Successful Disinfection in Wells

ChloraPal™

Enhances chlorine

DESIGN WATER
TECHNOLOGIES

Coliform bacteria

Most bacterial problems in wells are due to coliform bacteria. Although coliform bacteria are non-pathogenic, their presence suggests that conditions may be favorable for pathogenic organisms like e coli (fecal coliform) which are associated with animal waste. A source for e coli can be a feed lot, septic tank or a broken sewer line, inadequate grout around a well casing, or a broken well casing.

Chlorination has been the routine method for disinfection because of cost and availability, but it has not been totally successful due to improper techniques and product usage.

Why do water samples show positive after chlorination?

1. Improper placement of chlorine. Bacteria may be present in areas outside the well and into the formation. It's difficult for chlorine to reach into the formation by simply dumping it from the surface. Extremely high concentrations occur at the static water level, causing potential corrosive problems, but chlorine becomes diluted before reaching the bottom of the well. Even if you overcompensate with chlorine, it will not automatically move into the formation without development. Pelleted chlorine falls to the bottom of a well but doesn't go into solution easily in cold water and doesn't automatically move into the formation.

2. Improper development or lack of development in wells. Many types of bacteria are naturally occurring within an aquifer. When a well is drilled, bacteria are exposed to oxygen which can encourage growth. Subsurface soil bacteria can be picked up and carried by the drilling process. Debris can also be deposited into the aquifer by any drilling method. This debris can include drilling fluids (bentonite, foam, water), drill cuttings from the borehole, and smearing effects of the drill bit and drive shoe. Well development removes this damage to allow the highest flow possible to the well but also removes debris that can hide bacteria. The most important part of well completion is development.

3. High pH of natural groundwater. It's more difficult to get negative samples if the natural pH of groundwater is greater than 7.0. It becomes almost impossible when pH is over 7.5. Refer to page 3 for a further explanation.

4. Improper sampling in the field. Bacteria can be picked up from the system, so take water samples as close to the well as possible. Singe the sample spigot to disinfect, run the water for 15 minutes, remove the cap from the sample bottle and hold the cover in one hand while filling the sample bottle. Do not set the cap down. Do not breathe on the cap as you may contaminate with air borne bacteria. Fill the bottle completely, label the container, and refrigerate, until you send or bring it to a lab. Get the sample to the lab within 24 hours.

5. Improper testing or handling of samples in the laboratory. A sample can be contaminated in a laboratory. If you suspect this is happening, take multiple samples and send them to different laboratories. Problems in labs are rare.

Bacteria in wells

Bacteria can be introduced during the drilling process, but they can also be injected into wells during new pump installation or maintenance. The pump, electrical cable, and pump column pipe should not be set directly on the ground surface to avoid potential contamination. *E coli (fecal coliform)*, and families of iron bacteria are often found in subsurface soils and can be easily injected into wells.

In older wells and pipelines, polysaccharide slime (iron bacteria) and mineral scale provide an environment for coliform to survive and physical protection from chlorination. If large amounts of debris are present, physical or chemical treatment will be required to remove this, prior to successful chlorination. Chlorine is <u>not</u> effective in removing slime or iron bacteria. See our booklet "Well & System Rehabilitation."

Chlorine as a product

In this text, references to chlorine pertain to calcium and sodium hypochlorite only, not chlorine gas. Chlorine is commonly available in granular or pellet form (calcium hypochlorite) and in liquid form (sodium hypochlorite). These are strong oxidants and can be very dangerous when stored near organic materials.

Calcium Hypochlorite: Granular or pelleted chlorine is generally available in 65-70% available chlorine. Granular chlorine should be mixed at the surface as a liquid and injected into the well. The pellets do not dissolve easily in cold water and can remain in the bottom of a well for years. The use of calcium hypochlorite in high alkaline or hard water (>180 ppm calcium hardness) will precipitate calcite as a pasty substance. This can cause severe plugging and a reduction in well yield. It is also very difficult to remove.

Sodium Hypochlorite: Liquids are available as common household bleach with approximately 5.5% available chlorine and commercial grades with up to 12% available chlorine. Bleach is most commonly used because of availability. Do not use the scented brands because they can leave a residual. The potency of household bleach declines 20-25% every month, so beware even with newly purchased product. It may not be potent.

Traditional treatment with chlorine

Chlorine is often just dumped into a well from the surface. When it's ineffective (50-100 ppm?), more chlorine is used to over compensate for the problem. More chlorine doesn't mean success. Higher concentrations create reddish water and a dangerous chlorine odor. In either situation, it's the oxidation process that is providing the reaction, not the biocidal. Oxidation doesn't necessarily kill bacteria. It is however, corrosive to pitless units, pumps, well casing, and pipelines.

Conditions where chlorine will not be effective

If major amounts of scale or slime (iron bacteria) are present in a well or system, chlorine will not penetrate this mass to kill coliform bacteria.

E coli (fecal coliform). DO NOT CHLORINATE. First, identify the source. These bacteria must have a warm bodied source to survive. Suspect a dead animal in the well, cracked well casing or inadequate grouting of the borehole annulus to the well casing which might allow contamination from a surface area. Flush the well from the bottom with plain water over the surface. Once the source is identified and removed, then disinfect.

Successful chlorination

There are four basic factors for successful chlorination. 1. placement of chlorine. 2. chlorine concentration. 3. development. 4. pH of solution.

Placement of chlorine

Chlorine must come in contact with bacteria to be effective. That includes the entire column of water, the area outside the screen, and into the borehole. An easy way to accomplish this in wells with less than 300' of water, is to flood the well with two times the volume of the casing and borehole with a pretreated chlorinated solution. If there is more than 300' of water in a well, we recommend the solution be evenly distributed throughout the borehole with a tremie line.

Development

Chlorine can't kill bacteria unless it makes contact. Any movement of chlorine back and forth into the formation will increase success. This can be done by a surge block operating below the static level or an air compressor lifting water to surface and allowing it to fall back. Even movement of the pump up and down in the well casing will create some development action. Any movement may help break down any potential physical barriers where bacteria can hide.

pH and chlorine effectiveness

Liquid or granular chlorine is a tremendous alkaline. When mixed into water, pH rises dramatically. Chlorine is 100% biocidal at a pH of 5.5, but is 100% oxidative at a pH over 10. When 50 ppm chlorine is mixed into water with a natural pH of 7.1, pH will rise to 8.0. The biocidal effectiveness is now 12%. As pH rises, chlorine becomes more oxidative in nature. When 200 ppm chlorine is mixed into water with a natural pH of 7.1, pH rises to over 9.0 and the biocidal effectiveness decreases to 2%. A 1,000 ppm chlorine solution drives pH to over 10 and the biocidal effectiveness becomes less than 1%.

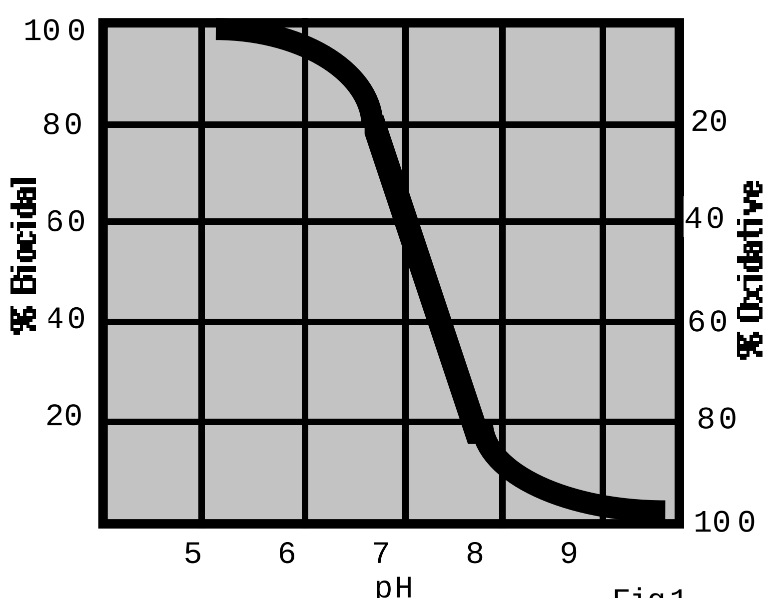

Fig1

In an oxidative state, chlorine, 1. oxidizes whatever minerals that are in solution (reddish water),
2. creates severe corrosion on metals (discoloration).
3. produces an extremely dangerous chlorine gas (odor). 4. is very slow to kill bacteria (failure). This oxidation uses chlorine, leaving lower concentrations available for killing bacteria.

In a biocidal state, the entire residual is available for killing bacteria. Common acids (sulfamic & hydrochloric) can be used to lower pH but have some major concerns, 1. There is no control of pH and if pH drops below 4, a dangerous gas (Cl2) is released, which is lethal, 2. Acids easily mix with water in the formation allowing a rise in pH, which defeats the purpose. 3. requires handling and safety concerns.

ChloraPal™, 1. provides specific dosages, 2. is not dangerous to use, 3. has buffers to retain pH which keeps chlorine biocidal, even in the formation, 4. provides much better cleaning power than chlorine, or chlorine and acids. alone.

How to successfully treat a well.

Step 1:

The label on the ChloraPal™ container has a table with two times the volume of water in the most common casing sizes (see Fig 2). Multiply this number by the total footage of water (total depth minus static water level). For example, a 4” well has 125’ of water; multiply 1.3 x 125’ = 162 gallons of water. Use a tank at the surface with approximately this amount of water for mixing ChloraPal™.

For other well diameters, calculate the amount of water per foot of casing, multiply by the total footage of water in the well, and multiply by a factor of 2.

Step 1

Casing Diameter	Volume of Water in casing x2
2”	0.32 gal/ft
4”	1.30 gal/ft
5”	2.10 gal/ft
6”	3.00 gal/ft
8”	5.40 gal/ft
10”	8.50 gal/ft
12”	11.90 gal/ft
14”	14.30 gal/ft
16”	19.00 gal/ft
18”	24.00 gal/ft
20”	30.00 gal/ft
24”	47.00 gal /ft

Fig 2

Step 2:

Check the pH of the mix water. If pH is between 6.5-7.5, the dosage of ChloraPal™ is 0.002 quarts per gallon of water for a chlorine solution of 50 ppm. Multiply the total gallons of water in tank (Step 1) times 0.002 quarts. Example: 160 gal in the tank x 0.002 qts. = 0.32 quarts (1/3 quart) of ChloraPal™. Pour ChloraPal™ into the tank and mix. pH will decline to approximately 4.7.

If the natural pH of mix water is 7.5 to 8.5, the dosage of ChloraPal™ becomes 0.003 quarts per gallon of water. If pH is over 8.5 to 9, use 0.004 quarts of ChloraPal™ per gallon of water. When the pH of water is less than 6, ChloraPal should not be required. DO NOT pour ChloraPal™ directly into liquid or dry chlorine.

Step 3:

The ChloraPal™ label provides easy-to-follow instructions for proper amounts of liquid or granular chlorine for a 50 ppm solution.

Check the percentage of chlorine on the label being used in the field. Multiply the chlorine amount (in gallons or in pounds) in Step 3 times the total gallons of water in the surface tank in Step 1. For example, granular chlorine with 65-70% available chlorine, multiply 0.0006 lbs per gallon x 160 total gallons = 0.096 lbs total or 0.1 lb of chlorine. Mix this into the solution of water and ChloraPal™ (Step 1 & 2). **Check pH which should be approximately 5.5-6.0.** Pump or pour this solution directly into the well.

When using liquid household bleach, ALWAYS check pH once chlorine is mixed into the ChloraPal™ solution. If lower than 5.5, the chlorine is depleted. Sparingly, pour more chlorine into the solution and mix, until pH rises to 5.5. If too much chlorine is used accidentally and pH rises above 6.0, simply adjust downward with very, small amount of ChloraPal.™ Be aware, bottles of bleach bought at the same time may vary tremendously.

Step 3

For 50 ppm chlorine solution

Type of Chlorine Available %	Amount of chlorine per gallon of water
Calcium Hypochlorite	**Granular chlorine**
65-70%	.0006 pounds
Sodium Hypochlorite	**Liquid chlorine**
12-15%	.0004 gallons
10%	.0005 gallons
5-6%	.001 gallons

Fig 3

Treatment of underground lines and a plumbing system with the well

Calculate the amount of water in underground lines and piping system to be treated. Add this to the water already planned in the surface tank in Step 1. For example, if a plumbing system contained 20 gallons of water, add that to the 160 gallons in the example in Step 1 for a total of 180 gallons of water. All dosages of ChloraPal™ and chlorine should be based upon total gallons. Pump or pour the treated solution into the well and pump into the system until pH drops to 5.5 at all faucets or areas of the piping system.

Removal of chlorine solution and sampling

Let solution set overnight (12-24 hours). Pump to waste or flush through the system until pH returns to normal. In a domestic well, this may take 30-40 minutes for pH to rise to normal. In large diameter wells, it may take 90 minutes depending upon pumping rate. Once pH returns to normal, obtain samples for bacterial analysis.

Safety issues

All chemistry in ChloraPal™ is nontoxic and non harmful. A pH of 5.5 is not harmful for incidental consumption. Chlorine is less harmful in concentrations of 50 ppm than 200.

Chlorine concentrations

A solution of 50 ppm chlorine mixed into a ChloraPal™ has approximately 2.5 times more effective killing power than 1,000 ppm of chlorine in regular water. Field tests have shown that a 50 ppm solution of chlorine and ChloraPal™ was effective while 7 treatments with a 1,000 ppm chlorine solution failed in the same well.

Chlorine is consumed by bacteria. A certain amount of chlorine is available to kill a certain number of bacteria. If a positive sample occurs with a solution of ChloraPal™ and chlorine and all pH was monitored according to recommendations, repeat the treatment with a 200 ppm solution. Remember, development is critical.

For chlorine concentrations other than 50 ppm

Simply divide the desired concentration by 50 for a multiplier factor for both the amounts of ChloraPal™ and chlorine. For example, 200 ppm, 200 ÷ 50 = 4. Multiply ChloraPal™ (Step 2) and chlorine (Step 3) by 4 times for proper amounts of each.

Time required for treatment

The kill is instant using ChloraPal™ and chlorine, however we recommend letting the solution set overnight (12-24 hours) for better penetration of potential damage from drilling fluids in new wells and minor amounts of mineral scale or slime in older wells. ChloraPal™ does have penetrating agents to help this process. Development is important. If major scale or slime exists see our booklet “Well & System Rehabilitation.”

For limestone or fractured rock formations

Estimate the total water volume in the well casing and fracture zones or caverns in the bore hole and at least double this volume for the chlorine solution. It is impossible to accurately estimate the volume in large cavernous zones.

Lab Services/Technical Services

If you experience a positive sample with the use of ChloraPal™ and chlorine please call our Technical Service Hot Line at 888-4 DSN H2O (888-437-6426) for assistance.

Our lab services can help determine problems/solutions in wells and systems. These include 1) analysis of water chemistry to determine tendencies for mineral scale and corrosion in water and effects on metals, 2) identification/quantification of slime bacteria, including iron bacteria, 3) identification/severity analysis of anaerobic bacteria (odor & corrosion problems) including Sulfate Reducing Bacteria. 4) total bacterial counts via ATP analysis, 5) problem analysis for coliform/fecal coliform.

Coliform bacteria can be identified by most local labs and is generally preferable because of time. We can however, determine whether bacteria are located near the well bore or in the aquifer through time tests and count measures. Please contact your local “Unicid” distributor or call us for prices and information.

Another Product by

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