DISINFECTION

This section consists of the following subsections;

- Purpose of Disinfection
- Responsibility for Disinfection
- Commonly Used Chlorine Compounds
- Stability of Commonly Used Chlorine Compounds
- Recommended Chlorine Concentrations for Disinfecting Wells
- Procedure for Disinfecting Wells
- Effectiveness of the Disinfection Procedure

PURPOSE OF DISINFECTION

During the construction, repair, and alteration of a well and during pump installation, maintenance, and repair, bacteria can be introduced into both the well and the aquifer. These bacteria may be pathogenic or may metabolize iron and manganese in the ground-water, and cause incrustation of the well screen or clogging of the pore space in the aquifer. The simplest and most effective way to kill harmful bacteria introduced by these activities is to disinfect the entire water supply system with a chlorine solution.

RESPONSIBILITY FOR DISINFECTION

Immediately following construction, repair, or alteration, the well driller should disinfect the well. If a pump is to be installed by the well driller immediately upon completion of the well, the driller should disinfect the well and the pumping equipment after the pump has been installed.

If the pump is not installed upon completion of the well, the pump contractor should disinfect the well and the pumping equipment after the pump has been installed. The pump contractor should also disinfect the entire water supply system after any maintenance or repair work is done on the pump.

COMMONLY USED CHLORINE COMPOUNDS

Sodium hypochlorite and calcium hypochlorite are the most common chlorine compounds used to disinfect private water supply systems. Sodium hypochlorite solutions are available in several strengths. Most household laundry bleaches consist of sodium hypochlorite dissolved in water. These solutions generally contain 5% to 5.25% available chlorine and can be purchased at most grocery stores. Stronger sodium hypochlorite solutions, containing 12% to 12.5% available chlorine, are sold for use in water and wastewater treatment plants, and for use in swimming pools.

The calcium hypochlorite compound used most often by water well and pump contractors is known as high-test calcium hypochlorite. This compound is available as granules or tablets which commonly contain 65% by weight available chlorine.

STABILITY OF COMMONLY USED CHLORINE COMPOUNDS

The chlorine compounds commonly used in preparing disinfectant solutions are not stable. Therefore, outdated products or compounds which have been improperly stored should never be used to prepare solutions with specified chlorine concentrations.

Sodium hypochlorite is so unstable as a dry compound that it can be purchased only as a solution. Sodium hypochlorite solutions, however, are also unstable. A sodium hypochlorite solution with 10% available chlorine, for example, loses chlorine at a rate such that after six months there is approximately 5% available chlorine remaining in the solution. Sodium hypochlorite solutions more than 60 days old will not contain the same chlorine concentration as the original solution and should not be used in preparing solutions with specified chlorine concentrations.

Dry calcium hypochlorite, on the other hand, is relatively stable. For example, after 12 months of storage in a cool, dry environment, properly packaged calcium hypochlorite will retain approximately 90% of the chlorine originally available in the compound. If, however, the compound becomes moist, it will lose chlorine more rapidly.

Chlorine irritates the eyes, skin, and respiratory tract. Furthermore, dry chlorine compounds become strongly corrosive in the presence of moisture. Chlorine, in solution, is a strong oxidizing agent that reacts vigorously with hydrocarbons, such as oil and grease, and other organic compounds, such as turpentine, ethyl alcohol, glycerol, carbon tetrachloride and charcoal. For safety, follow the handling instructions on the product label.

RECOMMENDED CHLORINE CONCENTRATIONS FOR DISINFECTING WELLS

When a well is disinfected, the initial chlorine concentration should be 100 mg/l throughout the entire water column. Disinfection of the distribution system, when connected, should also be accomplished using an initial chlorine concentration of 100 mg/l.

PROCEDURE FOR DISINFECTING WELLS

This subsection consists of the following parts;

- Preparation
- Determining the Required Amount of Chlorine Compound
- Mixing the Disinfectant Solution
- Placement of the Disinfectant Solution
- Retention Time for the Disinfectant Solution
- Flushing the System

Preparation

Prior to introducing disinfectant into a well, the interior of the well casing, the pump, and any piping, should be thoroughly cleaned and flushed to remove all foreign substances such as oil, grease, joint dope, soil, sediment, and scum. A thorough cleaning is necessary because only bacteria which come in contact with the disinfectant will be killed. Additionally, when chlorine comes in contact with hydrocarbons and other organic compounds which may be used during the construction and completion of a well, the reaction can be violent.

Determining the Required Amount of Chlorine Compound

(1) Determine the number of feet of water in the well.

(2) Referring to the first two columns of Tables 6 and 7, determine the number of gallons of water per feet of water in the well.

(3) Multiply the number of feet of water in the well by the number of gallons of water per foot to determine the total number of gallons of water in the well.

(4) Determine the amount of chlorine compound required to produce a disinfectant solution with the required chlorine concentration. Tables 6 and 7 provide guidance for producing a disinfectant with a chlorine concentration of 100 mg/l using compounds consisting of 5.25% sodium hypochlorite, 12% sodium hypochlorite, and 65% calcium hypochlorite. Note that the required amounts of chlorine compound indicated in Table 6 (for well diameters of one foot or less) were calculated per 100 feet of water depth while the required amounts of chlorine compound indicated in Table 7 (for well diameters of two feet or more) were calculated per foot of water depth.

For specific water volumes or for compounds consisting of concentrations different than those presented in Tables 6 and 7, the following equations apply:

(1) For Sodium Hypochlorite Compounds (liquid):

$$\text{Volume Sodium Hypochlorite Compound Required (cups)} = \frac{\text{Required Concentration}}{\text{Concentration of Compound}} \times \text{Gallons of Water in Well} \times \frac{16 \text{ cups}}{1 \text{ gallon}}$$

(2) For Calcium Hypochlorite Compounds (tablets or granules)

$$\text{Weight Calcium Hypochlorite Compound Required (ounces)} = \frac{\text{Required Concentration}}{\text{Concentration of Compound}} \times \text{Gallons of Water in Well} \times \frac{133 \text{ weight in ounces}}{1 \text{ gallon of water}}$$

Note that in both equations the Required Concentration and the Concentration of Compound should be in decimal form. For example, a required concentration of 100 mg/l = 0.0001 and a compound with a hypochlorite concentration of 5.25% = 0.0525 .

When using the equations, round off the calculated values to the nearest 1/8 cup for liquid sodium hypochlorite compounds and the nearest 0.1 ounce for dry calcium hypochlorite compounds.

Mixing the Disinfectant Solution

Once the required amount of chlorine compound has been determined, the compound should be mixed with or dissolved into clean water, being sure to add additional chlorine compound to compensate for the mixing water. If, for example, 10 gallons of water are used for mixing the compound, an additional 1/2 cup of 5.25% sodium hypochlorite solution, an additional 1/8 cup of 12% sodium hypochlorite solution, or an additional 0.2 ounces of 65% calcium hypochlorite compound should be added.

The purpose of mixing the chlorine compound with water is to ensure that, when the disinfectant solution is placed in the well, the surfaces of all components above the water level in the well will come in contact with the disinfectant. It is best to mix the chlorine compound in a plastic, ceramic, or wood container because metals are corroded by strong chlorine solutions.

TABLE 6
AMOUNT OF CHLORINE COMPOUND REQUIRED TO PRODUCE A CHLORINE CONCENTRATION OF 100 MG/L (FOR WELL DIAMETERS OF ONE FOOT OR LESS)"

DIAMETER OF WELL CASING IN INCHES	GALLONS OF WATER PER FOOT OF WATER DEPTH	GALLONS OF WATER PER 100 FEET OF WATER DEPTH	SODIUM HYPOCHLORITE REQUIRED PER 100 FEET OF WATER DEPTH (CUPS, LIQUID MEASURE) USING 5.25% SOLUTION	SODIUM HYPOCHLORITE REQUIRED PER 100 FEET OF WATER DEPTH (CUPS, LIQUID MEASURE) USING 12% SOLUTION	CALCIUM HYPOCHLORITE REQUIRED PER 100 FEET OF WATER DEPTH (OUNCES, DRY WEIGHT) USING 65% COMPOUND
1 ½	0.092	9.2	¼	1/8	0.2
2	0.163	16.3	½	1/4	0.3
3	0.367	36.7	1 1/8	1/2	0.8
4	0.653	65.3	2	7/8	1.3
5	1.020	102.0	3 1/8	1 3/8	2.1
6	1.469	146.9	4 ½	2	3.0
8	2.611	261.1	8	3 1/2	5.3
10	4.080	408.0	12 3/8	5 1/2	8.4
12	5.876	587.6	17 7/8	7 7/8	12.0

TABLE 7
AMOUNT OF CHLORINE COMPOUND REQUIRED TO PRODUCE A CHLORINE CONCENTRATION OF 100 MG/L (FOR WELL DIAMETERS OF TWO FEET OR MORE)*

WELL DIAMETER IN FEET	GALLONS OF WATER PER FOOT OF WATER DEPTH	SODIUM HYPOCHLORITE REQUIRED PER FOOT OF WATER DEPTH (CUPS, LIQUID MEASURE) USING 5.25^ SOLUTION	SODIUM HYPOCHLORITE REQUIRED PER FOOT OF WATER DEPTH (CUPS, LIQUID MEASURE) USING *12*\ SOLUTION	CALCIUM HYPOCHLORITE REQUIRED PER FOOT OF WATER DEPTH (OUNCES, DRY WEIGHT) USING 65« COMPOUND
2	23.5	¾	1/4	0.5
3	52.9	1 5/8	3/4	1.1
4	94.0	2 7/8	1 1/4	1.9
5	146.9	4 ½	2	3.0
6	211.5	6 ½	2 7/8	4.3
7	287.9	8 ¾	3 7/8	5.9
8	376.0	111/2	5	7.7
9	475.9	14 1/2	6 3/8	9.8
10	587.6	17 7/8	7 7/8	12.0

THE FOLLOWING INFORMATION APPLIES TO TABLES 6 AND 7:
REQUIRED AMOUNTS WERE CALCULATED USING EQUATIONS 1 AND 2 (REFER TO TEXT) AND:
(1) LIQUID MEASURES WERE ROUNDED OFF TO THE NEAREST ONE-EIGHTH CUP (1/8 CUP s 2 TABLESPOONS)
(2) DRY WEIGHTS WERE ROUNDED OFF TO THE NEAREST ONE-TENTH OUNCE:
(A) SIX 65% CALCIUM HYPOCHLORITE TABLETS = APPROXIMATELY I OUNCE
(B) THREE HEAPING TABLESPOONS OF 65% CALCIUM HYPOCHLORITE =: APPROXIMATELY 1 OUNCE
FOR COMPOUNDS WITH CHLORINE CONCENTRATIONS DIFFERENT FROM THOSE IN THE TABLES, USE EQUATION 1 OR 2 (REFER TO TEXT) TO DETERMINE THE AMOUNT OF COMPOUND REQUIRED.

Placement of the Disinfectant Solution

For drilled or driven wells, pour the disinfectant solution into the top of the well, being sure that the casing walls are wetted completely. In order to thoroughly distribute the disinfectant, the well should be pumped, recirculating the pumped water back into the well for at least 15 minutes. Recirculation should be accomplished by connecting a hose to a faucet on the discharge side of the pressure tank and running it back to the well. If a pump has not been installed and a temporary pump is not available, a bailer or plunger should be used to mix the disinfectant throughout the well.

After the disinfectant has been circulated throughout the well and the pressure tank, all the household faucets should be turned on, letting the water run until the odor of chlorine is detected. Then turn off the faucets and seal the top of the well.

For dug wells, the disinfectant solution should be splashed around the lining or wall of the well, being sure that the solution comes in contact with all parts of the well. The top of the well should then be sealed and the well should be pumped until the odor of chlorine is detected in the discharge.

Retention Time for the Disinfectant Solution

The disinfectant solution should remain undisturbed in the well and, if connected, in the distribution system for a minimum of two hours.

Flushing the System

Pump the well and flush all traces of chlorine from the distribution system, being sure to turn on all the household faucets. If the water supply system ultimately discharges to a septic tank, care should be taken to flush the distribution system slowly, keeping the faucets turned on low. This prevents the septic system from becoming overloaded.

EFFECTIVENESS OF THE DISINFECTION PROCEDURE

After all the chlorine has been flushed from the water supply system, the local Board of Health should require that a water sample be collected, and submitted to a state certified laboratory for a bacteriological analysis that detects the presence of coliform bacteria. If the results of the analysis indicate more than one coliform bacterium per 100 mls of water, the well should not be put into service and the system should be disinfected again using a higher concentration of chlorine or a longer retention time. After disinfection, the water should be sampled again and analyzed to ensure that the standard for coliform bacteria is not exceeded. For new wells, the local Board of Health may choose to require testing for additional parameters (refer to the following section entitled, "Water Quality and Water Testing").

Ineffective disinfection may be related to the chlorine concentration of the disinfectant, the pH or turbidity of the water, or the retention time of the disinfectant solution. For water with a high pH, a higher initial chlorine concentration is required to obtain the same level of disinfection achieved with less chlorine in low-pH water. This is because the hypochlorous ions, which function as the bactericide, are more effectively neutralized as the pH increases. The effectiveness of the disinfectant also decreases as turbidity increases. Retention time of the disinfectant solution in the system is also critical to the effectiveness of the disinfection procedure; the disinfectant must remain long enough to kill the bacteria.