

Disinfection with Hypochlorination


Produced by




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Produced by


 **AIR & WATER QUALITY INC.**
"Maine's Water Experts"

3/27/2004

Disinfection with Hypochlorination

Introduction


1. Pathogens
2. Disinfection
3. Sterilization

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Disinfection with Hypochlorination

Pathogens

- Organisms including bacteria, viruses, or cysts that can cause disease in a host.
- There are many organisms that can not cause disease and therefore are not pathogens.

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Disinfection vs. Sterilization

- Disinfection inactivates pathogens.
- Sterilization is the complete destruction of all organisms



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Hypochlorination and Its Chemistry

1. Reactions with water
2. Sources of hypochlorite
3. Factors affecting disinfection



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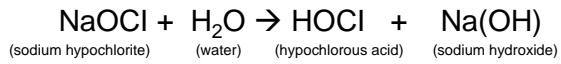
Hypochlorination

The process of injecting hypochlorite compounds into the water for the purposes of disinfection.



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Reaction of Sodium Hypochlorite with Water

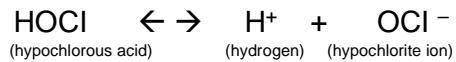


The Hypochlorous acid is a strong disinfectant.



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Production of Hypochlorite Ion



Hypochlorous acid can break down into the hypochlorite ion which is much less effective disinfectant than the hypochlorous acid. This occurs as the pH of the water increases.



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Creation of Chloramines

Ammonia + Hypochlorous Acid → Chloramines + Water

- $\text{NH}_3 + \text{HOCl} \rightarrow \text{NH}_2\text{Cl} + \text{H}_2\text{O}$
- $\text{NH}_3 + \text{HOCl} \rightarrow \text{NH}_1\text{Cl}_2 + \text{H}_2\text{O}$
- $\text{NH}_3 + \text{HOCl} \rightarrow \text{NHCl}_3 + \text{H}_2\text{O}$



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Sources of Hypochlorite Compounds

- In small systems the source of hypochlorite is usually 6% or 12% sodium hypochlorite.
- 6% sodium hypochlorite is commonly found as “Ultra” bleach at your local supermarket.
- 12% sodium hypochlorite is purchased from a chemical supplier.



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Other Sources of Hypochlorite

- Calcium hypochlorite purchased in powder form (HTH – High Test Hypochlorite).
- HTH will need to be mixed with water.



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Sodium vs. Calcium Hypochlorite

- Solutions of sodium hypochlorite are easier to mix than the powdered calcium hypochlorite.
- Calcium Hypochlorite has a longer shelf life – one year as opposed to sodium hypochlorite which should not be stored for more than 60-90 days in a cool dark environment.



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Sodium vs. Calcium Hypochlorite

- Calcium Hypochlorite can cause scaling problems especially if fed with fluoride or potash.



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Scaling in a pipe



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Scaling in a pipe



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Factors Affecting Disinfection

- Temperature
- pH
- Turbidity
- Organic compounds
- Inorganic compounds
 - Non reducing agents
 - Reducing agents



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Temperature

- Elevated temperatures increase the effectiveness of the disinfectant.
- Higher temperatures also cause a more rapid destruction of the disinfectant.
- Generally the increased effectiveness is more beneficial than the destruction of the disinfection is detrimental.



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Turbidity

Excessive turbidity will decrease the effectiveness of disinfection.

The loss of effectiveness is the result of a number of factors:

- The particles causing the turbidity can carry large numbers of organisms
- The material forming the turbidity can change the chemistry of the water



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pH

- Elevated pH levels cause the HOCl to disassociate into OCl⁻ ion that is far less effective disinfectant than HOCl.



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Organic Compounds

- Organic Compounds react with disinfectant and prevent it from being available to inactivate pathogens



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Organic Compounds

- Organic compounds can also cause the creation of Trihalomethanes (THM's) when the disinfectant reacts with them. THM compounds may create health risks.



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Inorganic Compounds

- Reducing agents like NH_3 combine with the chlorine and reduce the chlorine's effectiveness.
- Some reducing agents like ferrous iron, manganous manganese, and hydrogen sulfide combines with the chlorine and completely destroy its disinfection properties.



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Breakpoint Chlorination

- Chlorine Demand
- Chlorine Dose
- Free Chlorine Residual



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Chlorine Demand

The chlorine demand is the amount of chlorine that is required to complete the reaction with all the reducing agents and organic compounds in the water.



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Chlorine Dose

The dose is the total amount of chlorine that must be added to reach the chlorine residual desired.

$$\text{chlorine dose} = \text{chlorine demand} + \text{chlorine residual}$$



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Breakpoint Chlorination

- Breakpoint chlorination is the process of adding chlorine to the water until the **demand** has been satisfied.



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Breakpoint Chlorination

- The **breakpoint** is the condition where the **demand** has been met and any additional chlorine injected will show up as free chlorine residual. (continued)



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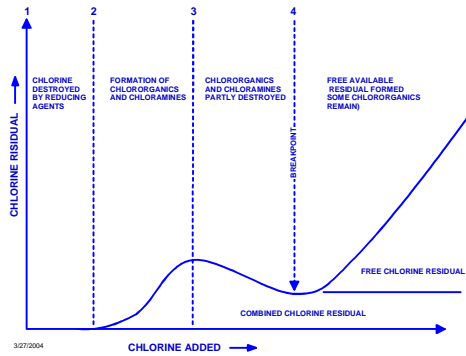
The breakpoint can be expressed as follows:

$$\text{Chlorine Dose} = \text{Chlorine Demand}$$



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BREAKPOINT CHLORINATION CURVE WITH AMMONIA AND ORGANICS(SURFACE WATER)



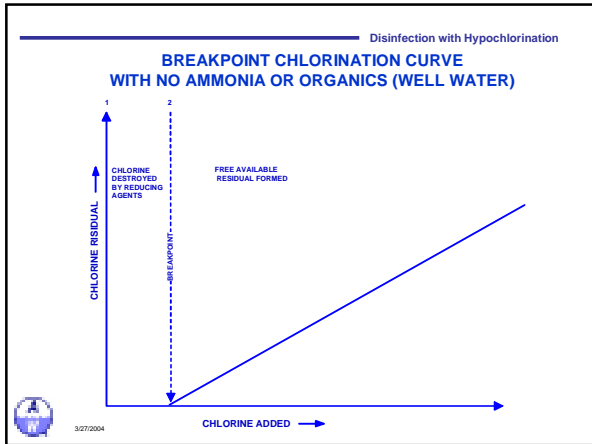
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Breakpoint Chlorination for Well Water

Well water that does not contain ammonia or organic compounds, will have the free residual equal to the chlorine dose less the demand created by reducing agents like iron and manganese.



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Determining the Dose

- First use a water quality report to calculate the demand.
- Then use a chlorine residual curve to confirm calculations.

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Disinfection with Hypochlorination

Estimating the Dose for Well Water

Chlorine Demand – find the sum of

mg / L of Fe X 1 = ___ ppm

mg / L of Mn X 1 = ___ ppm

mg / L of H₂S X 4 = ___ ppm


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Disinfection with Hypochlorination

Estimating the Dose for Well Water

Chlorine Residual- add this:

Residual in ppm




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Disinfection with Hypochlorination

Estimating the Dose for Well Water

The **dose** is equal to the sum of **demand** and the **residual**



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Disinfection with Hypochlorination


Example: Estimating Dose for Well Water

Sample test results show there is-

- .40 ppm of Fe
- .05 ppm of Mn
- 1.00 ppm of H₂S

And

0.5 ppm of Cl residual is desired



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Example: Estimating Dose for Well Water

Chlorine Demand	Chlorine Residual
.40 ppm for Fe	.5 ppm
.05 ppm for Mn	
+ 4.00 ppm for H ₂ S	
<u>4.45 ppm demand</u>	



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Example: Estimating Dose for Well Water

chlorine demand + chlorine residual =
chlorine dose

$$4.45 \text{ ppm} + .5 \text{ ppm} = 4.95 \text{ ppm Cl}$$



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Chlorine Residual Curve

- This is required to determine the dose that must be added to achieve the desired residual.
- It is accomplished by drawing a sample of water close to the injection point and then graphing the chlorine concentration for at least an hour at 15 minute intervals. (continued)



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Chlorine Residual Curve

- This procedure is very important when the source of water is surface water.
- This procedure does not have to be performed as often for groundwater as for surface water supplies. Well water is not influenced by storms and the excess loads from the turbidity that results. (continued)



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Chlorine Residual Curve (continued)

- Creating a residual curve is a good method to use on ground water supplies to determine initial chlorine dose.



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Example of Chlorine Residual Curve

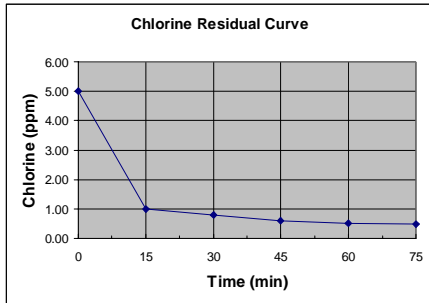
Time (min)	Cl (ppm)
0	5.00
15	1.00
30	0.80
45	0.60
60	0.50
75	0.48



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Example of Chlorine Residual Curve

Disinfection with Hypochlorination



chlorine demand = chlorine dose - chlorine residual
4.52 ppm = 5.0 ppm - .48 ppm



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Example of Chlorine Residual Curve

Disinfection with Hypochlorination

chlorine demand =
chlorine dose - chlorine residual
4.52 ppm = 5.00 ppm - .48 ppm



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Contact Time Calculations

Disinfection with Hypochlorination

- Log Removal
- Determining CT
- Calculating Contact/Detention Time
- Tracer Studies



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Log Removal

Disinfection with Hypochlorination

- Log removal is based on factors called multiples of 10.
- 1 log removal means the amount of the original that is left is 1/10 that of the original.
- If one has 1/10 of 100% ($1/10 \times 100$) left, there is only 10% remaining
- If there is 10% remaining, the removal had to be 90%.



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Log Removal

Disinfection with Hypochlorination

- 2 log removal means that 1/10 of 1/10 ($1/10 \times 1/10 = 1/100$).
- If one has 1/100 of 100% ($1/100 \times 100$) then there is only 1% left of the original.
- If there is only 1% left then 99% has been removed.



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Log Removal

Disinfection with Hypochlorination

- So 4 log removal means 1/10 $\times 1/10 \times 1/10 \times 1/10$ or 1/10000 of the original is left.
- If one has 1/10000 left of 100% ($1/10000 \times 100$) then there is only .01%.
- If there is only .01% left then 99.99% has been removed.



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Log Removal for Viruses

- Well/Ground water should only need to meet disinfection required for viruses as there will be no cysts.
- The removal required for viruses is 4 log.



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$$CT = A$$

- C= chlorine concentration in ppm
- T= detention in minutes
- A = value determined from a table of CT values or values dictated by the regulatory agency for adequate disinfection.



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CT Table for Viruses

Table C-7. CT Values for Inactivation of Viruses by Free Chlorine, pH 6.0-9.0

Inactivation (Log)	Temperature (°C)								
	4	5	6	7	8	9	10	11	12
2	4.4	4.0	3.8	3.6	3.4	3.2	3.0	2.8	2.6
3	6.7	6.0	5.6	5.2	4.8	4.4	4.0	3.8	3.6
4	8.9	8.0	7.6	7.2	6.8	6.4	6.0	5.6	5.2

Source: AWWA, 1991. Modified by linear interpolation between 5°C increments.



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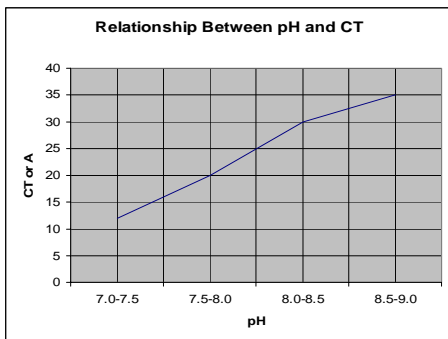
Relationship Between pH and CT

pH range	"A" for 5 °C
7.0-7.5	12
7.5-8.0	20
8.0-8.5	30
8.5-9.0	35



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Graph of pH vs CT



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Example for CT

pH = 7.2 T = 30 min
 C = .4 A = ?

CT = .4 X 30 = 12
 Therefore A = 12



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Example for CT

The Maine DWP requires a .5 ppm Cl_2 level for 10 minutes for disinfection of well water. What is the CT? What is the A?

$$C \times T = A$$
$$.4 \times 10 = 5$$



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Calculating T for CT

T is the time the chlorine is in contact with the water before the first distribution point.



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Calculating T for CT

If there is no mixing, the T will equal the volume of the storage container divided by the flow rate from the delivery pump in gallons per minute.



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Calculating T for CT

$$T = \text{Volume (gallons)} / \text{Flow (gpm)}$$



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Example for calculating T

Volume = 120 gallons

Flow = 10 gpm

$$T = 120 / 10 = 12 \text{ mins}$$



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Calculate the volume for the time required at a given flow

$$V = T \text{ (min)} \times \text{Flow (gpm)}$$



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Example to Calculate Volume of Tank Required

- Flow from pump is 20 gpm.
- If T is to be 10 min, what size tank is required?



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Example to Calculate Volume of Tank Required

20 gpm X 10 min = 200 gallons

- This volume assumes no mixing and the CT requires 10 min of detention.



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Calculating Volume of Tanks and Pipes

Rectangular Tanks

$V = L \times W \times H \div 1728 \times 7.48$

Dimensions are in inches and volume is in gallons



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Calculating Volume of Tanks and Pipes

Round Vertical Tanks
 $V = 3.14 \times r^2 \times H \div 1728 \times 7.48$
Dimensions are in inches and volume is in gallons



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Disinfection with Hypochlorination

Calculating Volume of Tanks and Pipes

Round Horizontal Tanks or Pipes
 $V = 3.14 \times r^2 \times L \div 1728 \times 7.48$
Dimensions are in inches and volume is in gallons



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Disinfection with Hypochlorination

Example for Calculating Volume

The length of 2" pipe from the pump house to the first distribution point is 100 feet. What volume of water is in the pipe?

$$3.14 \times 1^2 \times 1200 \div 1728 \times 7.48 = 16 \text{ gallons}$$



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Tracer Studies

Tracer studies are done to determine actual detention times (T).



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Tracer Studies

- Some kind of chemical is injected that can be measured with common test equipment.
- The two most common methods are step-dose and slug-dose.



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Tracer Studies

- Step-dose method requires a constant injection of tracer chemical.
- The dosing can be done with a solution feed pump.



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Tracer Studies

Slug-dose method requires the introduction of a large quantity of tracer chemical over a very short time.



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Tracer Studies

With both methods, the time it takes 10% of the tracer chemical to pass the endpoint is considered the detention time. This time is designated as T₁₀



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Tracer Studies

To calculate actual T for the system-

$$T = T_{10} \times F_t / F_s$$

Where Ft = flow during tracer study
Fs = peak flow for system



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Tracer Study

For storage systems that do not have a constant water level in clear wells or atmospheric storage tanks, the minimum elevation of water in the storage must be maintained during the tracer study.



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Tracer Study

For atmospheric storage where levels may vary - "the system may install a weir to ensure a minimum water level and provide a reliable detention time"

"EPA Guidance Manual Disinfection Profiling and Benchmarking"



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Weir Option

- Atmospheric tanks used for detention.
- Pump is protected with low water shut down.



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The real test for proper **CT**?

Negative bacteria results!!!



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Components of the System

- Pump to inject solution
- Solution tank to hold mixture
- Injector and injection point
- Control valve options
- Retention tank for contact



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Choosing the right pump

- Positive Displacement or Peristaltic
- Liquid end material
- Pumping rate
- Pressure
- Frequency control
- Proportional control



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Peristaltic Pump

Disinfection with Hypochlorination



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Peristaltic Pump

Disinfection with Hypochlorination

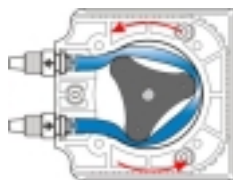


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Peristaltic Pumps

Disinfection with Hypochlorination

Peristaltic pumps operate by forcing rollers against a tube -as each roller moves along the tube it squeezes the tube forcing the liquid along the tube.



Peristaltic Pump progressive squeezing action (No check valves)

Picture by Blue-White Industries



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Peristaltic Pump Operation

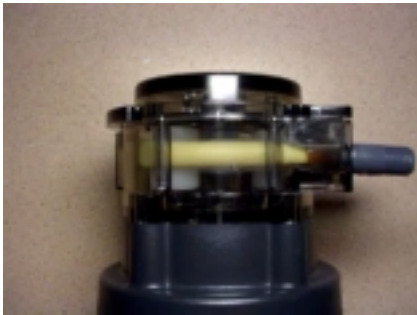
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Peristaltic Pump Operation

Disinfection with Hypochlorination



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Benefits of Peristaltic Pumps

Disinfection with Hypochlorination

- No check valves to get fouled with scale or other small particles
- Will not lose prime when pumping liquids that create gases like with peroxide and hypochlorite solutions.
- Prime easier
- Can over come higher suction lift



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Cons of Peristaltic Pumps

- Less tolerant of lack of maintenance
- May not pump against high back pressure commonly found in pressurized well systems.
- Requires more maintenance



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Example of a diaphragm pump



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Example of a diaphragm pump



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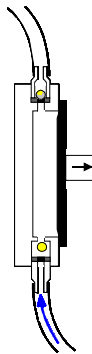
Positive Displacement or Diaphragm pumps

These pumps move liquid by pushing a diaphragm in and out of a cavity. Two check valves provide control of the flow of liquid in and out of the cavity as the diaphragm moves.



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Diaphragm Pump Operation



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Diaphragm Pumps

Pros –

- Operate over wide pressure ranges
- Maintenance and repair usually only requires cleaning and very seldom requires part replacement.
- Variable frequency and stroke length offers a wider range of outputs for a given pump (continued)



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Diaphragm Pumps (continued)

Pros –

- More commonly used in small pressurized systems making parts more readily available.



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Diaphragm Pumps

Cons –

- Do not pump gaseous liquids well
- Must have liquids that do not allow solids to precipitate



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Liquid Contact Materials

Materials must be resistant to chlorine like

- Polyethylene
- Ceramic
- SAN
- Teflon
- Hypalon

Check with manufacture and make sure they know what kind of liquid will be pumped.



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Pressure

The pumps maximum discharge pressure should be at least 20 psi above the expected pressure at the injection point of the system.



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Frequency control

All diaphragm pumps have at a minimum stroke length control. More expensive pumps have both frequency and stroke length control. Having both functions, allows for more precise adjustment of pump dosing rates.



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Proportional control

Proportional control allows the output of the pump to be automatically changed by the input from a water meter.



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Pros/Cons of Proportional Control

- Pro - This type of pump can be used on systems where the flow of water fluctuates significantly.
- Con - These pumps are much more expensive and require the extra cost of a water meter.



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Pumping Rate - Sizing?

- If you are replacing a pump, determine the old pumps capacity and voltage to select the new pump.
- If you are picking a new pump, you must determine the chlorine demand, the well pump flow and the well pump voltage.



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Choosing Feed Pump Capacity

If the pump can only vary the stroke, choose the pump to have approximately twice the capacity in GPD than is required to do the job.



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Choosing Feed Pump Capacity

If the pump has both a stroke and frequency control, use 25% of the pumps maximum output for deciding the size pump you need.



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Choosing Feed Pump Capacity

Example- If the pump's max. output is 30 GPD, what is the output with the stroke and frequency set at 50%.

Solution: $30 \times .5 \times .5 = 7.5 \text{ GPD}$
 $30 \times .25 = 7.5 \text{ GPD}$



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Well Pump Capacity

There are three ways to determine well pump capacity-

1. From pump curves
2. Onsite flow test
3. Water meter readings



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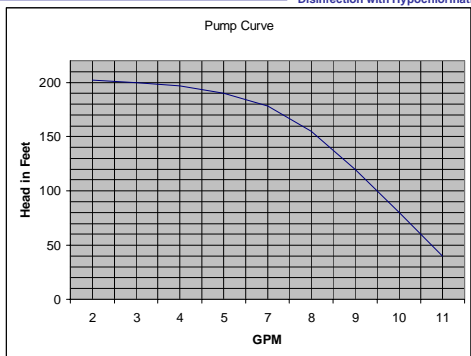
Pump Curve

- You can check with the pump supplier to get a pump curve if you don't have it. He can also help you use the curve to determine the pump's performance in your system.



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Pump Curve



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Onsite Flow Test for Pressurized Systems

- Turn off the water to the distribution system.
- Activate pressure switch to fill pressure tank.
- Draw off a known quantity of water without having the pump start.
- Start the pump to refill the pressure tank and record the refill time. (continued)




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Onsite Flow Test for Pressurized Systems (continued)

- Calculate the pump flow by -

 gallons drawn off
 X 60 = gallons/min
 seconds to refill tank




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Disinfection with Hypochlorination

Onsite Flow Test for Pressurized Systems (continued)

- Calculate the pump flow by -

 2 gallons drawn off
 X 60 = 8 gallons/min
 15 seconds to refill tank




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Disinfection with Hypochlorination

Using a Water Meter

- Record the starting value of the water meter.
- Start the well pump and run it for a minute.
- Note the ending value on the water meter. (continued)



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Using a Water Meter (continued)

- The difference between the starting value and ending value on the meter will be the delivery rate on the well pump in gallons/min.



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Calculating Pump Output

__ mg/L(Cl₂ dose) X __ gal/min (well pump) X 16 =

__ oz bleach/5 gallons sol. X __ gal/day(feed pump)



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Example 1

- Concentration of Chlorine .4 ppm
- Well pump capacity 20 gpm

.4 ppm X 20 gpm X 16 = 128 oz X 1 gpd

Or

15 gpd X 8.5 oz



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Example 2

- Concentration of Chlorine .4 ppm
- Well pump capacity 75 gpm

$$.4\text{ppm} \times 75\text{ gpm} \times 16 = \underline{480}\text{ oz} \times \underline{1}\text{ gpd}$$

Or

$$15\text{ gpd} \times 32\text{ oz per 5 gallons}$$



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Example 3

- Concentration of Chlorine 2.8 ppm
- Well pump capacity 75 gpm

$$2.8\text{ppm} \times 75\text{gpm} \times 16 = \underline{3360}\text{oz} \times \underline{1}\text{ gpd}$$

Or

$$15\text{ gpd} \times 224\text{ oz per 5 gallons}$$

Or

$$15\text{ gpd} \times 1.75\text{ gallons bleach per 5 gallons}$$



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Solution Tanks



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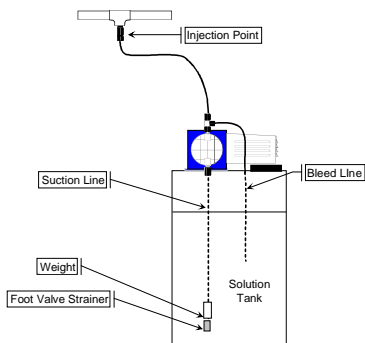
Solution Tanks

- Polyethylene construction
- Flooded suction
- Place to mount pump
- Bulkhead fitting for suction and bleed return
- Large enough to hold at least one weeks supply
- Child proof lid



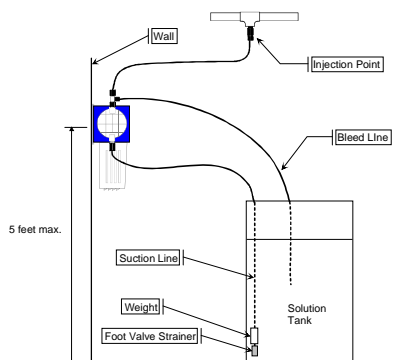
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Solution Feed Pump Tank Mount



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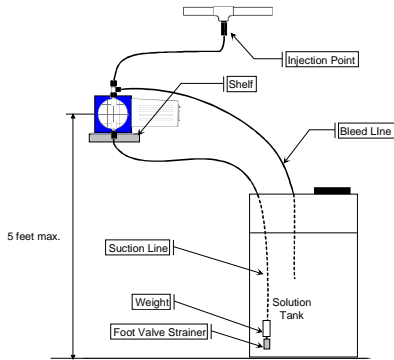
Solution Feed Pump Wall Mount



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Solution Feed Pump Shelf Mount

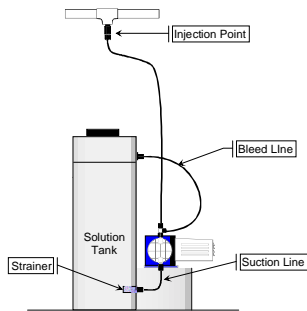
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Solution Feed Pump Flooded Suction

Disinfection with Hypochlorination

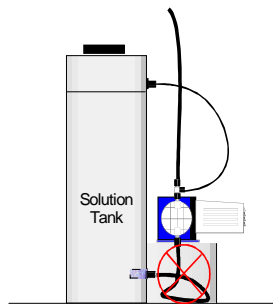


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Solution Feed Pump Flooded Suction

Disinfection with Hypochlorination

Connect suction line so there are no loops to trap air.



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Injector and Injection Point

- The Injector tip should be placed in the center of the pipe receiving the injector.
- The injector should be installed from under the pipe to allow the check valve in the injector to seal.



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Injector and Injection Point

- The injector should be installed in the well pump discharge line and before any distribution – including the pressure tank.



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Injector

- Most injector tips can be trimmed to fit a wide range of pipe sizes



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Injector



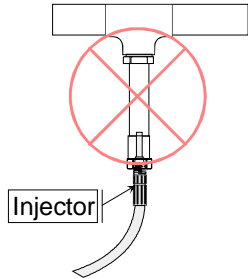
- Some injectors use a duck bill check valve



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Injector Location

The injector should not be placed in a stub of pipe. This will allow the build up of chemical and cause either scaling or corrosion in the stub.



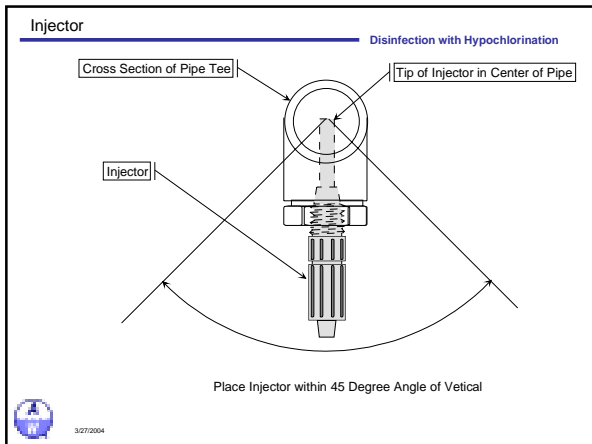
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Injector Orientation

- The injector needs to be installed with the tip pointing up.
- This allows the check valve in the injector to seat properly.



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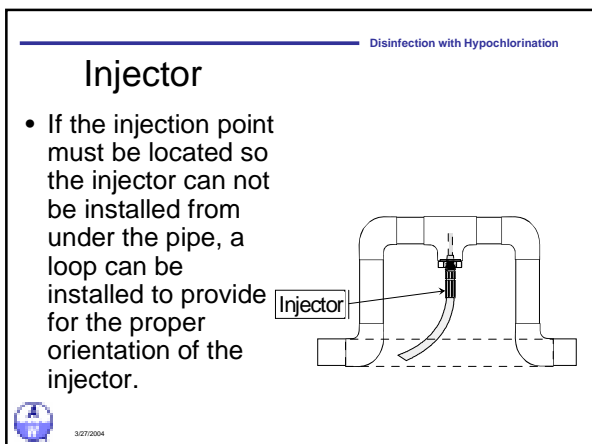


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Injector Check Valve

- The check valve allows the solution pump to be primed without back pressure
- The check valve also provides for the removal of the discharge line during servicing.

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Control Valves

- Bleed valve-
- Multi-function valves



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Bleed Valves



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Bleed Valves

- At a minimum all diaphragm pumps should have a bleed valve.
- The bleed valve provides for easy priming by bleeding off air and removing back pressure
- The bleed valve also relieves pressure in the discharge to provide for easy service.



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Multi-function Valves

Disinfection with Hypochlorination



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Multi-Function Valves

Disinfection with Hypochlorination

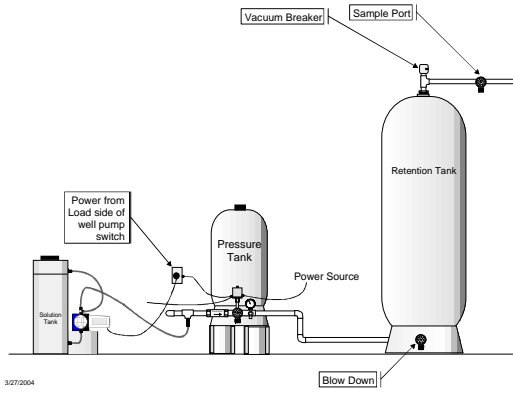
- Anti-siphon protection
- Back pressure
- Priming aid/line drain
- Pressure Relief
- Degassing



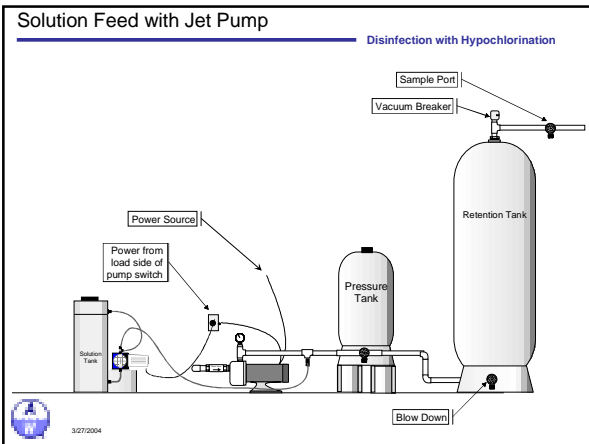
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Solution Feed with Submersible Pump

Disinfection with Hypochlorination



3/27/2004



Disinfection with Hypochlorination

Installation

3/27/2004

- Disinfection with Hypochlorination
- ## Installation Check List
- ✓ Check voltage of pump.
 - ✓ Check maximum pressure rating on pump.
 - ✓ Mount pump to provide flooded suction. If peristaltic pump, don't mount in flooded suction position or on tank.
- 3/27/2004

Installation Check List

- ✓ If diaphragm pump, make sure pump discharge is vertically over pump suction – some heads have arrows that should point up.
- ✓ Locate injection point.
- ✓ Install injector with the tip point up and tip in middle of stream.



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Installation Check List

- ✓ Install anti-siphon valve if there is no back pressure on injector.
- ✓ If diaphragm pump, install bleed valve or 4 function valve.
- ✓ Install suction and discharge tubing on pump.



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Installation Check List

- ✓ Connect suction line to chemical tank and leave discharge tubing disconnected from injector.
- ✓ Connect outlet for solution pump to load side of pressure switch.
- ✓ Plug in pump.



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Installation Check List

- ✓ If diaphragm pump, check pump stroke for proper zeroing and adjust if necessary.
- ✓ Place enough water in solution tank to cover pick-up strainer.
- ✓ Set pump to its highest output.



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Installation Check List

- ✓ Bleed air from pump.
- ✓ Time how long it takes to fill the discharge line to within one inch of the end.
- ✓ Connect tubing to injector leaving a small amount of air in tubing.



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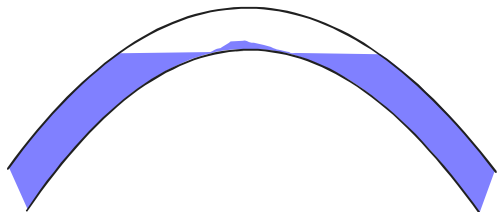
Installation Check List

- ✓ Fill solution tank 1/3 to 1/2 full with solution.
- ✓ Allow system to run long enough to adjust pump and solution concentration.



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Observing Solution Injection



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Adjusting and Checking Residual

- Calculate the dose desired.
- Calculate the concentration of the solution for the solution tank

$$\frac{\text{__ mg/L(Cl}_2\text{ dose)} \times \text{__ gal/min (well pump)}}{\text{__ gal/day(feed pump)} \times 16} = \text{__ oz bleach/5 gallons sol.}$$



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Adjusting and Checking Residual

- Make up enough solution to cover the pick-up strainer in solution tank.
- Run water to cause pump to turn on.
- Collect sample from a point down stream over several pump cycles.
- Adjust as necessary.



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Adjusting Chlorine Residual

- Once dose is adjusted, sample residual at a point that is after the retention tank and before distribution.



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Chlorine Residual Testing

- Type of test
- Where to test
- How often to test



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Types of Test

- Orthotolidine
- DPD



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Orthotolidine Test Kit

- The Orthotolidine test is not a valid test for chlorine residual in public water supplies.



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Orthotolidine Test Kit

- These kits are used as pool test kits.
- This method will detect the presence of chlorine but is not accurate enough at low chlorine concentrations.



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DPD Test kit

- Suitable to test chlorine residual for public water supplies.



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DPD Test kit

- Suitable to test chlorine residual for public water supplies.
- Be careful to follow directions as some of these kits can do two concentrations and some include free and combined residual procedures.



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Where and When?

- Free chlorine needs to be measured just before distribution and it needs to be tested daily.
- The free chlorine needs to be tested at the bacteria sampling site at the time of sampling.



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Where and When?

- Exceptions – In special circumstances, daily reading can be twice weekly with DWP permission



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Solution Feed Sights and Sounds



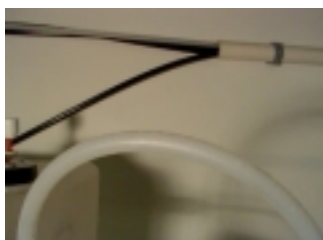
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Solution Feed Sights and Sounds



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Solution Feed Sights and Sounds



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Solution Feed Sights and Sounds



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Trouble Shooting

- Acute Problems
- Chronic Problems



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Common Acute Problems

Most problems are -

- Solution level below pick-up
- Ball check valves
- Air/gas locks
- Small leaks
- Incorrect solution concentrations
- Plugged injector



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Solution Level

If solution level is not over pick-up.

- Add solution.
- Bleed air and check concentrations.



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Ball Checks

If pump is not moving solution and/or will not pump after bleeding air –

- Remove ball checks and clean.
- Replace seats if they appear damaged.



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Air Locks

If there is air in the suction line of the pump-

- Confirm solution is over pick-up
- Make sure there are no loops in suction line.



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Small Leaks

Small leaks-

- Check for spraying from discharge line
- Check around pump head and multi-function or bleed valve



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Incorrect Solution Concentration

Confirm concentration is correct –

- This may require the dumping of existing solution and starting over.
- It may require the addition of more solution.
- It may require water testing to confirm demand has not changed.



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Plugged Injector

Plugged injector-

- This is only likely to happen if feeding potash or soda ash with chlorine.
- To confirm remove injector and inspect.



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Common Chronic Problems

- Ball check not seating due to build of scale from hard water.
- Loss of prime due to coiled up suction line.
- Loss of residual from varying demand.- H₂S, Organic loading from run off



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Safety

- Provide MSDS data
- Wear eye protection suitable for splash of liquids
- Wear chemical resistant gloves
- Wear apron to protect clothing



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Safety

- Provide eyewash
- Provide pressure relief for service
- SOP for handling materials



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Safety

- Secure chemicals to prevent unauthorized access
- Secure system from unauthorized access
- Provide childproof lids on solution tanks and chemicals



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Safety

- Don't place equipment or sample points in confined spaces
- Provide ventilation where concentrated chemicals are stored
- Make sure chemicals are not stored with or in incompatible materials



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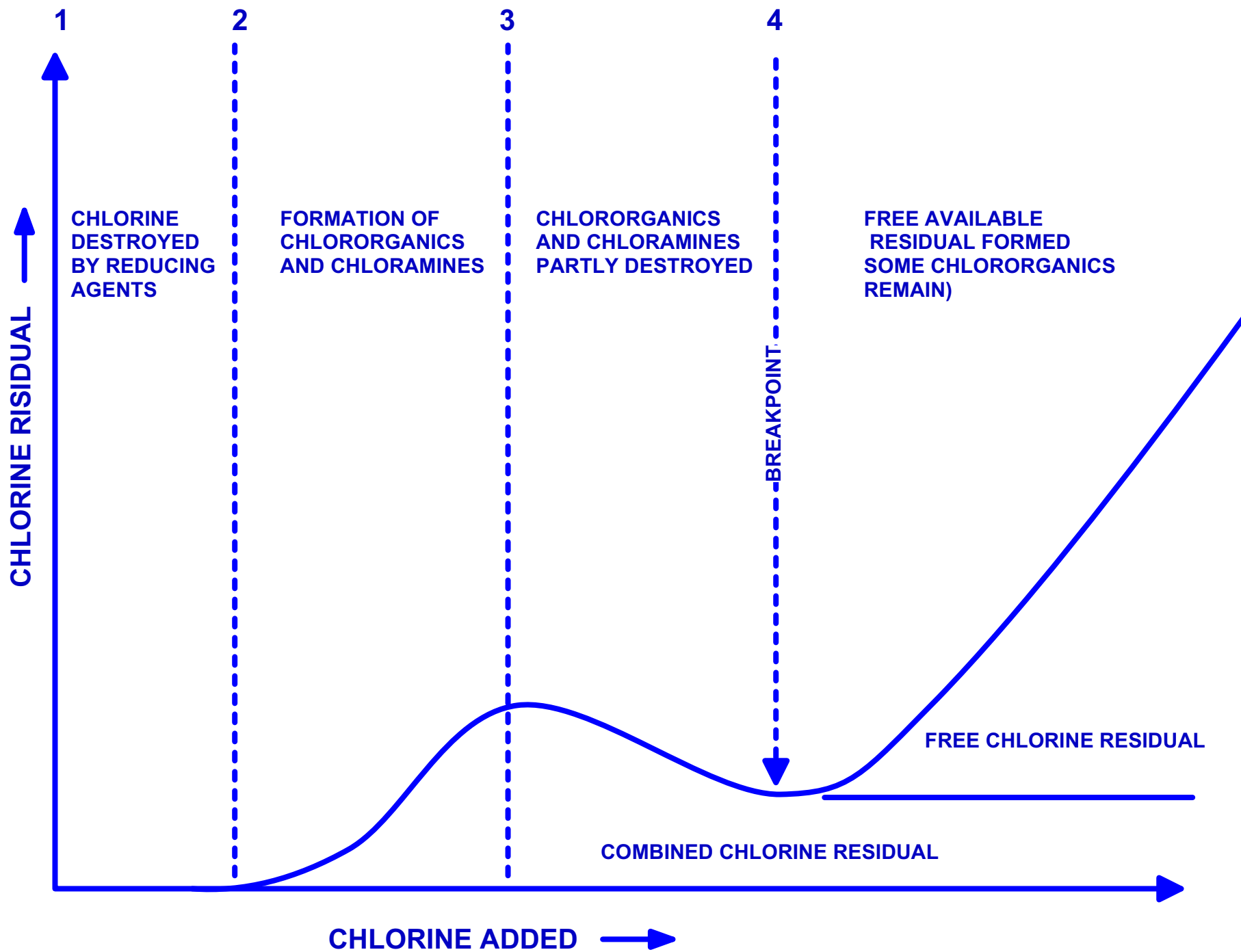
Safety

- Have electrical circuits installed by licensed electricians
- Make sure system is properly grounded
- Provide for a disconnect to allow safe servicing of equipment

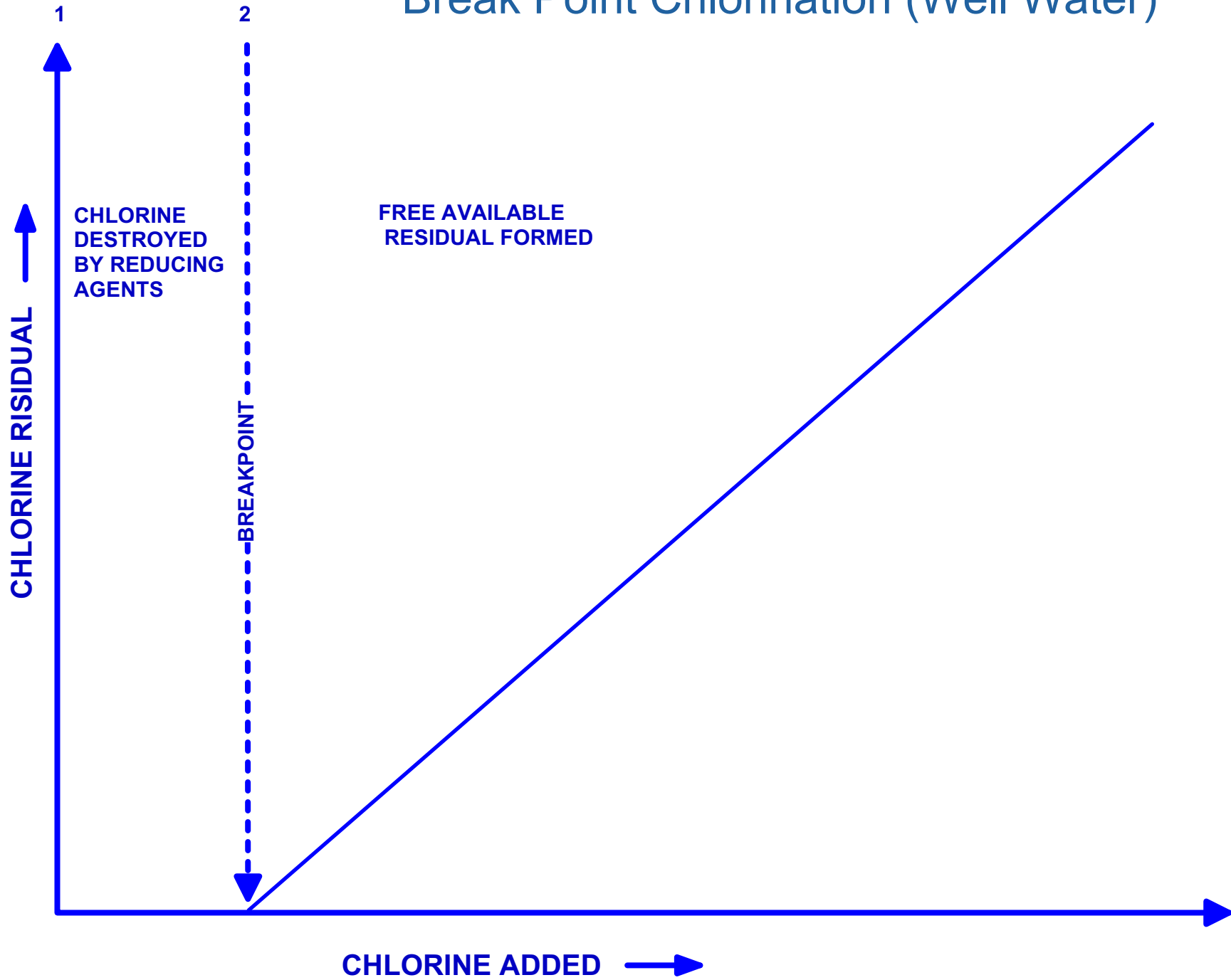


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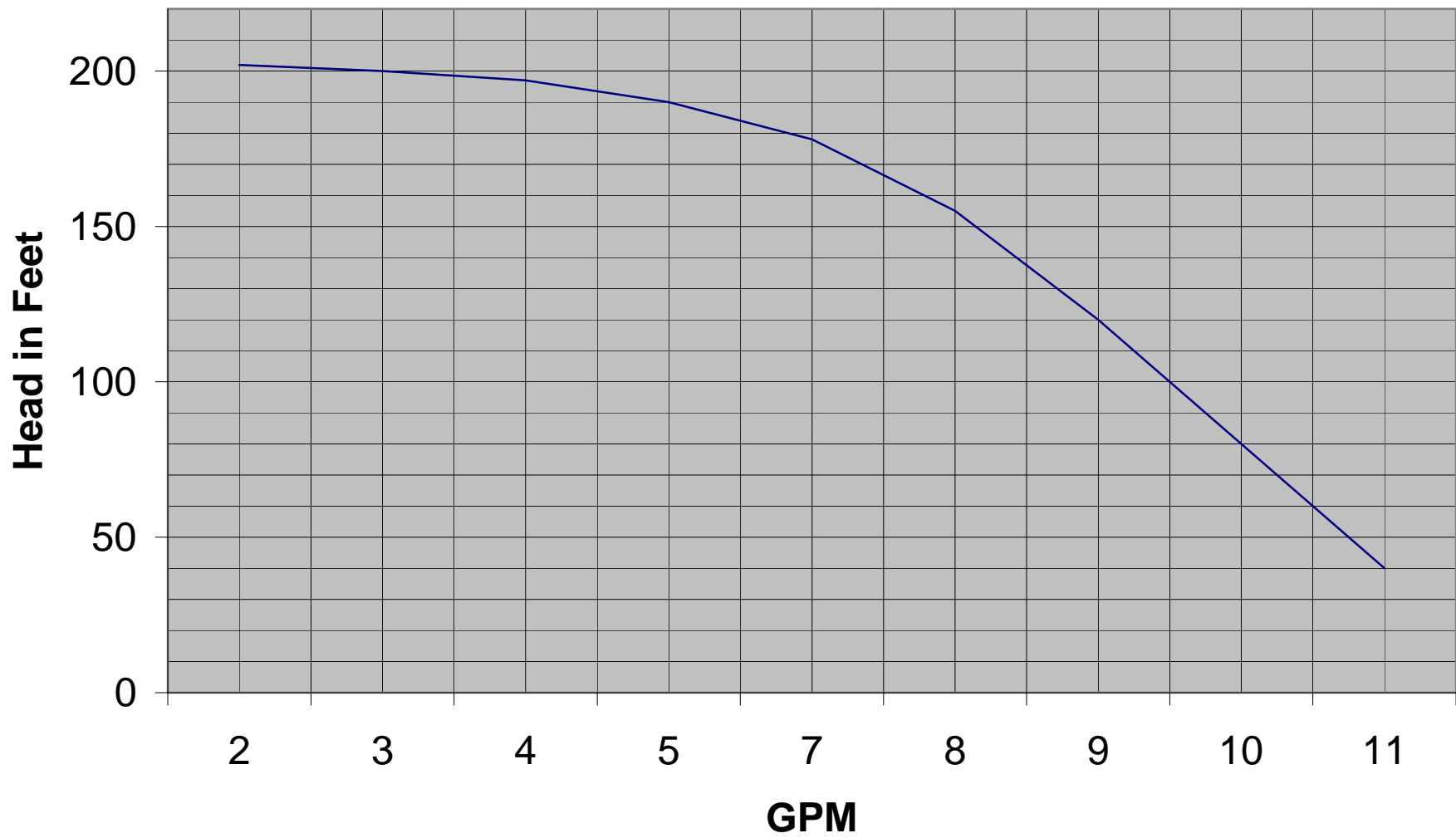
Break Point Chlorination



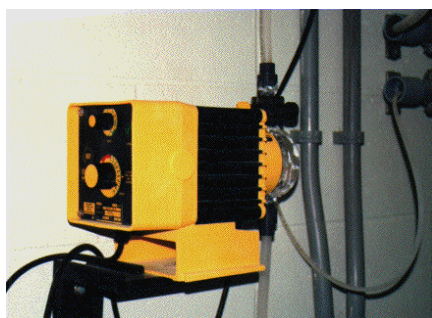
Break Point Chlorination (Well Water)



Pump Curve



Starting up a chemical feed pump disinfection system.



A chemical feed pump

Use this guide to help start up your chemical feed pump system. If you have any questions, contact Field Services at 287-2070.

1. Purchase a flooded suction chemical feed pump. Flooded suction pumps are less likely to become airbound. Keep the pump supplier's number handy for spare parts and manuals.
2. Keep the chemical injection lines as short as possible to minimize air binding and leaks.
3. Make sure the chemical feed pump activates when the well pump turns on. The well pump and the chemical feed pump should be on the same circuit. *If multiple wells are in use*, the chemical feed pump must be paced to flow using a water meter. An electrical signal is sent out by the water meter to the chemical feed pump. As the meter turns faster, the speed of the pump increases.
4. Check the chemical feed pump to make sure the stroke and feed settings are set as close to 50% as possible for each. Chemical feed pumps work best when the stroke and feed are within the range of 25% to 75%.
5. Remove dust and other debris from the chemical storage tank. Keep the chemical storage tank covered in a cool, dry area. Make sure that dust, debris and insects can not enter the top of the chemical storage tank.
6. If you use a hose to fill the chemical storage tank with water, *do not leave the hose in the tank* after you're done filling it. This is a hazardous cross connection that can carry serious health risks.
7. Use an initial solution ratio of about 1 part household bleach to 15 parts water. Write down the date and the amount of bleach and water added to the tank. This can tell you whether you should increase or decrease the solution strength later to get the correct chlorine residual.
8. The target chlorine residual is 0.5 mg/l in the system. Purchase a DPD method, free chlorine, low range (0 mg/l to 3.5 mg/l) chlorine test kit. Follow the instructions in your chlorine test kit to measure chlorine residual. Pick the faucet nearest the chemical feed system to sample. **Report the chlorine residual levels to the Drinking Water Program on the enclosed forms each month!**
9. You may find that the chlorine residual is too high or too low. You can either increase or decrease the solution strength to compensate for the chlorine residual levels, or you can make small adjustments (in 5% increments) in the stroke and feed rate.

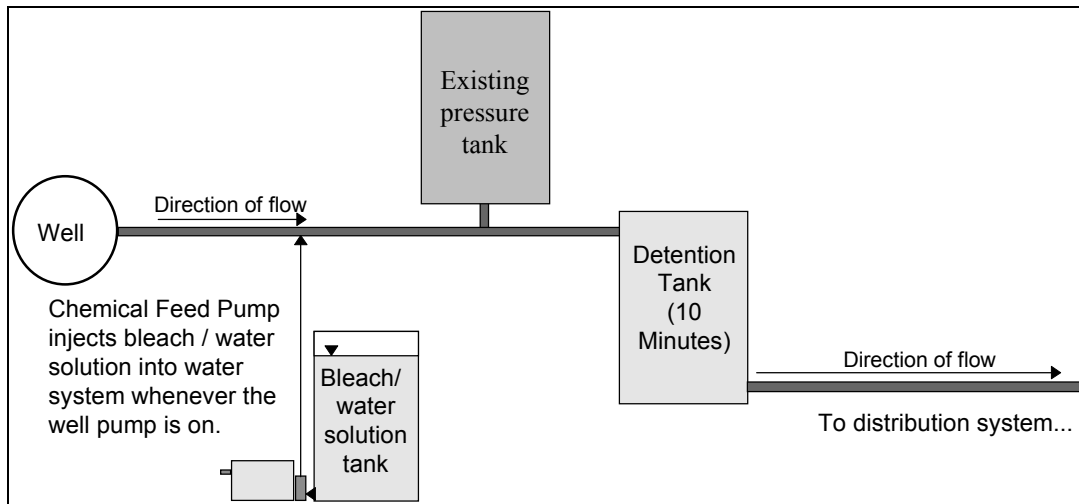


Figure 1: Chemical Feed Pump Disinfection System

Figure 1 shows a typical installation of a chemical feed pump disinfection system. The parts added to the existing well and pressure tank system are the:

- chemical feed pump
- bleach / water storage tank
- detention tank.

The chemical feed pump draws a bleach and water solution from the bleach / water storage tank and pumps it into the water line from the well. The chemical feed pump is wired so that each time the well pump comes on, the chemical feed pump turns on. This ensures that the only time chemicals are injected into the water supply is when the well pump is on. A water treatment installer can recommend the size of the chemical feed pump based on flowrate from the well and operating pressure. Be sure to request a flooded suction pump with an off gassing head. These items will make the pump easier to maintain and operate.

The strength of the solution in the bleach / water storage tank varies, but an initial concentration of 1 gallon of household bleach (5.25% sodium hypochlorite) to 15 gallons of water is a good place to start.

The detention tank is where the bacteria are destroyed. The chlorine solution works best if it has time to kill bacteria. The Drinking Water Program requires systems to have at least 10 minutes of contact time before chlorinated water reaches the first customer.

The size of the detention tank is calculated by the formula below.

$$\text{size of tank (gallons)} = (10 \text{ minutes}) \times (\text{pump rate in gallons per minute})$$

For example, say your well pump worked at 5 gallons per minute (gpm). 5 gpm times 10 minutes equals 50 gallons. 50 gallons is the size of the detention tank needed to get 10 minutes of detention time.

Finally, ensure that you have your pump supplier's number handy for emergency repairs. Familiarize yourself with the parts of the pump and keep the owner's manual nearby.