IRRIGATION MANAGEMENT

S E R I E S

Shock Chlorination Treatment for Irrigation Wells

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Public water supply wells are regularly tested to ensure the water is safe to drink. The presence of bacteria in a well can be a health risk. The consequences of bacteria in a well used for nonhuman consumption may not be a human health risk, but certainly can be a risk to the long-term performance of the well. Bacterial growth can build up as layered slimes that inhibit well performance by restricting water intake through the well screen. These materials also can cause equipment problems once the water is pumped to the surface for use. The presence of bacteria and other contaminates also could indicate a structural defect in the well, allowing direct entry of surface water.

A properly designed well should prevent contamination during normal operating conditions. During construction, repair, or even some monitoring activities, the opportunity for water contamination exists. To minimize the chance of bacterial contamination, any maintenance procedure that exposes the interior of the well to the open atmosphere should be followed by a shock chlorination. Any well that has been severely infected with bacterial growth should be treated at least annually.

Maintenance of Wells

Good records can help an irrigator determine well performance and identify developing trends. Records also should include the well log of the aquifer material made during drilling and the construction log that records the type of casing, screen, and placement levels.

The initial static pumping water level and the discharge rate also are important information. Newer wells that have an observation tube along the main well casing make these water level readings easier to obtain. An initial water quality test also should be taken.

Well tests that show high iron or manganese are especially vulnerable to bacterial infestations. Bacterial infections can be treated with shock chlorination.

Mineral incrustation potential may be noted also, particularly in declining aquifer systems when well screens become exposed (not-submerged) due to the declines. Mineral incrustation is a buildup of materials that have precipitated out of the water and attached to the screen and casing. These materials can clog the screen openings and porous space in the gravel pack and aquifer material directly outside the screen area and limit the flow into a well. Removal of this material may require an acidation treatment. This treatment should be made by a licensed well service provider.

Well records can be used to calculate the specific capacity of a well. The specific capacity of the well is the discharge rate divided by the drawdown or gallons per minute per foot of drawdown. Drawdown is the difference in the static water level and the pumping water level.

Example:

Year 1 reading:

Static water level =	125 ft
Pumping water level =	180 ft
Discharge rate =	800 gpm

Drawdown = 180 ft – 125 ft = 55 ft
Specific capacity = 800 gpm ÷ 55 ft = 14.5 gpm/ft

Year 2 reading:

Static water level =	125 ft
Pumping water level =	200 ft
Discharge rate =	750 gpm

Drawdown = 200 – 125 = 75 ft
Specific capacity = 750 ÷ 75 ft = 10 gpm/ft

Percent specific capacity of original = 10 ÷ 14.5 × 100 = 69%

This indicates a loss of 31 percent of the original specific capacity and that the well may benefit from shock chlorination treatment, especially if the initial water test indicated high iron or manganese content, a current water test indicates the presence of bacteria, or physical evidence that a reddish or blackish slime exists.

Loss of specific capacity should not be the sole indication of a need for treatment. Loss of specific capacity could be due to mechanical failures. Declining water tables also can contribute to a loss of specific well capacity.

Shock Chlorination

Chlorine is a strong oxidizing agent that is widely used to disinfect water supplies. A shock chlorination treatment for wells usually refers to a high concentration of chlorine being introduced to a well. The concentration can be in the range of 500 to 2,000 mg/l for severely infected wells. However, in severely infested wells where the bacterial growth is thick and likely extends into the nearby aquifer materials, it is unlikely that a single chlorination treatment will be totally effective.

Chlorination itself does not remove bacterial growth on the pump, casing, screen, and aquifer material. The treatment, especially with vigorous agitation or surging, will cause sloughing of the slimes. Severely infested wells may require multiple treatments. It is unlikely that all bacteria will be destroyed, so most wells will need routine (perhaps annual) chlorination treatment. However, lower concentration may be possible.

Many Kansas irrigators may find their well's performance would improve after a shock chlorination treatment. Producers considering SDI (subsurface drip irrigation) definitely need to be certain their wells are bacteria free or regularly treated, or face additional filtering or emitter clogging problems with their SDI systems.

Shock Chlorination Procedure

The chlorination procedure described in this publication assumes that either a liquid or dry source of chlorine is being used. Chlorine also is available as a gas. Chlorine gas, while it is a relatively inexpensive chlorine source, is a very powerful oxidizing agent and must be handled with extreme care. It is extremely corrosive and causes severe damage to human tissue immediately upon contact. Its use has been mostly restricted to large municipal wells due to special handling and equipment needs. Chlorine gas, introduced to the well water through plastic tubes, readily mixes to form a disinfecting solution. However, the gas introduction must be done carefully to avoid damage to screens. Gas as a highly concentrated chlorine source may increase the risk of violent reaction with hydrocarbons (oil) that may be present in irrigation wells.

Determine Volume of Water for Treatment

The volume of water to be treated is based on the treatment diameter and the depth of water in the well. Because iron bacteria can also live in the aquifer material immediately adjacent to the well, an additional one or two foot diameter should be added to the well diameter to increase the effectiveness of the treatment. This means effective diameter of treatment for an 18 inch well casing should be a 30 to 42 inch (2.5 to 3.5 ft.) diameter.

Determine the Amount of Chlorine Needed for Treatment

Table 1 shows the amount of material needed to make a 500 mg/l chlorine treatment solution based on the concentration of the chlorine source. The concentration of the chlorine source is read from the label on the material. Common household bleach is usually either a 5.25 or 7.5 percent sodium hypochlorite (NaOC1) concentration. Another source of chlorine is high-test hypochlorite powder, commonly referred to as HTH. HTH generally contains 65 to 75 percent calcium hypochlorite [$Ca(OC1)_2$]. Multiply the table value by the depth of water in the well to determine the amount of product needed for the treatment. The values in Table 1 are based on a 500 mg/l treatment solution. Multiply Table 1 values by 2 or 4 to obtain quantity for 1,000 or 2,000 mg/l treatment amounts respectfully.

A spreadsheet program, ShockSDI, is available at *www.oznet.ksu.edu/sdi*. The program can calculate the amount of chlorine needed to treat a well for any effective diameter, water depth, chlorine product percentage, and treatment concentration.

Introduce Chlorine to the Well

The chlorination treatment will be most effective if the entire water column in the well is treated. For new wells or wells where the pump has been pulled for servicing, the distribution and mixing of the chlorine is less difficult than when treatment has to be made with the pump in place.

Chlorine distribution may occur by placing dry calcium hypochlorite in a bag or porous container suspended on a cable that is lowered to the bottom of the well. Raising and lowering the material throughout the water column will distribute it. Another alternative is mixing the chlorine in a surface tank and circulating the mix into the well using the well service provider's pump.

While it is best to uniformly distribute the material throughout the water column, distribution will be more difficult for wells with the

Table 1. *Quantities of chlorine product to disinfect one foot of water depth in irrigation wells at 500 mg/l concentration.*

Effective treatment diameter	Amount of Product to disinfect 1 foot of water depth: Sodium Hypochlorite Liquid Bleach (fluid ounces)			High-test Hypochlorite Powder (dry ounces)	
	5.25%	7.5%	10%	65%	70%
6 inches	1.79	1.25	0.94	0.14	0.13
8 inches	3.18	2.23	1.67	0.26	0.24
10 inches	4.97	3.48	2.61	0.40	0.37
12 inches	7.16	5.01	3.76	0.58	0.54
14 inches	9.75	6.82	5.12	0.79	0.73
16 inches	12.77	8.91	6.68	1.03	0.95
18 inches	16.11	11.28	8.46	1.30	1.21
24 inches	28.65	20.05	15.04	2.31	2.25
30 inches	44.76	31.33	23.50	3.62	3.36
36 inches	64.45	45.12	33.85	5.42	4.83
42 inches	87.73	61.41	46.06	7.09	6.58
48 inches	114.59	80.21	60.15	9.26	8.59
54 inches	145.02	101.52	76.14	11.71	10.88
60 inches	179.04	125.33	94.00	14.46	13.43

Example 1. *A 12-inch diameter irrigation well is 270 feet deep. However, the static water level is at a depth of 140 feet. The irrigator uses the recommendation of adding at least 1 additional foot to the well diameter for treatment. Using 7.5 percent sodium hypochlorite and the table above, the required quantity to reach 500 mg/l concentration is 20.05 ounces × 130 ft = 2,607 ounces or approximately 21 gallons.*

Example 2. *To attain a concentration of 1,000 mg/l with the same product and well, the irrigator would use twice the amount or 41 gallons.*

exiting pump in place. The pump column pipe and centering brackets prevent lowering a container of dry chlorine granules or pellets and the passing of a hose for introducing a liquid chlorine solution. The best available alternative would be to mix the chlorine solution into a surface tank and then drain into the well. After pouring the solution into the well, surge the well vigorously by starting and stopping the pump intermittently. Do not allow water to discharge from the well, because this would result in dilution of the chlorine concentration.

The effectiveness of the treatment is related to the duration (contact time) of the treatment. The longer the bacteria are exposed to the disinfectant, the greater the potential for killing the bacteria. Low chlorine concentrations can be effective, if given long duration. Agitation will increase effectiveness. After the introduction of the chlorine into the well, agitation will help mix and distribute for good exposure. After this introduction and agitation, let the chlorine set for at least 4 hours.

Agitation

After initial contact time, the well should be agitated again. Additional agitation increases the effectiveness of the treatment because agitation will dislodge the bacterial slime and expose new layers to the chlorine solution. Agitation also will help to move the chlorine solution through the screens into the surrounding gravel pack and aquifer material. The movement in and out of the aquifer also may help bring the dislodged growth material into the well, where it can later be removed by pumping.

Agitation can be achieved in wells without the pump by surge plungers, air pumps, and scrubbers. Scrubbers brush the inside of the well screens. Many wells will need treatment without the physical removal of the existing pump and wellhead equipment because of the expense of pulling deep well pumps. Treatment with the pump in place will make it more difficult to distribute the chlorine throughout the water volume. However, the treatment can still be effective, particularly if the well is periodically treated so it is not infested with heavy buildup of the bacterial slime.

The chlorine solution also may be forced through the well screens into the gravel pack and surrounding aquifer by adding additional water to the well in an amount equal to the volume of the water inside the well. This additional water volume will provide the head or pressure to push the water out of the well. This is a good procedure for wells being treated with the pump in place.

Exposure Time

Allow for contact or exposure time. After surging the well, give the chlorine time to work. As noted previously, bacteria can be killed by short exposure to high concentration or long exposure to low concentration. After 4 hours of exposure, surge the well vigorously again to expose new bacterial slime layers to the chlorine as the outer layer flakes off.

Allow the treatment to have 24 to 72 hours of exposure time. It is permissible to surge the well occasionally, but do not let any water discharge during surging.

Purge the Well

Purge the well to remove the organic debris and the remaining solution. Pump the well until the water is clear and the chlorine odor is gone. Do not pump this water through an SDI or center pivot sprinkler package, because clogging may occur. Be careful of the disposal area because the chlorine solution may still be strong enough to damage or kill vegetation.

Resetting the Pump

If the well has been treated with the existing pump removed, the well should be retreated when the pump is reinstalled. Only the water inside the well casing needs treatment.

Safety Reminders

Chlorine is irritating to the skin, eyes, and respiratory tract. When handling chlorine, wear protective clothing and eye protection, and have good ventilation in a confined area. If using highly concentrated formulations, consider using a self-contained breathing apparatus.

Chlorine also can be very corrosive. This is why distribution of the chlorine throughout the water in a well through a hose is preferred.

As a strong oxidizing agent, chlorine can react with hydrocarbons. It is possible for a violent reaction with pump oil floating on the water surface to occur with chlorine that is poured into a well.

Never mix chlorine and acid. This will result in the release of chlorine gas, which is very toxic as noted previously.

Summary

Shock chlorination of irrigation wells can be a relatively inexpensive treatment to prevent buildup of bacterial slimes that can cause losses of well capacity and operation (clogging) problems for some irrigation systems, especially SDI systems. However, shock chlorination will not remove incrustations of mineral deposits. These deposits, caused by a chemical rather than a biological process, would require a different treatment for removal. While shock chlorination is an effective treatment for iron and manganese bacterial slimes, once a well has been severely infested, it will likely need periodic treatment to keep the bacterial growth in check.

Chlorine is a chemical product that is relatively common, but it can cause injury to humans with improper handling. Always follow safety recommendations. Be careful when pumping the well after treatment to make sure the treated water is contained, because it can injure plants and harm surface water sources until the chlorine volatilizes to the atmosphere.

Licensed well service providers are familiar with shock chlorination procedures and have the equipment to accomplish the task. Some large wells with multiple screens or wells with severe infestations may be difficult to treat and it may be best to have service providers handle the treatment.

Sources of Information

F.G. Driscall. 1986. Groundwater and Wells, 2nd Edition. Johnson Filtration Systems. St. Paul, MN.

Related K-State Research and Extension Publications

Powell, G. M. and D. H. Rogers. 1998. *Shock Chlorination for Private Water Systems*. Water Quality Series Bulletin MF-911. Kansas State Research and Extension. Manhattan, KS.

Related K-State Research and Extension Irrigation Web sites

Subsurface Drip Irrigation
www.oznet.ksu.edu/sdi

General Irrigation
www.oznet.ksu.edu/irrigate

Mobile Irrigation Lab
www.oznet.ksu.edu/mil

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