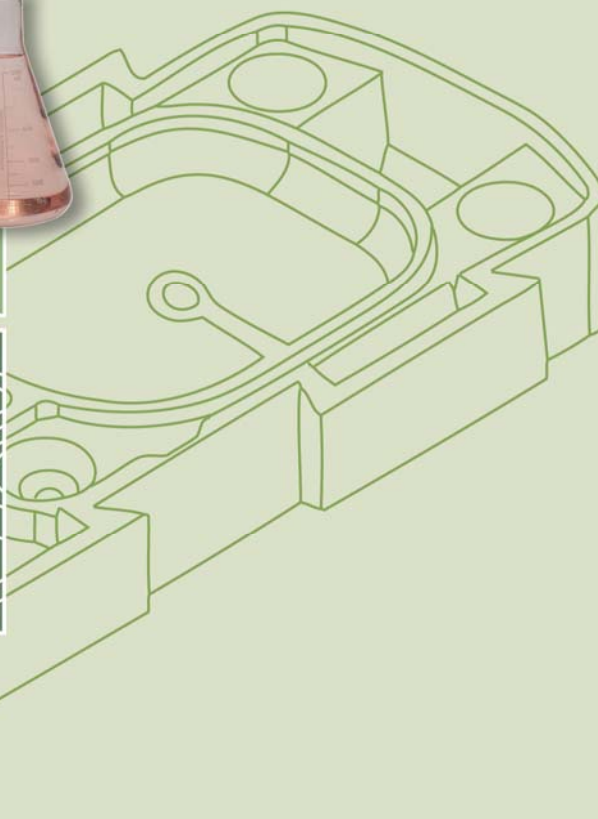


Preventive & Routine Maintenance Guide



Technical Library

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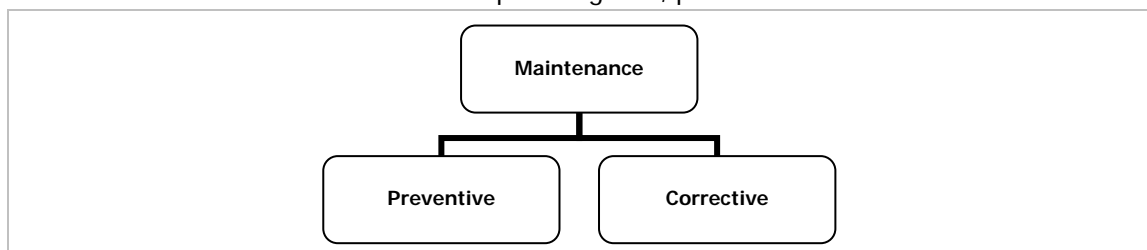
Chapter 1 Introduction

Drip systems maintenance is a very important tool to help keep your system running at peak performance and increase the life expectancy of your drip system.

This can be achieved by implementing a simple but strict maintenance program. The following chapters will help you choose the correct procedure and guide you through implementation.

The best way to determine whether your maintenance program is working is by constantly monitoring and recording your system flow rates and pressures and comparing it against data recorded after installation. If similar flow rates and pressures are maintained your maintenance program is effective.

Drip Maintenance can be divided into two simple categories, preventive and corrective.



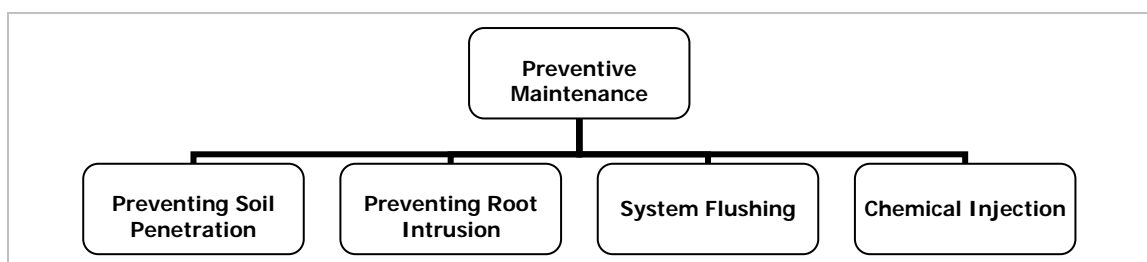
Preventive maintenance is a procedure or group of procedures to prevent or inhibit obstructions from plugging, clogging or blocking your drippers, providing that these procedures are conducted accurately.

Corrective maintenance is a procedure to remove the obstruction that has caused the dripper to be blocked. This is a very dangerous position to be in because not all obstructions can be removed and the required treatment is aggressive and might damage other system components.



Netafim always recommends Preventive Maintenance as it will improve system performance and prolong system life expectancy. Corrective Maintenance should only be used as a “last resort” when system performance is compromised due to lack in Preventive Maintenance.

This document will focus mainly on Preventive Maintenance, which can be further divided into four categories:




Chapter 2

Preventive Maintenance for Drip Systems

General Guidelines

This chapter provides general guidelines for diagnosing common problems in drip systems as well as instructions on how to take samples from dripperlines and water sources.

Sampling Dripperlines

 In order to diagnose dripperline problems, complete a Netafim QA01-01 Incident Report and follow the instructions outlined below.

1. When the area is comprised of several plots, take a sample from a representative plot;
2. The minimum requirement for a sample is 30 cm (15 from each side of the dripper hole), nevertheless Netafim recommends taking samples comprising of at least three drippers, this allows to perform accurate flow tests if required (See Figure 1 for further info);
3. At least one of the dripper samples should include the serial number imprint;
4. Samples should be taken from a representative area; if the effected area is visibly noticed, take the samples from that area, otherwise it is recommended to take samples from the end and the beginning of the lateral (See Figure 1 for further info);
5. Take 16 dripperline samples as per above instructions;
6. Wrap the samples tightly with wet paper and place in a plastic bag;
7. Liaise with your local Netafim Dealer to send samples for analysis;
8. Repair the pipes in the field.

note

These instructions are suitable for both Integral and Online drippers.

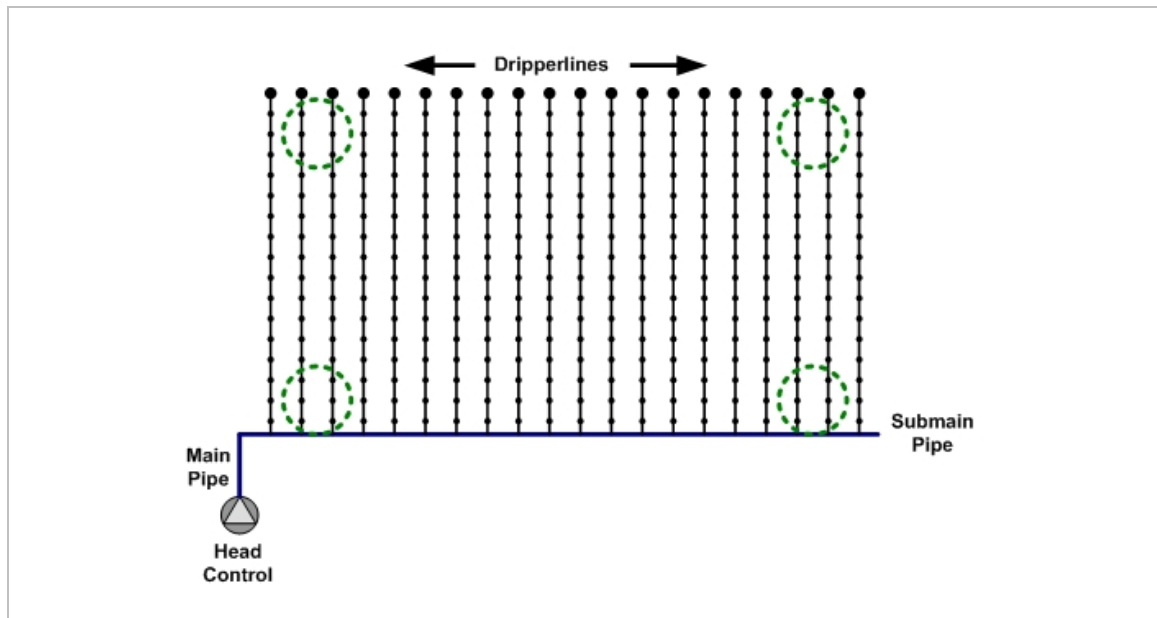



Figure 1. Taking Dripperline Samples

Water Sampling for Analysis

 To take a water sample for analysis, perform the following steps:

1. Allow the water source to operate for 2-3 hours before sampling;
2. Take a sample using a one litre plastic spring water bottle (or similar) making sure you do not use sparkling drink bottles. Rinse the bottle three times using water from the source being sampled;
3. Write the following details on the sample bottle:
 - a. Customer Name.
 - b. Location.
 - c. Water Source.
 - d. Sampling Date.

note

- Never take samples directly from the water source (dam, river etc.).
- Take samples after but as close as possible to the pump.
- If the pump is located more than 1 km from the field, you must take another sample of the water from the pipes located at the start of the field.
- To analyze the effect of fertilizers in the water, sample the water from after the fertilizer injection point.

4. Open the water and let it run for 60 seconds;
5. Fill up the bottle so that no air remains;
6. Cap the bottle tightly and keep the sample in a cool, shaded place;
7. Send samples to a water analysis laboratory;

8. The following tests are required:

- EC
- pH
- Calcium (Ca)
- Magnesium (Mg)
- Sodium (Na)
- Potassium (K)
- Bicarbonate (HCO_3)
- Carbonate (CO_3)
- Chloride (Cl)
- Sulfate (SO_4)
- Phosphate (PO_4)
- Nitrogen- Ammonium (N-NH_4)
- Nitrogen- Nitrate (N-NO_3)
- Boron (B), Iron (Fe)
- Manganese (Mn)
- TSS
- TDS (if possible)

Chapter 3

Preventing Soil Penetration in Drip Systems

Soil (i.e. sand) is the most harmful element for drippers as it does not decompose, after penetrating the dripper, it cannot be removed or dissolved, even with the use of chemicals.

Soil can penetrate the system in two main ways, with the water flow or directly from the local soil.

note

When using a pump, water should be pumped from the highest level (with float placed at depth of 0.5 m to 1 m below the surface of the water).

Filtering the water supply will usually keep soil out. However, soil can also penetrate the system through loose grommets or connectors that act as a “venturi” and suck the soil into the system. Another threat to the system is from soil that may enter the system directly via the laterals during connection. The best way to avoid damage caused by soil penetration is to take the proper preventive actions.

Preventing internal soil penetration

1. Do not leave pipe inlets and outlets open:
 - After installing the distribution pipes, seal the ends immediately.
 - Install grommets and connect the lateral immediately after making the holes.
2. Flush mains, sub-mains and laterals before system pressurisation (see Chapter 5 system Flushing, page 7).
3. Verify proper filter system installation and operation.

Preventing soil suck-back

Soil suck-back is a phenomenon caused by dripperlines draining in undulating terrain, introducing air through dripper and sucking soil with it. Suck-back can be significantly reduced through the addition of vacuum breakers at high points, allowing air into the system. For additional information please contact your Netafim representative.

note

When using Anti-Siphon (AS) dripperlines, draining and filling will result in flexing of the tube, eventually leading to failure. Vacuum breakers should be added to prevent this damage.

note

It is especially critical to add vacuum breakers in Sub-surface Drip Irrigation (SDI).

Chapter 4

Preventing Root Intrusion in Drip Systems

Root intrusion is a phenomenon of roots penetrating the dripper causing reduced flows and in the worst case - blockages. One of the main reasons for root intrusion is deficit irrigations, or in other words not matching irrigations to plant water use. Under these conditions, roots will tend to develop close to the emitter, eventually penetrating it.

How we schedule our irrigation can help minimize root intrusion by matching (or exceeding) irrigations to plant water use. Maintaining appropriate moisture within the profile by properly scheduling irrigations allows roots to explore the profile and not concentrate around the emitter.

Using continuous soil moisture monitoring enables better control of the wetting pattern thus maintaining optimum soil moisture within the profile.

If there is a requirement for the crop to have a stress period there are two alternative programs that can be implemented:

1. A series of short irrigations to keep high moisture content around the dripper only.
2. Another practice is to inject herbicides that kill the roots tips without killing the plants themselves.



The use of some herbicides is prohibited depending on local country (state) regulations; please check all local regulations before use.

Chapter 5

System Flushing

System flushing is the procedure of opening flushing valves on your mainline, submains or laterals whilst under pressure. This procedure increases the water velocity inside the pipeline or dripperline to scour and remove contaminants off internal walls or from individual drippers and flush them out of the system.

System flushing should be conducted at regular intervals. The frequency will depend mainly on your water quality, loading and the weather. Table 1 indicates a starting point for your maintenance flushing program, from this, individual site conditions will influence whether to increase or decrease the flushing interval.

Recommended flushing velocities are:

- Mainline: 1.0 metre per second
- Sub-main: 1.0 metre per second
- Laterals: 0.5 metre per second

In certain cases, the pressure of the regulating valve must be increased to enable appropriate velocities, nevertheless, care is required in order not to exceed the burst pressure of the dripperline and take-off adapters.

Table 1. Flushing Interval Based On Water Quality

Quality	Water Source	Flushing Interval
Good	<ul style="list-style-type: none"> • Municipal • Bore water with no presence of iron or magnesium Supply 	6 months
Average	<ul style="list-style-type: none"> • Rivers, Dams or Lagoons which are slow flowing • Dams or Lagoons in a cold climate where the pumping point is properly placed, taking winds and the possibility of sedimentation into account • Effluent water after class A treatment 	4 months
Poor	<ul style="list-style-type: none"> • Bore water which is drawn from a poor quality aquifer • Rivers, Creeks or Canals found in hot climates with increased biological growth and no chemical treatment • Dams or Lagoons in a hot climate. Poor placement of the pumping point in the direction of wind with little or no sedimentation or a soluble content that enables the development of a high organic load • Effluent water after effective sedimentation with little or no biological treatment 	Monthly
Very Poor	<ul style="list-style-type: none"> • Bore water which has a high load of iron or magnesium • Rivers, Creeks or Canals affected by flood flows and having a shortage of sedimentation facilities • Dams or Lagoons where the water source has been mixed with effluent or flood waters and the pumping point is poorly placed • Effluent water without sedimentation due to water flow and added oxygen 	Fortnightly

Chapter 6

Chemical Injection for Preventive & Routine Maintenance

This chapter provides general guidelines for chemical injection of different substances.

General Guidelines & Precautions

All types of water can be used for irrigation: well, river, reservoir, drinking, wastewater, canal, lake, etc. Water quality varies and presents diverse physical, chemical and biological characteristics.

note

It is necessary to test water before use and treat it as required.

Determining the Suitability of Chemicals for Injection

In Australia, a wide range of chemical fertilizers and disinfectants in solid, liquid and gaseous states are available. Different chemical preparation techniques combined with the concentration and dosages of salts, emulsions and coagulants makes it impossible to supply a detailed list of pre-approved manufacturers and products that are permitted or forbidden for use.

note

Before injecting any chemical into your system, determine its suitability. Injection of unsuitable chemicals may cause damage to the system.

The following problems can be expected when unsuitable chemicals are injected:

- Sedimentation in drippers due to the reaction between water and fertilizers.
- Physical and chemical damage to dripperlines.

A list of permitted chemical is provided in page 29. When using any chemical or combination of chemicals Netafim recommends:

1. Consulting Netafim Agronomic Department.
2. Sending new chemicals to Netafim for complete testing.
3. Basic tests should be performed on fertilizers as follows:
Use 1 litre (at required concentration) and wait 24 hours before checking for the appearance of sedimentation, flocculation or suspended solids.
4. Once a chemical has been injected, irrigation must be applied for a minimum period of time according to the irrigation system specifications (see Chapter 8 Injections times for chemical treatment, page 30).

note

Whenever in doubt contact your Netafim representative

Forbidden Chemicals

It is forbidden to use certain chemicals in drip irrigation systems.

- Never use any Poly-phosphate
- Never use Red Potassium Chloride
- Never use Red Potassium Sulphate
- Never use Borax
- Never use organic products with high contents of suspended solids (without preliminary treatment).
- Never use products and fertilizers with low solubility, e.g. Gypsum.
- Never use waxy chemicals, oil solvents, petroleum products and detergents.
- Never use active Chlorine (at the injection point) with more than 40 ppm.
- Never use acid with a pH lower than 2.

Chemicals Requiring Approval by Netafim

The following chemicals can only be used with the prior consent of Netafim:

- Solid/liquid organic fertilizers.
- Pesticides.

Permitted Chemicals

A list of permitted chemical is provided in Permitted Chemicals, page 29.

Acid Treatment for Drip Irrigation Systems

Acids can be used to dissolve chemical contaminants such as carbonates, calcium, phosphate, hydroxide deposits, etc.



Acid treatment is ineffective with most organic matters.

Safety

Warning



Acids are types of poison and are dangerous to humans. Before using acid, read all safety instructions provided by the acid manufacturer.

Regard all instructions for acid treatment as subordinate to all legal provisions and to the instructions of the acid manufacturer.

- ▶ Always add acid to water – NEVER add water to acid.
- ▶ Avoid contact with eyes; contact of acid with the eyes can cause blindness.
- ▶ Avoid contact with skin; contact of acid with skin can cause burns.
- ▶ Use protective clothing when working with acid; wear goggles, gloves, full-length trousers and sleeves, and closed high shoes.
- ▶ Avoid swallowing or inhaling; swallowing acids or inhaling their fumes can be fatal.
- ▶ Be present during treatment; be present for the full duration of the treatment. Keep all unauthorized persons away from the treatment area.
- ▶ Do not use Acids with concrete pipes.

Acids Types & Concentrations

Acids come in various forms and in different concentration levels, for example:

- Nitric Acid 60%
- Phosphoric Acid 75% - 85%
- Sulphuric Acid 90% - 96%
- Hydrochloric Acid 30% - 35%

The most common acids are Sulphuric Acid and Hydrochloric Acid.

Acid Injection Concentration Recommendations

The level of acid concentration added to the irrigation water depends on the type of acid being used, its percentage and valence. The below info can be used as guidelines:



Acids must be free of insoluble impurities, e.g. gypsum, etc.

Table 2. Typical Acid Concentrations

Acid Percentage	Recommended Concentration in Treated Water
Hydrochloric acid, 33%	0.6%
Phosphoric acid, 85%	0.6%
Nitric acid, 60%	0.6%
Sulphuric acid, 65%	0.6%



If your acid has a different percentage other than the ones listed in Table 2, adjust the percentage accordingly.



Calculate the acid concentration when using a different starting concentration as follows:

For example:

98% Sulphuric acid is available. What percentage Y should be used?

$$Y = (0.6\% \times 65\%) / 98\% = 0.4\%$$



The specified Acid concentrations depend on the water characteristics and should be used as the starting point. It is recommended to perform a titration test to determine site specific concentration.

Usage

Acid injection is the process of injecting specific concentrations of acid into the irrigation system during regular system operation to lower the pH level in the water. This will dissolve calcium, magnesium carbonates, iron, manganese sulphides and other chemical contaminants. Acid injection can also be used to burn plant roots that have entered the dripper.

In general, acid treatment can be divided to two types:

1. **Chemical clogging prevention / treatment** – treatments are typically considered for dissolving minerals and Iron. The pH level should be between 2.5 - 5.
2. **Root intrusion treatment** – treatments are to be considered for burning roots that have intruded into the dripper passages. The pH level should be between 2 - 2.5.
Several heavy treatments may be required, depending on the severity of root intrusion (see Chapter 4 Preventing Root Intrusion in Drip Systems, page 6 for further instructions).

Each treatment is designed to lower the pH of the water sufficiently enough to treat the targeted problem, while minimizing the amount of acid to be used, i.e. there's no requirement to lower the pH to a level of 2.0 for the treatment of dissolving calcium carbonates. pH levels can be gradually lowered providing after treatment the drippers are checked and found to be properly cleaned.

Performing Titration Test

The above concentrations are based on previous experience and can be used as a starting point, nevertheless, they are highly dependant on water and acid quality.

Netafim recommends performing a titration test to determine injection levels based on site specific conditions, i.e. actual water and acid qualities (see Titration chart, page 34).

Equipment required:

1. 10 litre bucket
2. 1 ml dispenser, acid resistant
3. 0-14 pH test strips or metre
4. 10 litre water sample
5. Acid

Procedure:

1. Place 10 litres of your water sample in a bucket;
2. Record pH level of water sample;
3. Add 1 ml of acid and mix solution;
4. Record pH level of water sample;
5. Repeat steps 3 and 4 until the required pH level is obtained.

For example:

- Reason for treatment: Dissolving iron remains
- Required pH level: 3 ppm
- Measured Acid requirement: 50 ml Acid per litre water
(quantity needed to reach pH of 2-3)

Determining Injection Quantity & Time

How long the acid should be injected for depends on the flow rate of the system and the quantity of acid being injected.



The actual injection time may vary from the calculated one. The measurement should be taken at the last dripper in the system while the pH is in the range of 2.5 for at least 5 minutes.

Calculation when using system flow rate in cubic metres per hour

$$\text{Required Acid injection rate (Litres per hour)} = \frac{\text{Titration Acid level (ml)} \times \text{system flow rate (m}^3\text{/hr)}}{10}$$

$$\text{Required Acid quantity (Litres)} = \frac{\text{Required injection rate (l/hr)} \times \text{Injection time (minutes)}}{60}$$

Example

- Titration Acid level: 50 ml
- System flow: 100 m³/hr
- Calculated injection time: 90 minutes

Calculation is:

$$\text{Injection rate (Litres per hour)} = \frac{50 \times 100}{10} = 500$$

$$\text{Required Acid quantity (Litres)} = \frac{500 \times 90}{60} = 750$$

Calculation when using system flow rate in litres per second

$$\text{Required Acid injection rate (Litres per hour)} = \frac{\text{Titration Acid level (ml)} \times \text{system flow rate (l/sec)} \times 3.6}{10}$$

$$\text{Required Acid quantity (Litres)} = \frac{\text{Required injection rate (l/hr)} \times \text{Injection time (minutes)}}{60}$$

Example

- Titration Acid level: 50 ml
- System flow: 27.78 l/sec (100 m³/hr)
- Calculated injection time: 90 minutes

Calculation is:

$$\text{Injection rate (Litres per hour)} = \frac{50 \times 27.78 \times 3.6}{10} = 500$$

$$\text{Required Acid quantity (Litres)} = \frac{500 \times 90}{60} = 750$$

Injecting Acid into the System

Steps prior to applying an acid treatment

1. Make sure that the injection pump is high capacity and acid resistant.



Acids are very corrosive to materials such as steel, aluminum, asbestos-cement, etc. PE & PVC pipes are resistant to acids. Consider these factors before planning the treatment. Always consult your Netafim representative when in doubt.

2. Before starting the treatment make sure the system is properly flushed (see Chapter 5 System Flushing for further instructions)



Failure to flush the system prior to using acid is harmful to the system.

3. Record Flow:

The Acid Injection procedure should start by recording the valve flow rate; this is done for three reasons:

1. The current flow rate recorded can be cross-referenced with the original valve flow rate to determine if any system deterioration has occurred.
 2. To determine if the system flushing and acid injection process has improved your valve flow rates.
 3. To determine injection quantities based on titration test.
4. Perform a titration test (see Performing Titration Test, page 12) and calculate injection rate and time (see Chapter 8 Injection Times for Chemical Treatment, page 30).



See Working Acid Injection Form, page 35

Acid treatment process



To apply an acid treatment to the system, perform the following steps:

Injection

1. Inject acid according to the levels calculated based on the titration test
2. Adjust injection levels until reaching the desired pH level.
3. Continue to irrigate for the required period of time according to Table 9, page 30.



It is recommended to measure the pH at the end of the dripperline to verify the required pH is obtained.

4. Turn off the injection pump.

Wait

5. Allow the treated water to sit in the system from 2 to 6 hours before proceeding to the next step. This period may be longer when treating root intrusion.

Flush

6. The entire system should be flushed, following the same procedure as mentioned earlier.

Record flow

7. The system flow rate should be recorded to verify treatment improved system performance.
8. If the treatment hasn't improved system performance try repeating the treatment using a lower pH.



Notice pH levels should be within system specs and never lower than 2.0

Chlorine Treatment for Drip Irrigation Systems

Chlorine is a strong oxidizer. It is useful for the following purposes:

1. Preventing & eliminating the growth of organic slime, iron slime, sulfur slime.
2. Oxidation of elements such as Iron, Sulfur, Manganese, etc.
3. Cleaning organic sedimentation and bacterial slime from irrigation systems.
4. Improving the filtration efficiency, especially sand/media filtration.

note

- Chlorine is effective only on organic matter.
- Chlorine is ineffective on inorganic matter such as sand, silt, scale etc.

Safety

Warning



Chlorine material (liquid, solid or gas) is dangerous to humans.

Before using chlorine, read all safety instructions provided by the chlorine manufacturer.

Regard all instructions for chlorine treatment as subordinate to all legal provisions and to the instructions of the chlorine manufacturer.

- ▶ It is highly recommended to use a separate container for chlorine injection.
- ▶ Before filling any tank with chlorine solution, be sure to wash it very carefully in order to remove any fertilizer remains.
- ▶ Avoid contact with eyes.
Contact of chlorine with the eyes can cause blindness.
- ▶ Avoid contact with skin.
Contact of chlorine with skin can cause burns.
- ▶ Use protective clothing when working with chlorine.
Wear goggles, gloves, full-length trousers and sleeves, and closed high shoes.
- ▶ Avoid swallowing or inhaling.
Swallowing chlorine or inhaling its fumes can be fatal.
- ▶ Be present during treatment.
Be present for the full duration of the treatment. Keep all unauthorized persons away from the treatment area.

note

Direct contact between chlorine and fertilizers may cause an explosive thermal reaction. This is extremely dangerous!

note

Injecting chlorine into irrigation water containing fertilizer is not hazardous.

note

Direct contact between chlorine and acid is highly dangerous!

Materials

Chlorine is available for commercial use in several forms. Each type has its advantages and disadvantages. Consider the convenience, availability and price of each material before deciding which to use.

Commonly available forms include:

- **Gaseous chlorine (Cl_2)**
- **Solid chlorine (Calcium Hypochlorite) – 65% available chlorine**
When both the calcium level and alkalinity of the water are above medium and the pH is above 8.0, consult a Netafim expert for advice on whether Calcium Hypochlorite can be used.
- **Liquid chlorine (Sodium Hypochlorite) – 12% available chlorine**
Liquid chlorine is unstable and decomposes spontaneously in the storage tank, according to time, temperature and solar radiation.

note

Do not store liquid material for long periods. Keep it in the shade, if you must keep it in direct sunlight paint the storage tank white.

Usage

Methods of Application

Generally, there are two methods of chlorination:

1. Continuous Injection

Chlorine should be continuously injected throughout the whole irrigation cycle. This is the most efficient method, but chlorine consumption is highest.

2. Intermittent Injection

Chlorine is injected at a regular interval. Depending on the water quality the interval will be higher with sources that contain a large proportion of organic material. Usually chlorine is injected until it reaches the furthest point in the valve. The valve is turned off and left to allow contact time between the chlorine and the organic matter.

A higher organic load will require a longer contact time.

The system is then flushed, in the order of Mainlines, Submains, and then Laterals (for injection time guidelines see Table 9, page 30).

note

Chlorine residue should be checked at the most distant part of the system. Open the end of the third lateral from the edge and let water flow for 10 seconds before sampling.

Determining the Injection Point

Chlorine can be injected in two different points in a system. Each position has its advantages and disadvantages.

Table 3. Chlorine - Injection Point

Injection Point Location	Remarks
As close as possible to the main pump of the water source (river, dam, well).	Prevents the growth of bacterial slime in the main pipe and protects the drip system much better than when the injection point is far away from the water source.
Far from the main pump and as close as possible to the treated plot.	Does not protect the main pipe and is not recommended in cases of effluent, sulfur, iron & manganese.

Dosage

The amount of Chlorine required depends on the water quality, the cleanliness of the pipes and laterals in addition to the size of the system.



Measure chlorine concentration using a 'chlorine test kit'.

Table 4 lists the recommended levels for Chlorine concentration before and after injection (residual). After injection, measure the residual concentration and adjust the dosage as follows:

- In the event that the residual concentration is too low, increase the injected concentration.
- In the event that the residual concentration is too high, decrease the injected concentration.

Table 4. Chlorine Dosage

Injection Method/Purpose	Injected Concentration	Residual Concentration*
Continuous Injection	~2 ppm (dependant on water quality)	0.5 – 1 ppm
Intermittent Injection	~10 ppm (dependant on water quality)	2-3 ppm

- * Measurement should be taken at the farthest point away from the injection point.

Measuring the Concentration of Chlorine in a System

Controlling chlorine residue is an integral part of the treatment. Follow these guidelines to ensure that the correct dosage is being used:

1. The concentration of Chlorine must be examined on a regular basis. When using continuous injection it is recommended to check at least once or twice a week.
2. Injected amount must be adjusted according to the residual concentration.
3. The concentration of chlorine at the injection point should be no greater than 30 ppm.
4. Residual Chlorine Concentration is checked at the most distant point within the system.


5. Before taking a sample, open the end of the dripperline and enable the flow of water for 10 seconds.
6. The chlorine test kit has two reagents, one is for measuring combined chlorine and the second for measuring free chlorine. When testing a municipal supply, or an irrigated farm, measure the free chlorine. When measuring drain & wastewater, measure combined chlorine.
When ammonia based fertilizer is injected into the system, measure combined chlorine.
7. Flush the treated system once a month and note any changes in the color of the flushed water.
8. If the concentration of Chlorine in the water is higher than the test kit capacity, the sample should be diluted with distilled water only! To determine the concentration, multiply the result by the dilution factor.

Determining how much Chlorine Gas to Inject

Determining how much chlorine to inject depends on site specific conditions, i.e. the type of chlorine and the water quality.

When using chlorine gas, the dosage is based on a chlorinator which controls the gas flow. The calculation is simple because the material is pure (100%):

1 gram of chlorine gas in 1 m³h of water = 1 ppm

 Calculate the Rate of chlorine gas flow into the system as follows:

Flow rate of the treated system:	100 m ³ /h
Desired chlorine residue at the end of the system:	1 ppm
"Chlorine demand" in the system:	4 ppm
Required concentration at the injection point	5 ppm (1 + 4)

Rate of chlorine gas flow into the system = 5 * 100 = 500 grams/hour

Determining how much Liquid & Solid Chlorine to Inject

Determining how much chlorine to inject depends on site specific conditions, i.e. the type of chlorine and the water quality.

The stability of liquid chlorine is much lower than that of solid chlorine. Do not store liquid chlorine for long periods of time.

Chlorine injection can be done using:

- A fertilizer tank (injected directly into the tank)
- A tank & electrical pump
- A dosage pump

Calculation when using system flow rate in cubic metres per hour

$$\text{Required injection rate of product (Litres per hour)} = \frac{\text{desired concentration of product (ppm)} \times \text{system flow rate (m}^3\text{/hr)}}{\text{active ingredient (\%)} \times 10}$$

Example 1

- Desired concentration: 10 ppm
- System flow: 260 m³/hr
- Calcium Hypochlorite: 65%

Calculation is:

$$\text{Injection rate (Litres per hour)} = \frac{10 \times 260}{65 \times 10} = 4$$

If the injection pump injects into the mainline at 1000 litre per hour, for each hour of treatment we need to mix 4 litres of Calcium Hypochlorite in 996 litres of water to make up 1000 litres of solution ready for injection.

Example 2

- Desired concentration: 10 ppm
- System flow: 180 m³/hr
- Sodium Hypochlorite: 12%

Calculation is:

$$\text{Injection rate (Litres per hour)} = \frac{10 \times 180}{12 \times 10} = 15$$

If the injection pump injects into the mainline at 1000 litre per hour, for each hour of treatment we need to mix 15 litres of Sodium Hypochlorite in 985 litres of water to make up 1000 litres of solution ready for injection.



It might be required to adjust injection rate in order to achieve required residual concentration.

Calculation when using system flow rate in litres per second

$$\text{Required injection rate of product (Litres per hour)} = \frac{\text{desired concentration of product (ppm)} \times \text{system flow rate (l/sec)} \times 0.36}{\text{active ingredient (\%)}}$$

Example 1 - Calcium Hypochlorite

- Desired concentration: 10 ppm
- System flow: 72.22 litre/sec (260 m³/hr)
- Calcium Hypochlorite: 65%

Calculation is:

$$\text{Injection rate (Litres per hour)} = \frac{10 \times 72.22 \times 0.36}{65} = 4$$

If the injection pump injects into the mainline at 1000 litre per hour, for each hour of treatment we need to mix 4 litres of Calcium Hypochlorite in 996 litres of water to make up 1000 litres of solution ready for injection.

Example 2 – Sodium Hypochlorite

- Desired concentration: 10 ppm
- System flow: 50 litre/sec (180 m³/hr)
- Sodium Hypochlorite: 12%

Calculation is:

$$\text{Injection rate (Litres per hour)} = \frac{10 \times 50 \times 0.36}{12} = 15$$

If the injection pump injects into the mainline at 1000 litre per hour, for each hour of treatment we need to mix 15 litres of Sodium Hypochlorite in 985 litres of water to make up 1000 litres of solution ready for injection.



It might be required to adjust injection rate in order to achieve required residual concentration.



It might be required to adjust injection rate in order to achieve required residual concentration.

Hydrogen Peroxide Treatment for Drip Irrigation Systems

Hydrogen Peroxide is one of the most powerful oxidizers known. Hydrogen peroxide always decomposes exothermically into water and oxygen gas.



note

- Do not use Hydrogen Peroxide when using steel, cement coating and asbestos cement tanks and pipes.
- Hydrogen Peroxide is not efficient for the prevention or dissolution of scale sediments, sand, silt, etc.

Safety

Warning



Hydrogen Peroxide is dangerous to humans and animals. Before using Hydrogen Peroxide, read all safety instructions provided by the manufacturer. Regard all instructions for Hydrogen Peroxide treatment as subordinate to all legal provisions and to the instructions of the manufacturer.

- ▶ Before filling any tank with Hydrogen Peroxide solution, be sure to wash it very carefully in order to remove any fertilizer remains.
- ▶ Avoid contact with eyes.
Contact of Hydrogen Peroxide with the eyes can cause blindness.
- ▶ Avoid contact with skin.
Contact of Hydrogen Peroxide with skin can cause burns.
- ▶ Use protective clothing when working with Hydrogen Peroxide. Wear goggles, gloves, full-length trousers and sleeves, and closed high shoes.
- ▶ Avoid swallowing or inhaling.
Swallowing Hydrogen Peroxide or inhaling its fumes can be fatal.
- ▶ Be present during treatment.
Be present for the full duration of the treatment. Keep all unauthorized persons away from the treatment area.

note

Direct contact between Hydrogen Peroxide and fertilizers containing ammonia may cause an explosive thermal reaction which may cause the tank to explode. This is extremely dangerous.

note

Injecting Hydrogen Peroxide into irrigation water containing fertilizer is not hazardous.

Physical & Chemical Properties

Benefits of using Hydrogen Peroxide include:

- Its rapid oxidation reaction causes immediate consumption upon contact with the irrigation water, and there is no continuous oxidation activity throughout the irrigation system (as is the case when chlorine is used).
- It is environmentally friendly.
- It does not create dangerous residues.
- Preventing the accumulation of bacterial slime in pipes and dripper line extensions.
- Cleaning the dripperline system in which organic sedimentation and bacterial slime have accumulated.
- Oxidation of micro elements to prevent the development and reproduction of bacteria (iron, manganese and sulphur).
- Improving the efficiency of initial filtering under high organic stress conditions.
- Disinfecting irrigation, sewage, wastewater and drinking 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.

Table 5 lists the physical and chemical properties of Hydrogen Peroxide at different concentrations.



Due to safety and cost considerations, Netafim recommends using Hydrogen Peroxide at concentrations of no more than 35% or 50%.

Table 5. Physical & Chemical Properties of Hydrogen Peroxide

	Concentration			
	35%	50%	60%	70%
Physical State	Liquid	Liquid	Liquid	Liquid
Colour	Colourless	Colourless	Colourless	Colourless
Characteristic Odour	Yes	Yes	Yes	Yes
Molecular weight H ₂ O ₂ :	34.01	34.01	34.01	34.01
Boiling point:	108°C	114°C		125°C
Freezing point:	-32°C	-51°C		-37°C
Vapour pressure at 25°C	23 mm Hg	18 mm Hg		11 mm Hg
Specific gravity (H ₂ O=1)	1.132	1.195	1.240	1.288
pH	<5	<4		<2

Usage

Injected Hydrogen Peroxide is the concentration (ppm) of Hydrogen Peroxide calculated at the injection point.

Residual Hydrogen Peroxide is the concentration (ppm) of Hydrogen Peroxide measured at the most distant part of the treated system.

Hydrogen Peroxide requirements for waste and industrial waste water are high, and low for municipal supply water and other types of water with low organic load.

In waste and industrial wastewater conditions, it is not possible to calculate the required concentration of Hydrogen Peroxide, and therefore it is necessary to inject an arbitrary amount, use the test kit to check the residual concentration at the end of the system and then correct the dosage accordingly. In municipal supply water conditions or conditions due to other types of water with low organic load, it is easy to calculate the amount of Hydrogen Peroxide to be injected into the system.

Methods of Application

Generally, there are two methods of applying Hydrogen Peroxide:

1. Continuous Injection at low dosage

Hydrogen Peroxide is continuously injected throughout the irrigation cycle. This is the most effective method however Hydrogen peroxide consumption is at its highest.

2. Intermittent Injection

Hydrogen Peroxide is injected at a regular interval. Depending on the water quality, the interval will be higher with sources that contain a large proportion of organic load. Usually Hydrogen peroxide is injected until it reaches the furthest point in the valve. The valve is turned off and left to allow a contact time between the Hydrogen Peroxide and the organic matter.

A higher organic load will require a longer contact time.

The system is then flushed, in the order of Mainlines, Submains, and then Laterals (for injection time guidelines see Table 9, page 30).



Hydrogen Peroxide residue should be checked at the most distant part of the system. Open the end of the third lateral from the edge and let water flow for 10 seconds before sampling.

Determining the Injection Point

Hydrogen Peroxide can be injected in two different points in a system. Each position has its advantages and disadvantages.

Table 6. Hydrogen Peroxide - Injection Point

Injection Point Location	Remarks
After the water pump and before the pipes.	Protects the main and secondary pipes against accumulation of bacterial slime on the walls of the pipes when waste or industrial waste water is used.
Directly into the system head.	The water supply must be with low organic loads (municipal supply water, brackish water, well water etc.).

Dosage

The amount of Hydrogen Peroxide required depends on the water quality, the cleanness of the pipes & laterals, in addition to the size of the system.



Measure Hydrogen Peroxide concentration using a 'hydrogen peroxide test kit'.

Table 7 lists the recommended levels for Hydrogen Peroxide concentration at injection point and the matching residual Hydrogen Peroxide levels. Measure the residual concentration and adjust the dosage as follows:

- In the event that the residual concentration is too low, increase the injected concentration.
- In the event that the residual concentration is too high, decrease the injected concentration.

Table 7. Hydrogen Peroxide Dosage

Injection Method/Purpose	Injected Concentration	Residual Concentration*
Continuous Injection	10 to 50 ppm	0.5 ppm
Intermittent Injection	50 to 100 ppm	2 to 3 ppm
One-time Treatment for cleaning the system including the filters	200 to 500 PPM	8 to 10 ppm

* Measurement should be taken at the farthest point away from the injection point.

Measuring the Concentration of Hydrogen Peroxide in a System

Controlling hydrogen peroxide residue is an integral part of the treatment, follow these guidelines to ensure that the correct dosage is being used:

1. The concentration of Hydrogen Peroxide must be examined at least once or twice a week on a regular basis. Additionally, when using the Continuous Injection method, the injected amount must be adjusted accord to the residual concentration.

2. The concentration of Hydrogen Peroxide at the injection point should be no greater than 500 PPM.
3. Residual Hydrogen Peroxide Concentration is checked at the most distant point within the system.
4. Before taking a sample, open the end of the dripperline for 10 seconds.
5. The Hydrogen Peroxide Kit includes litmus paper for measuring the concentrations of Hydrogen Peroxide.
6. If the concentration of Hydrogen Peroxide in the water is higher than the test kit capacity, the sample should be diluted with distilled water only. To determine the concentration, multiply the result by the dilution factor.

Calculation of Hydrogen Peroxide Injection Rates

Hydrogen Peroxide injection can be done using:

- A fertilizer tank (injected directly into the tank)
- A tank & electrical pump
- A dosage pump

Calculation when using system flow rate in cubic metres per hour

Required injection rate of product (Litres per hour) = $\frac{\text{desired concentration of product (PPM)} \times \text{system flow rate (m}^3\text{/hr)}}{\text{active ingredient (\%)} \times 10}$

Example

- Desired concentration: 50 ppm
- System flow: 150 m³/hr
- Hydrogen Peroxide active ingredient: 50%

Calculation is:

$$\text{Injection rate (Litres per hour)} = \frac{50 \times 150}{50 \times 10} = 15$$

If the injection pump injects into the mainline at 1000 litre per hour, for each hour of treatment we need to mix 15 litres of Hydrogen Peroxide in 985 litres of water to make up 1000 litres of solution ready for injection.



It might be required to adjust injection rate in order to achieve required residual concentration.

Calculation when using system flow rate in litres per second

$$\text{Required injection rate of product (Litres per hour)} = \frac{\text{desired concentration of product (ppm)} \times \text{system flow rate (l/sec)} \times 0.36}{\text{active ingredient (\%)}}$$

Example

- Desired concentration: 50 ppm
- System flow: 41.67 litre/sec (150 m³/hr)
- Hydrogen Peroxide active ingredient: 50%

Calculation is:

$$\text{Injection rate (Litres per hour)} = \frac{50 \times 41.67 \times 0.36}{50} = 15$$

If the injection pump injects into the mainline at 1000 litre per hour, for each hour of treatment we need to mix 15 litres of Hydrogen Peroxide in 985 litres of water to make up 1000 litres of solution ready for injection.



It might be required to adjust injection rate in order to achieve required residual concentration.

Chapter 7 Fertigation & Injection

This chapter provides general guidelines for Fertigation.

Fertigation - Technical Aspects

Follow these guidelines when using Fertigation systems:

1. The Fertilizer must be completely soluble and free of impurities.
2. Select the fertilizer according to pH of the irrigation water.

Table 8. Selecting Fertilizer based on pH of Irrigation Water

Neutral or Basic pH (>7)	Acidic pH (<5)
<ul style="list-style-type: none"> ▶ Do not use basic fertilizers. ▶ Never use fertilizers containing calcium without receiving permission from Netafim™ 	<ul style="list-style-type: none"> ▶ Use basic fertilizers.

3. Add iron chelate only.
When adding iron to the system, use only high quality (i.e. stable and strong) iron chelate. Avoid cheap products that may decompose into the system. This can lead to ineffective nourishment for the plants and plugged drippers.



Never inject ionic iron into the drip system. Ionic iron is harmful to the system. Use iron chelate.

4. Phosphoric fertilizers can cause serious difficulties, adhere to the following rules when using them:
 - a. Avoid high concentrations of phosphoric fertilizers in the water.
 - b. Never turn off the irrigation and fertigation system at the same time. Turn off the Fertigation pump before the end of the irrigation in order to flush the phosphate remains from the system. Consult Table 9, page 30 for the recommended minimum time for turning off the Fertigation pump before the end of the irrigation cycle.
 - c. Use only phosphoric fertilizers based on orthophosphate. Never use phosphoric fertilizers based on polyphosphate.
 - d. When the irrigation water is basic (pH >7) or the water hardness is high, use only acidic phosphoric fertilizer.
5. In greenhouses, during periods of heavy fertilization, the pH of the solution (water & fertilizer) should be reduced to 6.0.

Permitted Chemicals



Before using any chemical, it is essential to obtain information from the manufacturer regarding its: chemical quality, purity, recommended dosage, solubility, EC-PH and method and order of preparation.



- Remove the membrane or oily surface layer formed after fertilizer preparation.
- Any product not included in this list requires initial approval by Netafim™.

The following chemicals (liquid or highly soluble) are permitted for injection in drip irrigation systems:

N – Nitrogen

- Urea
- Ammonium Nitrate
- Nitrate Acid

P – Phosphorus

- Phosphoric Acid
- MAP = Mono Ammonium Phosphate (with high solubility)
- Ammonium Phosphate

K – Potassium

- Potassium Nitrate
- Potassium Chloride

Microelements

- Chelates, EDTA, DTPA, EDDHA, HEDTA, ADDHMA, EDDCHA, EDDHSA, Boric Acid

Chapter 8

Injection Times for Chemical Treatment

Table 9. Dripperline Flow Time (minutes) for Chemical/Fertigation Injection

17 mm. OD - 14.6 mm. ID dripperlines

Distance between drippers (metre)	0.3				0.5				0.8				1.0			
Nominal dripper flow rate (l/h.)	1.0	1.6	2.3	3.5	1.0	1.6	2.3	3.5	1.0	1.6	2.3	3.5	1.0	1.6	2.3	3.5
Total lateral length (metre)																
100	16	12	8	5	30	18	13	8	43	27	19	12	52	33	23	15
200	18	13	9	6	33	21	14	9	49	31	21	14	59	37	26	17
300	19	14	10	6	35	22	15	10	52	33	23	15	63	39	27	18

16.5 mm. OD - 15.9 mm. ID dripperlines

Distance between drippers (metre)	0.3				0.4				0.6				0.8			
Nominal dripper flow rate (l/h)	0.8	1.1	1.6	2.7	0.8	1.1	1.6	2.7	0.8	1.1	1.6	2.7	0.8	1.1	1.6	2.7
Total lateral length (metre)																
100	29	21	14	8	36	26	18	11	51	37	25	15	64	47	32	19
200	32	23	16	9	40	29	20	12	57	41	29	17	73	53	36	22
300	33	24	17	10	43	31	21	13	61	44	30	18	77	56	39	23

20 mm. OD - 17.5 mm. ID dripperlines

Distance between drippers (metre)	0.3				0.5				0.8				1.0			
Nominal dripper flow rate (l/h.)	1.0	1.6	2.3	3.5	1.0	1.6	2.3	3.5	1.0	1.6	2.3	3.5	1.0	1.6	2.3	3.5
Total lateral length (metre)																
100	28	17	12	8	42	26	18	12	62	39	27	18	75	47	33	21
200	31	19	13	9	47	30	21	14	70	44	31	20	85	53	37	24
300	32	20	14	9	50	31	22	14	75	47	33	21	91	57	39	26
400	34	21	15	10	52	33	23	15	78	49	34	22	95	59	41	27
500	35	22	15	10	54	34	23	15	81	51	35	23	98	61	43	28

23 mm. OD - 20.8 mm. ID dripperlines

Distance between drippers (metre)	0.3				0.5				0.8				1.0			
Nominal dripper flow rate (l/h.)	1.0	1.6	2.3	3.5	1.0	1.6	2.3	3.5	1.0	1.6	2.3	3.5	1.0	1.6	2.3	3.5
Total lateral length (metre)																
100	39	24	17	11	60	37	26	17	88	55	38	25	106	66	46	30
200	43	27	19	12	67	42	29	19	99	62	43	28	120	75	52	34
300	46	29	20	13	71	44	31	20	106	66	46	30	128	80	56	37
400	47	30	21	14	74	46	32	21	111	69	48	32	134	84	58	38
500	49	30	21	14	76	48	33	22	114	71	50	33	138	86	60	39

Table 9. Dripperline Flow Time (minutes) for Chemical/Fertigation Injection

22.7 mm. OD - 22.2 mm. ID dripperlines																
Distance between drippers (metre)	0.3				0.4				0.6				0.8			
Nominal dripper flow rate (l/h)	0.8	1.1	1.6	2.7	0.8	1.1	1.6	2.7	0.8	1.1	1.6	2.7	0.8	1.1	1.6	2.7
Total lateral length (metre)																
100	56	40	28	16	71	51	35	21	99	72	50	29	126	91	63	37
200	62	45	31	18	79	57	39	23	111	81	56	33	142	103	71	42
300	65	47	33	19	83	61	42	25	118	86	59	35	151	110	75	45
400	67	49	34	20	87	63	43	26	123	89	62	36	157	115	79	47
500	69	50	35	21	89	65	45	26	127	92	63	38	163	118	81	48

25.7 mm. OD - 25.0 mm. ID dripperlines																
Distance between drippers (metre)	0.3				0.4				0.6				0.8			
Nominal dripper flow rate (l/h)	0.8	1.1	1.6	2.7	0.8	1.1	1.6	2.7	0.8	1.1	1.6	2.7	0.8	1.1	1.6	2.7
Total lateral length (metre)																
100	70	51	35	21	90	65	45	27	126	91	63	37	159	116	80	47
200	78	57	39	23	100	73	50	30	141	102	70	42	180	131	90	53
300	82	60	41	24	106	77	53	31	150	109	75	44	191	139	96	57
400	86	62	43	25	110	80	55	33	156	113	78	46	200	145	100	59
500	88	64	44	26	113	82	57	34	161	117	80	48	206	150	103	61

FAQ

Acid Injection

1. **Question** What type of acid should I use and where can I buy it?

Answer Hydrochloric Acid is the most commonly used, and is generally considered to be one of the 'safer' acids available. It is used a lot in domestic swimming pools for pH control so is available from swimming pool shops, hardware stores and hopefully your local irrigation dealer.

2. **Question** Do I inject the acid "undiluted"?

Answer Usually you should do an initial dilution of about one tenth (1/10) of your injector pump maximum capacity

Chlorine Injection

1. **Question** What is the easiest way to determine which treatment works best for my system?

Answer Take 2 water samples each from the end of your laterals, treat one sample with chlorine and the other sample with acid. Allow the samples to stand overnight and view which method best dissolves the contaminants.

2. **Question** Should I lower the pH of the water to 6.5 for the chlorine to work better?

Answer This is true, but if you look at it logically, you need two injection pumps to conduct this operation. If you chlorinate on a regular basis or continuously, then it would be economical to do so. If you don't chlorinate regularly, then the only draw back is that you will use more chlorine.

3. **Question** How can I measure free chlorine at the end of the dripperline if I don't have any testing equipment?

Answer Depending on how good your nose is, you should be able to smell the chlorine in the water if it's higher than 2 ppm.

4. **Question** How long will chlorine last for while it's in containers?

Answer This depends on the storage environment. Typically speaking, the chlorine will degrade over time. You should buy just enough chlorine for your chlorination program or a maximum of 20 days supply, whichever comes first.

Hydrogen Peroxide

1. **Question** What is the lifespan of Hydrogen Peroxide?

Answer Hydrogen Peroxide has a lifespan of a few days, therefore it is recommended to allow Hydrogen Peroxide 12 to 36 hour contact time. After that time please flush the system.

2. **Question** Should I lower the pH of the water to allow Hydrogen Peroxide to work better?

Answer Unlike Chlorine, Hydrogen Peroxide is not sensitive to high pH and therefore there is no need to lower the pH when injecting it.

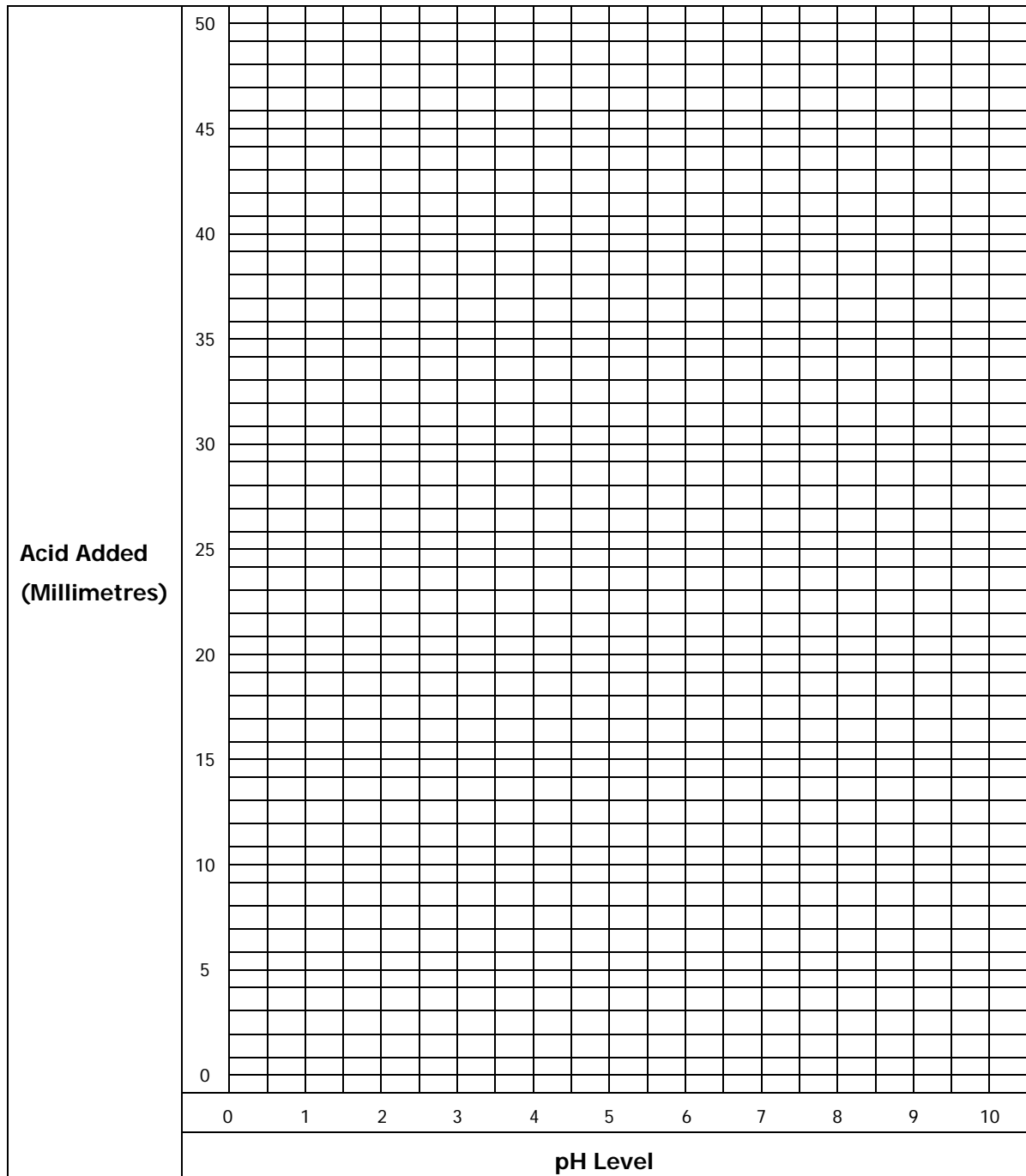
3. **Question** Why should I flush the system prior to Hydrogen Peroxide treatment?

Answer Flushing the system prior to Hydrogen Peroxide treatment will improve the efficiency of the treatment and reduce the injected quantity, moreover it will also reduce the risk of chemical reaction between different fertilizers in the system to the Hydrogen Peroxide.

Charts & Forms

Titration chart

Date _____



Working Acid Injection Form

[illegible]

Working Chlorine Injection Form

[illegible]

Velocity Calculation Form

Valve/Shift No.

Pipe Work	Length	Velocity m/sec	Time Sec.
Mainline		1.0	
Submain		1.0	
Lateral		0.3	
Injection Time			

Valve/Shift No.

Pipe Work	Length (m)	Velocity m/sec	Time Sec.
Mainline		1.0	
Submain		1.0	
Lateral		0.3	
Injection Time			

Valve/Shift No.

Pipe Work	Length (m)	Velocity m/sec	Time Sec.
Mainline		1.0	
Submain		1.0	
Lateral		0.3	
Injection Time			

Valve/Shift No.

Pipe Work	Length (m)	Velocity m/sec	Time Sec.
Mainline		1.0	
Submain		1.0	
Lateral		0.3	
Injection Time			

Valve/Shift No.

Pipe Work	Length (m)	Velocity m/sec	Time Sec.
Mainline		1.0	
Submain		1.0	
Lateral		0.3	
Injection Time			

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