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Drip System
Maintenance Guidelines

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1 Introduction

The drip irrigaton system is the most effective irrigation technology with the most accurate watering uniformity according to plant demand.
The aim of this manual is to present the recommended installation steps and maintenance instructions for the drip irrigation system in order to achieve the best performance for many years.

Proper installation of the drip irrigation system is the first step in achieving this goal, but continuous water quality control and maintenance programs are required to prevent dripper clogging or blockage and faults in the drip irrigation system.

The maintenance guidelines include:

- Water quality classification and dripper clogging causes
- Recommendations for drip irrigation system installation
- Water filtration and chemical treatment for preventing dripper clogging or for cleaning and repairing blockage

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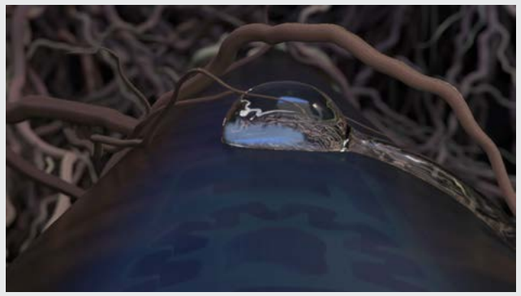
Water Quality for Irrigation & Dripper Clogging Causes

Different water is used for irrigation: borehole water, surface water, saline water, treated wastewater and effluent water. Each type of water carries various concentrations of inorganic and organic dissolved and particulate matter, which might cause dripper clogging or blockage of the irrigation system.
Clogging causes of drip irrigation systems can be divided into three main groups: physical clogging factors, chemical clogging factors, and biological clogging factors.

Physical Clogging Factors

Physical clogging is caused by suspended particles in the water, which have entered the irrigation system from the water source.
The physical clogging factors can be inorganic, i.e., sand particles, mud or clay in the water, or organic that develop in the water source, such as algae, zooplankton and other organisms.



Treating the water source and planning water intake and filtration system properly reduce damage caused by physical clogging. Proper water intake from the water source followed by sand removal by hydro-cyclone and water filtration, combined with proper installation and maintenance of the drip irrigation system prevents the risk of dripper physical clogging, as described in Chapter 5.

Chemical Clogging Factors

Chemical clogging of drippers is caused by dissolved matters in the water, which precipitate or crystallize during the water flow through the irrigation system and clog drippers.

The main chemical clogging factor is calcium carbonate scale. Iron and manganese dissolved in the water precipitate blocking the drippers. Fertilizers added to the water might also cause chemical clogging of the drippers.

Treatment of the driplines and the water for averting scale precipitation (lowering of the pH) or removal of iron and manganese from the irrigation water prevents clogging of the drippers caused by chemical factors as described in Chapter 6.

Biological Clogging Factors

Biological clogging is due to living organisms that develop as biofilm in the irrigation system, pipeline and irrigation equipment. The main biological factors clogging the drippers are microbes, colonial protozoa, mussels, etc.

Routine, continuous, or intermittent disinfection with chlorine or peroxide is necessary to prevent and lessen the damage caused by biological clogging, as described in Chapter 7.

Water Quality Analysis

Water quality analysis needs to be conducted for any new water source to find the potential elements that might harm the drip irrigation system and the crop.

The following parameters should be measured during the water analysis:

PH	**E. C.**	**TSS**	**CHLORIDE**	**SODIUM**
POTASSIUM	**CALCIUM**	**MAGNESIUM**	**CARBONATE**	**IRON**
MANGANESE	**BORON**	**SULPHATE**	**N-AMMONIUM**	**N-NITRATE**
PHOSPHATE	**BICARBONATE**			

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3 Installing of Dripline System in the Field

The dripline system shall include all the components specified in the table below and shown on the drip irrigation system layout (see pages 8-9). The components shall be installed properly to ensure the performance of the irrigation system over time.

Basic components of a drip irrigation system and their function for optimal operation

	Purpose	Inspection and Maintenance
Pump	To supply water at the required flow rate and pressure.	Ensure sufficient pressure for the entire drip system.
Main filter with automatic flushing method	To remove particulate matter that might clog the drippers.	Ensure that the type and the size of the filter corresponds with the water quality and the system flow rate.
Fertigation unit	To inject fertilizers to the irrigation water.	Ensure that type and size corresponds with the fertilizer and the system flow rate.
Chemical injection unit	To inject acid, chlorine or peroxide into the irrigation water.	Ensure type and size to correspond with the chemicals and the system flow rate.
Main pipeline	To deliver water from the pump station to the field.	Ensure that the pipe diameter corresponds with the system flow rate with a reasonable head loss.
PRV and air release valves	To adjust the system pressure and to prevent the risk of water hammer.	
Sub-main and distribution pipes	To deliver the water to the field blocks and to the driplines.	Ensure that the pipe diameter fits the system's flow rate with reasonable head loss.
Field/check filter with manual or semi-automatic flush	Field water filter with manual or semi-automatic flushing to prevent dripline blockage.	Flush the filter to prevent head-loss in the driplines. Check the main filter in cases where the check filter clogs too often.
Dripline wall thickness	Choose the dripline wall thickness according to the water pressure.	Ensure that the pressure in the driplines does not exceed the recommended value to prevent lateral bursting.
Mechanical dripline laying	To prevent any physical damage to the dripline during mechanical laying.	Check the machines to ensure there are no obstacles or dripline harming.
Dripline laying	Lay the drippers on the top side of the dripline to reduce dirt accumulation in the dripper inlet filter.	Lay a flat dripper dripline with the emitters facing up.
Lateral ends flushing method	To enable lateral flushing to remove sediments from the dripline.	

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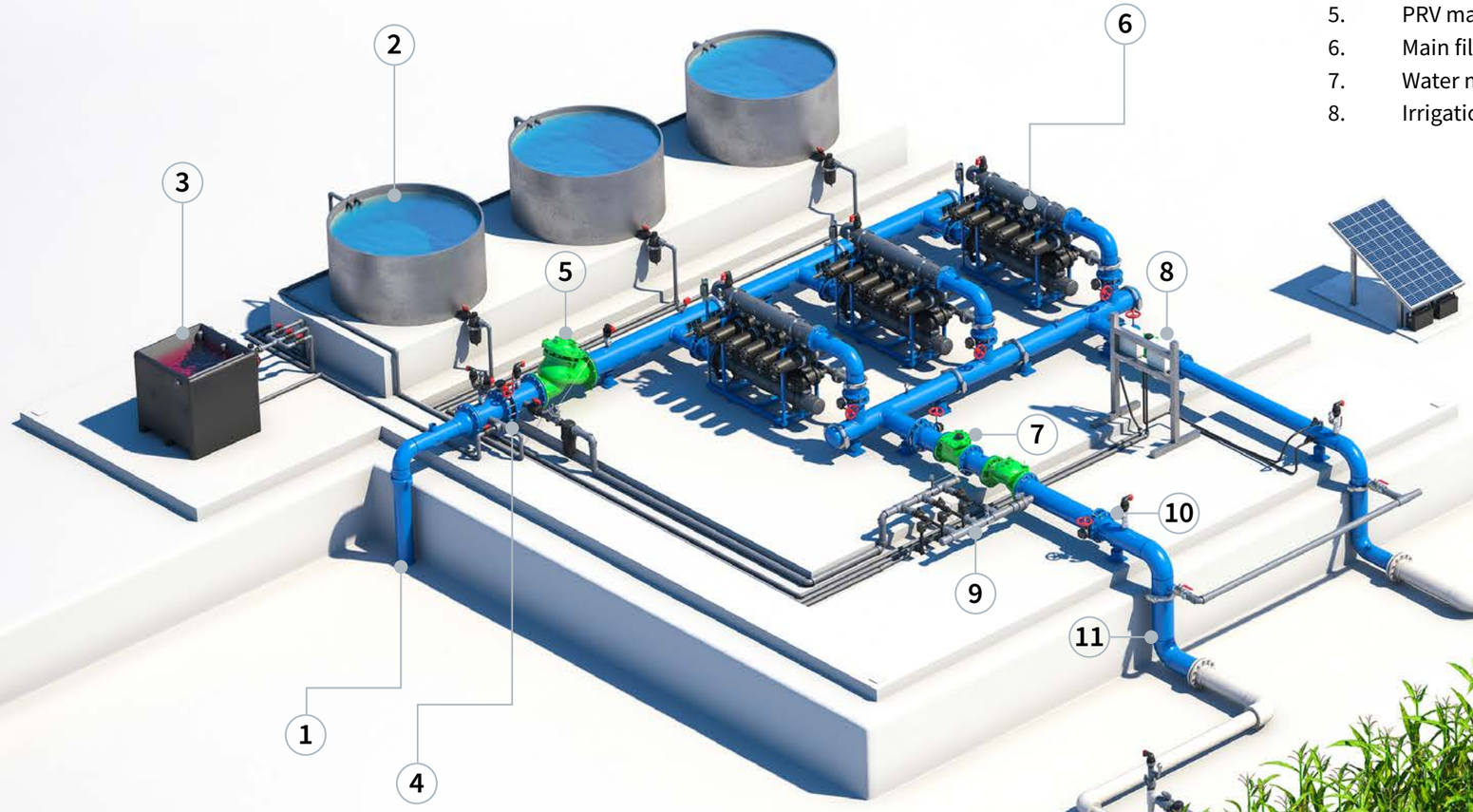
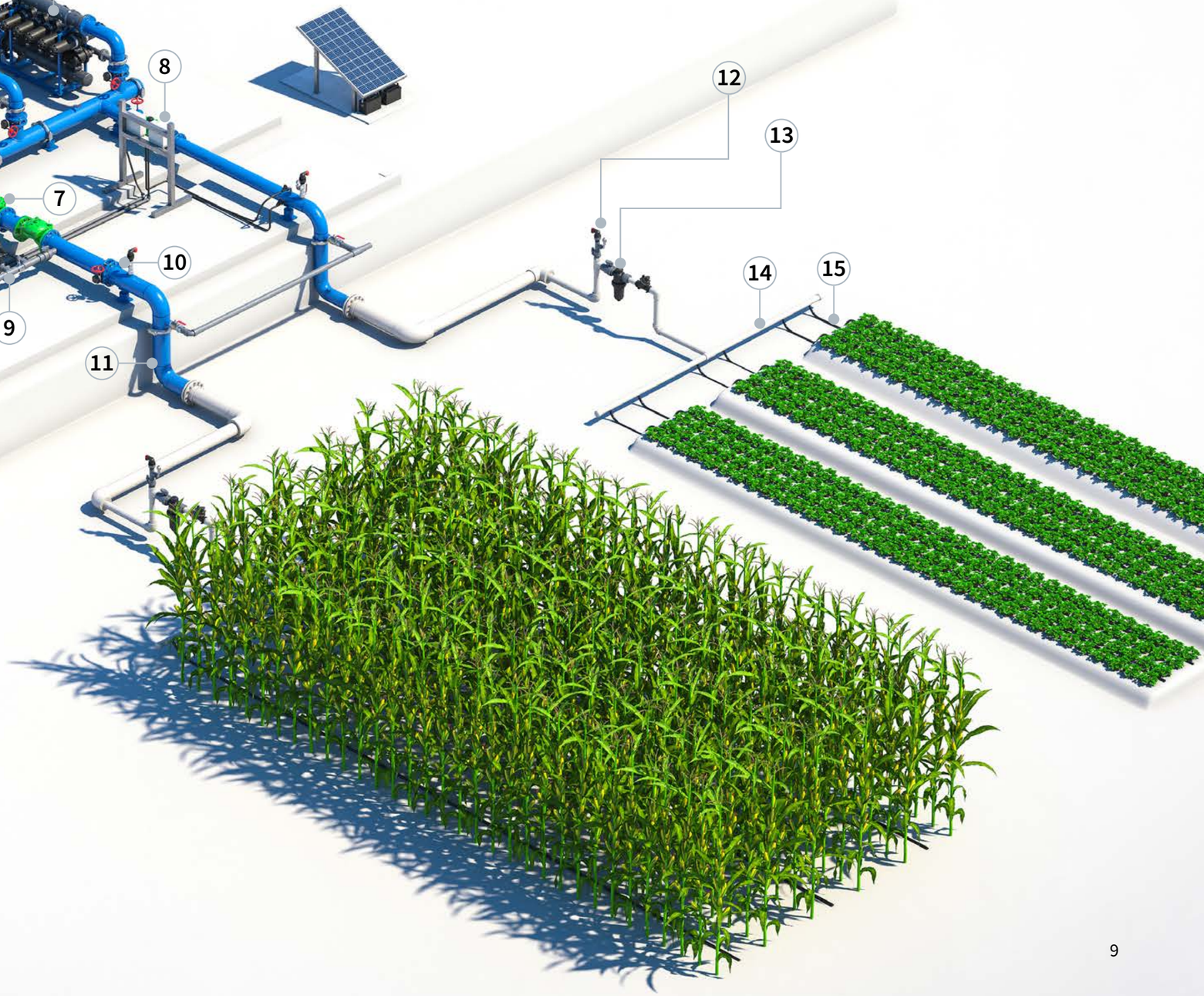
Drip Irrigation System

1. Inlet from pump
2. Fertigation tanks
3. Chemical tank
4. Main inlet valve
5. PRV main valve
6. Main filter with automatic flushing
7. Water meter
8. Irrigation controller
9. Fertigation unit
10. Main outlet valve
11. Main outlet pipe to the field
12. Air release valves
13. Field/check filter
14. Sub-main and distribution pipes
15. Dripline (lateral)





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4 Dripline System Monitoring and Maintenance Procedure

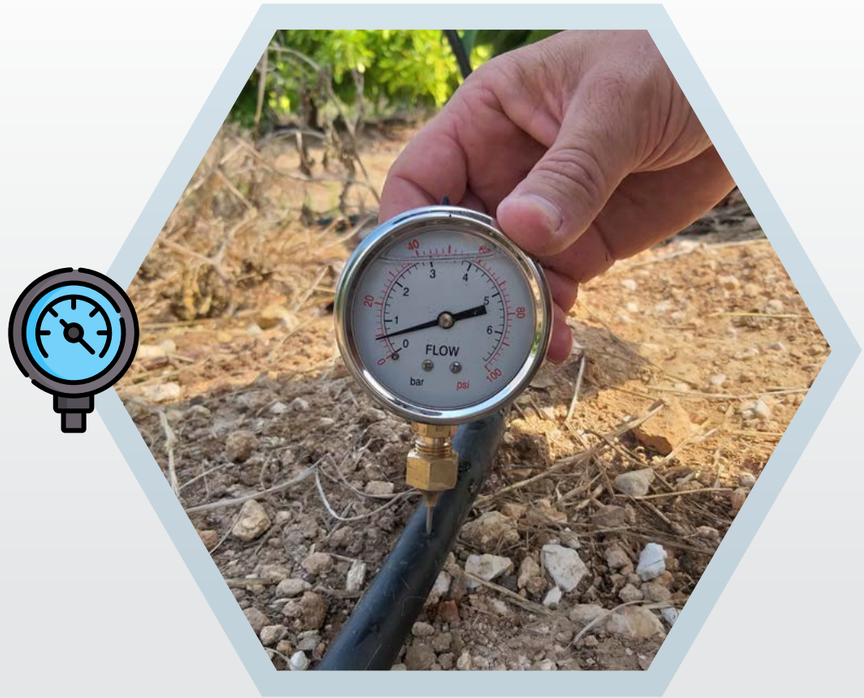
Monitoring and maintenance procedure of the dripline system is imperative to ensure the system's performance over time and to prevent technical failure of the system. Some of the monitoring can be done automatically by the drip irrigation controller and alarm at any deviation of the set point value.

Proper operation and maintenance program of all the components is essential to the longevity and reliability of the drip irrigation system. It includes the following points:

- Regular checking of all the irrigation components (pumps, filters and driplines/pipes).
- Special attention should be given to the filtration system.
- General awareness of all the dos and don’ts of a drip system installation.
- Regular flushing of sediment from the pipes and the laterals.
- Chlorination or hydrogen peroxide treatment.
- Occasional acid treatment to dissolve any chemical deposits.

System Pressure

The best indication of proper operation is securing the system working according to the pressure limits specified in the product's technical documents.
System pressure should be checked at the ends of laterals and sub-mains.
Minimum and maximum recommended pressures must be adhered to.



Pressure-compensated drippers have a minimum pressure limit below which they do not regulate properly. Check the relevant technical data sheet for the dripper model you are using and do not operate the system above or below the pressure limits.
It is necessary to design the system to maintain minimal and maximal pressure as mentioned in the technical sheets.
In order to allow efficient lateral flushing at lateral ends, pressure at the lateral open ends should be at least 5-8 m or higher.

System Flow Rate

Flow rate is usually measured using a water meter at the water supplying point, or the pump station, at the head of the irrigation system. The system flow rate must correspond with the designed flow rate and any significant change is indicative of operation failure, e.g., a flow rate increase indicates pipe bursting and a flow rate drop indicates valve opening failure or dripper blockage.

The flow rate of the system should be monitored throughout the season. It is important to operate the system according to the designed flow rate and pressure ranges to ensure accurate irrigation.

Field Valves

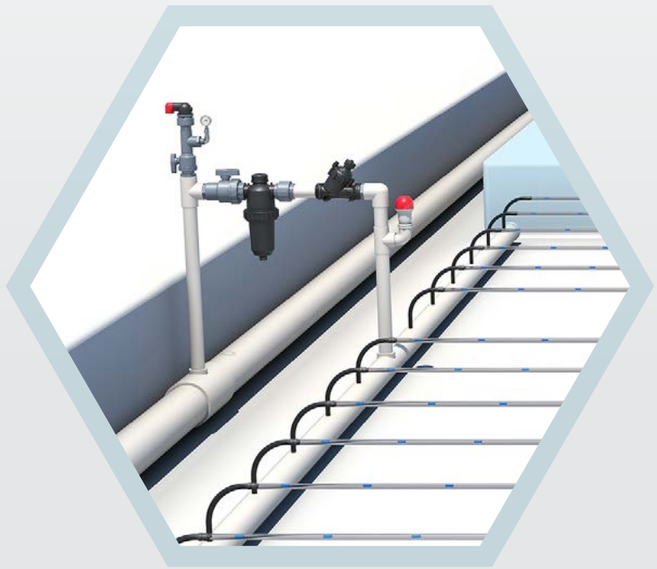
It is advised to install and use Pressure Reducing Valves (PRV) to ensure pressure control downstream the field in order to keep the pressure entering the sub-main pipe in accordance with the design.

Sub-Main Pipes

Sub-main pressure should be in accordance with design. Low pressure might be caused by blocked field filters, deterioration of or faulty pumps, opening too many field valves at the same time not in accordance with the hydraulic design, incorrect system design and additional causes which should be checked.

System commissioning and operating the system for the first time.

- Flush all pipes – main pipeline, sub-mains and delivery pipes.
- Flush drip laterals in groups, not all together.
- Measure actual flow rate and working pressure for each shift (after the system is working for at least 30 minutes or more).
- See correspondence between the measurements taken and the system design.
- The results obtained should be documented and used as a starting point for future comparisons.
- Consult the system installer or supplier if the flow rate and/or pressure measurements diverge the designed parameters by more than 5 %.



Pump Check and Inspection

- Make visual for all components. Check for leaks at inlet and outlet points and corrosion from the pump base and other construction elements.
- See that the pump environment is clean. Keep it clear from unnecessary objects.
- Check the inlet device to the pump; see that it is clear of objects that may cause blockages.
- Make sure the electrical supply system and devices to the pump are properly isolated and protected from moisture in addition to other interferences such as animals and pests.
- Listen to the sound of the pump and ensure it is free of hisses and irregular vibrations or any other indicative symptoms of problems.
- See that pressure and flow rate are in accordance with the technical sheet.

Routine and periodic inspections and measurements: once a week, month or according to needs.

- Check and measure flow and pressure and compare the results to the documented data from the first operation. Conduct such operations for each irrigation shift.
- Make sure water is clean and check the pressures at the end of the laterals. The pressures should be within the possible pressure range of this dripper lateral.
- Check the pressure difference at the head control of the system. If the pressure drop is higher than 10 m or more than the system design, check possible causes for the pressure decrease: pipe burst, filter blockage, valve failure, etc.

Once a season or according to needs, in addition to the monthly inspections. According to the performance of the system, you may need to check more often during the irrigation season.

- Flush the mainlines and sub-main pipes.
- Flush dripper laterals.
- Check proper performance of all manual and hydraulic valves.

At the end of the irrigation season flush all pipes.

- Drain the water from all the system components at areas where temperature may drop below 0.0 Celsius.
- Inject chemicals and flush lateral pipes.
- Take all necessary measures for an inactive period between irrigation seasons. See more details in Chapter 9.

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5 Water Quality and Water Treatment Requirements

Water quality is a major factor that affects the blockage of filters and drippers. It is mandatory to control water quality and water treatment in order to ensure proper performance of the drip irrigation system. Irrigation water sources are varied and include surface water (rivers, lakes, canals and irrigation reservoirs), groundwater of springs and boreholes and treated effluent water. The water quality of each water source needs to be analyzed to determine its effect on the soil, the crop and the irrigation system. The major clogging causes of drip irrigation systems are physical, chemical and biological.

Physical blockage is caused by inorganic and organic particles (such as silt and sand, or algae and zooplankton) that come from the water source and clog the water passages of the irrigation system.

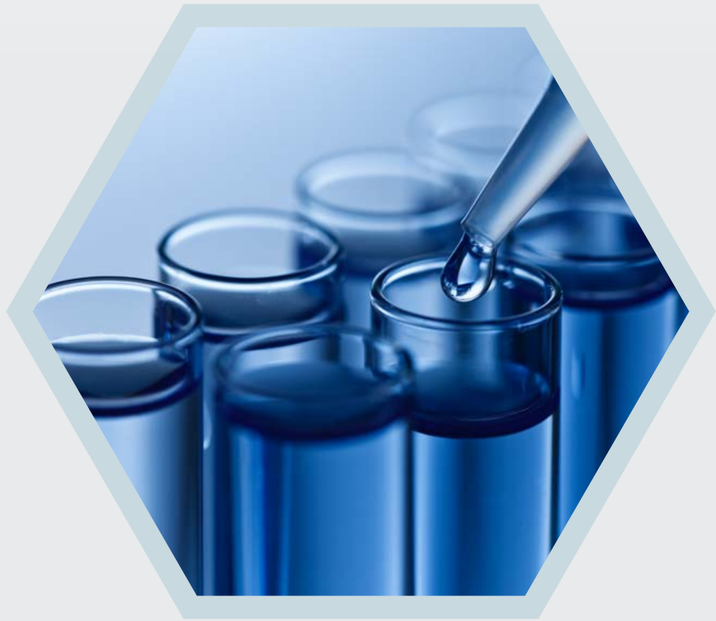
Chemical blockage is caused by dissolved elements in the water source that precipitate within the irrigation system (such as calcium-carbonate, iron and manganese) and block the drippers.

Biological clogging is caused by organisms (such as bacteria, colonial protozoa and mussels) that grow inside the irrigation system and their biomass blocks the water passage.

Summary on clogging types and hazard levels.

Clogging Type	Clogging Hazard Level		
	Low	Moderate	Severe
Physical:			
TSS (Total Suspended Solids)	< 50 ppm	50-100 ppm	> 100 ppm
Chemical:			
pH	< 7	7- 9	> 9
TDS (Total Dissolved Solids)	500 ppm	500-1,500 ppm	> 1,500 ppm
Iron	0.1 ppm	0.1-1.5 ppm	> 1.5 ppm
Manganese	0.1 ppm	0.1-0.5 ppm	> 0.5 ppm
Calcium	10 ppm	10-50 ppm	> 50 ppm
Carbonates	100 ppm	100-200 ppm	> 200 ppm
Biological:			
Bacterial population per cm^3	10,000	10,000-50,000	> 50,000

Water filtration, dripline flushing and chemical injection (acids, chlorine or peroxide) are needed to protect the blockage of the drip irrigation system. Intensity and frequency of water treatment directly depend on clogging hazard level.



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6 Filtration and Filter Maintenance

The filtration system is designed to remove from the water large particles that might block the drippers' water passages. For drip irrigation systems, the following water filtration rates are generally followed: 130 micron/120 mesh for most of the drippers and of 100 micron/140 mesh for drippers with a flow rate less than 0.9 l/h. The degree of filtration depends on water quality, dripper type and application.

Take note of the specification of the drip model you are using and consult Metzer representatives when in doubt.

The water filtration system is composed of a main automatic filter (screen, disc, or media filter) that is usually installed at the pump station or the gate of the farm and of field or backup filters (manual or semi-automatic, screen or disc filter) that are installed at the head of each irrigation block.

Note

The following instructions are only general guidelines. Each filtration system has specific maintenance and operation instructions. Read carefully maintenance requirements and always follow manufacturer's instructions for the specific system used.

Main filtration systems use 3 filtration methods:

It is highly recommended that the main filtration systems are operated automatically, and filter washing and cleaning-system control is activated automatically by a designated controller and does not depend on manual operation. This will ensure reliability and accuracy of filters washing and cleaning, as well as logging of system performance data.

The automatic washing and cleaning controller will operate the cleaning process once it arrives at a set differential pressure (usually 0.5 bar, 7 PSI), or at set time intervals. The best and immediate indication of filter efficiency – the difference between inlet and outlet pressure. Pay close attention to those pressures during the irrigation season. Routine pressure differences shall be in the range from 3 to 7 meters at normal operation.

If the system requires flushing/cleaning very often or continuously, it may point to the system malfunction: exceeding flow rate, excessive dirt load to the filtration system or other problems, which shall checked with manufacturer instructions and system design.

Caution

Before attempting to remove filter cover, make sure the filter isolation valve is closed and all internal pressure has been released. Make sure there is no water under pressure in the filtration system. Attempting to remove the cover while under pressure can result in serious injury or death.

Maintenance of Media Filtration Systems

Read the manufacturer instructions and proceed accordingly.

The following operations shall be carried out at least at the beginning and end of each irrigation season:

- First release all pressure from the system! Drain water from the filtration system.
- Inspect media/sand levels in the tanks – the level shall not be lower than indicated by the manufacturer.
- Inspect for contaminates, identify their nature (organic or inorganic) and treat accordingly. Periodical treatment with sodium hypochlorite might be required according to manufacturer instructions.
- Check that media is not stuck together in blocks and is loose and clean.
- Try to observe (from above) if there are channels allowing water to flow without utilizing the entire surface area of media/sand.
- Remove backup filter elements, inspect for contaminates or any media particles that may be passing through the filtration elements at the bottom of the tanks. Treat or repair accordingly.
- Run manual flushing cycle and check that no media particles are flushed out through the flushing outlet. If particles are flushed out, the flow control valve on the flushing outlet shall be adjusted.
- Run fully automatic flush cycle. Do it twice at relatively close intervals.
- Ensure the control system of flushing and cleaning is working properly.

Maintenance of Disc Filtration Systems

Read the manufacturer instructions and proceed accordingly.

The following operations shall be carried out at least at the beginning and end of each irrigation season:

- First release all pressure from the system!
- Open the covers and inspect the condition of the discs. Take note of accumulated organic or inorganic sediments and build-up, deformed discs, gaps between discs, material accumulated between discs, etc.
- In case of organic or inorganic sediment and build-up, cleaning the discs with acid or sodium hypochlorite might be required. Follow manufacturer instructions.
- If dirt on the discs remains after the automatic cleaning, perform manual cleaning.
- Run fully automatic flush cycle.

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Maintenance of Screen Filtration Systems

Read the manufacturer instructions and proceed accordingly.

The following operations shall be carried out at least at the beginning and end of each irrigation season:

- First release all pressure from the system!
- Open the cover and remove the screen and suction nozzle assembly.
- Inspect the condition of the screen and make sure it is intact without holes or tears. Take note of accumulated organic or inorganic sediments and build-up. If needed, follow manufacturer instructions on seasonal cleaning of the screen.
- Inspect the condition of the suction nozzles. Look for broken or worn-out nozzles which should be replaced.
- Run fully automatic flush cycle.
- Visually check the integrity of the screen and other filter components. Make sure there are no tears, splits, ruptures and cracks.

Secondary Field (Backup) Filters

Field filters, or secondary filters, are installed in the field close to the irrigated blocks and are used as a secondary safety measure protecting drippers from the main filtration system failure or downstream dirt intrusion. The filters are located usually near to the field valves.

The field filters of different types, shall be cleaned after every irrigation cycle.
Poor maintenance of the field filters might result in loss of pressure and flow in the sub-mains and the driplines and cause drippers blockage. Field filters incorporate a screen element or disc element.

Each filter type has its own specific cleaning method by means of manual or semi-automatic flushing. Filter cleaning shall be carried out according to the manufacturer instructions only.

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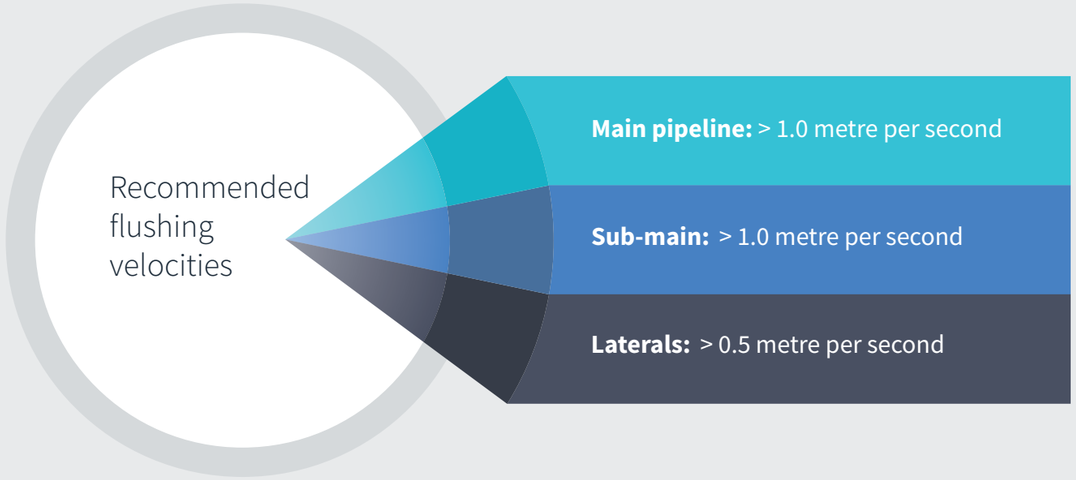
7 Flushing Drip Laterals and Distribution Pipelines

Lateral flushing is the basic maintenance procedure and must be executed regularly. Laterals shall be flushed at the beginning and the end of every irrigation season and during the season at intervals depending on water quality and amount of dirt that accumulates at the end of laterals.
To flush the laterals efficiently with sufficient flow velocity, it is advised to apply the highest possible pressure allowed according to the drip pressure rating and open the lateral ends in small groups and not all simultaneously.

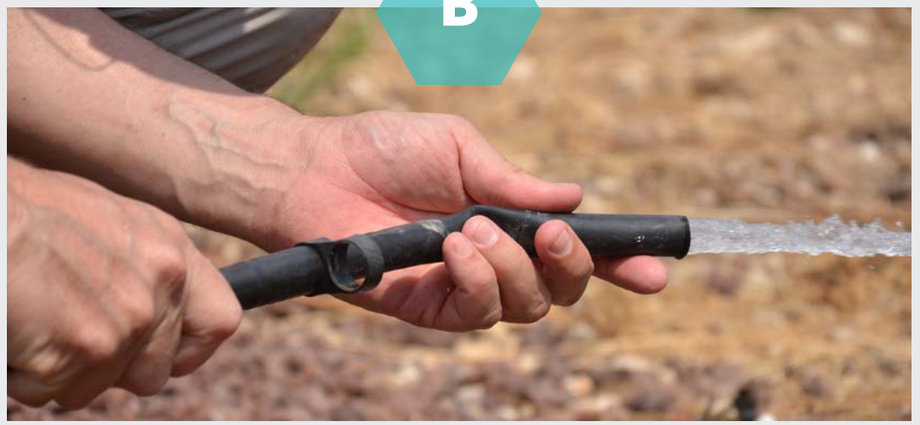
The recommended flushing flow velocities are:



Each lateral should be flushed until the water exiting the lateral end is clear, or at least has the same colour and turbidity as the water entering the system head control.
It is recommended to flush the sub-main lines and the main lines at least at the beginning and the end of each irrigation season and also during the irrigation season according to the water source and water quality.

A

B



Important note

Flushing the dripline laterals is very important to prevent drippers blockage and dirt accumulation within the driplines.

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Chemical Injection for Preventing Drippers Clogging and Curing Blocked Drippers

Injection of acid or oxidants prevents accumulation of chemical precipitates and organic slime in drip irrigation. Acid injection reduces the pH of the water to prevent precipitation of calcium-carbonate and other chemicals and at a higher concentration dissolves calcium-carbonate scales, iron and more precipitates in the drippers.

Oxidant injection, such as chlorine or hydrogen peroxide prevents biofilm development in drippers and laterals, and at a higher concentration assists in removing the biofilm build-up from clogged drippers and cleans the blocked system.

Prevention treatment is always preferable over a cure treatment. It saves chemicals and keeps the irrigation system clean, it is also cost effective and has less environmental impact.

Chlorination and Hydrogen Peroxide Injection

Chlorination

Chlorine is a strong oxidating agent that prevents the development of bacterial and organic biofilm slime and oxidizes reduced elements, such as iron, manganese and sulphide, that prevent the development of iron and sulphur bacteria. Chlorination also assists the filtration and filter flushing in low quality water with high organic loading.

Warning

Chlorine material (liquid, solid or gas) is a dangerous chemical.
Before using chlorine, read all safety instructions provided by the manufacturer.
Never mix or store chlorine with fertilizers or acids to prevent explosion!

There are 3 chlorination methods:

- Continuous chlorination
- Intermittent chlorination
- Curing, or system-cleaning chlorination

Continuous chlorination is carried out throughout the entire irrigation system from the water source without interruption. The chlorine concentration shall be low. The injection rate shall be such that active chlorine reaches the farthest drippers in the field.

Intermittent chlorination is carried out as continuous, but only for several hours every week or so (varied between from daily to fortnightly according to water quality) at a slightly higher injection concentration than the continuous chlorination.

Curing or system cleaning chlorination is carried out to clean blocked drip irrigation system, it requires much higher chlorine concentration (more than 10 times). Chlorine is injected for several hours separately to each field.

Intermittent chlorination is the most recommended chlorination method to keep the irrigation system free of organic contaminants and to prevent overuse of chlorine.

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General Operation Points for Intermittent Chlorination

- Injection point: recommended before the main filter to assist filter flushing.
- Chlorine dosage definition: 5-10 ppm chlorine concentration of is most common for intermittent chlorination. Start the chlorination at 5-10 ppm and check the chlorine level at several points up to the last dripper. Adjust the injection concentration according to the measurements to ensure active chlorine reaches the most remote dripper in the field.
- Chlorination frequency: chlorination frequency shall be determined according to the irrigation design to ensure that chlorinated water is supplied within all irrigation shifts in the planned chlorination cycle (once a week, or from daily to fortnightly).
- Chlorination duration: chlorination duration of 2-4 hours is recommended for each chlorination cycle.

Calculation of the Injection Rate

Check the irrigation system flow rate, if possible, with a flow meter.
For this calculation example, assume the following data:

- Irrigation flow rate: 100 m^3/h
- Chlorine (sodium hypochlorite) concentration: 10%
- Desired treatment concentration: 10 ppm

Use the following equations to calculate the chlorine injection rate:

$$\textbf{Injection rate (l/h)} = \frac{\text{desired concentration (ppm)} * \text{flow rate } (m^3/h)}{\text{concentration (\%)}}$$

$$\textbf{Injection rate} = \frac{10 * 100}{0.1} = 10 \text{ l/h}$$

The total quantity of chlorine required for each chlorination cycle is calculated by multiplying the injection flow rate by the duration of the chlorination cycle.

General chlorination recommendations:

- In this example we have estimated the travel time from the injection point to the end of the furthest lateral to be 30 minutes and aiming for a residual level of 5 ppm, so at this stage the residual level needs to be examined at the end of the furthest lateral and the injection rate shall be adjusted if required.
- Before commencing chlorine injection, flush all pipelines: main, sub-mains and laterals.
- At the end of the injection period allow the system to stand for 2 hours and then flush all the pipelines: main, sub-mains and laterals again in this order.

Safety Precautions

Read carefully and follow all manufacturers' instructions. Ensure that proper protective clothing, breathing apparatus and goggles are worn at all times when handling chlorine or any other hazardous chemical.

Injection of Hydrogen Peroxide (H_2O_2)

Hydrogen peroxide is the strongest oxidant with friendly environmental by-products of oxygen and water. The oxidation reaction of hydrogen peroxide is very rapid with a very short retention time in water.

Hydrogen peroxide injection recommendation:

- The technology of hydrogen peroxide is almost similar to the above chlorination principles.
- The recommended concentration of hydrogen peroxide injection must be 3-5 times higher than the chlorine because of the rapid oxidation and the short retention time of H_2O_2 in the water.
- Use the above calculation instructions of the chlorination for hydrogen peroxide injection.

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9 Acid Treatment

Safety precautions

Acids are dangerous and highly toxic. It is critical to read carefully and follow all the manufacturer instructions. Ensure that proper protective clothing, breathing apparatus and goggles are worn at all times when handling acids.

Acid is used to clean mineral deposits from pipes and drippers that have accumulated in the system over time. These minerals have precipitated naturally from the water or by use of incompatible chemicals or fertilizers. Acid treatment may also be used to improve physical and chemical properties of your soils and fertilizers absorption by the plants.

Types of acid used:

- Hydrochloric acid 33-35 %
- Sulphuric acid ~ 90 %
- Phosphoric acid 75-85 %
- Nitric acid ~ 60 %

Acid treatment is used to dissolve such deposits as:

- Carbonate precipitates of calcium or magnesium
- Iron deposits
- Manganese deposits

Methods of Acid Treatment

There are 3 types of acid treatment for keeping the drip irrigation system free of chemical blocking. Acid treatment reduces the water pH to prevent precipitation of chemical deposits or to clear the system from such deposits.

Continuous acid treatment
Decreasing the water pH below the saturation concentration of $CaCO_3$. Usually pH level of around 5.5-6.5 is sufficient to prevent carbonate precipitation.

Intermittent acid treatment
To dissolve and remove new carbonate and iron precipitates from the drippers and the laterals.
The ph decreased to 3-4 (a concentration of 1-1.5g/L of Hydrochloric acid 35%) for about 2 hours treatment, every week to every 3 months.

Curing or acid treatment for system cleaning
The treatment is done when drippers are found to be blocked by carbonates, iron or manganese. The pH of the water is reduced to a level of 2-3 for 0.5-2 hours of treatment. Acidic water stays overnight in the driplines, the following morning the driplines are flushed.

Corrosion

Acids are corrosive to iron and other types of metal pipes. PVC and polyethylene are resistant to acid. Always flush the system after the acid treatment in order to prevent damage from acid remaining in the pipes after the treatment.

Calculations for acid injection

Calculation of injection time

In order to estimate the injection duration time required for the acid solution to reach the furthest point in the proposed blockage, calculate the distance from the location of injection to the furthest lateral, e.g., 600 m.

Assume the average velocity is 1 m per 3 seconds.
Add 5 minutes for the acid solution to run through the dripper.

Time required = 600 * 3 seconds = 1800 seconds or 30 minutes
Minimum duration of injection = time required + time to run through drippers
Minimum duration of injection = 30 minutes + 5 minutes = 35 minutes

Acid dosing calibration for irrigation water

Conduct a titration test on 200 litres of water to measure the required amount of acid required to lower the pH.

- Fill the water tank with water to a level of 200 l and measure the pH of the water.
- Start adding a measured and recorded amount of acid until water pH starts to decrease.
- Continue adding small amounts of acid to lower the water pH reaches a value of 2. Record the amount of acid used.

For the sample calculation let's assume that you used 120 ml of acid to lower the pH to a value of 2 in 200 l of water. In order to calculate the amount of acid necessary for treating 1000 l (1 m^3) of water you need to multiply 120 ml by 5:
120 ml * (1000 l / 200 l) = 600 ml per 1000 l (1 m^3).

Let's assume the field flow rate is 31 m^3/h.

Calculation of acid amount

Acid concentration (ml/m^3) * water flow rate (m^3/h) = 600 ml/m^3 * 31 m^3/h = 18,600 ml/h = 18.6 l/h
Total quantity of acid required for 35 minutes injection = 18.6 l/h * (35 minutes / 60 minutes) = 10.85 l.

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10 Control and Monitoring of the Irrigation System

The irrigation control system is an important operational component of the irrigation system and shall be checked and monitored regularly.
The main criterion of the control system correct operation – irrigation is conducted according to the irrigation program.
Make certain at the beginning of the irrigation season that the various components are operating according to the program of the irrigation controller.
Make sure that the field valves open in the field according the controller's commands.
Ascertain that the (electric) power source is working properly and that the required electrical voltage is properly and regularly supplied.

Monitor and check if the irrigation flow rate, pressure and the time of the irrigation shift meet with the irrigation program. Any change is indicative of a fault in the irrigation operation and the reason must be observed and repaired.
At the beginning of the season, see that the program saved from the previous year is compatible with the tasks of the present new irrigation season and update the data as needed.

Inactivity period

If the drip system is shut down and stays inactive for 60 days or more, the following steps shall be
carried out:

- Run chemical injection.
- Flush all the pipes: main, sub-mains and dripline laterals.
- Prepare the pump and disconnect the electricity. In some cases, remove the pump from the site.
- Run a filter cleaning/back flushing.
- In frozen climates, drain water from the pump and the pipes, and all the accessories.

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