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Maintenance of Irrigation Wells (Chlorination and Acidizing)

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FS 618
(Replaces FS 195 and FS 290)

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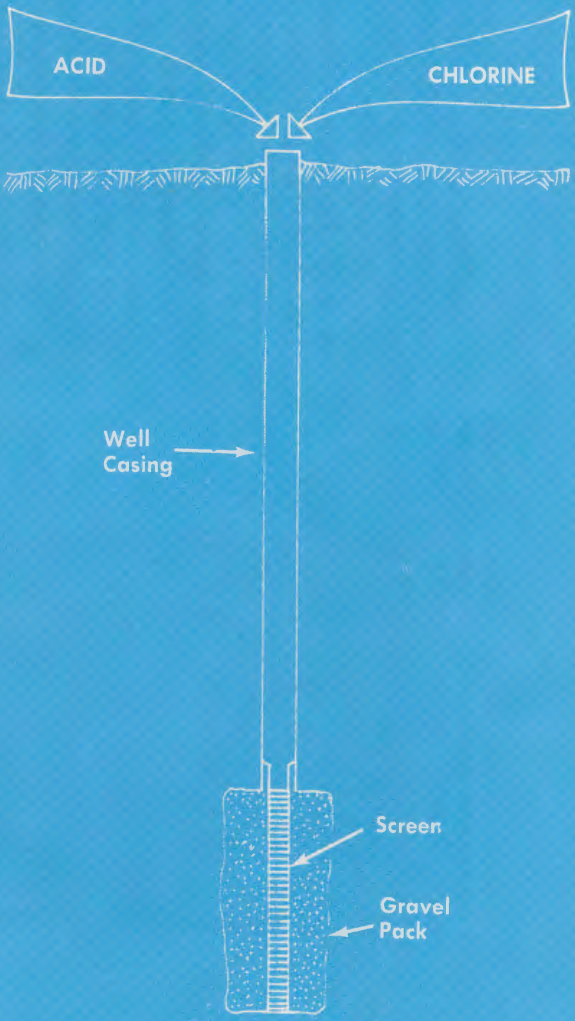

Cooperative Extension Service
South Dakota State University
U. S. Department of Agriculture

Maintenance of Irrigation Wells

(Chlorination and Acidizing)

By
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After an irrigation well has been constructed, certain recommended procedures for operation and maintenance are necessary to retain maximum production. It takes only one water shortage due to well failure to prove that a continuing maintenance program is worth the time and costs involved.

I. WELL RECORDS

The first and most important step is to maintain accurate records. Each year measurements must be made of the static water level (when pump is shut off and water level in the well has stabilized), pumping rate (gallons per minute, gpm), and the water level when the pump is operating. The difference between the pumping level and the static level is the drawdown. A yearly record of drawdown and discharge is needed to detect and diagnose a well problem correctly. The equipment needed for all these tests may be purchased or is available on loan through your county Extension agent. From these measurements calculate the specific capacity of the well (gpm/ft. of drawdown) as shown under Sample Calculations and compare it with the value calculated from the pumping test completed when the well was constructed.

Sample calculations for specific capacity of irrigation wells:

	(New Well) Year No. 1	Year No. 2	Year No. 3
Static Level (feet)	15	12	14
Discharge (gpm)	1000	1000	900
Pumping Level (feet)	65	67	69
Drawdown (feet)	65-15 =50	67-12 = 55	69-14 = 55
Specific Capacity (gpm/ft dd)	$\frac{1000}{50}$ =20	$\frac{1000}{55}$ =18.2	$\frac{900}{55}$ = 16
Comparison to new well	100%	91%	80%

The above indicates that the performance of the well has decreased 20% in two years.

II. WELL PROBLEMS

The two main problems—iron bacteria and mineral incrustation—are different in origin and require different treatments for removal. In either case, however, the result is a partially plugged well screen with a consequence of obtaining less water or a greater pumping head.

Iron Bacteria

Waters containing even small quantities of iron provide a source of energy for the growth and development of iron bacteria. These bacteria accumulate in the form of a slimy organic substance on the well screen, casing, pump, and out into the water bearing formation. As the bacteria condition builds up, it reduces the open slot area of the screen and the open spaces in the formation, thus reducing well yield. If exposed to air, this buildup hardens. Procedures for preventative maintenance for this problem are described in Section IV of this publication, "Chlorination Procedures."

Mineral Incrustation

Mineral incrustation is a buildup primarily of calcium and magnesium carbonates that have precipitated out of the water and have bonded the aquifer materials into a hard mass over the screen openings and out into the water bearing formation. The settling out of these inorganic substances is probably caused by a reduction in the ability of the water to keep them in solution because of a change in pressure within the formation during pumping. Water entering the well screen at a rate greater than 0.1 foot per second can also contribute to rapid incrustation. A properly designed well will have velocities of less than 0.1 foot per second. The rate of buildup of incrustation accelerates with time because some of the slots become plugged, the water must enter the remaining slots at a higher velocity which in turn causes more incrustation and the problem is quickly out of hand. The procedure for removal of incrustation is described in Section V, "Acidizing the Well."

III. ANNUAL MAINTENANCE

The following procedures and practices are recommended for increasing the useful life of the irrigation well and to prevent iron bacteria and mineral incrustation.

1. Keep continuous records of well operation as described in Section I.
2. Never allow the pumping level to drop below the top of the screen because this will accelerate the buildup of incrustation and the hardening of iron bacteria.

3. Chlorinate the well in both the spring and fall. Follow the procedures outlined in Section IV, "Chlorination Procedures."
4. Acidize the well when the specific capacity has declined to 80% of the original value. An examination of Year No. 3 under Sample Calculations, indicates that the specific capacity of the well has declined to 80% of what it was when the well was new (.80 x 20=16 gpm/ft. drawdown) and the well should be acidized. Waiting until the well deteriorates beyond the 80% level may mean several acid treatments will be necessary and the well may never return to its original condition.

IV. CHLORINATION PROCEDURES

Either of the following chlorine materials may be used in a maintenance program for iron bacteria control: (a) high-test dry calcium hypochlorite (H-T-H) approximately 70% available chlorine, which can be obtained through chemical companies, well drillers, and some irrigation sales firms, and (b) common household bleach, usually 5% chlorine, available in supermarkets.

Chlorinate in Spring and Fall

The following chlorination procedure is recommended:

1. Determine the number of feet of water in the well. (This is equal to total well depth minus the static water level.)
2. From Table 1 determine the amount of material required for your casing diameter. Note that the quantities given are for each 10 feet of water in the well.
3. Introduce the chlorine into the well using one of the following methods. (This is dependent upon the form of chlorine used.)
   a. Drop H-T-H *pellets* to the bottom of the well. (This is the easiest form of chlorine to use.)
   b. Dissolve H-T-H *granules* by slowly adding 10 gallons of water and stirring until smooth. Pour the solution to the bottom of the well through a rubber or plastic hose.
   c. Pour *liquid* bleach to the bottom of the well using a rubber or plastic hose. Protective clothing, gloves, and goggles should be used as chlorine solutions can cause skin burns.
4. Allow to stand for 4 hours.
5. Surge the well vigorously for *one hour* (start and stop the pump intermittently, but do not allow water to discharge from the well).
6. Force the chlorine solution into the aquifer by introducing a "head" of water into the top of the well equal to the volume of water standing in the well (See column 2, Table 1).

Table 1. Quantities of chlorine material to use for each 10 feet of water in irrigation well.

Well Diameter (Inches)	H-T-H 70% Chlorine (pounds per 10 feet of water)	Bleach 5% Chlorine (quarts per 10 feet of water)	Gallons of "head" water for each 10 feet of water depth in the well (gallons)
8	.2	1	26
10	.3	2	41
12	.4	3	59
14	.5	4	80
16	.6	4	104
18	.8	5	132

7. Allow to stand for 24 hours.
8. Surge the well for *one hour*.
9. Pump to waste until water is clear and odor of chlorine is gone.

V. ACIDIZING THE WELL

The chemicals suitable for removal of mineral incrustation include sulfamic acid (not sulfuric), a commercially prepared 100% acid in either granular or crystalline form available from chemical companies or through an irrigation well driller. Sulfamic acid must be mixed with water and requires the addition of a cold water detergent as a wetting agent and in some cases the addition of an inhibitor to prevent attack of the acid on the metal casing in the well. Acid should not be used in wells cased or screened with bronze, cast iron, aluminum or galvanized metal without an inhibitor. Fiberglass, plastics, rubber, and wood are resistant to the acid and need no inhibitor. Concrete casing is readily attacked by most acids and cannot be inhibited. Some companies have a commercially prepared compound that contains all the necessary ingredients (acid, detergent, and inhibitor) in a pellet form. This combined pellet form is much simpler to handle but also more costly.

During acid treatments all the safety precautions related to the handling of strong caustic solutions should be followed. Wear protective clothing, gloves, and goggles, and provide good ventilation around the well.

The following procedures should be used for acidizing irrigation wells whose specific capacity has decreased as much as 20-30%.

1. Test the well for discharge and drawdown.
2. Chlorinate the well by following steps 1 through 9 described earlier in Section IV.
3. Determine the amounts of material needed from Table 2. In this case the screen size and length are the determining factors.
4. Introduce the acid into the well by one of the following methods:
   a. A barrel, a sprayer pump, and a hose long enough to reach the bottom of the well are required. Put about 30 gallons of water in the

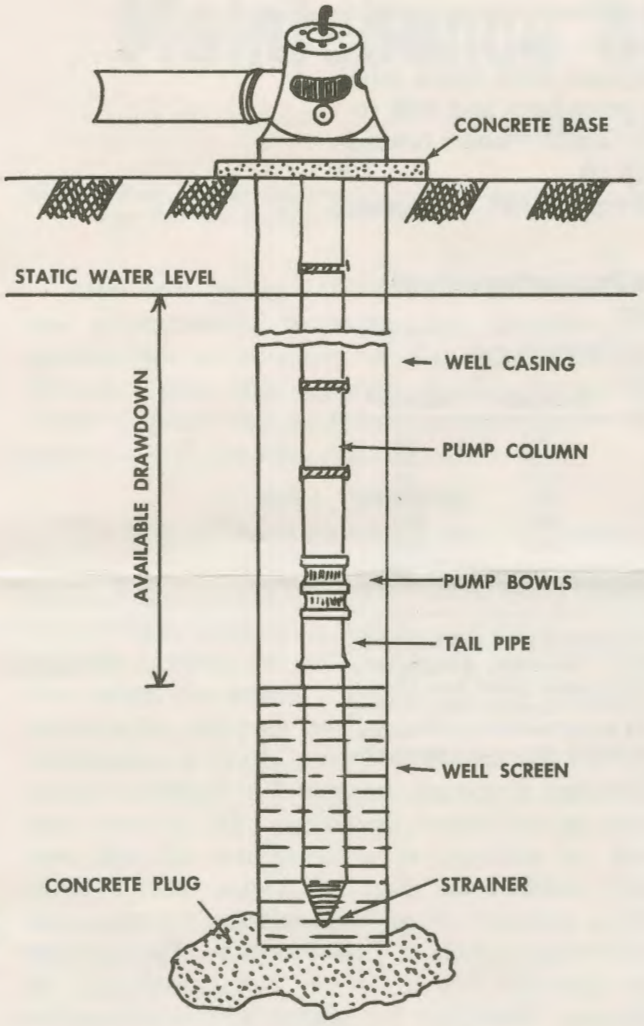

Figure 1. This is a typical well installation. The water level during pumping should never be below the top of the screen. When the water level is below the top of the screen, air enters and may cause incrustation. The low water level also leaves less open area for the water to pass through resulting in increased velocities and decreased pressure which is conducive to incrustation. Available drawdown is the distance from the static water level to the top of the screen.

barrel and while continuously stirring, add the sulfamic acid, detergent and inhibitor (if used) until a weak slurry is formed. Do not make it too thick. Stir continuously while injecting the slurry into the screen area of the well with the sprayer pump and hose. Repeat the process until the required amount of acid is used and then flush the pump with clear water.

b. For acid in the pellet form, pour the required amount of tablets into the top of the well according to the manufacturer's recommendations.

5. Pour the proper amount of common salt or rock salt into the top of the well to ionize the acid and make it more effective. See Table 2 for correct amounts.
6. Allow to stand for 4 to 6 hours.
7. Surge the well for *one hour*.
8. Add an amount of "head" water to the top of the well equal to the total volume of water in the well (See column 2, Table 1) to force the acid into the aquifer.
9. Allow to stand overnight (at least 10 hours).
10. Surge for *one hour*.
11. Pump to waste until the water is clear.
12. Test the well for discharge and drawdown to evaluate the effectiveness of the treatments.
13. Chlorinate a second time as described in Section IV.

Figure 2. These incrustations were caused by precipitation of material carried up to the screen in solution.

Figure 3. This incrustation was caused by iron bacteria in the water. The jelly-like colloidal substance fills the screen openings and formation voids; it turns hard when exposed to air.

Badly deteriorated wells (those with a specific capacity which has dropped by more than 30%) should be treated by an irrigation well driller who has knowledge of acidizing procedures and will redevelop the well *by jetting* for about 4 hours instead of the surge treatment in Step 10.

Continue a chlorination program with treatments twice a year.

Table 2. Quantities of material for irrigation well acid treatment

Screen Diameter (inches)	Pounds of Material for each 10 feet of screen			
	Sulfamic Acid	Cold Water Detergent	Rock Salt	Inhibitor*
8	33	3.3	5.0	3.3
10	51	5.1	7.5	5.1
12	75	7.5	11.0	7.5
14	100	10.0	15.0	10.0
16	130	13.0	19.5	13.0
18	165	16.5	25.0	16.5

*To be used on bronze, cast iron, aluminum, or galvanized screens.

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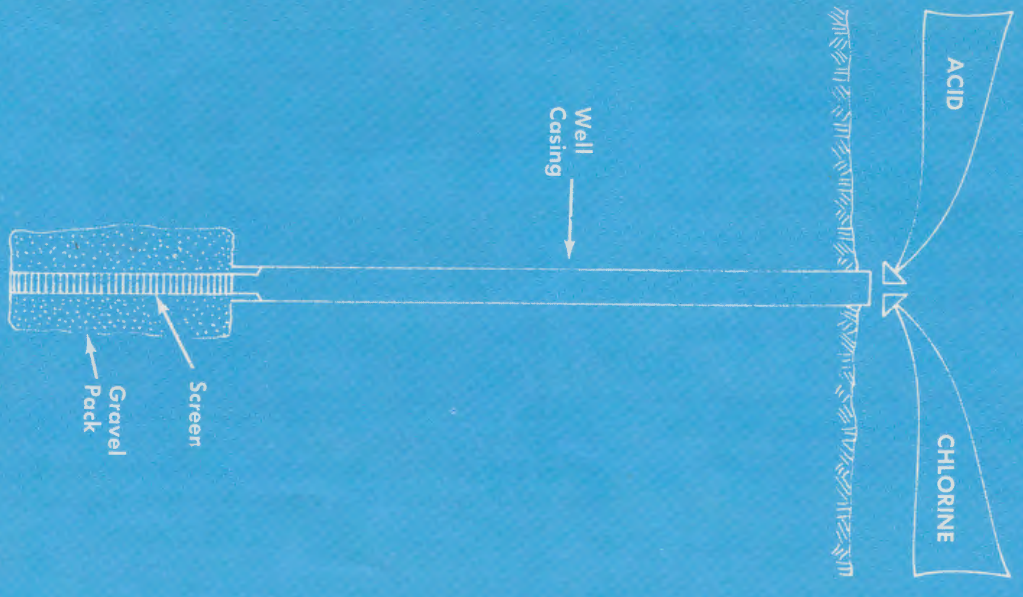

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