Getting the Most from Your Irrigation System
Maintenance of Microirrigation Systems

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Powerpoint at: http://ucanr.edu/schwankl

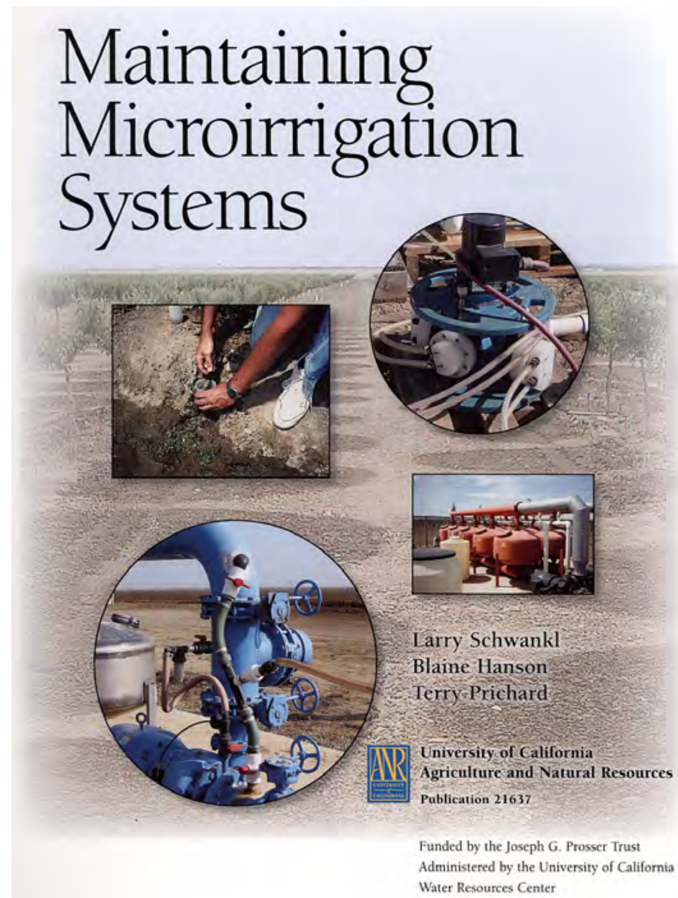
Maintenance of Microirrigation Systems

- Powerpoint presentation on Microirrigation Maintenance.

- Web site on Maintenance of Microirrigation
  http://micromaintain.ucanr.edu

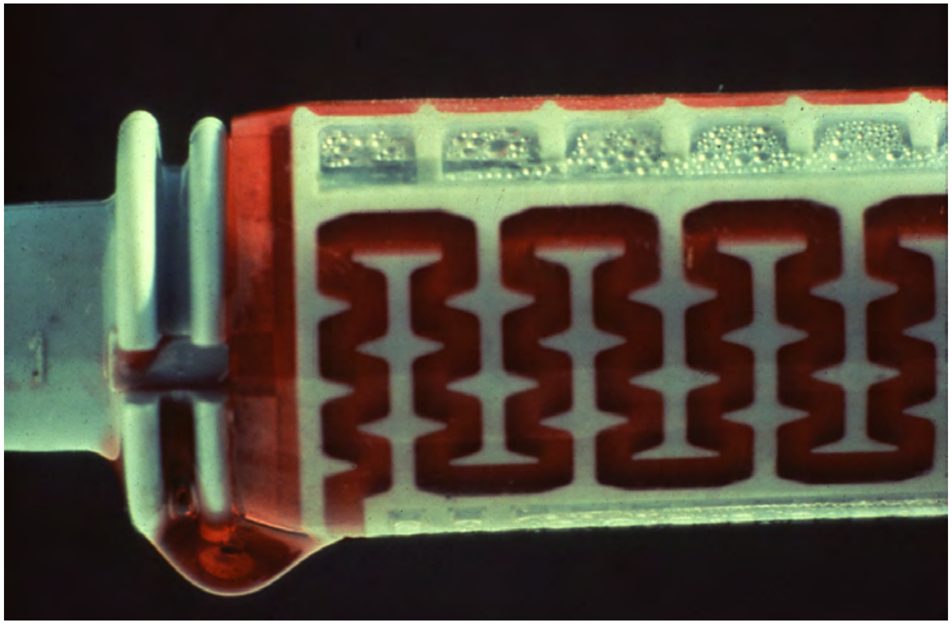
Maintenance of Microirrigation Systems

- **Powerpoint presentation on Microirrigation Maintenance.**



Emitters:

- Small passageways make clogging a major problem.



Clogging of Microirrigation Systems

- **Sources: Physical Clogging – Particulates**
  Chemical Precipitates
  Biological Clogging

Clogging of Microirrigation Systems

- Sources: Physical Clogging – Particulates

- Solution: Filtration

Filters:

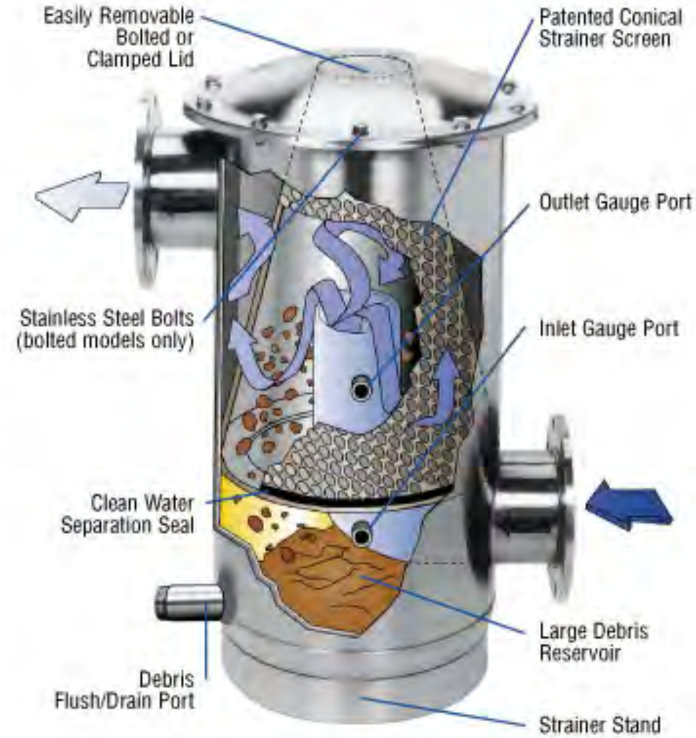
- Screen, disk, and sand media filters are all available.

- They can all filter to the same degree

  BUT

  they req. different frequency of cleaning.

Screen Filters



Mesh size recommended by emitter manufacturer

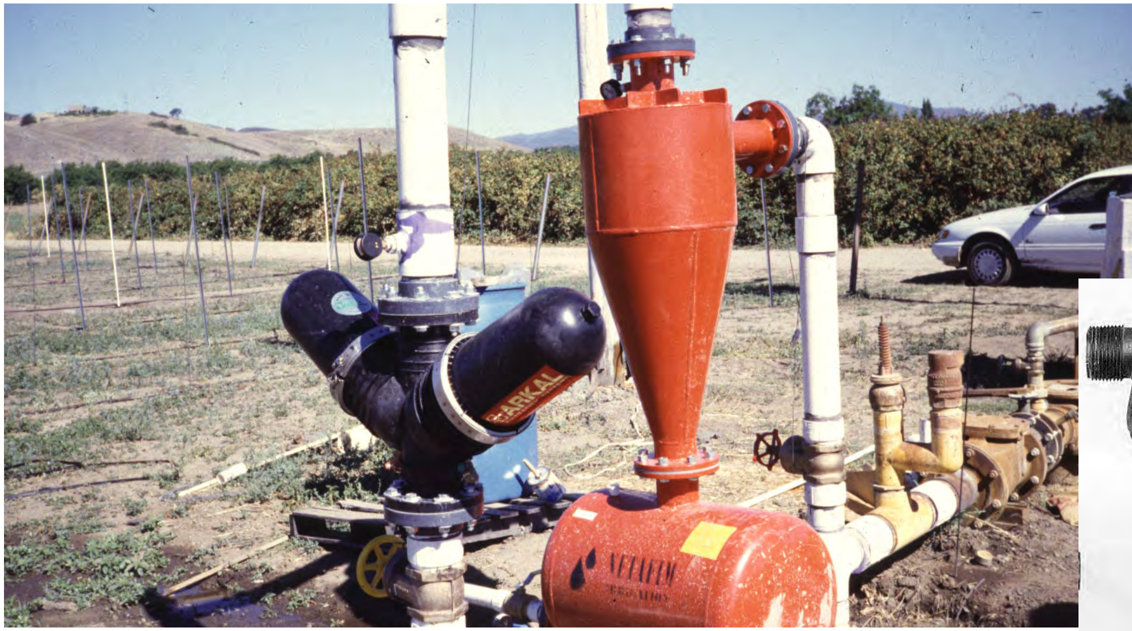
Screen Filters

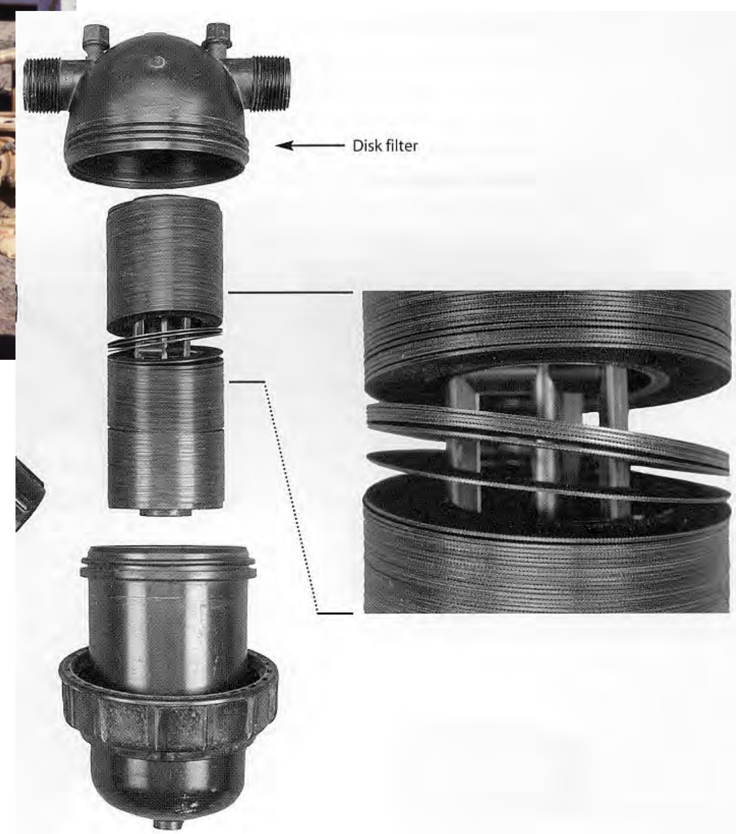
Screen Filters

- The degree of filtration is measured by mesh size.

Soil Particle	Particle Diam (mm)	Mesh Size	Mesh Opening Size (mm)
Very coarse sand	1 - 2		
Coarse sand	0.5 - 1	20	0.711
Medium sand	0.25 - 0.5	40	0.420
Fine sand	0.1 - 0.25	100	0.152
Very fine sand	0.05 - 0.10	200	0.074
Silt	0.002 - 0.05	320	0.044
Clay	< 0.002		

Disk Filters





Also rated by mesh size

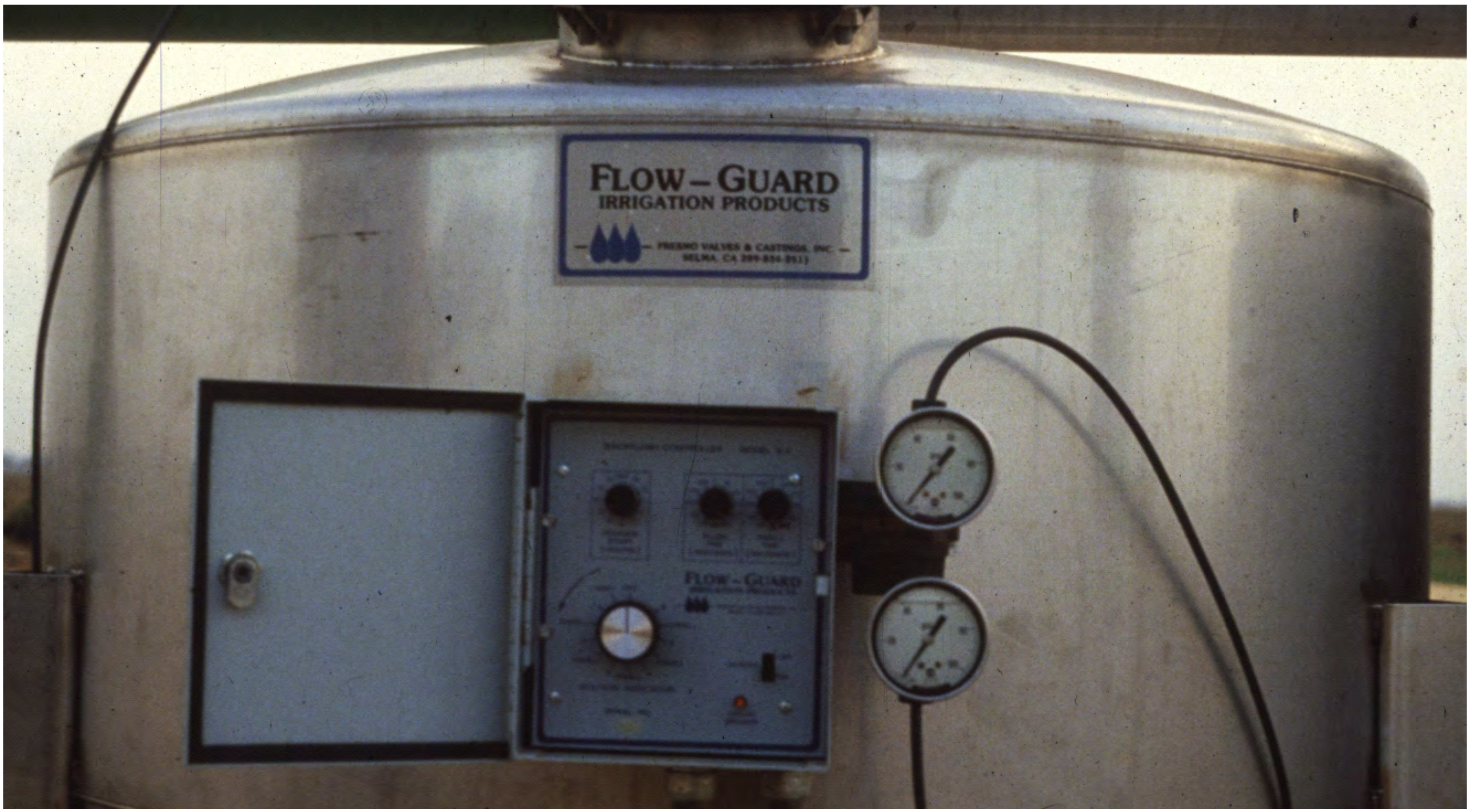
Sand Media Filters

Sand Media Filters

Media Designation Number	Material	Mean Effective Sand Size		Filtration Quality
		(mm)	(in.)	(mesh)
8	crushed granite	1.50	0.059	100-140
11	crushed granite	0.78	0.031	140-200
16	crushed silica	0.66	0.026	140-200
20	crushed silica	0.46	0.018	200-230
30	crushed silica	0.34	0.013	230-400

Sand Media Filters

Backwash Systems



Chemical Precipitate Clogging

- Lime (calcium carbonate) and iron are the most common problems.

Calcium Carbonate (Lime)

Iron Problems

Chemical Precipitate Clogging

Water quality levels of concern:

- **Calcium: pH > 7.5 and 2.0 meq/l (120 ppm) of bicarbonate**

- **Iron: pH > 4.0 and 0.5 ppm iron**
  - **Special water sample reqd.**

Chemical Precipitation - Solutions

Source: Lime

Solution: pH Control (Acidification)

+

filtration

Iron Precipitation - Solutions

- Precipitate iron in a pond / reservoir.

Iron Precipitation - Solutions

1. Precipitate iron in a pond / reservoir.

2. Chemicals (e.g. phosphonic acid, phosphonate) may keep iron in solution.
   - Maintenance, not clean-up products.

Biological Clogging Problems

Biological Clogging - Solutions

Solution: Filtration (usually media filters)

+

Biocide

Most common biocides are chlorine and copper.

Biological Clogging - Solutions

Solution: Filtration (usually media filters)

+

Biocide

Most common biocides are chlorine and copper.

Acid may deter biological growth but not eliminate it.

Chlorine - Sources

- Liquid – Sodium Hypochlorite
- Solid – Calcium Hypochlorite
- Gas Chlorine

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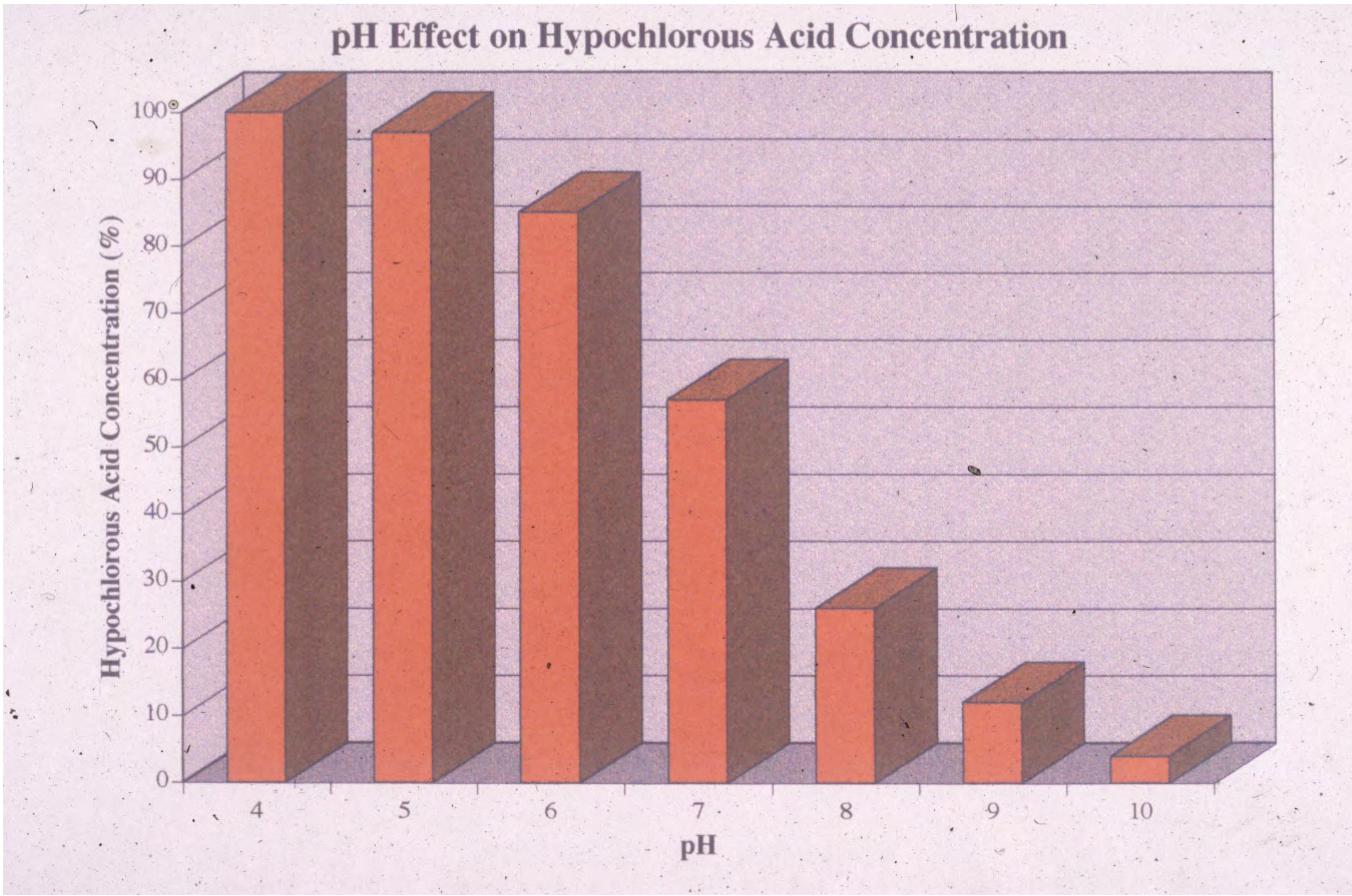
- Liquid – Sodium Hypochlorite
- Solid – Calcium Hypochlorite
- Gas Chlorine

- When add chlorine to water:
  - Forms hypochlorous acid + hypochlorite.
  - Hypochlorous acid is the more powerful biocide.
  - If pH is lower (acidic), more hypochlorous acid is present – better biocide.

Chlorine as a Biocide



Chlorine – Recommended Rates

	Free Chlorine
Continual Injection	1-2 ppm
Periodic Injection	10-20 ppm

Contact time is important – inject for at least a few hours. Longer is better.

Test for chlorine using a pool / spa test kit

Chlorine – Injection Rates

- **Sodium hypochlorite (liquid)**
  - **Example: Household bleach with 5.25% active chlorine.**

$$\text{Chlorine injection Rate (gal/hr)} = \text{System flow Rate (gpm)} \times \text{Desired Cl Conc. (ppm)} \times 0.006 \div \text{Strength of Cl solution (\%)}$$

- **Calcium hypochlorite (solid)**
  - **65-70% available chlorine.**
  - **12.8 lbs. of calcium hypochlorite added to 100 gallons of water forms a 1% solution.**
  - **Then use above formula for injection rate.**

Flushing of Microirrigation Systems

- Silts and clay particles pass through even the best filters.

Soil Particle	Particle Diam (mm)	Mesh Size	Mesh Opening Size (mm)
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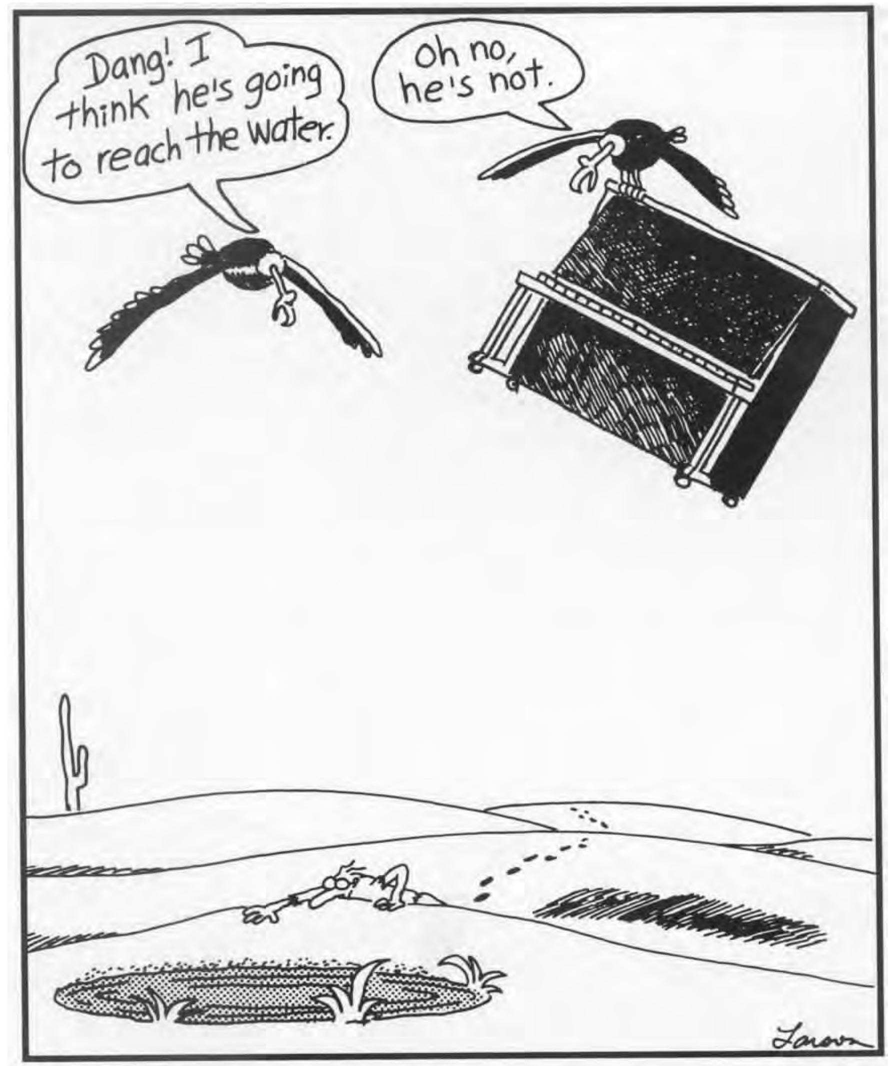
Flushing of Microirrigation Systems

Flushing of Microirrigation Systems

- Silts and clay particles pass through even the best filters.
- Need to flush the system - mainlines, submains, and laterals (in that order).
  - Flush laterals by hand or use automatic flushing end caps.

Maintenance of Microirrigation Systems

Questions:



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Solutions to existing clogging problems (III)

System evaluation for emission device clogging (IV)

Routine maintenance tasks (V)

Website Authors

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Maintenance of Microirrigation Systems

Predicting Clogging Problems

"What should I watch for?"

Solutions to Existing Clogging Problems

"I Have a Clogging Problem and I Want to Solve It"

System evaluation for emission device clogging

"How do I determine if I have a clogging problem?"

Routine Maintenance Tasks

"What should I do to keep my microirrigation system running well?"

Microirrigation systems include microsprinklers for tree crops, drip emitters for trees, vines, and some row crops, and drip tape for row and field crops. Microirrigation systems apply water to the soil through emitters that are installed along drip lines and contain very small flow passages. Microirrigation systems can apply water and fertilizers more uniformly than other irrigation methods. This uniformity results in potentially higher yields, higher revenue, and reduced irrigation operating costs.

Uniformity, a performance characteristic of irrigation systems, is a measure of the evenness of the applied water throughout the irrigation system. Distribution uniformity (DU), sometimes called emission uniformity (EU), is an index that describes how evenly or uniformly water is applied throughout the field. A uniformity of 100% means the same amount of water was applied everywhere. Unfortunately, all irrigation systems apply water at a uniformity of less than 100%, and thus some parts of a field receive more water than others. Field evaluations have shown that microirrigation systems have the potential for higher uniformity than other irrigation methods. However, clogging reduces the uniformity of applied water in microirrigation systems, thus increasing the relative differences in applied water throughout a field.

The small flow passages in the emitters and microsprinklers make microirrigation systems highly susceptible to clogging. Clogging reduces the uniformity of the applied water and decreases the amount of applied water. Clogging also decreases the amount of salt leaching around the lateral line in saline soils.

The objective of this web site is to provide information to irrigators about the causes of clogging and the methods for preventing or correcting clogging problems in microirrigation systems. Among the topics covered are the sources of clogging, chlorination, preventing chemical precipitation, filtration, flushing, and monitoring microirrigation systems.

This web site is divided into sections to allow the users to more quickly access the information they want. For example, if you already know you have a clogging problem and you want to solve it, go to the section **Solutions to Existing Clogging Problems - "I have a problem and I want to solve it".**

Agriculture and Natural Resources, University of California

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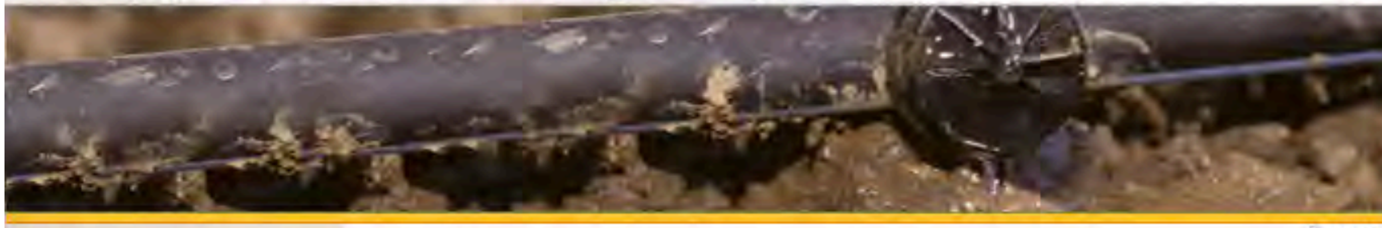
- Scenario 1: Determining the appropriateness of water, let’s say it is groundwater, for microirrigation.
  - Do you need to worry about clogging?



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Predicting clogging problems

"What should I watch for?"

Water Source

A water quality analysis can often predict the emitter clogging hazard. This can be especially useful if a microirrigation system is new or even in the planning stages. If there is an indication that emitter clogging is likely, system design changes or maintenance procedures can be implemented to mitigate the problem.

Sand media filters for an almond orchard Photo: Jack Kelly Clark

Follow the links below depending on whether your microirrigation systems' water is from surface water or from groundwater.

Surface water sources are: (1) waters from a creek, river, pond, or reservoir, or (2) waters that have been stored in a pond. Even if the water was originally from a well (e.g. groundwater pumped into a reservoir for storage), if it has been stored in a pond or reservoir you should categorize it as a surface water source.

Open ditch canal - a surface water source Photo: L. Schwankl

Groundwater sources are those that are pumped from a well and delivered directly to the microirrigation system by pipeline.

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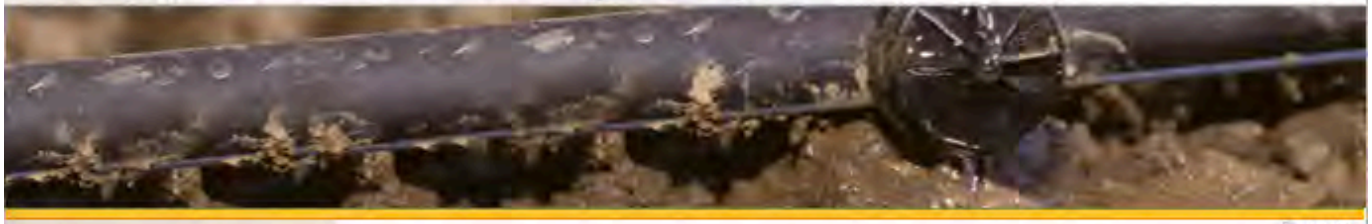
Groundwater

Groundwater sources present possible clogging hazards for microirrigation systems. Some of these are also common to surface water sources (particulate matter and biological contaminants), but in addition to these groundwater may present chemical precipitate hazards that are seldom encountered with water from surface water sources.

Groundwater well with sand separator Photo: L. Schwankl

- **Particulate matter** such as sand, silt, and clay particles are frequently present in groundwater. Many agricultural wells are prone to pumping sand, especially at start-up when the flow rate is particularly high during the initial filling of the irrigation system.
- **Biological clogging problems** are much less common when you use groundwater than when you use surface water sources. It can occur, though, especially where dissolved iron or manganese is present in the water. In that case, iron or manganese bacteria can be present in the well and in the irrigation system. Other biological contaminants that can cause clogging can also grow inside the microirrigation system.
- **Chemical precipitates** that can result in the clogging of emitters can pose a much greater potential hazard when you use groundwater as compared to using surface water sources. Water constituents such as calcium, magnesium and iron are in solution in the groundwater but can precipitate, becoming potentially clogging particles, when pumped from the ground and exposed to air.

For more information on **Assessing Water Quality and Taking a Water Sample, click here**.



Assessing Water Quality and Taking a Water Sample

The irrigation water used in microirrigation systems should be carefully evaluated to assess any potential clogging problems.

Collecting a Water Sample

Contact the laboratory that will be doing the water analysis to get guidance on collecting the sample. Often the laboratory will also provide sample bottles and any necessary additions, such as acid, for the sample.

As general guidance, when collecting a sample from a well, first allow the pump to run for at least 15 minutes (even longer is preferable). A liter or quart sample volume is usually ample for chemical constituent analyses. Make sure the sample bottle is clean and rinsed. Flush the bottle with the water to be sampled a few times prior to gathering the sample. Collect the sample as close to the well as possible but do not collect samples too close to a chemical injection point since there may be insufficient mixing. Thoroughly flush all pipes and components prior to sampling.

Surface water is more difficult to sample, and its test results can change significantly over the season. Try to take as representative a sample as possible. If suspended solids, organic matter, or both, are of concern, a liter-sized sample may not be adequate. Contact the laboratory doing the analysis for more guidance.

Deliver the sample to the lab as soon as you can. Storing the sample in a cooler or a refrigerator until it can be delivered is a good idea; keeping it in a hot pickup truck for days before taking it to the lab should be avoided since volatile and biological contaminants in a sample can change with time and high temperature may speed the process.

If the water is to be analyzed for iron, the sample must be acidified to a pH of 4 or below; otherwise, the soluble (ferrous) iron in solution will precipitate as insoluble (ferric) iron before it reaches the lab and the water analysis will show little iron in solution. Thus, two samples must be collected: one acidified sample for iron and one plain sample for the remaining constituents in solution. The laboratory can provide a sample bottle with the correct amount of acid in it for gathering the iron sample. Do not rinse the bottle prior to collecting the sample.

Water Quality Criteria

Table 1 provides criteria for assessing the potential of an irrigation to cause clogging. Other quality considerations include the following.

- Bicarbonate concentrations exceeding about 2 meq/l or 120 mg/l and pH exceeding about 7.5 can cause calcium carbonate precipitation.
- Calcium concentrations exceeding 2 to 3 meq/l can cause precipitates to form during injection of some phosphate fertilizers.
- High concentrations of sulfide ions can cause iron and manganese precipitation. Iron and manganese sulfides are highly insoluble, even in acid solutions.
- Clogging problems from iron and manganese are caused by the conversion of soluble iron and

Units of Concentration

The concentrations of chemicals in water are expressed on either a weight basis or a volume basis. Concentrations expressed on a weight basis are parts per million (ppm), percent concentration (%C), and milligrams per kilogram (mg/kg). Concentrations expressed on a volume basis are milligrams per liter (mg/l), milliequivalents per liter (meq/l), and millimoles of charge per liter (mmolc/l). Millimoles of charge per liter (mmolc/l) is the designated SI unit (International Standard of Units). Relationships between units are as follows:

1 ppm = 1 mg/l (for all practical purposes in dealing with dilute water solutions)

1 ppm = 1 mg/kg

1% concentration = 10,000 ppm

1% concentration = 1.33 ounce by weight per gallon of water

1 mmolc/l = 1 meq/l

Also keep in mind that 1 ppm means 1 pound of dry chemical material is dissolved in 1 million pounds of water, whereas the concentration percentage is the ratio of the weight of the dry material in the solution to the weight of the solution multiplied by 100. Grains per gallon may also be used as a concentration unit. To convert grains per gallon to mg/l, multiply the grains per gallon by 17.12.

Many laboratories report concentrations of chemical constituents in a water sample as mg/l or meq/l. Sometimes converting mg/l to meq/l or vice versa is desirable. Table 2 provides useful conversion factors.

Table 2. Conversion factors

Constituent	Convert ppm to meq/l	Convert meq/l to ppm
	Multiply by	
Na^{+} (sodium)	0.043	23
Ca^{++} (calcium)	0.050	20
Mg^{++} (magnesium)	0.083	12
Cl^{-} (chloride)	0.029	35
$SO_4^{=}$ (sulfate)	0.021	48
$CO_3^{=}$ (carbonate)	0.033	30
HCO_3^{-} (bicarbonate)	0.016	61

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- Clogging problems from iron and manganese are caused by the conversion of soluble iron and manganese to insoluble forms (for more information, see the section Preventing iron and manganese clogging). This conversion process occurs for iron if the pH exceeds about 5 and for manganese if the pH exceeds about 9.

Table 1. Relative microirrigation system clogging potential of irrigation water

Water characteristics	Minor	Moderate	Severe
suspended solids (ppm)	< 50	50–100	> 100
pH	< 7.0	7.0–8.0	> 8.0
total dissolved solids (ppm)	< 500	500–2,000	> 2,000
electrical conductivity (dS/m)	< 0.8	0.8-3	> 3
manganese (ppm)	< 0.1	0.1–1.5	> 1.5
iron (ppm)	< 0.2	0.2–1.5	> 1.5
hydrogen sulfide (ppm)	< 0.2	0.2–2.0	> 2.0
bacterial population (number per ml)	< 10,000	10,000–50,000	> 50,000

Source: Bucks and Gilbert 1979; Nakayama and Bucks 1991.

Microirrigation Maintenance Website

Scenario 2: Choosing a filter

- What types of filters are available and **how can you choose the best filter for your situation**?

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Filtration - Maintenance of Microirrigation Systems
Screen **filter** Photo: L Schwankl. The degree of filtration is expressed as mesh size or equivalent mesh size. The mesh size is the number of openings per inch.

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How to Choose a Filter

How to Choose a Filter

Filtration Guidelines

Many options are available for filtration. Guidelines developed by the industry are shown in table 6.

References

Bruce, D. A. 1985. Filtration analysis and application. In Drip/trickle irrigation in action. Proceedings of the Third International Drip/Trickle Irrigation Congress, Fresno, CA. Vol. 1.

Table 6. Filtration guidelines

Flow rate (gpm)	Concentration		Filtration*
	Organic	Inorganic	
< 50 gpm	L	L	A
	L	M	A+C
	L	H	A+C
	M	L	D or A
	M	M	C+D or C+A
	M	H	C+D or C+A
	H	L	D or A
	H	M	C+D or C+A
	H	H	C+D or C+A
50 to 200 gpm	L	L	A
	L	M	C+A
	L	H	C+A
	M	L	B or E
	M	M	C+B or C+D
	M	H	C+B, C+D, or C+E
	H	L	B, D, or E
	H	M	C+D or C+E
	H	H	C+B, C+D, or C+E
> 200 gpm	L	L	A
	L	M	C+A
	L	H	C+F or E, C+A or C+E
	M	L	B or E
	M	M	C+B or C+E
	M	H	C+B or C+E
	H	L	B or E
	H	M	C+B or C+E
	H	H	C+B or C+E

Source: Bruce 1985.

Key:
L = less than 5 ppm
M = 5–50 ppm
H = more than 50 ppm
A = pressurized screen or disk filter
B = suction screen filter
C = centrifugal sand separator
D = gravity flow screen filter
E = sand media filter

Note:
* Letter sequence indicates the sequence of the filters; C+E means a centrifugal separator followed by a sand media filter

Filtration Guidelines for Irrigation Water Filters

Scenario 3: Solving a clogging problem.

- You’ve noticed that the drip emitters are clogging and you’ve seen some reddish, slimy material on the filters and in the drip lines. You think it might be iron bacterial slime.

What do you do about it?

PRINT

Maintenance of Microirrigation Systems

Predicting Clogging Problems

"What should I watch for?"

Solutions to Existing Clogging Problems

"I Have a Clogging Problem and I Want to Solve It"

System evaluation for emission device clogging

"How do I determine if I have a clogging problem?"

Routine Maintenance Tasks

"What should I do to keep my microirrigation system running well?"

Microirrigation systems include microsprinklers for tree crops, drip emitters for trees, vines, and some row crops, and drip tape for row and field crops. Microirrigation systems apply water to the soil through emitters that are installed along drip lines and contain very small flow passages. Microirrigation systems can apply water and fertilizers more uniformly than other irrigation methods. This uniformity results in potentially higher yields, higher revenue, and reduced irrigation operating costs.

Uniformity, a performance characteristic of irrigation systems, is a measure of the evenness of the applied water throughout the irrigation system. Distribution uniformity (DU), sometimes called emission uniformity (EU), is an index that describes how evenly or uniformly water is applied throughout the field. A uniformity of 100% means the same amount of water was applied everywhere. Unfortunately, all irrigation systems apply water at a uniformity of less than 100%, and thus some parts of a field receive more water than others. Field evaluations have shown that microirrigation systems have the potential for higher uniformity than other irrigation methods. However, clogging reduces the uniformity of applied water in microirrigation systems, thus increasing the relative differences in applied water throughout a field.

The small flow passages in the emitters and microsprinklers make microirrigation systems highly susceptible to clogging. Clogging reduces the uniformity of the applied water and decreases the amount of applied water. Clogging also decreases the amount of salt leaching around the lateral line in saline soils.

The objective of this web site is to provide information to irrigators about the causes of clogging and the methods for preventing or correcting clogging problems in microirrigation systems. Among the topics covered are the sources of clogging, chlorination, preventing chemical precipitation, filtration, flushing, and monitoring microirrigation systems.

This web site is divided into sections to allow the users to more quickly access the information they want. For example, if you already know you have a clogging problem and you want to solve it, go to the section **Solutions to Existing Clogging Problems - "I have a problem and I want to solve it".**

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University of California and W-2128

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Solutions to existing clogging problems

I Have a Clogging Problem and I Want to Solve It

Clogged drip emitters and microsprinklers result in a reduction or total elimination of water discharge from the emitter. Partially clogged drip emitters are particularly problematic, since they reduce water application but can easily go unnoticed until they stop discharging entirely. Partial clogging of drip emitters is difficult to detect by eye, but you can be detect it if you measure timed water discharge rates from a sampling of emitters. Partially clogged microsprinklers are often easier to detect than partially clogged drip emitters since you can see an obvious disruption of the microsprinkler's spray pattern.

Pressure compensating (PC) drip emitter Photo: Jack Clark

Click here if you have detected clogging in your microirrigation system and you want to mitigate it.

If you know you have a clogging problem but you don't know the cause, click here to diagnose the problem.

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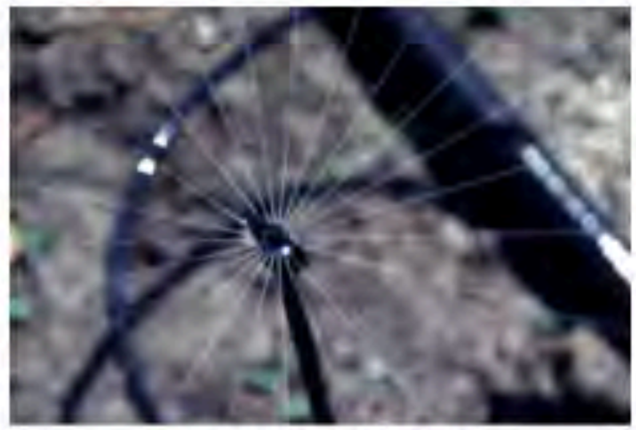
Solutions to Existing Clogging Problems

I already know what is causing the clogging

The treatment to solve a clogging issue in drip systems generally depends on the cause of the clogging.

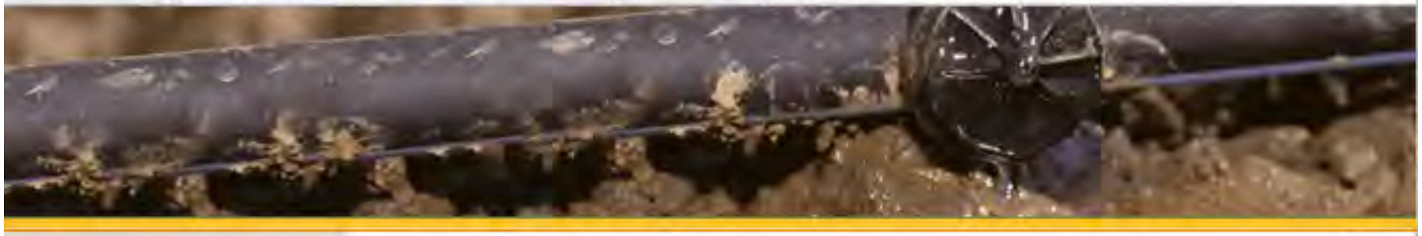


Microsprinkler Photo: L. Schwankl

Particulate clogging problems result when there are particles (sand, silt or clay mineral material or other contaminants) suspended in the water. Emitter clogging from particulates can occur with surface water sources (rivers, reservoirs, ponds, etc.) and with groundwater. Click here for more information on **particulate clogging problems** and ways to solve them.

Biological clogging problems are caused by biological materials (algae, bacterial slimes, etc.) that either are suspended in the water or are growing inside the microirrigation system. Most biological clogging problems are associated with surface water sources. Click here for more information on **biological clogging** and ways to mitigate it.

Chemical precipitate clogging problems are nearly always associated with groundwater sources. The chemical precipitates are in solution in the groundwater, but when the pumped water comes in contact with air, chemical precipitates can form and settle out in the microirrigation system. Common chemical precipitates include calcium carbonate (lime) and iron. Click here for more information on **chemical precipitate clogging** and ways of dealing with it.



Biological Clogging (slimes, algae, etc.)

Biological growths in drip lines and emitters can be a serious problem when the irrigation water contains organic sediments, iron, or hydrogen sulfide. The primary contributors to biological growths are algae and bacteria.

Storage reservoir with organic contamination Photo: L. Schwankl

Causes

Algae occur in surface waters used for irrigation; their food sources include carbon dioxide, nitrogen, and phosphorus. While the filtration of microirrigation systems removes some of the algae, small particles of algae can pass through the filter and into the drip system. Algae also provide an organic food for slime organisms.

Bacteria discolor the water and form precipitates and slimes that stick to the walls of the emitter flow passages. Although algae and bacteria may be small enough to pass through the filtration system, bacterial clogging may occur when mineral food sources are available in the water along with suspended particles to which the bacteria can attach and form larger masses that may clog the emitters. Food sources include organic carbon (dead algae), carbonates and bicarbonates, iron, and hydrogen sulfide.

Iron-rich water leads to the formation of iron bacteria, which convert soluble iron to insoluble iron precipitates. The result is a red, yellow, or tan slime in the drip lines and emitters. The source of the iron bacteria is not always clear, but it may be the result of contamination during well construction. Iron concentrations of 0.2 ppm are sufficient to support bacterial growth. Hydrogen sulfide in the irrigation water results in sulfur bacteria, a whitish slime with a rotten-egg odor.

Click here for information on predicting the biological clogging hazard.

Click here for information on solutions to biological clogging problems.

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Solutions to Biological Clogging

The solution to a biological clogging problem is usually two-pronged:

- good filtration to remove the suspended biological materials, combined with
- chemigation with a biocide to further clean up the biological contaminants.

Storage tank for chemicals injected through the microirrigation system Photo: L. Schwankl

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Biocides for biological clogging problems

Biocides for biological clogging problems

Treating irrigation water with a biocide will minimize the growth of organic contaminants and often destroy the organic material, minimizing the clogging hazard.

Three biocide methods are commonly used to treat irrigation water. In addition, use of acid is sometimes recommended for biological clogging problems. There are also a number of water treatment devices on the market which claim to control biological clogging problems.

- Chlorination
- Copper products
- Ozone treatment
- Acid
- Miscellaneous water treatment devices and chemicals

Double-venturi injection system Photo: L. Schwankl

Chlorination for biological clogging problems

Venturi injector with small pump. Photo: L. Schwankl

Chlorine is often added to irrigation water to oxidize and destroy biological microorganisms such as algae, fungi, and bacteria. While these microorganisms may be present in water from any source, they are most likely to exist at high levels in surface water from rivers, canals, reservoirs, and ponds.

When water containing high levels of microorganisms is introduced into a microirrigation system, it may clog the emitters. Using a good filter (such as a sand media filter) and acidifying the water can cut down on organic clogging, but some organic material will pass through the filter into the drip lines. Thus, chlorination or some other biocide usually will be needed to prevent clogging from organic material.

Forms of chlorine

Common sources of chlorine are chlorine gas, sodium hypochlorite (a liquid), and calcium hypochlorite (a powder or granules).

Adding chlorine to water produces mainly hypochlorous acid and hypochlorite, both referred to collectively as free available chlorine. Hypochlorous acid is the most effective agent for controlling biological growths. Its concentration depends on the pH of the water. Maintaining a pH of 7 or less means that at least 75% of the chlorine in the water is hypochlorous acid, while at a pH of 8 only about 25% of the chlorine is hypochlorous acid. At a pH of less than 3, chlorine gas predominates.

Chlorine gas

Dissolving chlorine gas in water produces hypochlorous acid, hydrogen, and chloride. Chlorine gas contains 100% available chlorine because it lowers the pH of the water to a level that results in mostly chlorine and hypochlorous acid. While using chlorine gas is generally considered the least expensive method of injecting chlorine, it is the most hazardous and requires extensive safety precautions. Trained personnel are needed for installing and using chlorine gas injection systems. The chlorine gas injection rate can be calculated from the following equation:

$$IR = Q \times C \times 0.012$$

where:

IR = the injection rate in pounds per day (the most common unit used for chlorine gas injection systems).

Q = the irrigation system flow rate in gallons per minute (gpm)

C = the desired chlorine concentration in the water in parts per million (ppm).

Sodium Hypochlorite

Sodium hypochlorite (liquid bleach) is usually available with up to 15% available chlorine. Household bleach is sodium hypochlorite with 5.25% available chlorine. Most liquid fertilizer injection equipment is capable of injecting liquid chlorine. If the injection point is downstream of the filters, it may be necessary to manually treat the filters with chlorine.

Adding sodium hypochlorite to water produces hydroxyl ions, which raises the pH of the water and in doing so may decrease the effectiveness of chlorination. Acid injection may be necessary to reduce the pH and increase the chlorine's effectiveness.

Do not mix chlorine and acids together because that can cause the formation of chlorine gas, which is highly toxic. Use different storage tanks and injection ports for acid and chlorine.

Use the following equation to determine the chlorine injection rate when using sodium hypochlorite:

$$IR = (0.006 \times Q \times C) \div S$$

Where:

IR = the injection rate in gallons per hour (gph).

Q = the irrigation system flow rate in gallons per minute (gpm).

C = the desired chlorine concentration in the water in parts per million (ppm).

S = the strength of the sodium hypochlorite source expressed as a percentage.

Example:

Sufficient household bleach (5.25% chlorine) is to be injected into a drip irrigation system with a flow rate of 500 gpm so that the final chlorine concentration in the irrigation water is 5 ppm. What should the bleach injection rate be?

$$IR = (0.006 \times 500 \times 5) \div 5.25 = 2.9 \text{ gph}$$

Calcium Hypochlorite

Calcium hypochlorite normally contains 65 to 70% available chlorine. Note that 12.8 pounds of calcium hypochlorite dissolved in 100 gallons of water forms a 1% chlorine solution. A 2% chlorine solution therefore requires adding 25.6 pounds of calcium hypochlorite to 100 gallons of water. Any chlorine stock solution can be mixed following the same pattern. The equation used for sodium hypochlorite injection rates can be used for the calcium hypochlorite solution once the percent concentration stock solution is determined. Use caution when dissolving calcium hypochlorite in water because of the possible formation of chlorine gas.

Desired chlorine concentrations

- Continuous injection of chlorine should be used if the irrigation water has high levels of algae and bacteria, and biological clogging is a serious problem. The recommended level of free chlorine is 1 to 2 ppm at the end of the irrigation system. It is important to check the concentration at the end of the lateral line since chlorine is consumed when it reacts with organic constituents and any iron and manganese in the water. The chlorine concentration can be determined with a good quality swimming pool or spa chlorine test.
- Periodic (e.g. once per month) injections at a higher chlorine concentration rate (10 to 20 ppm) for 2 hours or more may be appropriate where algae and bacterial slimes are less of a problem. The frequency of injection depends on the potential organic clogging.
- Super-chlorination (injecting chlorine at high concentrations) is recommended for reclaiming drip irrigation systems clogged by algae and bacterial slimes. Super-chlorination requires special care to avoid damage to plants and irrigation equipment.

Injection method	Chlorine conc. at the end of the last lateral
Continuous injection	1-2 ppm
Periodic injection	10-20 ppm

Questions???

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Presentations available at:

http://ucanr.edu/schwankl