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Maintaining Subsurface Drip Irrigation Systems

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Subsurface drip irrigation systems deliver low flow rates of water very uniformly. A properly designed and maintained system should last more than 20 years. A maintenance program includes cleaning the filters, flushing the lines, adding chlorine, and injecting acids. If these preventive measures are done, the need for major repairs, such as replacing damaged parts, often can be avoided, and the life of the system extended.

The purpose of preventive maintenance is to keep the emitters from plugging. Emitters can be plugged by suspended solids, magnesium and calcium precipitation, manganese-iron oxides and sulfides, algae, bacteria, and plant roots.

Make sure your system contains a flow meter and a couple of pressure gauges—one gauge before the filters and another after the filters. Give these devices a quick inspection every day. They indicate whether the system is working properly. A low pressure reading on a pressure gauge means that a part is leaking or a pipe is broken. A difference in pressure between the filters may mean the system is not being backflushed properly and that the filters need to be cleaned.

Know the properties of the water so that you can anticipate problems. The following table shows the potential of some water characteristics to cause plugging.

Plugging potential of irrigation water

Chemical property	Low	Moderate	Severe
PH	< 7.0	7.0 - 8.0	>8.0
Bicarbonate (ppm)		<100.0	
Iron (ppm)	<0.2	0.2 -1.5	>1.5
Sulfides (ppm)	<0.2	0.2 - 2.0	>2.0

Maintaining filters

The filter is important to the system's success. Water must be filtered to remove suspended solids. There are three main types of filters: cyclonic filters (centrifugal separators); screen and disk filters; and media filters. It is common practice to install a combination of filters to work more effectively.

Centrifugal separators

These filters need little maintenance, but they require regular flushing. The amount of sediment in the incoming water, the amount of water used, and the capacity of the collection chamber at the bottom will determine how often and how long the flushing valve needs to operate. The sediment can be released manually or automatically. If it is done manually, the bottom valve of the filter should be opened and closed at regular intervals. An electronic valve controlled by a timer can automatically open the filter. The automatic operation of the valve should be checked at least every other day during the season.

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Screen and disk filters

The small screen filters use a nylon strainer or bag, which should be removed and checked periodically for small holes. The flush valve controls the flushing of the screen filter. This can be operated by hand or automatically. Flush the screen filter when the pressure between the two pressure gauges drops 5 psi (one is located before the filters and the other after them). Automatic filters use a device called a "pressure differential switch" to detect a pressure drop across the filters. Other systems use a timer, which is usually set by the operator. The flushing can be timed according to the irrigation time and the quality of the water. The interval between flushing can be adjusted to account for differences in pressures across the filters. Automated flushing devices should be checked at least every other day on large systems.

Sand media filters

With these filters the most important task is to adjust the restricter backflush valve. If the backflow rate is too high the sand will wash completely out of the filter. If it is too low contaminating particles will never be washed out of the filter. The operator should set the best backflush rate. Bacterial growth and the chemistry of the water can cause the sand media to cement. Cementing of the media causes channels to form in the sand, which can allow contaminated water to pass into the irrigation system. The best way to correct the problem is by chlorinating.

Flushing lines and manifolds

Very fine particles pass through the filters and can clog the emitters. As long as the water velocity is high and the water is turbulent, these particles remain suspended. If the water velocity slows or the water becomes less turbulent, these particles may settle out. This commonly occurs at the distant ends of the lateral lines. If they are not flushed, the emitters will plug and the line eventually will be filled with sediment from the downstream end to the upstream end. Systems must be designed so that mainlines, sub-mains, manifolds and laterals can all be flushed. Mainlines, sub-mains and manifolds are flushed with a valve installed at the very end of each. Lateral lines can be flushed manually or automatically. It is important to flush the lines at least every 2 weeks during the growing season.

Injecting chlorine

At a low concentration (1 to 5 ppm), chlorine kills bacteria and oxidizes iron. At a high concentration (100 to 1000 ppm), it oxidizes organic matter and disintegrates it.

Bacteria produced by iron and manganese

The most serious problems with bacteria occur in waters that contain ferrous or soluble iron, manganese or sulfide. Iron concentrations higher than 0.1 ppm and manganese concentrations higher than 0.15 ppm can promote bacterial growth that clogs emitters. The iron bacterial growth looks reddish, whereas the manganese growth looks black. These bacteria oxidize iron and manganese from the irrigation water. In the western part of Texas this bacteria is associated with well water. Farmers there combat the problem by injecting chlorine, backwashing filters often, and sometimes by scooping out the top sand layers in filters.

It is hard to eliminate this bacteria, but it can be controlled by injecting chlorine into the well once or twice during the season. It might also be necessary to inject chlorine and acid before the filters. When the water contains a lot of iron, some of the iron will feed the bacteria and some will be oxidized by chlorine to form rust (or insoluble iron, ferric oxide). The precipitated ferric oxide is filtered out during the backflush. If the iron concentration is high and problems persist, you might need to aerate the irrigation water to oxidize the iron and let the sediment settle down. Aerate the water by pumping it to a reservoir and then re-pumping with a booster pump to the irrigation system.

Problems with iron and manganese sulfides can be solved with a combination of chlorinization, acidification and aeration. Sulfides can form a black, insoluble precipitant.

Use a swimming pool kit to test the free or residual chlorine in the water at the end of the lateral line. Remember that some of the chlorine you inject may be tied up in chemical reactions or absorbed by the organic matter in the water. If injection is continuous, a level of 1 ppm of free residual chlorine at the ends of the laterals will be enough to kill almost all bacteria. If injection is intermittent, the concentration should be 10 to 20 ppm for 30 to 60 minutes. You can wait several days between treatments.

If emitters are already partially plugged by organic matter, you may need a "superchlorination" treatment. In this case, inject 200 to 500 ppm chlorine and leave it in the system for 24 hours.

Some extra chlorine should be injected to account for the tied up chlorine.

Injection rate for chlorine

Calculate the injection rate with these formulas:

English

$$IR = \frac{0.006 \times F \times C}{P}$$

OR

Metric

$$IR = \frac{0.036 \times F \times C}{P}$$

Where:

IR = Injection rate, gallons

F = Flow rate of the system (GPH)

C =Concentration of chlorine wanted, ppm

P = Percentage of chlorine in the solution*

Where:

IR = Injection rate, liters

F = Flow rate of the system (LPS)

C = Concentration of chlorine wanted, ppm

*The percentage of chlorine for different compounds is as follows:

calcium hypochlorite—65%
sodium hypochlorite (household bleach)—5.25%
lithium hypochlorite—36%

Example:

A farmer wants to inject chlorine into his system. He wants to start with a level of 5 ppm in a system with a flow rate of 100 GPM. He is injecting household bleach that has a concentration of 5.25%.

$$IR = \frac{0.006 \times F \times C}{P} = \frac{0.006 \times 100 \times 5}{5.25} = 0.571 \text{ GPM of chlorine}$$

Tables for calculating the injection rate in gallons per hour of chlorine are shown below.

Gallons of chlorine (5.25%) per hour

Parts per million	Gallons per minute (GPM)								
	100	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**
1	0.114	0.171	0.229	0.286	0.343	0.400	0.457	0.514	0.571
2	0.229	0.343	0.457	0.571	0.686	0.800	0.914	1.029	1.143
5	0.571	0.857	1.143	1.429	1.714	2.000	2.286	2.571	2.857
10	1.143	1.714	2.286	2.857	3.429	4.000	4.571	5.143	5.714
15	1.714	2.571	3.429	4.288	5.143	6.000	6.857	7.714	8.571
20	2.286	3.429	4.571	5.714	6.857	8.000	9.143	10.286	11.429
25	2.857	4.286	5.714	7.143	8.571	10.000	11.429	12.857	14.286
30	3.429	5.143	6.867	8.571	10.286	12.000	13.714	15.429	17.143
50	5.714	8.571	11.429	14.286	17.143	20.000	22.857	25.714	28.571

Gallons of chlorine (10%) per hour

Parts per million	Gallons per minute (GPM)								
	100	**150**	**200**	**250**	**300**	**350**	**400**	**450**	**500**
1	0.060	0.090	0.120	0.150	0.180	0.210	0.240	0.270	0.300
2	0.120	0.180	0.240	0.300	0.360	0.420	0.480	0.540	0.600
5	0.300	0.450	0.600	0.750	0.900	1.050	1.200	1.350	1.500
10	0.600	0.900	1.200	1.500	1.800	2.100	2.400	2.700	3.000
15	0.900	1.350	1.800	2.250	2.700	3.150	3.600	4.050	4.500
20	1.200	1.800	2.400	3.000	3.600	4.200	4.800	5.400	6.000
25	1.500	2.250	3.000	3.750	4.500	5.250	6.000	6.750	7.500
30	1.800	2.700	3.600	4.500	5.400	6.300	7.200	8.100	9.000
50	3.000	4.500	6.000	7.500	9.000	10.500	12.000	13.500	15.000

Injecting Acid

Acids are injected into irrigation water to treat plugging caused by calcium carbonate (lime) and magnesium precipitation. Water with a pH of 7.5 or higher and a bicarbonate level of more than 100 ppm is likely to have problems with lime precipitation, depending on the hardness of the water. The amount of calcium and magnesium determines the hardness of the water. The hardness of water is classified as follows: soft (0 to 60 ppm of Ca and Mg); moderate (61 to120); hard (121 to180); very hard (more than 180 ppm). Moderate, hard and very hard water needs acid injection.

Sulfuric, phosphoric, urea-sulfuric, or citric acid can be used. The type most commonly used in drip irrigation is 98% sulfuric acid. Citric acid, or vinegar, can be used in organic farming, although it is much more expensive. If the irrigation water has more than 50 ppm of Ca, phosphoric acid should not be injected, unless the injection rates are high to lower the pH below 4.

Acid is usually injected after the filter so that it doesn't corrode the filter. If the filter is made of polyethylene, which resists corrosion, acid can be injected before the filter (as shown in Figure 1).

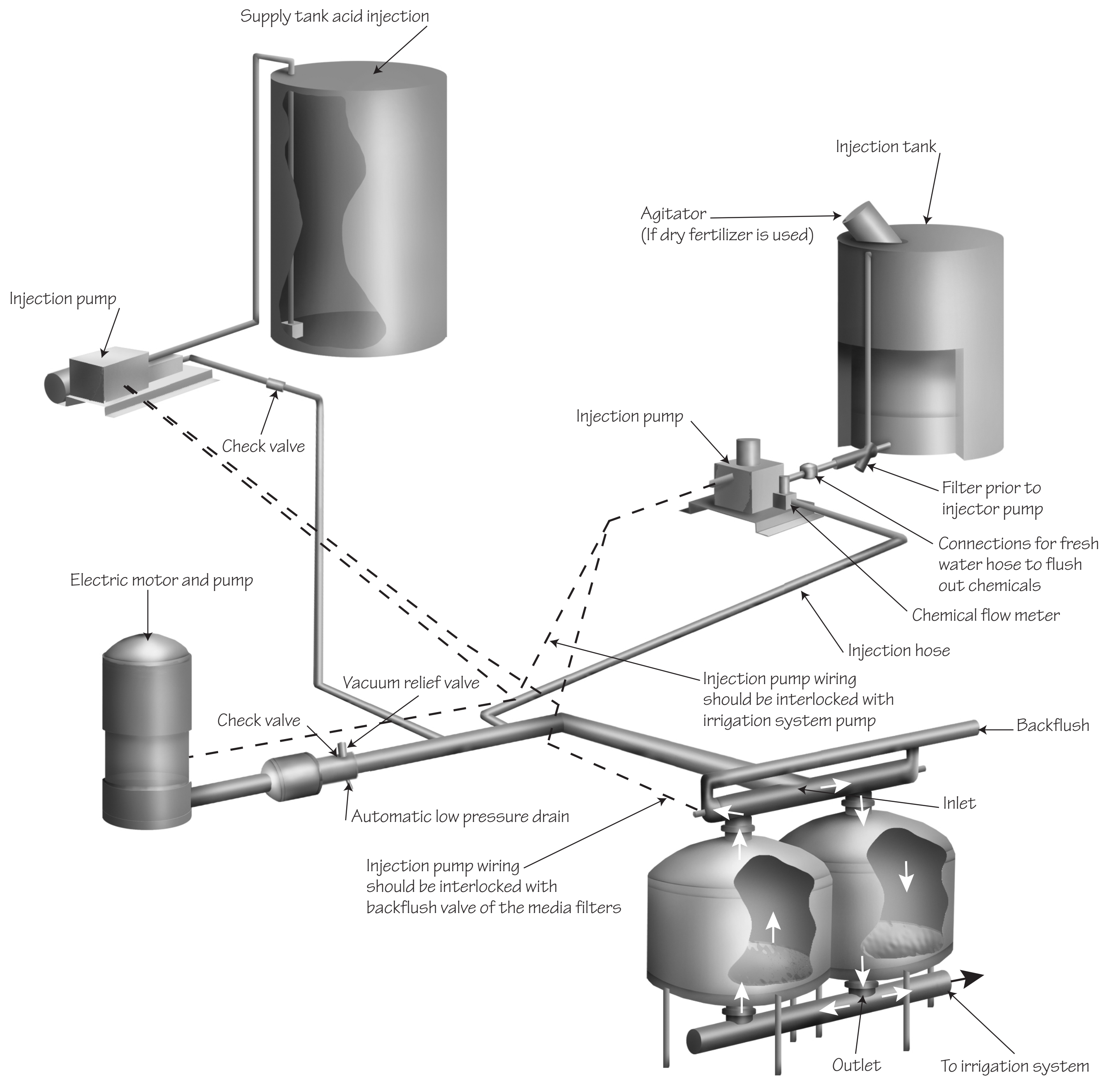

Figure 1. Safety devices and layout of the chemigation station.

The amount of acid to use depends on the characteristics of the acid you are using and the chemical characteristics of the irrigation water. A titration curve developed by a laboratory will show the amount of acid needed to reduce the pH to a certain level. If a titration curve is not available, use a trial-and-error approach until the pH is reduced to 6.5. Colormetric kits or portable pH meters can be used to determine the water pH at the ends of the hoses. Many farmers inject 1 to 5 gallons of sulfuric acid per hour, depending on the water pH, water quality, and well capacity.

Sulfuric acid is an extremely hazardous chemical. It is very corrosive and must be handled with proper equipment and clothes. Store sulfuric acid in polyethylene or stainless steel tanks with extra heavy walls. Always add acid to water, not water to acid. Never mix acid and chlorine or store them together in the same room; a toxic gas will form.

Besides clearing clogged emitters, acid injected into irrigation water improves the infiltration characteristics of some soils and releases micro-nutrients by lowering the soil pH. To reduce the cost, acid can be injected only during the last third of the irrigation time.

Other necessary maintenance

Keep out plant roots

It is important to keep plant roots from penetrating the tape. Once they do, the tape will have to be replaced. Vapam® and Treflan® are two products that control roots. In cotton, Vapam® is generally used at defoliation to keep roots out as the soil dries, while Treflan® is used before picking. Superchlorination also will keep roots out at a dosage of 400 ppm chlorine. Fill the tapes with chlorine and leave it overnight.

Prevent back-siphoning

Back-siphoning is the backflow of water into the tape. It can occur if a vacuum relief valve is not installed for each valve. Back-siphoning may cause worms and debris to enter the tape.

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