MAKING THE RIGHT CHOICE
IN
FIELD DECHLORINATION

A
FIELD GUIDE
ON
DECHLORINATION CHEMICALS
&
EQUIPMENT

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BY MEASUREMENT TECHNOLOGIES

FORWARD

The information that follows is presented to assist you in understanding the importance of proper management practices in field dechlorination and give you the necessary knowledge to assist in choosing the right equipment, chemicals & treatment strategy for your situation. Implementing the right procedures will assure success in achieving chemical dechlorination while at the same time also assuring the cost effectiveness of your procedures.

Why remove the chlorine from drinking water before discharging into the environment?

US-EPA, Canadian Environmental Quality and every State & Province have adapted regulations regarding chlorine levels in your discharge water. To protect the environment, effective & safe chemicals must be used. The most common chlorine neutralizing chemicals safe for aquatic life are calcium thiosulfate solution and ascorbic acid.

When it comes to dechlorination, the equipment you choose is only half of the solution. Low price equipment normally has a high daily operating cost. This cost is due to both the expense of chemicals and the inability to accurately control chemical usage. Equipment is a one time purchase (if you make the right choice); chemicals are an on going daily expense.

Environmentally friendly chemicals, at the right price, are the other half of the solution.

As a manufacturer of one the leading devices on the market, Measurement Technologies works hard to insure that information provided on equipment usage is factual and correct for each chemical you can consider. Chemical suppliers understand the performance of their chemicals, but how each type of equipment reacts with their chemical is not something they can accurately predict. You can see this by comparing information given by some chemical suppliers on equipment, and then compare it with the technical information on the same device given by its manufacturer. The manufacturer knows how their equipment should perform with each chemical they have approved. Using information from sources other then the equipment manufacturer could void warranties and result in poor equipment performance. If the chemical supplier understood the proper operation of equipment, they would be manufacturing their own equipment and selling the correct package. Relying on information provided by the equipment manufacturer and using the chemicals that they have approved, is your best answer. Then if you have a problem you can go to the source, the equipment manufacturer who understands the relationship between their device and the chemicals it is designed to work with.

STANDARD OPERATING PROCEDURES (SOP)

As dechlorination becomes the norm for daily operations, more operators and contractors have to conduct chemical treatment. Your standard operating procedures for dechlorination should have equipment as the primary issue, with only chemicals approved by the equipment manufacturer being used with the device. Each chemical has its own performance and reaction requirements. What determines chemical performance is the device introducing the chemical into the water flow. Chemicals are a known quantity no matter the seller. What determines how the chemical performs is the device; and the industry has ***NO*** standards for equipment. So as a specifier you need to understand how equipment to be used within your system will perform. In some applications, multiple types of equipment may do the job; however each will have different operating procedures. Some devices will only perform at 4 ppm of residual chlorine or lower, others will give a full range of chlorine neutralization at residual levels over 300 ppm. Once you have chosen the type of device you will use, your SOP will be dictated by the manufacturer's operation instructions with approved chemicals.

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PUBLIC IMAGE

As utilities and contractors get more involved with chemical dechlorination, public perspectives must be considered. If you are going to protect the environment by dechlorinating discharge water, then an environmentally friendly chemical should be the only option considered. The neutralizing of chlorine is not the only issue to consider in keeping the environment safe; monitoring of dissolved oxygen, pH and turbidity also need to be a factored into your choice of dechlorination chemical and process. And if you're system is a chloraminated system, then ammonia also needs to be monitored. However, in most systems ammonia levels tend to be below EPA discharge limits. In taking into consideration the need to protect against all environmental issues during chlorine neutralization, calcium thiosulfate solution is the only chemical that holds the promise of meeting all mandated requirements.

DAILY OPERATION

In daily operation, dechlorination equipment is used again and again. But once your dechlorination chemical goes down the stream into the environment it's gone. The lowest costing equipment often comes with the highest chemical costs because of a lack of precise control over chemical usage.

Implementing a cost effective field dechlorination program requires the development of a realistic standard operating procedure. A few of the questions you need to ask are;

- How will the equipment be used?
  Will it be connected to a 2.5 fire hydrant hose outlet, truck mounted, blow-off hydrants or even small diameter hoses. Some equipment can only be connected to 2.5 discharge outlets as the devices will not work with smaller diameter connections and lower flow rates.
- What levels of chlorine will you be treating?
  Will you need to dechlorinate potable drinking water with up to 4 ppm of chlorine residual level or will have a need to neutralize chlorine that is over 4 ppm.
- What type of dechlorination chemical do you want to use?
  Not all equipment can use every type of dechlorination chemical. Not all chemicals will protect the environment, some will lower pH and others will eliminate the dissolved oxygen in the water all which can kill aquatic life.
- What water volumes will you be treating?
  You may be flushing only be at high volume flows or have conditions that will require both high and low flow.

Dechlorination Chemicals

While there are many Dechlorination chemicals available in the marketplace, most of the chemicals will not only neutralize the chlorine but also effect the pH or dissolved oxygen in the water. The depletion of oxygen or the altering of the pH in water will harm aquatic life, so any chemical that has this side effect should not be considered for field dechlorination. Chemicals that require specific reaction times also require proper mixing. The H_2O Neutralizer® with its lateral by-pass venture injects the dechlorination solution into the main flow mixing with the water and forcing the reaction to take place within the device. All other devices, even including other vacuum induced devices require the longer reaction times as the chemical is not injected in the same way. This also applies to fast reacting chemicals like ascorbic acid and sodium ascorbate. When you do not have proper mixing of the chemical within the device you will face longer reaction times for the chemical to work well after the treat water has passed through it.

Chloraminated water is the addition of ammonia with chlorine in water being treated. Utilities create chloramines to extend the life of chlorine in the water system, and this also creates additional problems for discharging into the environment. The amount of ammonia added is typically less than EPA discharge guidelines, so the ammonia itself should not be an issue. However chloramines require longer reaction times; so if you are using a passive, drip or natural methods of dechlorination, monitoring is critical.

We will discuss further only chemicals that are safe for the environmental and humans.

Calcium Thiosulfate Solution (CTS)

Calcium Thiosulfate Solution is the answer, for cost effectiveness and ease of use, compared to granular or tablet form chemicals. It comes to the job site already in a liquid state, no mixing or measuring of product to make a solution. Just open the container, insert your suction tube and adjust the draw rate of the solution to match the residual chlorine strength. No wasting of chemical.

Calcium Thiosulfate Solution (CTS) is a non-hazardous, non-toxic solution, which is manufactured here in the United States in accordance with ANSI NSF Standard 60 for drinking water treatment. CTS is colorless, nearly odorless and

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pH neutral (6.5-7.5) and unlike many other water treatment chemicals, it is not an oxygen scavenger and does not require containment. Its NSF Standard 60 listing for dechlorination has been extended to cover ozone quenching where it is used at about one half the rate of bisulfites. Tank and line heating is not generally needed. Many wastewater plants fail to achieve sufficient mixing and reaction time for efficient dechlorination. Experience has shown that improvement in these functions significantly reduces chemical use.

Being a domestically made it offers minimal freight charges, which are often factored into your quoted product cost. It comes packaged in 1, 5 and 55 gallon containers, 260 gallons totes or tankers.

Neutralizing one pound of chlorine requires only 0.4 gallons of Calcium Thiosulfate Solution. At $19.80 per gallon your cost for treating one pound of chlorine would be approximately $7.92.

Why calcium thiosulfate over ascorbic acid? It is safer for the environment then ascorbic acid. The cost of ascorbic acid at time of this writing is over 3 times as costly as calcium thiosulfate for granular. Ascorbic acid tablets are 5 -6 times the cost.

Ascorbic Acid

Ascorbic acid has been used for field dechlorination since the early mid 1990's. Ascorbic is imported product and has a food grade and pharmaceutical grade rating. Some makers claim that ascorbic acid is 100% organic; being made from glucose (corn sugar) boiled with sulfuric acid, you decide. With the only current source being China, ascorbic acid is at times limited in availability with freight being a major factor in its pricing. Ascorbic acid is a popular additive in not only many food products that humans consume, but it is also an additive in fish food. Ascorbic acid comes in a granular/powder from the factories in China and is re-manufactured into tablets here in the United States.

Ascorbic acid has a low pH so it must be monitored and adjustments made to the discharge water if the chemical starts to lower pH to levels that can kill aquatic life.

Ascorbic acid is packaged in 25 Kg (55 pounds) containers and is re-packaged in smaller containers and tablets for sale into the marketplace. Tablets are commonly 4 oz. in weight with approximately 3 oz. of active ingredient in each.

It requires 2½ pounds of ascorbic acid to neutralize one pond of chlorine.

Sodium Ascorbate

Sodium ascorbate is ascorbic acid with approximately 30% sodium. It has all the advantages of ascorbic acid plus it is pH neutral. This chemical is only used by a few utilities because of the price. To treat 300,000 gallons of water at 1 ppm your cost would be $ 101.85. Sodium ascorbate is only available in granular form.

	Calcium Thiosulfate Solution	**Ascorbic Acid Granular**	**Ascorbic Acid Tablets**	**Sodium Ascorbate Granular**
Cost to neutralize	$ 99.00 per 5 gallons $19.80/gal.	$ 720.00 per 25Kg $13.09/lb.	$ 580.00 per 140 Tablets $4.14/tablet	$ 800.00 per 25Kg $14.55/lb.
One pound of chlorine	$ 7.92	$ 32.73	$ 55.23	$ 42.55
300,000 gallons of water at 1 ppm	$ 19.80	$ 82.47	$ 139.21	$ 119.13
10,000 gallons of water at 1 ppm	$ 0.99	$ 2.62	$ 4.42	$ 4.66
20,000 gallons of water at 50 ppm	$ 67.32	$ 274.89	$ 463.68	$ 305.55

NOTE: Ascorbic acid and Sodium Ascorbate pricing is from Pollardwater.com dated Aug. 26, 2009

Dechlorination Methods & Devices

Mother Nature

Natural methods of dechlorination can be as simple as holding water in a pond and let sunshine react with the chlorine, or letting the water run though hay bales. This type of dechlorination should only be used with low chlorinated water not chloraminated water.

Drip Method

This is a method that allows the chemical to drip or release over time into the water discharge stream without active mixing. Federal and State requirements call for the complete dechlorination to take place before you lose control of the

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water, so if this method is to be used it must be in a holding pond or containment. You may also spread the dechlorination chemical out over the surface of the water in the pond or containment and rely on the natural movement or circulation of water in the holding pond to complete the reaction. Any chemical that you use, even ascorbic acid, will require a minimum reaction time in order to complete the neutralization process. This type of dechlorination should only be used with low level chlorinated water not chloraminated water.

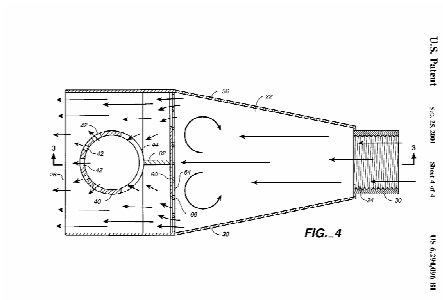
Passive Method

This method typically mixes untreated water with treated water to complete the neutralization process and in most cases this takes place outside of the device; essentially relying on mixing and dilution to bring residual chlorine levels to acceptable levels. So once again, no portion of the water can have residual chlorine above acceptable levels when you lose control of the water.

Some devices employing this method use a by-pass line off the mainline into a chamber with dechlorination chemical. The water passing through the chamber then re-enters the main flow of water and mixes with the non-treated water. Most are designed using a discharge hose and diffuser to allow for the mixing of the chemical. The by-pass normally has a control valve that can be adjusted, however with this design the chamber is under pressure so you must monitor the chemical flow at all times and adjust the control valve to compensate for variances in water flow. The reason for this is that the strength of chemical decreases over time and as water flows though the by-pass. Dechlorination chemicals used with this process are commonly in tablet form and should only be used for low chlorinated discharges (less than 4 ppm), as tablets will not dissolve at a rate that will match the residual chlorine levels of the discharged water above 4 ppm. Your flushing time is directly related to the size of the chemical chamber. Also if using tablets and they are wet when you move to a different location then start to flush again, your tablets will dissolve immediately; so monitoring the control valve is critical. To date the only devices using this type of by-pass design have been using tablet form of dechlorination chemicals.

Hydra-Flow's "Dechlor Demon"

Arden Industries "Bazooka".



Davco's LPD-250 (Patent # 6,294,096 B1) diffuser style devices work under the same principal as described above. Part of the water comes into contact with the chemical and the rest passes though the device without coming into contact with the treated water, the two portions of water then come together and mix outside of the device. Looking at the patent drawings to the left (fig. 4) you can see that only a portion of the water actually contacts the tablet camber and the water on the outside goes straight though the device without contacting the chemical. Mixing happens outside of the device to complete the neutralization process; this is stated in the patent documents. You must make sure that all chlorine is neutralized before you release to the environment. These types of devices use tablet form dechlorination chemical. If using ascorbic acid tablets you are using the highest costing chemical for dechlorination. By-pass style devices have a control valve for controlling chemical usage, while diffuser style device has no control and is designed for 4ppm of residual chlorine. If you are dechlorinating water that has lower residual chlorine you are wasting chemical. This type of dechlorination method should only be used with low level chlorinated water.

Vacuum Induced

These devices create a vacuum and draw in dechlorination solution and then mix it with the chlorinated water. All such devices have a means of controlling the rate dechlorination solution use. There are four main manufacturers of this type of device. All models but Measurement Technologies H_2O Neutralizer® have a fixed mainline orifice / venture opening. When you have a fixed opening you do not get a vacuum until you create adequate differential pressure at your orifice / venture opening, the size of the opening will determining when you start to draw a vacuum.

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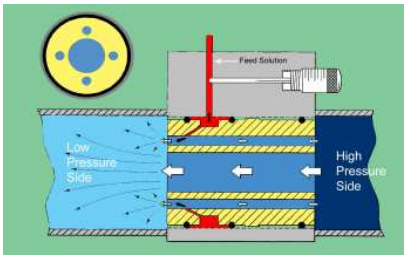
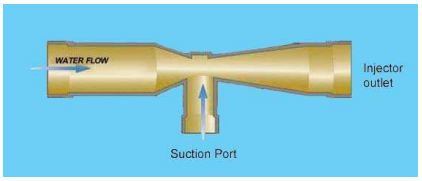
How does an Orifice work?

The outlet side of the orifice will have a lower pressure area after it vs. higher pressure on the inlet side. The water decreases in pressure and increases in velocity when going though the orifice and on the back side creates an area of vacuum allowing for the introduction of an additional fluid. A vacuum will not be created until the entire opening of the orifice is filled, and causes differential pressure. However, because of the square edges of an orifice you will lose vacuum as the flow increases; giving the device a limited window of operation where vacuum level is adequate, with no low flow and no high flow outside this range.



How does a Venturi work?

When the fluid enters the inlet of the venturi, it is constricted toward the injection chamber and changes into a high velocity jet stream. The increase in velocity through the injection chamber results in a decrease in pressure, enabling chemical solution to be drawn into the Venturi by the vacuum created and introduced into the fluid stream. The long exit taper from the injection chamber insures that the high flow does not lose a vacuum, so the size of the venturi injection chamber will determine when the vacuum starts at low flow.



Romac's deChlorinator starts at 200 gpm with only 1 inch of vacuum because of the 2" venturi. The venturi design is 3-to-2, the main tube being 3" while the venturi reduces down to 2". They claim that they can draw over 90 gph of feed solution however our testing has shown the draw rate at a full vacuum of 28+" inches to be only 44 gph. The device is listed as being able to chlorinate, though on the device it states chlorine gas injection is the chemical to be used. We would recommend that you consult a chlorine supplier to determine for yourself how smart it is to inject chlorine gas through an aluminum constructed device.

Arden Industries Bazooka liquid feed unit has two different openings 1.625" and 2.0" with the starting of vacuum at 200 gpm and ranging up to 375 gpm. This device will draw a good vacuum however it has a very small solution feed line, so we do not know what the GPH is. When we field tested this device it blew off the swivel inlet because its polymer material cut threads gave way. Both this style and the tablet feed style have the same body construction which is a combined orifice/venturi construction. The inlet is like an orifice ring and the exit side is like the long tapered outlet of a venturi. This is why they have a higher flow range then a conventional orifice ring design.

Baker Chemical Injector (Patent # 6,453,926) model 260i with 1.25" orifice opening at one time indicated a flow range of 160 – 260 gpm which looked reasonable (it has never been tested) now their web site indicates a 0 – 450 gpm range. This would be impossible because you have to fill the 1.25" opening and create differential pressure before you get the first inch of vacuum so the old performance numbers of 160 – 260 seems more realistic. The web site only talks about dechlorinating; all discussion of chlorinating is made with an auxiliary pump system, not the device.

The H_2O Neutralizer® (Patent # 6,264,846) model 3M is the only device that will chlorinate and dechlorinate effectively. It has an operating range of 8 gpm to 1300+ gpm with a full vacuum. This is done through its patented design mainline orifice ring and lateral by-pass venturi. The mainline orifice ring has three insert orifices which allow you change the size of the orifice opening; giving you the ability to adjust for a wide flow range while maintaining a full vacuum. The combination of orifice and venturi design insures that you create differential pressure in the orifice ring, with the lateral by-pass venturi on the high pressure inlet side of the orifice ring. After you introduce the solution into the

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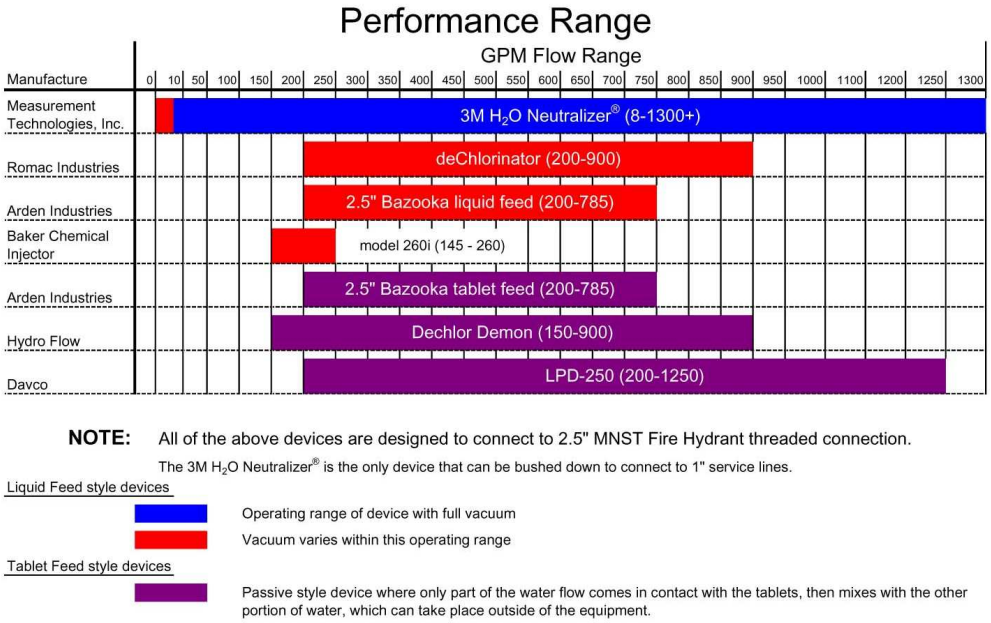
injection chamber of the venturi the lateral by-pass; stream flow is then re-introduced back into the mainline flow on the back side of the orifice ring, the low pressure side forcing the mixing of the two solutions, in turn insuring proper mixing and adequate reaction time within the device. This is the only device in the marketplace that operates using this mixing principal. Customers have report neutralizing residual chlorine levels of over 600 ppm using the 3M H_2O Neutralizer® Also available, is a 5 inch device designed for the 4.5" pumper outlet on fire hydrants and has a performance range of 600 – 5000 gpm. Either device can be re-configured with different end connections to both chlorinate and dechlorinate.

Performance Range Chart



NOTE: All of the above devices are designed to connect to 2.5" MNST Fire Hydrant threaded connection.

The 3M H_2O Neutralizer® is the only device that can be bushed down to connect to 1" service lines.

Liquid Feed style devices

Operating range of device with full vacuum

Vacuum varies within this operating range

Tablet Feed style devices

Passive style device where only part of the water flow comes in contact with the tablets, then mixes with the other portion of water, which can take place outside of the equipment.

Conclusion

Dechlorination equipment is essentially a mixing device in which the chlorine neutralizing chemical comes into contact with the chlorinated/chloramine water. There are four different ways to introduce the chemical to the chlorinated/chloramine water; natural, drip method, passive method or vacuum induced methods and each type comes with different performance capabilities and ability to use chemicals.

Equipment is a one time purchase. Your chemical costs form the bulk of your operating expenses for general daily flushing and neutralizing of super chlorinated water. These costs are what need to be focused on the most. The lowest costing equipment comes with the highest cost of chemical and the poorest control over usage of the chemical. The best equipment achieves proper control over chemical usage – your biggest expense – and effective treatment of water.

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