

DPI&F note

Sub-surface drip irrigation: System maintenance

Graham Harris, Senior Development Extension Officer (Irrigation), Delivery

Routine maintenance is essential to prevent problems with poor system uniformity and get the longest possible life out of systems. There are very well maintained systems in Australia that are still operating effectively more than 11 years after installation.

Water quality

The first step in maintaining a system is in the sampling of the water sources to be used. This information aids the designer in determining the flushing requirement for the system. This in turn affects the choice of emitter and drip tape size, as well as run length.

There are three types of clogging hazards that need to be considered in the design and maintenance program. These are physical, chemical and biological.

Physical hazards include sand and silt. Filtration is generally designed to remove particles above the maximum allowable particle size for the emitters being used. As a rule of thumb, this is usually particles greater than one-tenth the size of the smallest diameter in the emitter pathway. The reason for this is that bridging of particles greater than this size can lead to emitter clogging, particularly if bonding glues formed by biological activity develop in the tape or emitter.

There are several possible chemical clogging hazards:

- Bicarbonate concentrations exceeding about 2 meq/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 fertilisers. Special procedures are necessary for the injection of phosphate fertilisers.
- High concentrations of sulphide ions can cause iron and manganese sulphide precipitation. These precipitates are very insoluble, even to acid solutions. Frequent acidification or the use of a settling basin for separating these precipitants is needed.
- Irrigation water containing more than 0.1 mg/L sulphides may encourage the growth of sulphur bacteria within the irrigation system. Regular chlorination may be needed.
- Chlorination when manganese is present should be used with caution, as a reaction time delay may occur between chlorination and development of the precipitate. This may cause the manganese precipitate to form downstream of the filter leading to emitter clogging.

Not all these hazards are found in every water source. Hence the importance of correctly sampling and analysing your water sources. Table 1 summarises the water quality guidelines for clogging potential in SDI systems.

Biological clogging hazards result from the growth of bacterial slimes and algae within drip tapes and emitters. They combine with clay particles to block the emitters. Bacterial precipitation of sulphur and iron is a further problem.

Information contained in this publication is provided as general advice only. For application to specific circumstances, professional advice should be sought. The Department of Primary Industries and Fisheries has taken all reasonable steps to ensure the information in this publication is accurate at the time of publication. Readers should ensure that they make appropriate enquiries to determine whether new information is available on the particular subject matter.

©The State of Queensland Department of Primary Industries and Fisheries 2005
Produced by: Delivery Business Group

Note No: 17653
ISSN 0155 – 3054
Created: June 2005

No of pages 6



Queensland Government
Department of Primary Industries and Fisheries

Table 1 Water quality guidelines for clogging potential in SDI systems

				Level of concern		
				Low	Moderate	High
pH				< 7.0	7 - 8	> 8.0
Bicarbonate	HCO ₃	meq/L		<2.0	>2.0	>2.0
Iron	Fe	mg/L		< 0.2	0.2 – 1.5	> 1.5
Manganese	Mn	mg/L		< 0.1	0.1 – 1.5	> 1.5
Hydrogen sulphide	H ₂ S	mg/L		<0.2	0.2 – 2.0	>2.0
Total dissolved solids	TDS	mg/L		<500	500 - 2000	>2000
Suspended Solids		mg/L		<50	50 - 100	>100
Bacteria Count		no./mL		<10,000	10,000 – 50,000	>50,000

Treatment Options

The treatment options for the range of water problems that can clog SDI emitters are summarised in Table 2.

Table 2 Water treatments to prevent clogging in SDI emitters

Problem	Treatment Options
Carbonate precipitation (white precipitate)	<ol style="list-style-type: none"> 1. Continuous injection: maintain pH between 5 and 7 2. Periodic injection: maintain pH at under 4 for 30 to 60 minutes daily
Iron precipitation (red precipitate)	<ol style="list-style-type: none"> 1. Aeration and settling to oxidise iron (best treatment for high concentrations – 10 mg/L or more) 2. Chlorine precipitation – inject chlorine to precipitate iron <ul style="list-style-type: none"> • use an injection rate of 1 mg/L of chlorine per 0.7 mg/L of iron • inject in front of filter so that the precipitate is filtered out 3. Reduce pH to 4 or less for 30 to 60 minutes daily
Manganese precipitate (black precipitate)	Inject 1 mg/L of chlorine per 1.3 mg/L of manganese in front of the filter
Iron bacteria (reddish slime)	Inject chlorine at a rate of 1 mg/L free chlorine continuously or 10 to 20 mg/L for 30 to 60 minutes daily. pH must be under 7 for chlorination to be effective.
Sulphur bacteria (white cottony slime)	<ol style="list-style-type: none"> 1. Inject chlorine continuously at a rate of 1 mg/L per 4 to 8 mg/L of hydrogen sulphide (pH must be under 6 for chlorination to be effective), or 2. Inject chlorine intermittently at 1 mg/L at 1 mg/L free chlorine for 30 to 60 minutes daily (pH must be under 6 for chlorination to be effective).
Bacterial slime and algae	Inject chlorine at a rate of 0.5 to 1 mg/L continuously or 20 mg/L for 20 minutes at the end of each irrigation cycle.
Iron sulphide (black sand-like material)	Dissolve iron by injecting acid continuously to lower pH to between 5 and 7.

Maintenance schedule

Maintenance is largely preventative. Silt and organic matter should be excluded from the system as much as possible using settling ponds and filtration.

Regularly walk the field to check on the system and address problems quickly. Take samples from the ends of laterals and let it stand overnight to check for sediment. Test the water periodically. Check laterals for any deposits.

Flush the system regularly as determined by your water quality. Monitoring and recording system flow rates on a water meter can indicate if clogging is occurring and flushing required. Start the flushing process from the pump onwards. Make sure the filters are clean and pressures set correctly. Systematically clean the mainline, sub-mains, laterals and flushing manifold. Inlet water pressure may need to be increased to achieve the necessary flushing velocity in the laterals – check if this is needed on your design specifications.

Don't inject substances into the system unless they are completely water-soluble. The injection point must be before a filter. Mix the material to be injected with your irrigation water in a container and leave overnight – if sediments or deposits form do not use it.

Do not under-irrigate your crops as this will lead to root intrusion. If fallowing between crops make sure weeds are controlled as their roots can enter the system. Some water should be applied during a fallow to keep water about the tape – this will minimise insect damage. On cracking soils do not let them crack open exposing the laterals to mice attack. Because of the high investment with installing a SDI system (in the order of \$2,500 to \$5,000/ha) most irrigators crop continuously – this generally results in the greatest return on investment. If root intrusion occurs root hairs can be burnt out of emitters using acid treatment.

Pressures at the furthest end of the system should be regularly checked and recorded to ensure that the system is operating to design specification. Make sure accurate pressure gauges are used for this testing – gauges normally installed on irrigation systems have a short life and are generally inaccurate. Purchase a high quality gauge and use it to perform pressure checks.

Adhere to the maintenance schedule recommended by you system supplier to get the best from your system. Table 3 summarises a SDI system maintenance schedule if you do not have one available.

Table 3: Recommended SDI Maintenance Schedule

Prior to installation of system

Water quality analysis

Prior to starting the first irrigation season (and at any time system pressure or flow rate is reset)

1. Filter system adjustment

- Media cleaning
- Backflush flow adjustment
- Backflush frequency adjustment
- Backflush duration adjustment
- Backflush dwelling-time adjustment (the time between flushing of each two consecutive tanks)

2. System evaluation – test flow rate, operating pressure and distribution (emission) uniformity

Annually before the beginning of Irrigation Season

1. Undertake system evaluation – test flow rate, operating pressure and distribution (emission) uniformity
 2. Inspect pumping station and pump/motor maintenance
 3. Test bore and pump
 4. Inspect all system components and replace defective ones
 5. Inspect media and screen filters
 6. Flush system
-

During the irrigation season

1. Daily observations

- Walk the field and repair any system irregularities
- Check screen/media filter performance
- Check and record system pressure and flow rate

2. Weekly observations

- Check for emitters clogging
- Clean screens and strainers
- Flush laterals

3. Monthly observations

- Perform screen/media filter maintenance
 - Measure and record laterals pressure – compare to system design
 - Measure emitter discharge rate at selected locations
 - Check pH of water from lateral flushing – maintain below pH6.5
-

As needed

1. Acid injection
 2. Chlorine injection
-

Annually before system shutdown

1. System flushing
 2. Chlorination
-

Chlorination

Chlorination must be used routinely to kill algae and loosen bonded organic matter within the system for flushing out. It has no effect on scale (lime or calcium carbonate) deposits in the system. Liquid sodium hydrochloride is the recommended chlorine source. It is injected into the system during regular operation usually using the fertigation equipment (provided it is chlorine tolerant). Application is either continuous (a low dose rate) or intermittent (a high dose rate).

The injection point should be as close to the treated system as possible as the residual chlorine concentration decreases with time and distance from the injection point. There is no particular volume of chlorine that should be used as every system and its contamination issue is different. Table 4 summarises the recommended chlorine concentrations to achieve particular objectives:

Table 4 Recommended chlorine doses

Chlorination Objective	Chlorination Method	Required Concentration (mg/L)	
		System Start	System End
Sediment Prevention	Continuous	3 - 5	> 1
	Intermittent	10	> 3
System Cleaning	Continuous	5 - 10	> 3
	Intermittent	15 - 20	> 5

The required discharge of injected chlorine solution is calculated using the formula:

$$q = \frac{C_1 \times Q}{C_0 \times 10}$$

where

q = discharge of injected chlorine solution (L/hour)

C₀ = percentage of active chlorine in injected solution (%)

C₁ = Desirable concentration of active chlorine in irrigation water (mg/L)

Q = discharge of the treated system (m³/hour)

Example:

System flow rate: Q = 125 m³/hour

Active chlorine % in the solution C₀ = 10%

Desired concentration C₁ = 15 mg/L

$$q = \frac{C_1 \times Q}{C_0 \times 10}$$

$$= \frac{15 \times 125}{10 \times 10}$$

$$= 18.75 \text{ L/hour}$$

Use a chlorine test kit to measure the active chlorine in the irrigation water at the start and end of the system during chlorination to ensure that the required concentrations are reached.

Chlorine is more effective in acid waters. High pH or alkaline waters should be acidified to a pH of 6.5 for effective chlorine treatment.

WARNING: Active chlorine is very dangerous. Follow all safety instructions for its use and never place it in a tank containing any residual fertiliser. Direct contact of chlorine and fertiliser can result in an explosive reaction.

Acid injection

Acid injection should only be used to treat chemical deposits (carbonates, hydroxides and phosphates) in the SDI system – it is not effective for organic sediments. The aim is to drop the water pH to a level where these deposits become soluble and can be flushed from the system.

There are several technical acids available that can be used for acid injection – hydrochloric, sulphuric, nitric and phosphoric. They are marketed in a range of concentrations and most appropriate rate should be determined using a bucket titration. Add 10L of water to a bucket and using a glass eyedropper add acid 1 mL at a time and test pH until the desired level is reached. For periodic treatment this could be as low as pH 4.0. Using these measurements and system flow rates, an injection rate in L per hour of acid can be calculated.

Prior to treatment thoroughly flush the system. Inject acid for a period of 10 to 12 minutes – check the pH at the flushing end of the system to make sure the desired pH is achieved. Following treatment continue irrigating with clean water for at least one hour and flush the system thoroughly.

Acids are very corrosive to steel, cement and aluminium – polyethylene and PVC are resistant. Make sure the injection pump is tolerant of acids and has been calibrated.

WARNING: Acids are very dangerous – always follow all instructions for use and safety precautions. Always add acid to water, **NEVER** add water to acid as a dangerous reaction can result.

Treatment should always be done well before total clogging has occurred. Success in this situation will be limited as it is difficult for the acid to reach the precipitants in closed emitter passages.

Acid can be used to burn root hairs in emitters. However, high rates are required and it is very expensive. It is best to prevent root intrusion in the first place through appropriate design, installation and irrigation management.

Acknowledgement

This work was funded under the Rural Water Use Efficiency 2 initiative which is a partnership between industry and government: Department of Natural Resources and Mines, Queensland (www.nrm.qld.gov.au); Cotton Australia Ltd. (www.cottonaustralia.com.au); the Australian Cotton Research and Development Centre (cotton.pi.csiro.au) and the Department of Primary Industries and Fisheries, Queensland.



Further information

Burt, C.M. and Styles, S.W. (1999) Drip and Micro Irrigation for Trees, Vines, and Row Crops: Design and Management, California Polytechnic State University, San Luis Obispo, California

Dasberg, S. and Or, D. (1999) Drip Irrigation. Springer, New York.

Harris, G.A. (2005) Sub-surface drip irrigation – Advantages and Limitations, DPI&F Note, Brisbane

Harris, G.A. (2005) Sub-surface drip irrigation – System components, DPI&F Note, Brisbane

Harris, G.A. (2005) Sub-surface drip irrigation – System designs, DPI&F Note, Brisbane

Harris, G.A. (2005) Sub-surface drip irrigation – Installation, DPI&F Note, Brisbane

Harris, G.A. (2005) Sub-surface drip irrigation – Crop management, DPI&F Note, Brisbane

Hassan, F.A. (1998) Microirrigation management and maintenance. Agro Industrial Management, Fresno, California

There are an increasing number of commercial irrigators experienced with SDI within Australia across a range of crops. If considering SDI you should discuss this with experienced growers as well as the experienced field staff of the major SDI system suppliers who can put you in contact with experienced SDI irrigators.

Information is also available on the World Wide Web through the Trickle-L Discussion List. This list has over 650 members (irrigators, manufacturers, resellers, researchers, extension personnel) in 35 countries. Details on joining this list can be found at the Microirrigation Forum Web site at www.microirrigationforum.com. This site contains archives of discussions related to drip irrigation (and SDI in particular) that you can readily examine.

Emma Carrigan
DPI&F and Australian Cotton CRC
LMB 2, Goondiwindi Q 4390
Phone: (07) 4671 6714

Graham Harris
DPI&F and Australian Cotton CRC
PO Box 102, Toowoomba Q 4350
Phone: (07) 4688 1559

Sarah Knights
DPI&F and Australian Cotton CRC
PO Box 310, St George Q 4487
Phone: (07) 4620 8101

Amanda Love
Growcom/Cotton Australia
LMB 6, Emerald Q 4720
Phone: (07) 4983 7433 ■