor - Chlorine and hydrogen sulfide are examples of odors that may be reduced by the treatment methods suggested