

Maintenance Manual

Maintenance Manual

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INDEMNITY

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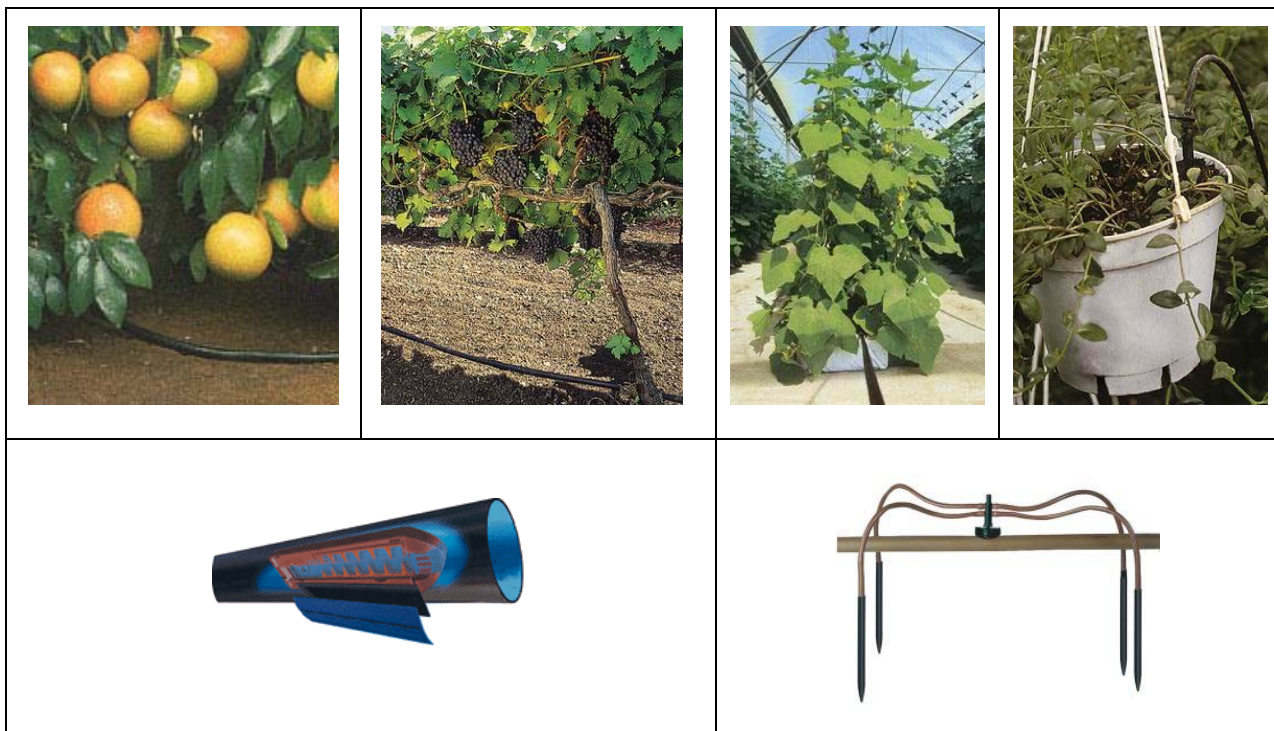
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GENERAL COMMENTS

The irrigation system

This is a very powerful tool to control and manipulate the crop. Today it is a very competitive market for producing crops, it is important to have a reliable irrigation system at all times to insure constant production of the highest quality.



Design

A well-designed system that allows for safety margins and maintenance procedures in the future must be one of the considerations when choosing a system.

Prevention is better than cure

One of the most pressing issues that we face during our visits to drip irrigation installations is the lack of proper preventative maintenance. People do not have the slightest doubt that they should service their tractors, cars, packing machinery etc. However, when it comes to the irrigation system it is different, it is simply not done properly.

Note

A wise man once said, "You only need to brush the teeth you want to keep".

PREVENT BLOCKING

List of precaution

- Oxidization of iron and manganese.
- Prevent calcium and magnesium precipitation by correcting pH.
- Rinse fertilizer rich water out of the system.
- Chlorinate to prevent slime formation.
- Maintain water source.
- Design for maintenance.
- Rinse main, sub-main and drip lines.
- Training of irrigation staff.
- Follow maintenance program.
- Install vacuum valves.
- Protect main-line hydraulics.
- Mark all valves and air valve setups to protect damage from tractors.
- Protect installation from vandalism.
- Follow correct installation procedures.
- Position drip lines (ground level or on wires) according to use and surrounding conditions.
- Suitable filtration, primary and secondary.
- Top float suction.

Note: Choice of equipment plays an important role, at times we can use regular pressure sensitive drippers according to the hydraulics, but because of poor water quality, it is advised to rather use RAM. Nowadays we also have the Uniram, which is developed with unique properties for the most extreme conditions.

SAND IN DRIP SYSTEMS

Sand is the most dangerous physical element for dripper blockages. Sand blocks the flow path of the dripper and it is impossible to get rid of the sand with any chemically treatment or without physical damaging the dripper. This applies for all types of drippers.

- The water source can be causing the sand problem and this problem can be avoided with settling dams, sand filters or a combination of these.
- Sand can also be a result of main-line breakages in the system and this problem can be avoided with secondary filters at block valves.
- Sand can also block the dripper externally with fine sand that can get blown in, with water (puddles or rain), in this last case it would be advisable to put the dripper line on a wire.
- Sand can also be sucked in when a vacuum condition prevails. Systems must be designed and provide for vacuum valves on the highest point of the sub-main.

DURING INSTALLATION

As sand is such a huge problem, it is very important to pay attention during installation.

- Ensure that main and sub-main stay clean at all times.
- Never leave inlets and outlets open, even for a short period of time.
- In the digging of holes, remove all "debris" and immediately install the start connector with the blank pipe till above the ground and bend the end over till the lateral is installed.
- Install the lateral and bend ends over.
- Flush main line.
- Flush sub-main line.
- Flush laterals, see "Flushing".
- Make sure that the whole team understands the above.

CHANGE FROM AN EXISTING SYSTEM TO DRIP

In micro sprinkler and overhead systems fertilizer is not normally given via the water. Systems have usually been used for a lengthy period of time and the main line, sub-main and laterals are usually very dirty. When such a system is changed to drip irrigation, fertilizer is a requirement and the chemicals loosen the dirt in the system over time and blocks the drippers.

Steps to prevent the above:

- Install Netafim disc filters (100 or 130 micron) at block valves.
- Install flush valves on main line and sub-main.
- Physically clean the main line. See "Cleaning of the main line".
- Chemically clean the sub-main.
- In the case that existing poly pipe or micro is used, also clean it chemically before drippers are installed.

INJECTION GUIDELINES

Where must the chemicals be injected?

If you are injecting chemicals at a central point, you must first ensure that the main line is clean, see "Cleaning of the main line". If the main line is not clean, the dirt will separate from the main line while treating the dripper lines and this dirt will follow the route to the dripper lines and create more blocking problems than before the treatment.

The safest is to inject chemicals just after the block valve to thus avoid dirt in the main line.

BREAK IN THE MAIN-LINE

Steps to be followed in the event of a breakage in the main line.

- System irrigation.
- Break in main line.
- Close all valves downstream of the break.
- Switch off the pump.
- Fix break.
- Open the flush valve of the main line.
- Turn on pump and slowly fill the main line.
- Flush main line.
- Open the sub-main and block valves.
- Close flush valve of the main line.
- Flush sub-main line.
- Close flush valve of the sub-main line.
- Flush drip lines (1-3 times).

Notes:

1. Velocity during flushing of drip lines must be ≥ 0.5 m/s, if too many lines are flushed at the same time, the flush is ineffective. See "Flushing".
2. Drip lines can each be opened and closed three times to cause a pressure difference, in this way RAM drippers go into a self cleaning cycle that will flush dirt out of the drippers.

CLEANING OF THE MAIN LINE

Pipelines are developed to deliver a certain quantity of water at a specified pressure to the end point. Inner diameter is decreased with deposits and if they are not cleaned, the system will work below standard.

Why maintain pipelines?

- It prevents the replacement of pipelines.
- Decreases pump wear and reduces electricity bill.
- Pipelines can do what they are developed to do.

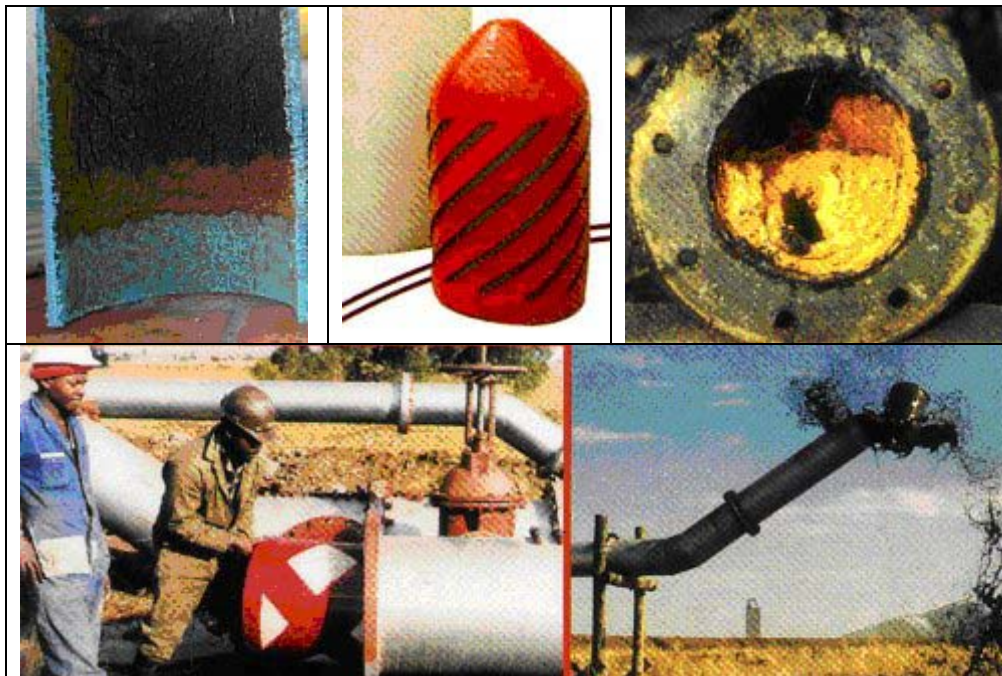
Chemical

To clean pipelines chemically is an option, but we do not have the experience and knowledge to do this and one can cause greater damage if main lines are only partially cleaned and then during irrigation more dirt is loosened and it blocks the drip system. It is prohibited to do an acid treatment in AC (asbestos-cement) pipes. The treatment will damage the AC pipe and will dump dirt into the drip system.

Physical

This option is more work the first time especially with older systems where the producer does not even know what his pipe network looks like. This means that the pipe must be opened (in PVC cut the line) A “pig” is installed in the line. Seal the line (use long repair connector piece) and pump the “pig” to the planned position of the network. At T-pieces or a narrowing (reducer) the “pig” must be removed and re-inserted after this obstacle, in the case where inner diameter are drastically different, the “pig” must be replaced with the suitable size. The results are obvious and the process must be repeated till the line is clean.

New pipelines can be designed to make allowances for the above-mentioned maintenance. Yes, it will entail more capital, but it can be saved again with long-term running costs.



For information contact Protea Pigs at www.proteapig.co.za

FERTILIZER – DO'S AND DON'TS

Fertilizer that is injected through the system can also contribute to blockages in the drippers. Trials have shown that there are great variations between the solubility of fertilizer and water qualities. Where sulphates are present in water, it can react with dissolved iron and manganese in the water and form an insoluble residue. These reactions can also occur between phosphate, calcium and magnesium.

Different liquid fertilizers can be incompatible during mixing. When mixing fertilizers oneself the following aspects must be taken into account:

- Safety aspects that are concerned with the mixing of solutions.
- Fertilizer solubility and purity grade must be kept in mind, where dry fertilizer is used.
- The reaction that can occur when two different liquid fertilizers are mixed together in the same tank.
- The reaction that can take place when fertilizer is injected in the system and the reactions that can occur with the irrigation water.
- Certain fertilizers have a cooling effect in water, and this decreases the solubility of the particular fertilizer.
- Check on the quality of water to be used when a phosphate solution is injected in a system. If unsure consult an expert.
- Ensure to install a small filter to prevent any fertilizer debris entering the irrigation system.

The majority of dry fertilizers are manufactured with a small layer of oil or a type of clay that prevents it from absorbing moisture and forming clumps. Normally the stabilizers form a deposit in the bottom of the tank. One must make sure that a clean fertilizer solution is used without disturbing the deposit in the bottom of the tank. This sediment on the bottom of the tank is a great danger for any irrigation system and can cause blockages. In the case where there is any doubt with regard to the compatibility of different fertilizers, it is advisable to seek professional advice from the distributors. A good rule of thumb is **“if in doubt, leave it out”**.

A simple **“Jar test”** can be done for the compatibility of different fertilizers in specific water:

- Add a few drops fertilizer in a given quantity of water so that the concentration of the dissolved fertilizer mixture in the water is the same to that which is to be given through the system.
- Cover the solution and keep it in a dark place for 12 hours.
- Ascertain if there is any deposit in the bottom of the bottle by shining a torch from the bottom of the jar. If there is no deposit, it is safe to use.

Technical aspect

- Phosphoric acid / ammonium phosphate & aqua ammonium, urea ammonium, calcium nitrate, fertilizer with iron, calcium ammonium nitrate or fertilizer with magnesium.
- Avoid high concentration in the water.
- Never use P fertilizers based on polyphosphate, use orthophosphate only.
- Never turn on irrigation and fertilizer at the same time. Turn off the fertilizer pump 30 minutes before the end of the irrigation, to flush phosphate remains from the system.
- Use Acidic phosphoric fertilizer if water have a high pH
- Fertilizers containing sulphate and calcium or magnesium can also under certain circumstances cause great problems as a result of precipitation in the system.
- Fertilizer that is incompatible in a concentrated form can be innocuous in a diluted form and can be injected with a two-tank system.
- Use iron chelate only. Make sure that the chelate is from high quality (stable and strong). Avoid cheap products, which can decompose into the system. This can cause ineffective feeding for plants and plugged drippers. Never use ionic iron into the drip system.
- If water is neutral or basic (pH > 7) do not use fertilizers containing calcium (calcium nitrate) or basic fertilizers.
- If water is acid (pH < 5) it is recommended to use basic fertilizers available, and calcium nitrate if the calcium concentration of the water is low.
- If you enrich the water (OHS or greenhouse) the pH of the solution should be corrected to pH = 6.
- Consult your irrigation designer for more information on hardware options after receiving your fertilizer program from the fertilizer company.

GENERAL MAINTENANCE

Cleaning of filters

Filters are a very important part of a system. They must be serviced regularly and the inside of the filter must be well cleaned. Make sure that there are no weak spots or leaks on the filter or piping. The filter station must be clean and without water in the off-season.

Sand filters

Change the sand every second year or when the sand grains are no longer sharp cornered. Inspect the lowest spring piece "mushrooms" very well and make sure that everything is in order. Where bad water is used with lime, make sure that there are no lime deposits in the grooves of the "mushrooms". Lime conditions can be removed with a weak solution of acid. If it is not necessary to replace the sand an overnight chlorination must be done to the filter. Flush the filter out well the next day until there is no more dirt. Inspect the disc filters for filter sand that can cause a problem in sand filters. Check the sand bed monthly and ensure that the sand is even or slightly bent upwards, so that no crevices are formed and sand depth is correct. Problems with this will indicate that the flush cycle must be adjusted.

Disc filters

Follow the guidelines for "Cleaning of Netafim discs".

Flush valves and solenoids

Flush out all dirt and test operation.

Flush management

Turn off only the circuit breaker that supplies power to the flush control. Disconnect the wires to the solenoids to prevent possible damage due to lightning.

Pump

The pump and circuit boards must be inspected every season. Test the starting and working stream loads as well as the balancing between the 3 phases to make sure that they draw the same load. Use an electrician for this work.

Controls

Make sure that the programming of the controller functions properly. One must also check that there is good communication between the controller and the different valves in the field. Store information. Turn off the circuit breaker that supplies power for the controller. Disconnect the wires to the solenoids to prevent possible damage due to lightning.

Hydraulic valves

The pressures must be checked again to make sure that they are still functioning properly. If necessary the valves must be opened and all parts washed before it is reassembled. The "finger filter" must be clean. Solenoids must also be cleaned and tested.

Fertilizer injection equipment



Connect the fertilizer system and test if it is working well. Test the injection rate of the pumps to see that they are still all right. Flush out and service according to the instructions of the equipment.

Drain the system

If the system will not be used for a few months, drain the water out of the system after all chemical treatment has been done. This will prevent algae build up or precipitation of carbonates or silt deposits in the system.

GENERAL CAUSES OF BLOCKAGES

Dripper blockages can be due to microbiological and/or chemical causes.

	
Organic sedimentation Bacteria, slime and algae	Silt buildup Carbons, hydroxides and phosphates
Oxidizing treatment Chlorine or Hydrogen Peroxide	Acid treatment

In exceptional cases where iron > 0.3 ppm or manganese >0.1 ppm in the irrigation water, special care regimes are necessary. See "Oxidation".

	
Iron	Manganese
A combination of treatments can be tried.	

In Iron and Manganese blockages there is no guarantee of saving drippers that are blocked and the problem must be dealt with before the water is used. See the article on "Oxidization". If it is in the form of bacteria you can try a double treatment of acid and hydrogen peroxide, see "Combination Treatment".

Drippers can also become blocked due to physical causes (solid materials) e.g. clay, silt, sand and organic material. Systems also get blocked with the use of unsuitable fertilizer and/or that a fertilizer program is not followed correctly. See article on "Fertilizers - do's and don'ts".

Mechanical treatment of drippers by hitting, pinching and bending actions is not recommended and will only damage the drippers.

PURIFICATION AND QUALITY OF WATER

Many methods can be followed to improve the quality of water. We can use a combination, depending on the circumstances and purpose for the use of water.

Quality of water – Total Suspended Solids (TSS)

Water quality	Levels of TSS
Good	TSS < 50 ppm
Average	TSS < 100 ppm
Poor	TSS < 150 ppm
Very poor	TSS < 200 ppm

ppm = mg/l

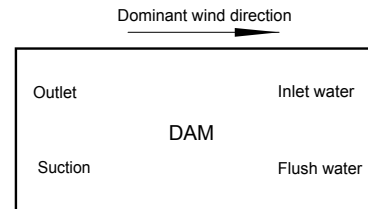
Note: TSS results do not include the organic matter and it will give a false impression of the water quality if you have a high organic count in the water. In this case we suggest doing a clogging test to classify the water.

Maintain water source

- Borehole - ensure that set up is correct and that sand is not being pumped. do not exceed maximum withdrawal.
- Dam - draw best quality water (top 600-1000mm)* control plant growth that takes up oxygen.
- River - draw best quality water (top 600-1000mm)*
- Canal - use "venturi" principal.

Suction options

- Floating (top) or bottom (bottom)
- Prevailing wind direction
- Backwash water position
- Inlet and outlet position
- Formation of dam and depth
- Standing time available
- *Suction depth $\geq 2.5 \times$ suction pipe cross section
- Suction rate of suction pipe must be between 0.50 and 0.75 m/s.
- The sum of the area of small holes must be $>$ than the cross section of the suction pipe.



PURIFICATION OF WATER

Treatment of dams to control algae

Fish

The quality of the dam can be improved with the correct type of fish that eat algae and micro organisms.

Copper Sulphate

Copper sulphate can be placed in bags on floats or scattered widely over the dam. The recommendation is to give between 0.5 and 2.0 ppm copper sulphate depending on the algae problem. The calculation is done on the top two meters of the dam. It is here that the most algae grow. If high algae loads are present it is recommended not to suction shallower than 750 mm from the surface. Small concentrations of copper sulphate are toxic to fish and care must be taken not to overdose dams. It is better to dose in smaller quantities or even dose only areas of the dam at a time.

Chaff bales

Chaff bales are packed on the water line, they must be moved as the water level changes, which needs labour.

Plant growth

Plant growth in a dam depletes oxygen supplies, this is bad and must be prevented and the dam kept clean.

Flocculation

Addition of a coagulation medium that results in the binding of the debris which then settles. The most general coagulation medium is Aluminium Sulphate and it is available in dry or liquid form.

Iron and manganese

This is also the biggest enemy of drippers and must be managed before the water is used. See "Oxidization of Iron and Manganese".

Table: Maximum level that is safe for use on drippers without preventative treatment.

Source	River, canal, dam	Borehole
Iron	0.8 ppm	0.2 ppm
Manganese	0.3 ppm	0.1 ppm

FILTRATION

Settling dams

At levels higher than 200 ppm TSS (total suspended solids) filters are unable to handle this and settling dams are used. The time depends on particle size and depth of the dam.

Table: Micron size and settling time

Fixed particles	Size (mm)	Settling time m/min	Minute for 1 meter
Rough sand	>0.500	38	0.03 (1.6 sec)
Mediumsand	0.250-0.500	22	0.05 (2.7 sec)
Fine sand	0.100-0.250	5	0.20 (12 sec)
Very fine sand	0.050-0.100	0.900	1.10
Silt	0.002-0.050	0.015	66
Clay	<0.002	0.0008	1250 (20.8 hours)

Float suction

The use of float suction is the best investment to improve water quality.

Sand separator

In sand loads higher than one ppm sand separator is used. Sand loads > 10 ppm requires at least a sedimentation dam. Silt loads > 50 ppm requires at least 10 hours of sedimentation.

Primary filters

This is the main filter station that must filter the water. Design these filters with great care so that the task that is expected can be performed (high silt loads during the rainy season). The SABI norm for drip irrigation is to follow the drip manufacturers recommendations to ensure that the guarantee on the drip system is valid.

Secondary filters

This is the second protection of the system and is normally installed at block valves or groups of block valves. These filters are of great value in the event of a main line break or where dirt that is small enough to pass through the primary filter and then build up to form larger particles that can cause a potential blockage. In systems where fertigation or asbestos main lines are still being used, it is a good choice to use these filters. We would recommend a filter with the same micron as the primary filter. This is the life insurance of a system.

OXIDIZATION OF IRON AND MANGANESE



In many instances there is iron and manganese in bore wells and even in collection areas of dams and these elements seep to the dam. This can cause blockages in pumps, valves, filters and drip or micro systems and can even partially block main lines.

Iron occurs in two forms, firstly, “ferrous” (Fe^{2+}) which is the soluble form and secondly “ferric” (Fe^{3+}) in the solid form. The soluble form is not visible and the water looks very pure. With oxidization it changes to a solid form with a red rust colour that can be clearly seen in any system that is subjected to the oxygen. The advantage is that iron in the solid form can be filtered.

The best method of oxidization is to air the water and pump it into settling dam. This dam must be right angled and deep (at least 3.0 meters). Pump water in to the one side via a fountain or slab and let it rinse over a stone structure for maximum exposure to oxygen. Then pump the water from the opposite side with a suction float about 0.6 meters under the surface of the water, the shallower the better, but if it is too shallow a whirlpool (vortex) will form and the pump will suck air which is not advisable. The dam must be able to stand a holding time of at least 12 hours to get satisfactory settlement.

Filtering must be a sand filter with Netafim black disc filters or Netafim Spin-Klin with black discs. Flushed water must preferably not return to the dam, if so it must be as far as possible from the suction pipe.

Manganese can be dealt with in the same method, but because it oxidizes and settles slower the standing time must be lengthened.

Oxidization can also be done by injecting oxidization treatments, mixing, contact time and filtering with sand filters plus Netafim black disc secondary filters, but it takes a great deal of management and in the long term is more expensive and less environmentally friendly.

Note: Work must be done to determine if oxidization of iron and manganese in low pH water has any benefit.

MAINTENANCE SCHEDULE - GENERAL

Monitor	Each cycle	Weekly	Monthly	Quarterly	Yearly *
Check the system for leaks		X			
Control working pressure at end point			X		
Control system flow (flow meter)		X			
Control pressure differential over the filters		X			
Open filters for inspection				X	
Set backwash cycle of filters if no pressure differential meter		X			
Service air valves, block valves and pressure control valves					X
Control all hydraulic and electrical connections of valves			X		
Service pump, motor and switches					X
Service fertilizer injector pump					X
Flush fertilizer system with water	X				
Flush main line			X		
Flush sub-main line			X		
Flush laterals (water quality)**			X		
Take water sample of system and analyze for change in water quality				X	
Chlorine or acid treatment	See notes				
Hydrogen peroxide treatment	See notes				
Treatment for root intrusion	See notes				

* At the end of the irrigation season – the system must be clean and free from water when it is not in use. In cash crops the systems must be treated after each harvest, if the drip lines are removed prior to harvest, they can be treated before the planting of the next crop, provided that this is done within two months.

** With bad quality, the laterals must be rinsed weekly.

MAINTENANCE SCHEDULE – WATER QUALITY

Program for field inspections for system maintenance must be based on the changing water quality.

The table below gives guidelines for inspections and intervals for flushing of drip systems.

Problem	Concentration	% Reduction in dripper flow or seasonal changes in water quality		
		Low (<5%)	Mild (5-25%)	High (>25%)
Inorganic				
Low concentration	<10 ppm	F6P2	F3P3	F3P1
Medium concentration	10-100 ppm	F3P3	F3P1	F1P1
High concentration	>100 ppm	F3P1	F1P1	F1PW
Organic				
Low concentration	<10 ppm	F3P3	F3P1	F1P1
High concentration	>10 ppm	F1P1	F1PW	F1Pd
Bacterial				
Low population	<10 000/ml	F3P3	F3P1	F1P1
Medium population	<50 000/ml	F1P1	F1PW	F1Pd
High population	<50 000/ml	F1Pd	FWPd	FdPd

Key		Description
F	=	Recommended block inspection
1-6	=	Monthly intervals between inspections
W	=	Weekly inspections
D	=	Daily inspections
P	=	Pipeline flushing

Modified from original table of Eksteen et al 1988

WATER ANALYSIS

Purpose of chemical water analysis

Water analysis are necessary to determine if the water is suitable for the planting of the planned crop and if there are any dangers of blockages of the planned irrigation system.

Table: Elements that must be analyzed to determine the suitability for drip irrigation.

Element	Unit	Element	Unit
pH		Chlorides as Cl ⁻	mg/l
EC (electrical conductivity)	mS/m	Sulphate (SO ₄ ⁻²)	mg/l
Sodium (Na ⁺)	mg/l	Carbonates (CO ₃ ⁻²)	mg/l
Potassium (K ⁺)	mg/l	Bicarbonates (HCO ₃ ⁻)	mg/l
Calcium (Ca ⁺²)	mg/l	Iron (Fe) ^{Total}	mg/l
Magnesium (Mg ⁺²)	mg/l	Manganese (Mn ⁺²)	mg/l

Table: Elements that can be calculated from above

SAR		T.D.S. (total dissolved salts at 180 °C)	mg/l
Total alkalinity		Langelier index @25° C	
Total hardness	mg/l	Corrosion index	

Table: Additional elements that must be analyzed for OHS / Euro Gap

Boron (B ⁻³)	mg/l	Nitrate Nitrogen (NO ₃ ⁻)	mg/l
Copper (Cu ⁺²)	mg/l	Ammonium Nitrogen (NH ₄ ⁺)	mg/l
Zinc (Zn ⁺²)	mg/l	Phosphates (P)	mg/l

Table: Additional information that must be analyzed for bad quality water for filtration purpose

Total suspended solids	mg/l	Total Bacterial count	mg/l
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Laboratories available for analysis

Bemlab BK, P.O. Box 12457, Stellenbosch Tel: 021 8516401 Fax: 021 8514379	Labserve, P.O. Box 1920, Nelspruit 1200 Tel: 013 7524745 Fax: 013 7524617
Matrocast Laboratories (PTY) Ltd, Brackenfell Tel: 021 9815558/9 Fax: 021 9816724	C.A.L. P.O. Box 812, Ifafi Tel: 012 3055003 Fax: 012 3055290

Any laboratory may be used; the above information is of possible laboratories.

Procedures that must be followed in the taking of samples

Fill a 500 – 1000 ml container that has been well rinsed with the sample water. Mark the container well with relevant information.

Remarks

- Bore wells – allow the water to run for 10 minutes before filling the container. Where iron and manganese can be a problem (look for precipitation at the source) a separate sample should be taken. Half fill the container with water, add 3 - 5 drops acid and then fill the rest of the container. This container must be marked separately for the analysis of iron and manganese only. Communicate this procedure to the laboratory staff.
- In dams it is recommended that the sample be taken at the same place as where the water is suctioned – surface or bottom.
- If the water is pumped from a dam, the sample must be taken directly after the pump.

CHLORINATION

The purpose of chlorination is to solve problems that are caused by organic sedimentation in the system such as bacteria, slime and algae.

Table: Recommendations for chlorination.

Chlorination purpose	Application method	Desired concentration (ppm)	
		System start	System end
Prevention of sedimentation	Continuous chlorination	3 - 5	0.5
	Periodic chlorination	5 - 10	1 - 2
Cleaning of system		10 - 15	2 - 3

Continuous chlorination

This is only recommended where it is legally required or for the contesting of cases like in nurseries. In the case of very high algae/bacteria counts or high iron or manganese in the water it can be adapted with consultation with an expert.

Periodic chlorination

It can be done monthly or weekly depending on the quality of water. Where the purpose of the chlorination is to improve the filter ability, the injection must be done near the filters. Ensure that there is complete dispersal of the chlorine in the filters. The chlorine concentration must be 2-3 ppm.

Cleaning of the system

This can be done 1-2 times a season. Perform the treatment directly after the season to leave the system clean in the off-season.

Super chlorination

These are dangerous words. The recommendation is not to exceed **50 ppm** because chlorine is an oxidization medium. Oxidization influences rubber that is used in most systems at start connectors as well as diaphragms of valves and drippers. Do not do this treatment while plants are actively growing in an artificial growing medium.

Calcium Hypo-Chloride (HTH swimming pool chlorine). This is a dry granular product with active concentrations of between 65 and 70%.

OR

Sodium Hypo-Chloride. This is a liquid product with active concentrations of between 12 and 15%.

Formula 1

Determination of the solution concentration with the use of a fixed injection rate:

$$\text{Concentration HTH solution (\%)} = \frac{\text{required chlorine (ppm)} * \text{system flow rate (m}^3/\text{hour)}}{\text{Injection rate of pump (l/hr)} * 10 \text{ (constant)}}$$

Note: maximum concentration of 4 % is advised to avoid fallout.

Formula 2

Determination of the quantity Cl product required for a given container:

$$\text{Kg or Liter of Cl}^- \text{ product} = \frac{\text{concentration of Cl solution (\%)} * \text{Capacity of container (l)}}{\% \text{ Cl}^- \text{ in Product}}$$

CHLORINATION

Example: Calcium Hypo-Chloride 67% active **or** Sodium Hypo-Chloride 12% active.
 Require 15 ppm Cl⁻ for injection.
 System delivery is 30 m³/hour.
 Delivery of injection pumps is 100 liters per hour.
 Capacity of container is 200 liters. Fill with 150 liter of water.

Concentration HTH solution	=	$\frac{\text{required } 15 \text{ ppm} * 30 \text{ m}^3/\text{hour}}{100 \text{ liters per hour} * 10}$	
(maximum 4%)	=	0.45% Cl⁻ concentration ->	
Kg of HTH product	=	$\frac{0.45 \% \text{ concentration} * 150 \text{ liters water}}{67\% \text{ Cl}^- \text{ in HTH}}$	= 1.0 kg HTH ->
OR			
Liter of Sodium Hypo-Chloride	=	$\frac{0.45 \% \text{ concentration} * 150 \text{ liters water}}{12\% \text{ Cl}^- \text{ in Product}}$	= 5.6 liter ->

Summary

We must dissolve 1.0 kg HTH in 150 liters of water. This gives us a chlorine solution of 0.45%. If we then inject this 0.45% chlorine solution at a rate of 100 liter per hour, we will get the required 15 ppm chlorine at the injection point, with a system flow of 30 m³/h.

If we use Sodium Hypo-Chloride (12% active) we must add 5.6 liter of product to 150 liters of water to give 0.45% solution of chlorine. If we inject a 0.45% chlorine solution with the same system conditions using either of the products will result in the same concentration of 15 ppm.

Duration of injection

Keep on with the injection for 20 minutes after 0.5 – 3.0 ppm active (measured with a swimming pool test kit that can test for “free available chlorine”) chlorine is measured at the last dripper. Measure while dripper is dripping, do not open the end of dripper line. The higher the biological activity is in the water, the longer it will take to measure active chlorine at the last dripper.

Point of injection

Do the injection at the block valves. In the case where injection must be done at a central point, the main-line must first be totally cleaned before any block valves are opened, if this is not done, all the dirt from the main-line will move to the drip lines and increase the existing problem.

Flushing of the system

Firstly flush the main and sub-main and then the drip lines, only one or two lines must be flushed at a time, otherwise the flow rate is reduced to < 0.5 m/s and flushing becomes ineffective. Flush before and after treatment. See “Flushing”.

Influence of the pH of irrigation water

The affectivity of chlorine is greatly influenced by the pH of the irrigation water. At a pH of 6,0 to 7,0 the activity of chlorine is optimal. When the pH of the water is higher than 8,0 the affectivity of chlorine is reduced to below 25% and the pH of the water must first be adjusted. See “Reducing pH with acid”.

Safety measures during chlorination

Active chlorine solutions are very dangerous for both man and animals. Follow the manufacturers instructions with regard to use and handling.

- Avoid eye and skin contact. Prevent the drinking of the solution or inhalation of the gases.
- Direct contact between chlorine and fertilizer can cause a thermo reaction that can lead to an explosion. It can be life threatening.
- Acid treatment and chlorination must be done at two different injection channels. A mixture of acid and chlorine in the same tank can lead to a highly toxic poisonous gas. Store products apart.
- Chlorination together with herbicides, pesticides and fertilizers, lowers the affectivity of the chlorine (use clean water during chlorination).
- Always add chlorine products to water and not vice versa.

REDUCING THE pH WITH ACID

The purpose of pH adjustment is to create a favourable condition to effectively chlorinate – see the table below to see the influence of pH.

Table: The relative quantity HOCL and OCL⁻ available at different pH values.

pH	% HOCL	% OCL ⁻
< 4	100	0
5	100	0
6	100	0
7	75	25
8	25	75
9	2.5	97.5
10	0	100
11	0	100

HOCL is the product that must do the work and as can be seen that in a pH higher than 7.0, it is ineffective.

Step by step – practical guidelines for acid adjustment:

1. Connect the fertilizer injection pump and get the system to working pressure.
2. Turn on the injection pump at full capacity and with clean water, determine the injection rate.
3. Fill a 50 liter container with clean irrigation water and measure the pH.
4. Add 1 ml acid (use syringe), mix and measure pH.
5. Repeat step 4 till the pH drops to between 5.0 and 6.0 (pH increases as soon as chlorine is injected).
6. Fill the injection container "D" with water and add calculated quantity acid.
7. Begin injecting with acid solution.
8. Measure pH downstream of the injector, if it is not 6.0, repeat the calculations.
9. Now you can begin with the chlorination downstream of pH adjustment. See "Chlorination".

Table: Different acids available.

Type of acid	Concentration of specific acid
Hydrochloric acid (HCl)	33-35%
Sulphuric acid (H ₂ SO ₄)	65%
Nitric acid (HNO ₃)	60%
Phosphoric acid (H ₃ PO ₄)	85%

See next page for an example.

REDUCING THE pH WITH ACID

Example:

Flow in treated block	=	30 m ³ per hour
Injection pump injects at	=	100 liters per hour
Container size – calibration (K)	=	50 liters
Container size – dosing (D)	=	200 liters (fill till 150 liters)
Acid for pH = 6.0	=	3 ml (answer of step 5)

Formula 1 Acid per 1000 liters water = $\frac{3 \text{ ml} \times 1000 \text{ liters water}}{50 \text{ liters container "K"}}$ = 60 ml acid

Formula 2 Volume acid per hour = 30 m³/hour x 60 ml acid = 1800 ml acid

Formula 3 Volume acid/container "D" = $\frac{1800 \text{ ml acid} \times 150 \text{ liter "D"}}$ = 2700 ml acid
100 liters per hour

Formula 4 Injection solution = 147.3 liters water + 2.7 liter acid = 150 liters

Formula 5 Injection time (container "D") = $\frac{150 \text{ liters solution}}{100 \text{ liters per hour}}$ = 1.5 hours

Notes:

1. If the 50 liter container "K" is used, every 30 minutes it must be mixed and this is not practical, use a larger container for the injection solution, but calibrate it with the 50 liter container.
2. The pH must not drop below 6.0.
3. Injection time is the time taken till container "D" is empty, but more than one block can be chlorinated during this time.

WARNING: Always add the acid to the water. Do not add water to acid. Acids are dangerous to handle. Wear protective clothing, gloves and glasses. It can lead to blindness and burns. The drinking or inhalation of the acid gasses can be fatal. Read the manufacturers instructions carefully that come with the acid. Acidification and chlorination must be done at two separate injection points. A mixture of acid and chlorine in the same tank can lead to a highly poisonous chlorine gas. Never store acid and chlorine together.

HYDROGEN PEROXIDE (H₂O₂)

The aim of this treatment is to solve problems that normal chlorine treatments do not solve. Hydrogen peroxide is more aggressive than chlorine to loosen residues in pipes.

Product

Hydrogen peroxide reduces the incidence of Fusarium and Verticillium fungi in soils and growth mediums. It reduces the growth of algae and slime in volcanic rock medium, greenhouse containers as well as irrigation systems. Hydrogen peroxide is used in water at 30 to 50 ppm in vegetables and flowers to reduce the above mentioned. The advantage of using Hydrogen Peroxide is:

- Rapid reaction
- Environmentally friendly
- Do not cause the creation of dangerous residues

Product	Concentration	Product pH	Specific Gravity	Oxygen
Hydrogen peroxide 35	35 %	2 - 3	1.13	16%
Hydrogen peroxide 50	50 %	1 - 2	1.20	23%

Corrosion:

Hydrogen Peroxide is a corrosive agent for steel, aluminium, cement coating and asbestos cement. In contrast, tanks made of Polyethylene and PVC is not sensitive to Hydrogen Peroxide. It is vital to take these factors into consideration when planning treatment.

Hydrogen Peroxide is a strong oxidizer, and is efficient in attaining the following objectives:

Preventing the accumulation of bacterial slime in pipes and dripper line extensions. Cleaning the dripper line system in which organic sedimentation and bacterial slime have accumulated.

- Oxidation of microelements to prevent the development and reproduction of bacteria (iron, manganese and sulphur).
- Improving the efficiency of initial filtering under high organic stress conditions.
- Disinfecting sewage and wastewater, irrigation water, drinking water and swimming pool water.
- Prevention and removal of odours in the water, impairing biological activity.
- Lowering BOD / COD values by oxidizing the polluting substance, both organic and inorganic.
- H₂O₂ is **not efficient** for the prevention or dissolution of **scale sediments, sand and silt**.

Recommendations

Treatment	When *	Injection concentration (ppm) **	Concentration at end of system (ppm)
Shock treatment	Yearly	200 – 500	100 – 250
Once off treatment	As required	30 – 50	8 – 10
Normal maintenance	Every second week	5 – 10	2 – 3

Notes:

1. * Depending on water quality.
2. Do not do this treatment continuously.
3. ** Never exceed 500 ppm concentration of Hydrogen Peroxide.

HYDROGEN PEROXIDE (H₂O₂)

Calculations

Formula 1

Determination of the solution concentration with the use of a fixed injection rate:

$$\text{Concentration peroxide (\%)} = \frac{\text{Needed peroxide (ppm)} * \text{system flow rate (m}^3\text{/hour)}}{\text{Injection rate of pump (l/hour)} * 10 \text{ (constant)}}$$

Formula 2

Determination of the quantity hydrogen peroxide (liters) needed for a given container:

$$\text{Peroxide needed (l)} = \frac{\text{concentration peroxide solution (\%)} * \text{capacity of container (liter)}}{\% \text{ Hydrogen peroxide (35 or 50)}}$$

Example:

Required 200 ppm hydrogen peroxide for injection.
 Use product with 50% concentration.
 System delivery is 30 m³/hour.
 Delivery of injection pump is 100 liters per hour.
 Holding tank is 200 liters. Fill with 150 liters of water.

$$\begin{aligned} \text{Concentration peroxide solution (\%)} &= \frac{\text{Required 200 ppm} * 30 \text{ m}^3\text{/hour}}{100 \text{ liters per hour} * 10} \\ &= \mathbf{6.0 \% \text{ concentration} \rightarrow} \\ \text{Liters peroxide needed} &= \frac{6.0\% \text{ concentration} * 150 \text{ liters water}}{50 \% \text{ H}_2\text{O}_2} \\ &= \mathbf{18 \text{ liters H}_2\text{O}_2 \rightarrow} \end{aligned}$$

Summary

We must add 18 liters hydrogen peroxide in 150 liters water. This gives us a 6.0% hydrogen peroxide solution. If we then inject this 6.0% solution at a rate of 100 liters per hour in a system with a flow of 30 m³/hour, we will get the required concentration of 200 ppm hydrogen peroxide at the injection point.

Duration of injection

Keep on with the injection for one hour or time of travel (time it takes for a drop to travel from injection point to last dripper) See "Flow time for systems". Use the method that takes the longest. The higher the biological activity is in the water, the longer it will take.

Use hydrogen peroxide kit (paper strips) to measure concentration (ppm), if value is higher than the ability of the measuring strip, the sample should be diluted with water. To calculate results multiply the value received by the dilution factor. See recommendation for the concentration at the end of the system.

HYDROGEN PEROXIDE (H₂O₂)

Standing time

Let the system stand for 12 to 36 hours so that the chemicals that have not drained out of the system can work. The lifespan of peroxide is a few days and not as short as chlorine. Flush the system after this time, see flushing of the system.

Point of injection

Do the injection at the block valves. In the case where injection is done at a central point, the main-line must first be totally flushed before any block hydrants are opened, if this is not done, all the dirt from the main-line will move to the drip lines and increase the existing problem.

Flushing of the system

Firstly flush the main and sub-main and then the drip lines, only one or two lines must be flushed at a time, otherwise the flow velocity is reduced to < 0.5 m/s and flushing becomes ineffective. Flush before and after treatment. See "Flushing".

Influence of the pH of irrigation water

Hydrogen peroxide is not sensitive to high pH like chlorine is.

Safety:

Measures during handling

Hydrogen peroxide solutions are very dangerous for man and animals. Follow the producer's instructions with regard to use and handling.

- Avoid eye and skin contact. Wear protective clothes, gloves and glasses.
- Avoid drinking or inhalation of gasses.
- Store apart from other chemicals.
- Always add hydrogen peroxide to water and not vice versa.
- Use clean water, not fertilizer rich water during hydrogen peroxide treatment.

Remember

- Contact with the Hydrogen Peroxide preparation may cause burns, contact with the eyes may cause blindness, and swallowing may cause death.
- In any case of operations related to Hydrogen Peroxide preparation (filling the storage tank, etc.), always use protective goggles, gloves, and shoes and clothes suitable for preventing contact between the substance and exposed skin. Before filling the tank with the substance, verify that it was thoroughly rinsed and is clean of fertilizer.
- Direct contact between Hydrogen Peroxide and some of the fertilizers containing ammonia causes rapid heating and may sometimes cause the tanks to explode. This is a lethal hazard for anyone in the vicinity.

ACID TREATMENT

The purpose of acid treatment is to loosen the scale deposit (carbonate, hydroxides, phosphates, etc) that occurs on the drip line. Treatment is not effective where organic deposits occur. See "chlorination and hydrogen peroxide". In certain cases the injection of acid can be sufficient to destroy the slimy bacteria.

Table: Concentration recommendations for different acids for water treatment.

Recommended concentrations of a specific acid in treated water	Acid type	Concentration of a specific acid
0.6 %	Hydrochloric acid (HCl)	33-35 %
0.6 %	Sulphuric acid (H ₂ SO ₄)	65%
0.6 %	Nitric acid (HNO ₃)	60%
0.6 %	Phosphoric acid (H ₃ PO ₄)	85%

In the event that the acid that is to be used is a different concentration to what is shown in the table, the following correction must be done:

Example:

Your sulphuric acid is 98%

$$\frac{65 \% * 0.6 \%}{98 \%} = 0.4 \%$$

In other words you must use 0.4 % concentration when you use a 98 % sulphuric acid.

Warning

This acid injection should reduce the pH of the water to between 2 and 3. Do not do this treatment while plants are actively growing in a growth medium or if the drip line is hung up on steel wires. Don't use nylon fittings on the injector pump or to connect to the system, these fittings cannot withstand high concentrations of acid.

Step by step – practical guidelines for acid treatment:

- Get the system to working pressure and flush out all lines.
- Irrigate for one hour with clean water to wet root areas and to protect roots.
- Connect the fertilizer injection pump to the block that needs to be treated.
- Turn on the injection pump to full capacity with clean water and determine the volume water that it gives in 10 minutes. This is the application volume. Test it again by placing the same volume in a container and ensure that it is the correct volume in the 10 minutes.
- Do calculations and prepare the solution that must be injected.
- Inject the acid so that it is a 0.6 % concentration in the water.
- After acid treatment, flush injection equipment with clean water.
- **Irrigate for a further hour after the acid has been applied.** This will ensure that the pH of the root areas returns to values it was before treatment.
- **Flush system.** Only one or two drip lines must be flushed together, otherwise there is a reduction in flow rate to < 0.5 m/s and flushing becomes ineffective.

ACID TREATMENT

Example:

Flow in treated block is	=	30	m ³ per hour
Injection pump injects at	=	100	liters per hour
Injection time	=	10	minutes
Acid concentration	=	0.6	%

Formula 1

$$\text{System volume for 10 minutes} = \frac{30\,000 \text{ litres/hr} * 10 \text{ minutes}}{60 \text{ minutes}} = 5\,000 \text{ litres}$$

Formula 2

$$\text{The volume acid} = \frac{5\,000 \text{ liters} * 0.6 \%}{100} = 30 \text{ liters}$$

Formula 3

$$\text{Injection rate for 10 minutes} = \frac{100 \text{ liters per hour} * 10 \text{ minutes}}{60 \text{ minutes}} = 17 \text{ liters}$$

Summary

The injection pump is too small, can only inject 17 liters in 10 minutes and we require injecting 30 liters of acid in 10 minutes. The required injection rate is 180 liters per hour {30 liter x (60 minutes ÷ 10 minutes)} if undiluted acid can be injected. If the injection pump can inject undiluted acid it is the best to inject the acid direct from the acid container. If dilution is required the injection rate will increase by the dilution factor.

Mixing

If dilution are required fill an **acid proof container** (plastic) with calculated amount of water and mix the acid carefully in the water, while the water is being stirred – follow “**step by step**” instruction.

Corrosion

Acid is very corrosive when it comes in contact with steel, asbestos-cement and aluminium pipes. Polyethylene and PVC pipes are tolerant to acid. Low pH can damage the irrigation system. In general, it can be deducted that corrosion is hastened when the pH is lower than 5.6 in the water. The ideal pH is between 5.8 to 6.2. With a pH higher than 6.5, calcium and phosphates can react and precipitate within the system. Do not use phosphoric acid in water with a high pH, calcium and bicarbonate content.

Localized corrosion can occur at the injection point, but can be reduced if the injection opening is installed in the middle of the pipe. For this one can use a 316 stainless steel elbow. The quantity acid needed can be ascertained by laboratory tests. It is advisable to continuously test to get a pH vs acid curve established. With this the acid necessity can be easily adapted as the water quality changes at various times of the year.

WARNING:

- Always add acid to water. Do not add water to acid.
- Acids are dangerous to handle. Wear protective clothing, gloves and glasses.
- It can lead to blindness or burns.
- The drinking and inhalation of the acid gasses can be fatal.
- Read the manufacturers instructions carefully.
- Never store acid and chlorine together.
- Use clean water (not fertilizer rich water) during Acid treatment.

COMBINATION TREATMENT

In where normal chemical treatments do give satisfied results you could try a combination treatment. Practical experience showed that we get good result if do an acid treatment with a hydrogen peroxide treatment direct after it.



Step by Step Instructions

- Inject chemicals at the block.
- Open block valve and pressurise the system.
- Flush Sub-mainline.
- Determine the maximum number of dripper lines that can be open at the same time to maintain a velocity of 0.5 m/s. Ram 17 must fill one a liter container within 12 seconds or less.
- Flush dripper lines and ensure that all lines are free from any obstructions due to bending or end stop fittings. Use your thumb to open and close the end of the dripper lines to develop a pressure differential in the dripper to initiate the self-flushing action of the RAM dripper.
- Do a 0.6% acid treatment for ten minutes (see instruction for acid treatment).
- Flush injection equipment with clean water for one minute.
- Do a hydrogen peroxide treatment (see instructions for hydrogen peroxide). This treatment must last for one hour or the duration of system flow time if it exceed one hour (see flow time for system).
- Contact time of 24 to 36 hours.
- Flush system.
- Wait for a week and repeat above starting with flushing the system.

Notes

- Never try to open blocking drippers by means of physical efforts (folding, hitting) this will only enlarge the problem.
- Hydrogen peroxide have a lifespan of ± 2 days and we must use this to our advantage and there are no need to do more than one treatment of the same block on the same day.
- Hydrogen peroxide treatment can be started with 500 ppm for the first two treatments and then be reduced to 200 ppm if more treatment is required.
- This combination treatment is only if a shock treatment are required.
- Monitor the process by cutting drippers (at the same place in the block) and to compare it with the control drippers that were cut before the first treatment.
- Monitor the flow and pressure of the system.
- The condition of the system will determine the amount of treatments required to clean the system.
- Check on site if you stop the acid treatment after a few combination treatments if you still get a satisfied amount of dirt flushing from the system, if the answer is yes then only do hydrogen peroxide treatments and reduce the ppm with time.
- See and follow all safety instructions (acid and peroxide).
- Always use clean water (not enriched with fertilizer) to do any chemical treatments.

PREVENTING ROOT INTRUSION IN SUB-SURFACE DRIP SYSTEMS

This problem occurs more on the permanent subsurface drip systems where roots growing into the buried emitters. For seasonal vegetables / crops, root intrusion is commonly minimised by avoiding water stress during the growing season, and at the end of the season the roots and plants are killed by acid injection.

For trees, orchards and sports fields, an active program of chemigation with TRIFLURALIN 5 (TREFLAN) is the only way of control. This herbicide only kills the root tips of the plants without killing the plants, themselves. Some emitters have the chemical TREFLAN impregnated into them.

Purpose of treatment:

Prevent root intrusion into sub-surface drippers. The chemical should be accumulated only on the soil particles surrounding the drippers and not to a greater volume of soil.

Treflan treatment is not recommended under the following conditions:

- a) When the soil is sandy and contains less than 8% clay.
- b) When plants are very young, close to planting, seeding, and in all cases in which the volume of roots is very small or in Soil less bedding.
- c) When the soil is wet above field capacity due to rain or irrigation.
- d) When dripper lines are not properly buried.
- e) When relevant authorities do not authorize Treflan treatment.

Procedures of treatment:

The following procedures must be followed a few days before treatment:

1. Turn on the system and wait for 20 minutes after the system has reached working pressure. Make sure that no puddles form above ground level. If there are puddles of significant size, the soil is not suitable for TREFLAN treatment or the soil is still too wet.
2. Inspect the whole system for leaks and bad connections and fix where necessary.
3. For the treatment of sports fields make sure that the drip line is buried deep enough and is not between the grass and the soil. If not avoid TREFLAN treatment.
4. Verify the quantity of drippers in the treatment block.
5. Check that the injection pump and connections are in working order. Calibrate the injection pump for 10 minutes and record the quantity of water that is pumped in the 10 minutes.
6. Disconnect the above ground system if it is connected to the subsurface system.
7. Test the ground moisture by hand. Do not continue with the treatment if the soil is too wet or after rain or irrigation. Prior to the treatment the plot must be partially dried by decreasing the intervals by 2 - 3 times between normal irrigations.

IMPORTANT: Puddles that appear above ground during treatment can damage lawns and crops.

When to start the First Treatment?

Crop	Treatment
Perennial crops	3 weeks after the beginning of irrigation period.
Orchards	Six months after planting of any type of crop. During this period, the root intrusion threat is that of wild weeds that must be treated anyhow. From the second year onwards, 4 weeks after the commencement of the irrigation season.
Seasonal crops & vegetables	Approximately 5 weeks after regular irrigation, it does not contain germination and encourage irrigation.
Field crops and perennial vegetables Asparagus, Alfalfa	1st year - 4 weeks after planting or 6 weeks after seeding. 2nd year onwards - 4 weeks after the commencement of "normal irrigation".
Grass / Lawns	4 weeks after planting and two to three weeks after laying the grass.

PREVENTING ROOT INTRUSION IN SUB-SURFACE DRIP SYSTEMS

Number of treatments per year:

This table indicates the number of treatments necessary to be done in a year. The number of treatments per year is a function between crop, climate and soil type.

For example:

If the irrigation season is 4 months long and the soil is heavy, one treatment is sufficient, if the soil is medium to light, 2 treatments are required.

Table: The quantity treatments necessary through the year.

Crop	Effective irrigation periods	Medium-heavy soils (50 – 80% sand fraction)	Lights soils (> 80% sand fraction)
All crops	< 2 months	1	1
	< 4 months	1	2
	< 8 months	2	3
	Through the year	3	4

* Effective irrigation is the period when the block is irrigated continuously. E.g. cotton planted in October, irrigation begins in the first week of December and the last irrigation is done at the end of February. In this case the “effective irrigation period” is 3 months.

Water Stress situations:

Any water stress means a danger of root intrusion into dripper lines, and therefore requires that Treflan treatment will preface the start of water stress period.

Water stress can be:

- Planned according to the grower’s discretion.
- Due to a fault or failure in the water supply.
- Due to an unexpected increase in the plant’s water consumption.

Quantity TREFLAN per treatment: 0.125 ml Treflan per dripper

e.g. treatment of a block with 8000 drippers

= 8000 * 0.125 ml = 1000 ml for the block.

(This amount refers to a preparation composed of 480 gram Treflan per liter)

Treatment process in 3 Stages:

The 1st stage - Treflan injection should be short 10 minutes. The 2nd stage varied according to the dripper flow, dripper spacing and lateral length. The second stage starts after injection has been terminated, and end when the flow time is completed, see tables for flow time on next page. Stage 3 starts at the end of the 2nd stage, turn off the water supply and wait 24 hours for next irrigation.

PREVENTING ROOT INTRUSION IN SUB-SURFACE DRIP SYSTEMS

Step-by-step treatment:

Stage 1 Treflan injection must be short, a maximum of 10 minutes long.

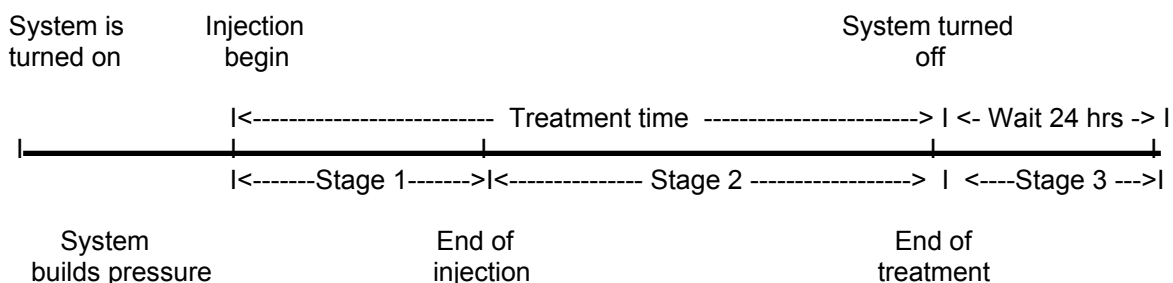
Stage 2 Treflan distribution time – determined by the dripper flow rate, spacing and the lateral length. (see Table below). It begins when the injecting of Treflan is completed.

Table: Treflan treatments – Distribution time for Stage 2

Dripper Line	Flow rate (l/h)	1.0 - 1.2	1.5 - 1.7	2.0 - 2.3	3.5 - 4.0
	Spacing (m)	Time of flow (minutes)			
Tiran 16 Ram 17	0.3	18	13	9	6
	0.5	27	20	15	9
	1.0	50	35	26	16
Tiran 20 Ram 20	0.3	28	19	14	8
	0.5	42	30	22	13
	1.0	75	54	40	24
Dripper Line	Flow rate (l/h)	0.8 - 1.0	1.1 - 1.3	1.5 - 1.7	2.3 - 2.6
	Spacing (m)	Time of flow (minutes)			
Streamline Super Typhoon	0.3	26	20	16	10
	0.5	39	27	25	15
	1.0	70	57	43	26
Python Oz Line	0.3	60	44	33	19
	0.5	90	77	52	31
	1.0	180	165	104	63

(This is an indication of distribution time for Stage 2, spacing and flow rate have a bigger influence than dripper length, see Tables "Time of flow" for precise data).

Stage 3 Wait 24 hours after treatment before resuming regular irrigation.



CLEANING OF NETAFIM DISCS

The most important action in the maintenance of the filter bank is to regularly clean the small filter that filters the control water. Open the filter weekly and flush it out. When this filter gets dirty, water cannot flow fast enough to open and close the backwash valves. With a reduced flow to the backwash valve the valve opens fully just prior to the signal to close the valve again. This means that the discs have not been properly flushed. As a result of this pressure, the dirt pushes in deeper into the grooves of the filter discs. The result of this is that the filter bank is constantly in a backwash action and low pressures will result in the rest of the system.

OPTION 1: Hydrochloric acid (HCl) and Hydrogen peroxide (H₂O₂)

Cleaning of manganese, iron and carbonate deposit

Step 1:

- Isolate filter bank and release pressure, now the filters can be opened. Remove all the dirty discs and tie the sets of discs to a plastic rope to keep together.
- Make a 10% hydrochloric acid solution in a large enough container. Pour in 7 liters water into the container and then add 3 liters hydrochloric acid (30-35%) to the water.
- Soak the discs in the solution. Make sure that the discs are loose enough to have good contact on both sides with the acid solution. Do not try and put too many discs in at a time.
- Stir the discs a few times in the solution.
- The contact time in the solution is ½ - 3 hours.
- If the solution is no longer cleaning the discs, replace it with a new mixture.
- Remove the discs and rinse them well in water. There should now only be a pale sedimentation on the discs.

Step 2:

- After the discs have been rinsed in water, they must be soaked in a 10% peroxide solution to remove the organic residue.
- Make up a 10% peroxide solution. Pour 7 liters of water into a container and add 3 liters hydrogen peroxide (35%).
- Soak the discs in the solution. Make sure that the discs are loose enough to have good contact on both sides with the peroxide solution. Do not try and put too many discs in at a time.
- Stir the discs a few times in the solution.
- The contact time in the solution is ½ - 3 hours.
- If the solution is no longer cleaning the discs, replace it with a new mixture.
- Remove the discs and rinse them well. There should no longer be any residue in between the grooves of the discs.

Rinse the discs off well with water. Replace them back in the filter bank and flush the filter bank a few times to remove all chemicals.

See next page for “Cleaning of organic and biological residue”

CLEANING OF NETAFIM DISCS

Cleaning of organic and biological residue

Step 1:

- Isolate filter bank and release pressure, now the filters can be opened. Remove all the dirty discs and tie the sets of discs to a plastic rope to keep together.
- Make a 10% peroxide. Pour in 7 liters water into the container and then add 3 liters hydrogen peroxide (35%) to the water.
- Soak the discs in the solution. Make sure that the discs are loose enough to have good contact on both sides with the peroxide solution. Do not try and put too many discs in at a time.
- Stir the discs a few times in the solution.
- The contact time in the solution is ½ - 3 hours.
- If the solution is no longer cleaning the discs, replace it with a new mixture.
- Remove the discs and rinse them well in water. There should now only be a pale sedimentation on the discs.

Step 2:

- After the discs have been rinsed with water, they must be soaked in a 10% hydrochloric acid solution to remove the organic residue.
- Make a 10% hydrochloric acid solution in a large enough container. Pour in 7 liters water into the container and then add 3 liters hydrochloric acid (30-35%) to the water.
- Soak the discs in the solution. Make sure that the discs are loose enough to have good contact on both sides with the acid solution. Do not try and put too many discs in at a time.
- Stir the discs a few times in the solution.
- The contact time in the solution is ½ - 3 hours.
- If the solution is no longer cleaning the discs, replace it with a new mixture.
- Remove the discs and rinse them well in water. There should now be no residue between the grooves of the discs.

Rinse the discs off well with water. Replace them back in the filter bank and flush the filter bank a few times to remove all chemicals.

OPTION 2: Hydroxyl Ammonium Chloride (NH₂OH.HCL)

This treatment only works where manganese is a problem. Filter discs are placed for a very short time (seconds) in a 10% solution of Hydroxyl Ammonium Chloride after which it will be clean. The product comes in a powder form and is dissolved in water. Use a plastic container with a tight fitting lid. Make a 10% solution by dissolving 500g of the product in 5 liters of water. Place one set of discs in the solution, seal and shake the container. Discs must thereafter be rinsed in clean water. This solution is normally sufficient to clean 15 sets of discs. This product can be bought at:

Saarchem of United Scientific. Cape Town (021) 592 5240
Johannesburg (011) 794 7899

WARNING: Always add the chemicals to the water. Do not add water to chemicals. Chemicals are dangerous to handle. Wear protective clothing, gloves and glasses. It can lead to blindness and burns. Drinking or inhalation of the gasses can be fatal. Read the manufacturers instructions carefully that come with the chemicals.

FLUSHING OF SYSTEMS – GENERAL

Drip lines

For effective flushing a flushing velocity of 0.5 m/s or more is recommended. It is best to only flush one or two lines together. The table below shows guidelines for the flushing of drip lines. See flushing of sub-surface drip systems.

Where pressure regulated valves are used, the pressure regulating must be cancelled and must be manually set to increase the pressure. Be careful not to exceed the maximum pressure where low-density polyethylene (LDPE) pipes, PVC start connectors and “grommets” are used.

Calculate the additional flow when the drip line is flushed.

$$Q = v * A \quad Q = ? \quad (\text{m}^3/\text{s}) \quad A = (\text{m}^2) \quad v = 0.5 \text{ m/s}$$

Table: Flushing guideline for drip lines

Product	Wall thickness (mm)	Inside diameter (mm)	Q=liter per hour per lateral	Seconds to fill one liter
Ram 17 D	1.00	14.4	293	12.3
Ram 20D	1.00	17.5	433	8.3
Tiran 16 N	0.80	14.2	285	12.6
Tiran 16 Q	0.90	14.2	285	12.6
Tiran 16 D	1.00	14.1	281	12.8
Tiran 20 D	1.00	17.5	433	8.3
SuperTyphoon125	0.32	15.9	357	10.1
Streamline 80	0.20	16.0	362	9.9

Example:

If Ram 17D is used a one liter container must be filled in 12 seconds with one drip line flushing water, if it takes longer, the flow velocity is lower than 0.5 m/s.

Main line and sub-main line

This must be done after the filters have been cleaned. The design of the system must allow capability for a flushing velocity of at least 0.5 meters per second during flushing.

The flushing of the system must be done as follows:

- Fill the system with water and get to the correct working pressure.
- Then begin to flush the main lines.
- Flush the sub-main lines.
- Flushing time must be calculated according to the length and flow speed of the lines.

If necessary clean the main lines, see “Cleaning of the main lines”.

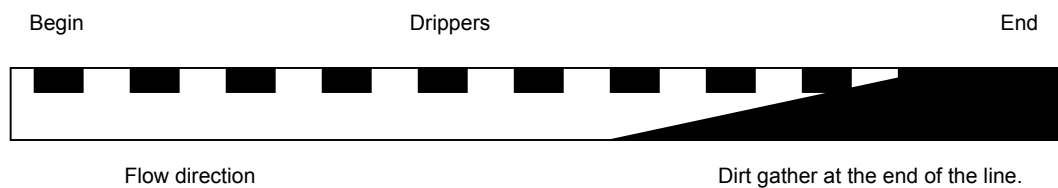
If there is a break in the main line or sub-main line, then follow the instructions for “Break in the main line”.

FLUSHING OF SYSTEMS – GENERAL

Water moves from the beginning to the end of the dripper pipe and the flow within the drip line decreases towards the end, this also means that the flow speed is also drastically reduced towards the end. All dirt in suspension will collect at the end of the drip line.

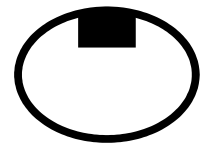
Regular flushing of the system, even without any chemicals will address this problem. Drip lines can be opened and closed three times to bring about a pressure fluctuation, in this manner RAM drippers will go into a self cleaning mode that will flush dirt out of the drippers.

If bacteria and slime begins to form, a chemical treatment must be combined with the flushing of drip lines.



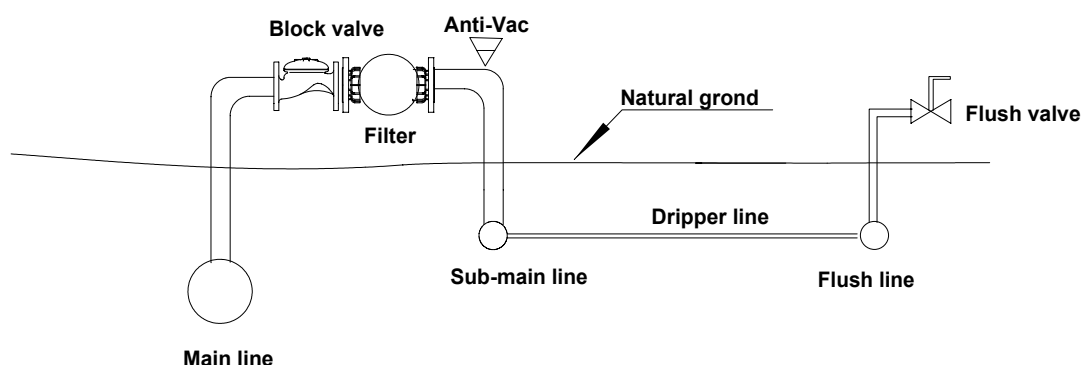
Position

Drip lines collect dirt on the underside of the line and if the dripper is on the top of the line there is a better chance against blockages. This is not practical for above ground systems, but is a requirement for underground systems.



Installation for sub-surface systems

Install the drip lines, sub-main and flushing manifolds at the same depth to prevent vacuum problems.



Rain

During heavy rains silt and sand can enter the drippers and when it dries sedimentation of the dirt in the flow path and can cause blockages of drippers. To prevent blockages one must irrigate after the run-off water has drained, usually one or two days after the rain. This is termed a technical irrigation because washing and not water is necessary.

FLUSHING OF SUB-SURFACE DRIP SYSTEMS

For effective flushing speeds of 0.5 m/s or more are recommended. Pressure regulating valves must be able to be set to increase the pressure during flushing.

Flushing option I:

Flush 1 or 2 drip lines at a time (see “Flushing of systems – General”) as with above ground drip irrigation. The lateral ends must therefore be above ground at the sides.

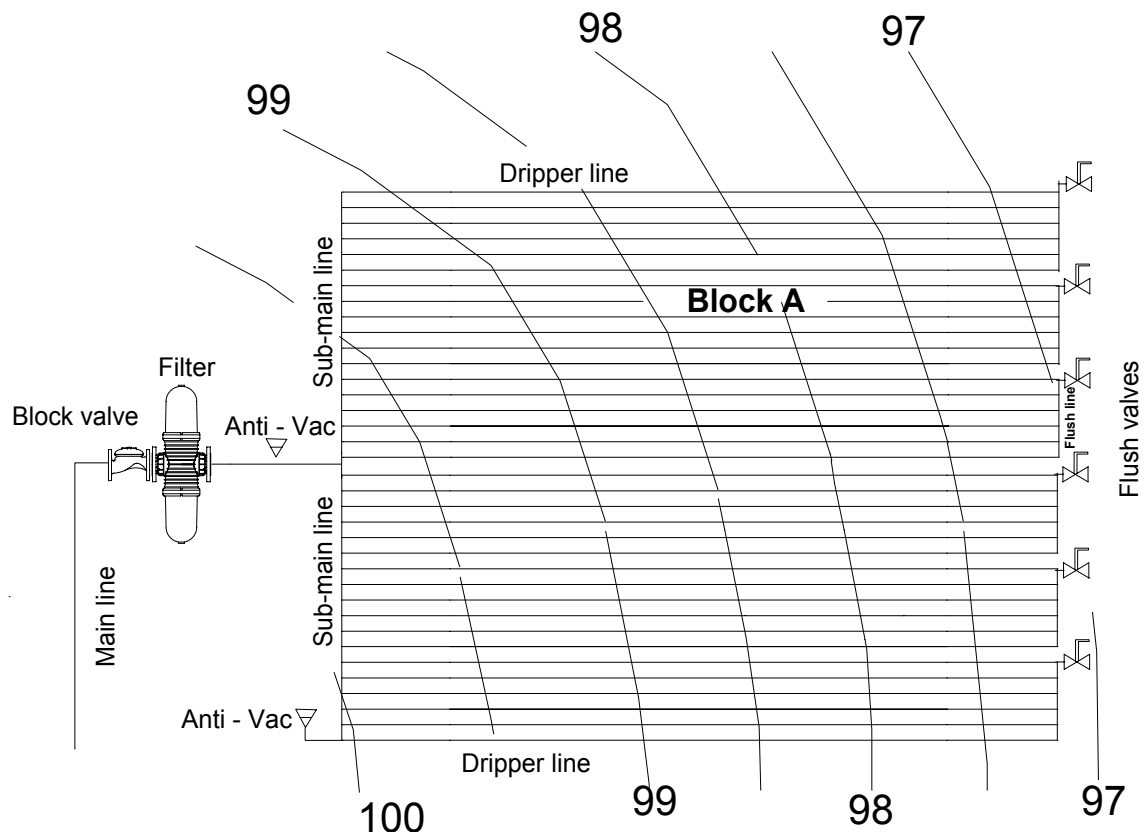
Flushing option II:

Determine the additional flow if the drip line is flushed laterally.

Increase the flow of the irrigation block by 10% to make allowances for the flushing of laterals. Divide this flow by l/hour per lateral (see “Flushing of systems – General”). The answer is the number of laterals that must be combined in a flushing manifold.

Example:

Tiran 16Q, block flow = 20 000 liters per hour (10% = 2000 l/hour) $2000 \div 285 = 7$ laterals. Choose the size of the flushing manifold with only one diameter so that less than 0.5 meters friction loss occurs of the distance (e.g. 32 mm class 3). If the 10% rule gives an answer of more than 10 laterals, ignore this and use only 10 laterals per flushing manifold.

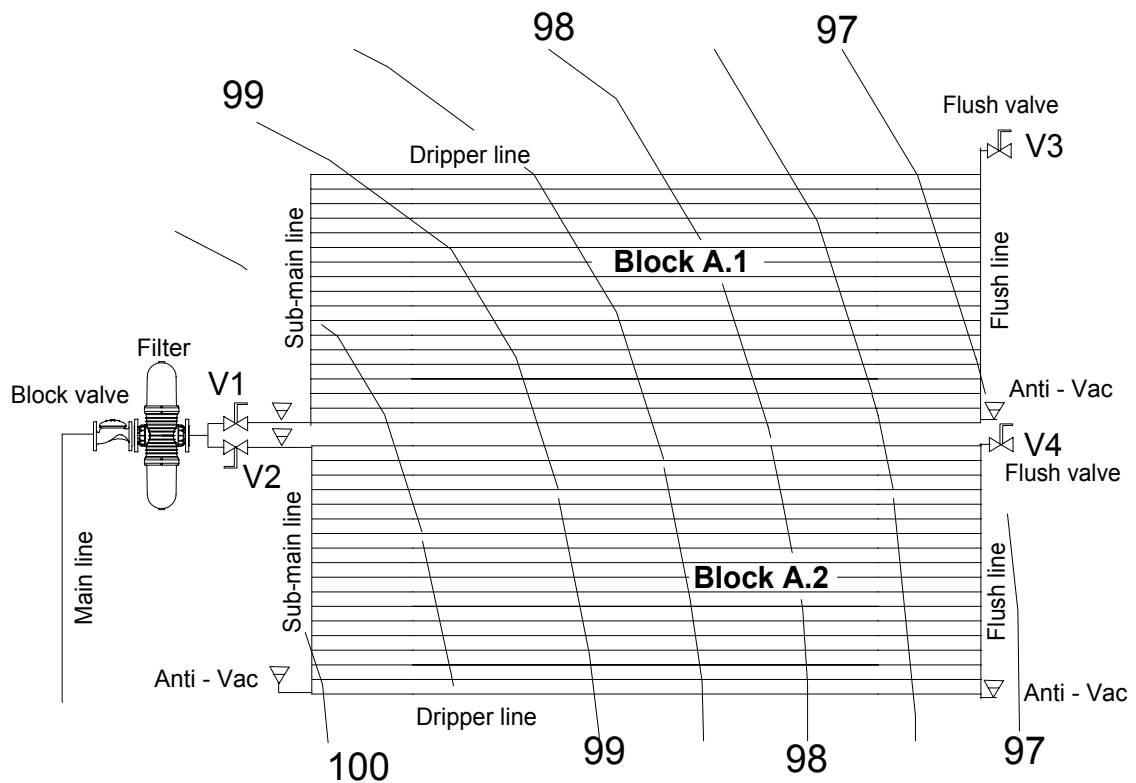


FLUSHING OF SUB-SURFACE DRIP SYSTEMS

Flushing option III:

Divide block "A" in two parts "A.1" and "A.2". During irrigation valves "v1" + "v2" are open and "v3" + "v4" are closed. During the flushing of the system valves "v1" + "v3" are open and "v2" + "v4" are closed to flush "A.1" When the flushing is over in "A.1", "v2" + "v4" are opened and "v1" + "v3" are closed to flush "A.2"

In this case the flushing manifold can be a mirror image of the sub-main. Ensure that the correct diameter pipe is chosen to result in less than 0.5 meters friction loss.



FLOW TIME FOR SYSTEMS

Flow time is the time taken for a drop to move from the injection point to the last dripper.

Table: Flow time in minutes from first to last dripper in the line.

Description	Flow (Liters/hr)	Length of drip line (meters)						
		50	100	150	200	300	400	500
Inside diameter 14.6mm								
Spacing:0.3m	1.2	14.3	16.0	17.0	17.7	-	-	-
	1.6	10.7	12.0	12.8	13.3	-	-	-
	2.3	7.5	8.4	8.9	-	-	-	-
	3.5	4.9	5.5	-	-	-	-	-
Spacing:0.5m	1.2	21.7	24.6	26.3	27.5	29.1	-	-
	1.6	16.3	18.4	19.7	20.6	21.8	-	-
	2.3	11.3	12.8	13.7	14.3	-	-	-
	3.5	7.4	8.4	9.0	9.4	-	-	-
Spacing:1.0m	1.2	37.7	43.4	46.8	49.2	52.5	-	-
	1.6	28.3	32.6	35.1	36.9	39.4	-	-
	2.3	19.7	22.7	24.4	25.7	27.4	-	-
	3.5	12.9	14.9	16.0	16.9	18.0	-	-
Inside diameter 17.5 mm								
Description	Flow (Liters/hr)	Length of drip line (meters)						
		50	100	150	200	300	400	500
Spacing: 0.3m	1.2	20.5	23.0	24.5	25.5	26.9	-	-
	1.6	15.4	17.3	18.3	19.1	20.2	-	-
	2.3	10.7	12.0	12.8	13.3	-	-	-
	3.5	7.0	7.9	8.4	8.7	-	-	-
Spacing: 0.5m	1.2	31.2	35.3	37.7	39.4	41.9	43.6	44.9
	1.6	23.4	26.5	28.3	29.6	31.4	32.7	-
	2.3	16.3	18.4	19.7	20.6	21.8	-	-
	3.5	10.7	12.1	12.9	13.5	14.3	-	-
Spacing: 1.0m	1.2	54.2	62.4	67.2	70.7	75.5	78.9	81.5
	1.6	40.6	46.8	50.4	53.0	56.6	59.2	61.2
	2.3	28.3	32.6	35.1	36.9	39.4	41.2	42.5
	3.5	18.6	21.4	23.1	24.2	25.9	27.0	-

This table shows flow time in minutes for the inside diameter of 14.6 and 17.5 mm, if you have measurements in between these values, you can interpolate. A smaller inside diameter and/or narrower spacing will reduce the flow rate. A larger inside diameter and/or wider spacing will increase the flow time.

Where block valves have a lengthened sub-main (where valves are installed in clusters) additional flow rate must be calculated $\{((\text{distance} \div 1.0 \text{ meters per second}) \div 60) = \text{minutes}\}$.

GUIDELINES FOR THE INVESTIGATION OF PROBLEMS

Steps that must be followed:

- Cut drippers out and see what is causing the problem.
- See “Methods in sample collection of drippers”.
- Talk with the irrigation staff that does the daily operation.
- Check for damage of the pipe and/or drippers.
- Test for iron, manganese, EC (electrical conduction) and pH in the field.
- Take water samples if necessary.
- Test flow of drippers (high or low).
- Mark drippers with problems as reference.
- If fertilizer could be the problem, do a jar test, see “fertilizer – Do’s and don’ts”.

Record the following: (see “Dripper investigation forms”).

- Test for iron, manganese, EC and pH in the field.
- Water source (borehole, river, lake, dam, canal or reservoir).
- Water depth at suction point.
- Suction point
 - distance from surface or bottom.
 - position with respect to inlet and rinse water.
- Filters
 - sand screens.
 - main filter bank, sand, screen or disc.
 - backwash methods, manual, time, volume or pressure difference.
 - manage filter, finger type per valve or communal disc filter.
 - block filters.
 - describe rinse cycle of filters and intervals of cleaning by hand.
- Fertilizer
 - list of fertilizer as well as program.
 - any other products that are pumped through drippers.
- Maintenance
 - rinse, chlorine or acid treatments to be followed.
 - rinse drip line to see if it has been maintained.
- Extent
 - take a look at the extent (% of block/farm) of the problem.
- Where
 - a) last drip line b) last drippers c) first drippers d) general

Action in the case where dirt is causing the problem.

- Give guidelines of maintenance to the producer or sell the Netafim maintenance service.
- Inject by block.
- Record pressure and flow before treatment.
- Test one block with chemicals to see if treatment works.
- Do treatment or treatments.
- Record pressure and flow after treatment.

DRIPPER INVESTIGATION FORM

Farm name: Date:

Owner: Tel:

Block number / name: Fax:

Dripper pipe data (mark with X)						
Product:			Date installed:			
ID numbers:						
ID numbers:						
ID numbers:						
Is the dripper blocked? Yes or No			Is the dripper damaged? Yes or No			
Cause of blockage (mark with X)						
Algae	Salts	Iron	Manganese	Sand	Silt	Other:
Describe other:						
Chemical data						
EC = mS/m			pH = (value)			
Iron = ppm			Manganese = ppm			
Flow (liter per hour) / Pressure (meter) data (see "Methods in sample collection of drippers")						
A1	A2	A3	A4			
B1	B2	B3	B4			
C1	C2	C3	C4			
D1	D2	D3	D4			
Water source (mark with X)						
Borehole	River	Earth dam	Canal	Reservoir	Lined dam	
Other source:			Are there fish in the dam: Yes or No			
Suction data						
Suction depth from surface = meters			Total depth at suction point = meters			
Suction pipe cross section = mm			Suction is positive.....or negative.....			
Foot valve:			Suction sieve:			

DRIPPER INVESTIGATION FORM

Pipeline data (mark with X)		Other	
Suction	Steel, PVC, Poly, Asbestos		
Rising pieces (pump, filter)	Steel, PVC, Poly		
Main-line	Steel, PVC, Poly, Asbestos		
Primary filtering (mark with X)			
Sand screens	Sand	Disc (.....microns)	Screen (.....microns)
Rinse management (mark with X)			
Manual	Time: everyminute for seconds	Volume (.....m ³ /h)	DP (.....Bar)
Rinse water (mark with X)			
Direct to atmosphere	In pipe (.....mm)	Back to dam	Back pressure (.....Bar)
Secondary filtering (mark with X)			
None	Sand	Disc (.....microns)	Screen (.....microns)
Fertilizer (mark with X)			
None	List of products *	Other products *	Do jar test (yes/no)
* Make a copy of program that is followed.			
Extent of problem (mark with X)			
Block:.....% of total block		Farm:.....% of the total farm	
Last drip line	Last drippers	First drippers	General
Maintenance schedule of drippers (mark with X)			
Rinse every....weeks	Chlorinate.....weeks	Acid.....weeks	None
Pressure (end)..... Bar	Flow (end).....l/hr	One or two lines open	All equal
Main-line treatment (mark with X)			
None	Chemical	Physical	
Notes:			

METHODS IN SAMPLE COLLECTION OF DRIPPERS

General

- Purpose of sample: routine investigation or blockage problems.
- Type of system and age of system.
- Water source.

Instructions

- Cut 30 cm pipe with the dripper in the middle.
- In case it is a large area with many blocks, choose just one block for testing.
- If the block have dripper lines left and right of the sub-mainline, mark as follows:
 - - mark left hand side A, B, C en D.
 - - mark right hand side A, B, C en D.
- Sample collection uses the 4 & 5 bases.
 - Drip line 4 & 5 from the beginning and end of the sub-main line.
 - Drippers 4 & 5 from the beginning and end of the drip line.

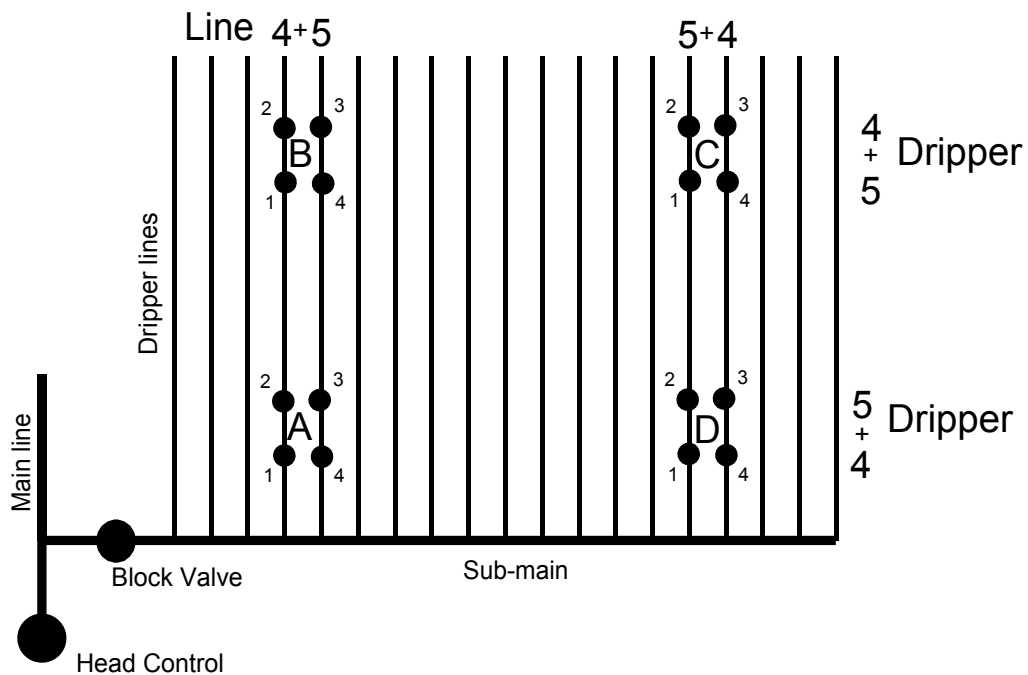


Diagram of sample taking

Notes:

- All samples must be wrapped in wet paper and put in a plastic bag.
- These guidelines are also for "button" drippers. Make sure that the dripper is cut out with poly pipe. Again, 30 cm with dripper in the middle.
- If you cut the drippers for samples as above then use the next set of drippers towards the inside from the cut drippers for flow and pressure test and record on the "investigation form"

REPORT FOR SEVERE PROBLEMS WITH BLOCKING DRIPPERS

Farm name: Date:

Owner: Tel:

Block number / name: Fax:

Instructions









- Choose the block with worse problem and cut 32 drippers as describe on page 5.3.1 “Methods sample collection of drippers” (normally we cut only 16 drippers, thus we will have to cut 8 drippers per position) to do tests to determine if we can clean the drippers and what recipe to use.
- Inline dripper line
 - Cut 30 cm pipe with the dripper in the middle.
- Button drippers
 - Cut 30 cm poly pipe with the dripper in the middle.
- All samples must be wrapped in wet paper and put in a plastic bag.
- Send samples to Netafim Cape Town to Technical Support Department.
- Do a soak test with different chemicals and concentrations.
- Take photos with microscopic camera at NDM.
- See “Results with possible treatment for blocking drippers”.
- See “Dripper investigation form” for detail as require.
- Do flow rate test at NDM before treatment.
- Do treatment with chemicals at Netafim (simulate field injection).
- Do flow rate test at NDM after treatment.

From results

In this example we can see that 10% concentration of HYDROCHLORIC ACID clean the dripper, but is not economical for a in field treatment. The next best results will be between the 0.6% concentration of HYDROCHLORIC ACID and the 200 ppm HYDROGEN PEROXIDE. We can do alternative injection of these chemicals and flush the system before and after treatment.

Alternatively we must remove the dripper line from the field and soak it in a bath (acid proof container) with a 10% HYDROCHLORIC ACID solution and circulate this solution through the dripper lines. After this treatment flush the dripper lines with clean water. This is not practical but we must investigate if this is safe for the equipment and if it is more economical than replacing it with new dripper lines.

RESULTS WITH POSSIBLE TREATMENT FOR BLOCKING DRIPPERS

Number	Product	Concentration	Photo
1	CONTROL (Clean water)	0%	
2	DRIP-A-TRON	10%	
3	HYDROXYL AMMONIUM CHLORIDE (NH ₂ OH.HCL)	10%	
4	CALCIUM HYPOCHLORITE HTH	15 ppm	
5	HYDROCHLORIC ACID (HCL)	0.6%	
6	HYDROGEN PEROXIDE (H ₂ O ₂)	200 ppm	
7	HYDROCHLORIC ACID (HCL)	10%	
8	HYDROCHLORIC ACID (HCL)	10%	

Note: Hydrochloric acid at 10% concentration is not economical or safe for an in field treatment. This is testing a specific result. Combinations of above tests can be done, example from one solution rinse with clean water and then next solution. You can also try other chemicals at concentrations as per manufacturer.