

GUIDE BOOK

# PREVENTIVE & ROUTINE MAINTENANCE GUIDE

2011

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# TABLE OF CONTENTS

<b>CHAPTER 1 GENERAL MAINTENANCE</b> .....	<b>1</b>
■ Introduction .....	2
■ Preventing Irrigation System Clogging .....	2
System Flushing .....	3
Irrigation Scheduling .....	4
Chemical Injection .....	5
<b>CHAPTER 2 PREVENTIVE MAINTENANCE FOR DRIP SYSTEMS</b> .....	<b>6</b>
■ System Description Questionnaire .....	7
■ Sampling Dripperlines .....	10
■ Water Sampling for Analysis .....	10
■ Preventing Sand Penetration in Drip Systems .....	12
■ Anti Drain (CNL) Intensive Irrigation Systems .....	13
Maintenance .....	13
Prevention is the Best Policy .....	13
<b>CHAPTER 3 CHEMICAL INJECTION FOR PREVENTIVE &amp; ROUTINE MAINTENANCE</b> .....	<b>15</b>
■ General Guidelines & Precautions .....	16
Forbidden Chemicals .....	17
Chemicals Requiring Approval by Netafim™ .....	17
Permitted Chemicals .....	17
■ Acid Treatment for Drip Systems .....	18
Safety .....	18
Usage .....	19
■ Guidelines for Injecting Chlorine into Drip Irrigation Systems .....	21
Safety .....	21
Materials .....	22
Usage .....	22
Dosage .....	23
Measuring the Concentration of Chlorine in a System .....	24
Determining how much Chlorine to Inject .....	25
■ Guidelines for Injecting Hydrogen Peroxide into Drip Irrigation Systems .....	26
Safety .....	27
Physical & Chemical Properties .....	28
Usage .....	28
Methods of Application .....	29
Determining the Injection Point .....	29
Dosage .....	30
Measuring the Concentration of Hydrogen Peroxide in a System .....	30
Determining how much of Hydrogen Peroxide to Inject into the System .....	31
■ Guidelines for Preventing Root Intrusion in SDI Systems .....	32
■ Injection Times for Chemical/Fertigation Treatment .....	35

<b>CHAPTER 4 FERTIGATION &amp; INJECTION</b> .....	<b>37</b>
■ Fertigation - Technical Aspects .....	38
■ Acidification .....	39
■ Permitted Chemicals .....	40
■ Using Chemical Agents in Irrigation Systems .....	41
Fungicides - Herbicides - Disinfection .....	41
■ Netafim™ Products in Organic Crops Irrigation-Nutrigation™ .....	42
Proper Nutrient Solution Preparation .....	41
Organic Nutrients .....	42
Head Irrigation Control System .....	43
■ Flushing .....	44
Chlorination .....	44
Acid Treatment .....	44
Summary .....	44
<b>CHAPTER 5 USEFUL CONVERSIONS</b> .....	<b>45</b>
■ General Conversion Tables .....	46
Distance .....	46
Area .....	46
Flow .....	46
Pressure .....	47
Power .....	47
Weight .....	47
Temperature .....	47
Volume .....	47
<b>FIGURES</b>	
Figure 1. Taking Samples from Dripperlines .....	10
<b>TABLES</b>	
Table 1. Flushing Velocities .....	4
Table 2. Recommended Acid Concentrations .....	19
Table 3. Chlorine - Injection Point .....	23
Table 4. Chlorine Dosage .....	23
Table 5. Physical & Chemical Properties of Hydrogen Peroxide .....	28
Table 6. Hydrogen Peroxide - Injection Point .....	29
Table 7. Hydrogen Peroxide Dosage .....	30
Table 8. Recommended Treflan Treatments according to Soil Type .....	33
Table 9. Timing Treflan Treatments .....	33
Table 10. Dripperline Flow Time (minutes) for Chemical/Fertigation Injection .....	35
Table 11. Selecting Fertilizer based on pH of Irrigation Water .....	38
Table 12. Distance .....	46
Table 13. Area .....	46
Table 14. Flow .....	46
Table 15. Pressure .....	47
Table 16. Power .....	47
Table 17. Weight .....	47
Table 18. Temperature .....	47
Table 19. Volume .....	47

# CHAPTER 1

# GENERAL MAINTENANCE

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.

## IN THIS CHAPTER

■ Introduction .....	2
■ Preventing Irrigation System Clogging .....	2
System Flushing .....	3
Irrigation Scheduling .....	4
Chemical Injection .....	5

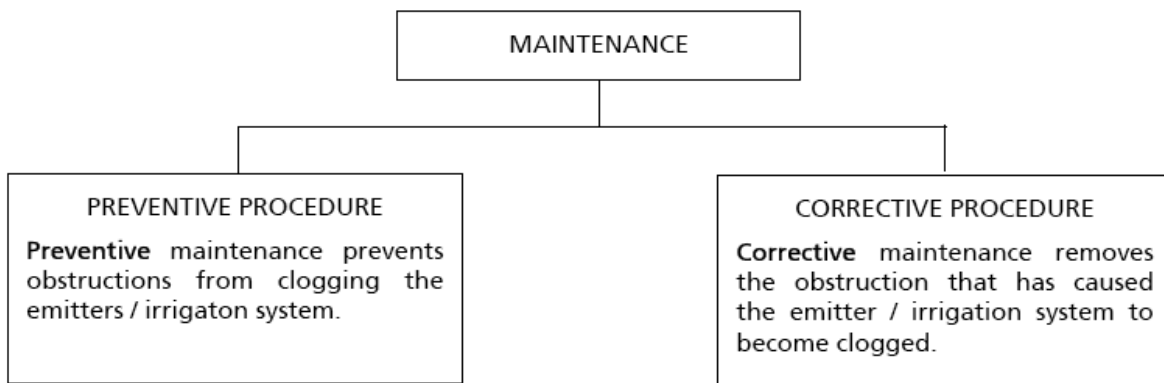
## INTRODUCTION

The implementation of a simple yet strict routine maintenance program for Drip-Irrigation systems will:

- Keep the system running at peak performance.
- Increasing the system's life expectancy.

The following chapters will guide you in determining the correct procedure and implementation. The best way to determine whether your maintenance program is effective is to constantly monitor and record the system flow-rate and pressures.

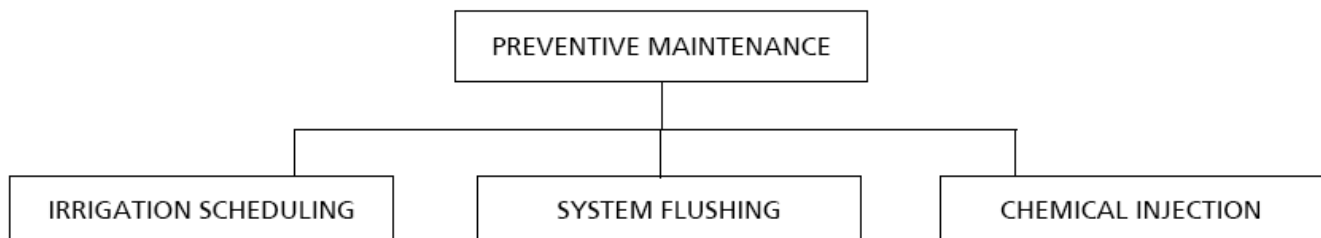
Maintenance is divided into two categories: PREVENTIVE and CORRECTIVE.



## PREVENTING IRRIGATION SYSTEM CLOGGING

Preventive maintenance for irrigation system clogging can be divided into three categories:

1. Irrigation Scheduling
2. System Flushing
3. Chemical Injection.



## SYSTEM FLUSHING

System flushing entails opening the flushing valves on the mainline, submain or laterals whilst under pressure. This procedure increases the velocity of water inside the pipeline or dripperlines to scour contaminants off of the internal walls or individual dripper filters thus flushing these contaminants out of the system.

- System Flushing should be conducted at regular intervals. The frequency depends mainly on water quality and the maintenance-flushing program.
- Systems flushing is effective only when the velocity increases inside the dripperlines, submain or mainlines and causes the scouring of the internal walls. In certain cases, the down-stream pressure of the regulating valve must be increased to permit such velocities in the submain and laterals. The pressure should not to exceed 2 times that of the recommended working pressure for the laterals.

**NOTE:** The flush can be manual or automatic, by opening the end of the main, submain or dripperline. Do not open more than 10 dripperlines at once.

Flushing is recommended at least once a month.

Additionally, Netafim™ offers valves and collector tubes to facilitate the flush system.

Table 1. Flushing Velocities

Location	Recommended Rate m/sec
Main	1.5
Submain	1.5
Laterals	0.5

### ✓ CALCULATE HOW LONG TO FLUSH EACH ITEM:

#### **Length of pipe/flushing velocity = time to flush**

In general, there are two waves of contaminants being flushed.

1. The first wave is from the contaminants sitting at the end of the lines.
2. The second one is a result of the scouring effect and is not as dark as the first one, but lasts for a much longer time.

**NOTE:** Flushing the main lines, secondary filters submains and laterals will considerably reduce the organic and mineral loading in the system, therefore minimizing the amount of chemical needed to be used. This will save time and money!

## IRRIGATION SCHEDULING

Irrigation scheduling for preventative maintenance only pertains to surface or subsurface drip installation systems. Proper irrigation scheduling can prevent or minimize two common problems:

### 1. ROOT INTRUSION

Root Intrusion occurs when the plant is 'water stressed' and the roots search for moisture. Potentially, the roots may grow into the dripper and block the passage of water in the dripper.

By monitoring the moisture level in the soil and scheduling the irrigation accordingly, the 'water stress' can be minimized, therefore reducing the condition where the roots will grow into the dripper.

If there is a need for the crop to have a 'drying of period', there are two alternative programs that can be implemented:

- a. A series of short irrigation cycles will maintain higher moisture content around the dripper only.
- b. Injection of herbicides that 'burn' the root tips only without damaging the plants.

### 2. GRAVITATION DRAINAGE

Gravitational Drainage is less common but may exist during prolonged periods of heavy rain. When the soils over saturated and the sub-surface dripperlines are empty (this condition is normally found on sloping sites), the water will flow backwards, from the soil into the dripper orifice bringing with it soil particles. Under such circumstances the dripperlines act as small drainage pipes. The small soil particles that are drawn back into the dripperline, if allowed to dry out, may eventually block the drippers. Introducing a brief irrigation cycle shortly after the rain stops will aid in flushing out the small particles and prevent blockages. When there are very heavy and prolonged rain conditions, flush all systems before 'pulse irrigating'.

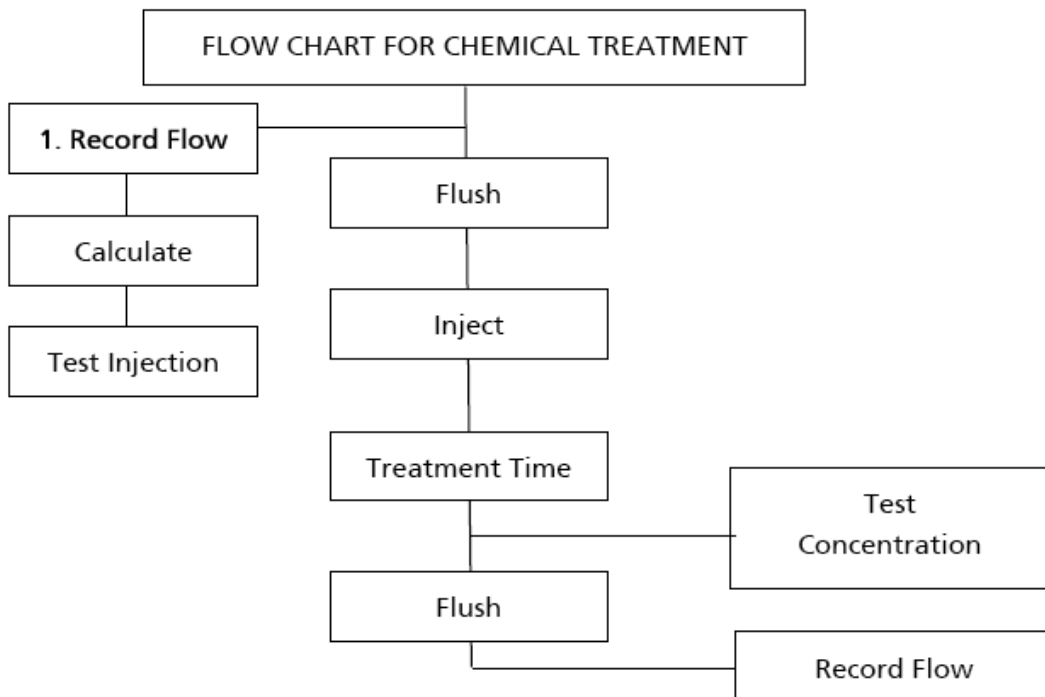
- a. A typical routine would be to 'pulse irrigate' every second day, until the soil is no longer over saturated.
- b. A Preventive ' Pulse Irrigation' routine would be to turn the system 'on' until it reached the planned operating pressure and leaving on for 5 minutes and then turning it 'off'.
- c. Another technical solution is to use in such cases is an Anti- Siphon (AS) dripperline.



## CHEMICAL INJECTION

The following flow chart is provided to guide you in determining in what order to perform chemical injection:

1. Start by recording the system flow.
2. Calculate the quantities needed.
3. Perform a test injection.



# CHAPTER 2

# PREVENTIVE MAINTENANCE

# FOR DRIP SYSTEMS

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.

## IN THIS CHAPTER

■ System Description Questionnaire .....	7
■ Sampling Dripperlines .....	10
■ Water Sampling for Analysis .....	10
■ Preventing Sand Penetration in Drip Systems .....	12
■ Anti Drain (CNL) Intensive Irrigation Systems .....	13
Maintenance .....	13
Prevention is the Best Policy .....	13

## SYSTEM DESCRIPTION QUESTIONNAIRE

Prior to requesting aid with common problems such as clogged drippers, sedimentation, and filtration difficulties, Netafim™ recommends filling in the following information and performing all the required tests.

Check all the relevant fields and fill in the required information and send to Netafim™ technical support.

Customer Name: \_\_\_\_\_

Country \_\_\_\_\_

### Define the Problem

Clogging     Problematic Flow-Rate     Routine Test

Other: \_\_\_\_\_

### General Data

Relevant Equipment Type: \_\_\_\_\_

Equipment age: \_\_\_\_\_

Size of the field/system \_\_\_\_\_ ha

System flow rate \_\_\_\_\_ m<sup>3</sup>/h

Total meters of dripperlines per ha \_\_\_\_\_ m

Dripperline location     Surface     Sub-Surface

Depth: \_\_\_\_\_ m

Dripper flow-rate \_\_\_\_\_ l/h

Average length of dripperline: \_\_\_\_\_ m

Working pressure:

after the head control filter \_\_\_\_\_ bar

at dripperline end

with the lowest pressure \_\_\_\_\_ bar

Irrigation frequency (specify units e.g. hours/day, days/week, pulses): \_\_\_\_\_

Soil Composition:

% Sand \_\_\_\_\_

% Silt \_\_\_\_\_

% Clay \_\_\_\_\_

Crop: \_\_\_\_\_

Water source:     Well     River     Lake  
                   Dam     Reservoir     Canal  
                   Other: \_\_\_\_\_

Reservoir size: \_\_\_\_\_

Holding time: \_\_\_\_\_

Maximum water depth: \_\_\_\_\_

**Pump Data**

Pump Type: \_\_\_\_\_

“Floating Suction Point”

pumping depth (in relation to the water surface): \_\_\_\_\_

“Permanent Suction Point”

pumping point location

(distance between the surface and the bottom): \_\_\_\_\_

Suction Direction

➡ vertical up    ➡ horizontal    ➡ vertical down

**Pipe Data**

Distance between the water inlet and the pumping point: \_\_\_\_\_

Pipe length from reservoir to field: \_\_\_\_\_

Pipe diameter: \_\_\_\_\_

Pipe Type:

- Steel                       PVC
- Asbestos Cement     Other \_\_\_\_\_

Working pressure at outlet of Head Control filter (bar): \_\_\_\_\_

**Filter Data**

Control Head filters:     Gravel     Disk     Screen     Hydrocyclon

Field Control filters:     Screen     Disk

Other types of filter:     Specify type \_\_\_\_\_

Filtration level (micron): \_\_\_\_\_

- Filter Operation
- works well     clogs frequently     flushes frequently
  - filtration system works properly (automatic & control)
  - automatic filter is OK but control filters become blocked rapidly
  - automatic filter is blocked rapidly and back flushed very often

**Fertilizer & Chemical Injection Data**

Specify the type of fertilizer & chemicals injected into the system: \_\_\_\_\_

Concentration of diluted fertilizer & chemicals injected into system: \_\_\_\_\_

Dosage of injected fertilizer & chemicals (l/m<sup>3</sup>/h): \_\_\_\_\_

Specify the formula used for injection: \_\_\_\_\_

Specify any additional chemicals injected into the drip systems: \_\_\_\_\_

**Water Treatments**

Chlorination     Acid treatment     Others: \_\_\_\_\_

**Dripperlines Data**

Follow the instructions outlined in Sampling Drinkerlines, page 10 and sample the water in the drinkerlines from one representative plot only.

Specify the amount of clogged drippers

many     some     few     none

Indicate the location of the clogged drippers:

At the last laterals

At the last drippers

Uniform dispersion in the plot

**Water Supply Sample**

Follow the instruction outlined in Water Sampling for Analysis, page 10 and take a sample of the water from the water supply.

## SAMPLING DRIPPERLINES

In order to diagnose dripperline problems, fill in the required data and follow the instructions outlined below.

- When the area is comprised of several plots, take the sample from one plot only.
- Take the sample from 30 cm lengths of lateral sections with the dripper in the center as shown in Figure 1.

**NOTE:** These instructions are suitable for both Integral and Online drippers. When taking samples of using online drippers, send the drippers with the 30 cm pipe sample as described below.

### ✓ TO TAKE A DRIPPER SAMPLE FROM DRIPPERLINES, PERFORM THE FOLLOWING STEPS:

1. Starting from both the beginning and the end of the lateral, cut a 30 cm sample (15 cm on each side of dripper's hole) from drippers 4 & 5.
2. Wrap the 16 samples tightly with wet paper and put in a plastic bag.
3. Send the samples to Netafim™ for analysis.
4. Repair the pipes in the field.

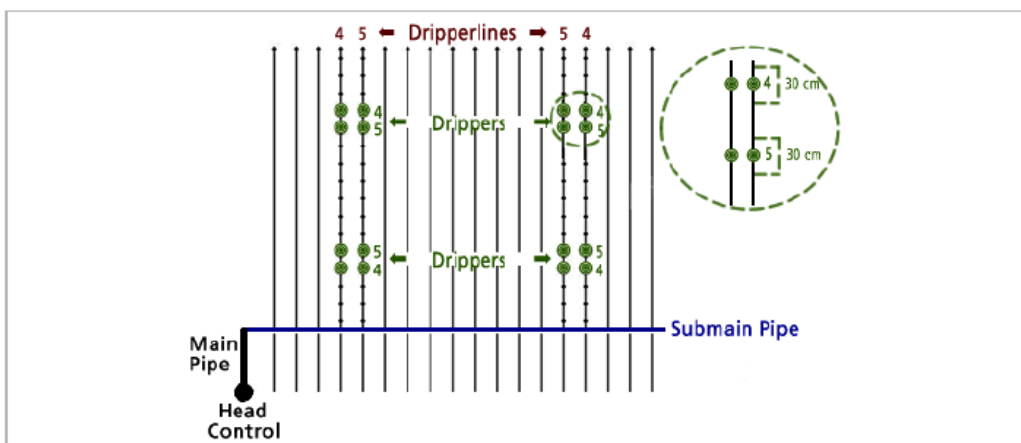


Figure 1. Taking Samples from Dripperlines

## WATER SAMPLING FOR ANALYSIS

### ✓ TO TAKE A WATER SAMPLE FOR ANALYSIS, PERFORM THE FOLLOWING STEPS:

1. Before taking any samples, flush-out a clean plastic one liter bottle with water from the water source being sampled.
2. 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 only from after the pump 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 in 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.

3. When taking a sample from the end of a dripperline we need to wait until the pressure is stable. Afterwards, open the dripperline and wait 2-3 minutes before taking the sample.

When taking the sample from the control head, Netafim™ recommends taking the sample after the system has been working for at least one hour.

4. Fill up the bottle so that no air remains (if possible, squeeze out the remaining air).

5. Cap the bottle tightly and keep the sample in a cool, shaded place.

6. Send the sample to Netafim™ (or another laboratory) as soon as possible after sampling.

7. When sending to another laboratory, have them analyze the following:

- Electrical conductivity (EC)
- pH
- Calcium (Ca)
- Magnesium (Mg)
- Sodium (Na)
- Potassium (K)
- Bicarbonate (HCO<sub>3</sub>)
- Carbonate (CO<sub>3</sub>)
- Chloride (Cl)
- Sulfate (SO<sub>4</sub>)
- Phosphate (PO<sub>4</sub>)
- Nitrogen- Ammonium (N-NH<sub>4</sub>)
- Nitrogen- Nitrate (N-NO<sub>3</sub>)
- Boron (B),
- Iron (Fe)
- Manganese (Mn)
- TSS
- TDS (if possible)
- Silica (Si)
- BOD (when using waste water)
- COD (when using waste water)

## PREVENTING SAND PENETRATION IN DRIP SYSTEMS

**NOTE:** Sand is the most harmful element for drippers. Sand does not decompose. After penetrating any kind of dripper, it cannot be removed or dissolved, even with the use of chemicals.

Sand can penetrate into the system in two ways, with the water flow or directly from the local sandy 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 water's surface).

Filtering the water supply will keep sand out. However, the biggest threat is posed from the local sandy soil that may enter the system directly via the laterals during connection. The best way to avoid damage caused by sand penetration is to take the proper preventative actions.

### TO PREVENT SAND PENETRATION DURING INSTALLATION, PERFORM THE FOLLOWING STEPS:

1. Check the system filter to make sure that sand doesn't penetrate through it.
2. Make sure that the main and sub main pipes are clean.
3. Do not leave pipe inlets and outlets open, even for short periods of time.
4. Install start connectors and connect the lateral immediately after making the holes.

**NOTE:** Never leave a pipe with open holes in the field.

5. After installing the distribution pipes, plug the ends immediately.
6. After installation has been completed, flush the system with maximum water flow. Start by flushing the mains and proceed to distribution pipes. Flush the distribution pipes in groups of six at a time.



## ANTI DRAIN (CNL) INTENSIVE IRRIGATION SYSTEMS

### CNL Anti-Drain Systems – Introduction

The Netafim™ Compensating Non Leak (CNL) anti-drain line of drip systems was developed specifically for short pulse irrigation and provides uniform irrigation.

To achieve uniform irrigation it is necessary to ensure that all the system drippers open and close simultaneously and that water in the dripperlines is not drained away before it can be effectively used. CNL drippers prevent drainage from high points in the system to low-laying points (provided the height differential does not exceed the permitted limits).

Maintaining water quality for CNL systems requires stricter care and maintenance than standard systems. Therefore, it is recommended to use CNL systems only when short pulse irrigation is really necessary.

### Anti-Drain System Requirements

- All the system components and accessories (for example, connectors and valves) must be manufactured to match system specifications and conform to the non-leakage requirement.
- Valve response time must be short in comparison with the length of the irrigation pulse. Otherwise, short irrigation pulses become too short to be of any value.
- The system must be able to supply all the required water to the crop at peak water consumption.

### Water Quality and Sources

Water quality refers to the concentration of chemical, soluble, and suspended solids in the water, as well as biological and physical characteristics of the water.

Water quality for agriculture is defined by the following criteria:

- Agronomic water quality – How well it fits the soil type and crop.
- Irrigation water quality – To what extent it prevents clogging of the irrigation system.

Possible water sources are fresh water, sewage, waste water, wells, reservoirs, canals, and flood water. All require varying levels of treatment before use.

Gathering all the parameters related to water quality assessment in specific water sources would be wrong as water comes from different places with a good probability of other sewage water being collected on the way.

The user has no control over the water quality, which also varies over time. This means that different treatment is required at different times to ensure appropriate water quality for the irrigation system.

Therefore, to monitor water quality, Netafim™ recommends sampling the water at the system input and analyzing it (on site or at an external laboratory) once per month.

Other factors affecting water quality that should be considered are fertilizers and chemicals used in the system itself for various treatments.

### Maintenance

Netafim™ recommends performing preventative maintenance of the irrigation system. If maintenance is performed from the day of installation, your system will run optimally.

**NOTE:** Remember: The best maintenance is preventative maintenance.

Preventative maintenance prevents physical, chemical, and biological system clogging. Some operations are performed at the water source, and some at the plot head (system input).

If the system remains full of water for an extended period of time, the water temperature may rise. This causes bacterial slime (biofilm) and sediments (insoluble minerals) to mount up quickly.

The following is a list of common water treatments:

- Selection of the optimal location, direction, and depth for the suction pump at the water source.
- Careful selection of the filter and filtration level.
- Effective flushing of the entire system.
- Oxidation treatments – for example, with chlorine, hydrogen peroxide, pressurized air, or ozone.
- Acidification treatments.

### **System Tips**

It is important to keep the following in mind:

- The continuous Chlorine injection for oxidation and disinfection is allow to use only when injecting concentration less than 1 ppm.
- You may use hydrogen peroxide for oxidation and disinfecting as often as you wish, for both continuous and localized injection. Refer also to Advantages of Hydrogen Peroxide (H<sub>2</sub>O<sub>2</sub>) as an Oxidation Agent, below.
- Do not let the pH level fall below pH3 for more than one hour. This is particularly important when any of the following are present in the system: Chemical agents, disinfectants, oxidants, or nutrients.
- Do not inject disinfectants, pesticides, weed killers, or oxidants together with nutrients. If necessary, stop the injection of the nutrients, flush the system with water only until there are no remaining nutrients, and then proceed with your maintenance operations.
- If you perform injection with nutrients more than twice per week, Netafim™ recommends flushing the system with water only after the injection to rid the system of remaining nutrients. If you perform injection with nutrients often, flush the system at the end of each day. Otherwise, flush the system at least once per week.
- After injecting pesticides (against weeds, roots, and organic nutrients), perform extended irrigation with water only until the system is free of the pesticides.
- Flush efficiently the irrigation system to remove mounting sediment of injected substances at dripperline ends. Do this immediately after injecting the chemicals into the system.

### **Problems Arising from Injecting Inappropriate Substances**

- Sediments may be deposited in the drippers as a result of reactions between nutrients and water.
- Physical and chemical damage to irrigation equipment.
- If you are in doubt as to which nutrients, disinfectants, pesticides, etc. to use, consult a Netafim™ expert prior to application and/or send a sample to Netafim™ for preliminary testing. We will endeavor to advise you.

# CHAPTER 3

# CHEMICAL INJECTION FOR PREVENTIVE & ROUTINE MAINTENANCE

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

## IN THIS CHAPTER

■ General Guidelines & Precautions .....	15
Determining the Suitability of Chemicals for Injection .....	15
Forbidden Chemicals .....	16
Chemicals Requiring Approval by Netafim™ .....	16
Permitted Chemicals .....	16
■ Acid Treatment for Drip Systems .....	17
Safety .....	17
Usage .....	18
■ Guidelines for Injecting Chlorine into Drip Irrigation Systems .....	20
Safety .....	20
Materials .....	21
Usage .....	21
■ Guidelines for Injecting Hydrogen Peroxide into Drip Irrigation Systems .....	25
Safety .....	25
Physical & Chemical Properties .....	26
Usage .....	27
■ Guidelines for Treflan (Trifluralin) Treatment for Subsurface Drip Systems .....	30
Root Intrusion .....	30
When not to use Treflan .....	30
Usage .....	30
■ Injection Times for Chemical/Fertigation Treatment .....	34

## 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

Worldwide, 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 which are permitted/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 Permitted Chemicals, page 39. 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 liter of water (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 dripperline specifications (see Injection Times for Chemical/Fertigation Treatment, page 34).

#### **FORBIDDEN CHEMICALS**

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

- Never use fertilizers containing more than 20 units of Phosphorus.
- Never us 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 39.

## ACID TREATMENT FOR DRIP SYSTEMS

Acids can be used to dissolve and decompose salts, carbonates, phosphate and hydroxide deposits.

**NOTE:** 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.

## USAGE

### INJECTING ACID INTO THE SYSTEM

✓ **TO APPLY AN ACID TREATMENT TO THE SYSTEM, PERFORM THE FOLLOWING STEPS:**

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

**NOTE:** 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 Netafim™ in case of doubt.

2. Before starting the treatment, flush all system components thoroughly using maximum flow.

**NOTE:** Failure to flush the system prior to using acid is harmful to the system.

3. Inject the acid into the irrigation system for the required time according to the desired concentration.
4. Turn off the injection pump.
5. Continue to irrigate for the required period of time according to Table 10, page 34.
6. Wash with clean water the injection pump after each use.

### ACID CONCENTRATIONS

The level of acid concentration added to the irrigation water depends on the type of acid being used, its percentage and valence.

**NOTE:** Acids must be free of insoluble impurities, e.g. gypsum, oils etc.

Table 2. Recommended 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%

**NOTE:** 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?

$$Y \times 98\% = 0.6\% \times 65\%$$

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

### DETERMINING INJECTION TIME

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

**NOTE:** 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.

For example:

Flow rate: 50 m<sup>3</sup>/h

Acid needed: 50 liters (use 1 liter of acid per m<sup>3</sup>)

Injection Time: 10 – 12 minutes

$$\text{Required Acid Concentration} = \frac{50 \text{ liter}}{(50 \text{ m}^3/\text{h} \times 1000 \text{ l/m}^3 \times 1 \text{ h} / 60 \text{ min}) \times 10 \text{ min}} = 0.6\%$$



## **GUIDELINES FOR INJECTING CHLORINE INTO 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.**

- 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.

## 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<sub>2</sub>, 100% active chlorine)
- Solid chlorine (Calcium Hypochlorite, contains 60%-85% active 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, contains 7%-13% active 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 a long period of time. Keep it in the shade, and paint the storage tank white if you must keep it in direct sunlight.

## 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. Selective Injection

Chlorine should be injected during the last hour, of irrigation. Do not forget to consider the time required to for the chlorine to reach the end of the system (refer to Table 10, page 34). With this method, both the chlorine consumption and efficiency are lower than with Continuous Chlorination.

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

**NOTE:** Chlorine residue should be checked at the most distant part of the system. Open the end of the fourth or fifth 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

**NOTE:** It is dangerous to inject chlorine and acids in the same injection point. When it is desirable to reduce pH by using acid injection instead of using chlorination, be careful to inject the acid in 2 different points with a minimum separation between them of at least 3 meters.

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.

**NOTE:** 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	< 30 ppm	0.5 – 1 ppm
Selective Injection	< 30 ppm	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 the following guidelines to ensure that the correct dosage is being used:

1. The concentration of Chlorine 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 chlorine at the injection point should be no greater than 30 ppm.
3. Residual Chlorine Concentration is checked at the most distant point within the system.
4. Before taking a sample, the end of the dripperline must be opened to enable the flow of water for 10 seconds before taking a sample.
5. The chlorine test kit has two reagents for measuring combined and free chlorine.
  - When testing a Municipal supply, measure the free chlorine.
  - When measuring drain & waste water, measure combined chlorine.
  - When ammonia based fertilizer is injected into the system, measure combined chlorine.
6. Flush the treated system once a month and note any changes in the color of the flushed water.
7. 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 TO INJECT**

Determining how much chlorine to inject depends on the type of chlorine.

**Chlorine Gas**

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

1 g of chlorine gas in 1 m<sup>3</sup>h of water = 1 ppm

✓ **CALCULATE THE RATE OF CHLORINE GAS FLOW INTO THE SYSTEM AS FOLLOWS:**

**Data**

Flow rate of the treated system:	100 m <sup>3</sup> /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 g/h

**Liquid & Solid Chlorine**

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

✓ **CALCULATE THE HOURLY FLOW RATE OF INJECTED CHLORINE SOLUTION AS FOLLOWS:**

Flow rate of the treated system	100m <sup>3</sup> /h.
Desired chlorine concentration of injected solution	10%
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 ( 1ppm+4ppm)

Rate of chlorine solution into the system = 5ppm\*100m<sup>3</sup>/h/[10% \* 10]  
= 5 l/h of chlorine solution

Formula to calculate chlorine solution injection:

Hourly flow-rate of injected chlorine solution (l/h) =  $\frac{\text{Required chlorine concentration (ppm)} * \text{Plot flow-rate (m}^3\text{/h)}}{\text{Chlorine solution concentration by percentage} * 10}$

## GUIDELINES FOR INJECTING HYDROGEN PEROXIDE INTO DRIP IRRIGATION SYSTEMS

### Advantages of Hydrogen Peroxide (H<sub>2</sub>O<sub>2</sub>) as an Oxidation Agent

The use of hydrogen peroxide for disinfection and oxidation of irrigation water has become wide-spread over the past ten years. Previously, chlorine was used, but this has shown after the oxidation and disinfection process make appear organic-chloride carcinogenic compounds, like Trichloromethane and also environmental pollution.

Many countries have, in fact, legislated against water chlorination, and this is a growing trend.

Today, hydrogen peroxide is commonly used for cleaning filtration media, discs and screens. It is also used as an oxidizing agent for fruit and vegetables prior to storage, and for the disinfection of public facilities, for example, spas.

Hydrogen peroxide is a strong oxidizing agent. It releases oxygen atoms which quickly react to oxidize organic matter. The advantages of hydrogen peroxide are its reaction speed, its environment-friendliness, and that it does not produce dangerous by-products. Hydrogen peroxide is environment-friendly – it causes no ground contamination, does no damage to the water aquifer, and indirectly makes more oxygen available for soil and plants.

The speed of the oxidation reaction means that the hydrogen peroxide is consumed immediately upon contact with the irrigation water – it is biodegradable. There is no residual oxidation activity throughout the irrigation system, as is the case with chlorine.

The speed of the oxidation reaction enables the use of hydrogen peroxide for fast disinfection and oxidation at the water source and in close proximity to the filters.

Hydrogen peroxide is also suitable for use in the oxidation of Iron and Manganese.

Hydrogen peroxide is commonly used in greenhouses, net houses, and in soilless media because irrigation systems for these often traverse only short distances. Additionally, chlorination might cause significant damage to the roots in soilless media.

The concentration of hydrogen peroxide required at the system input depends on the water quality (oxidation potential and the organic matter reduction and concentration in the water). Typically between 1 and 10 mg/l of hydrogen peroxide (active agent) is required per liter of water.

### Uses of Hydrogen Peroxide

Hydrogen peroxide is a strong oxidizing agent and is effective in achieving the following:

- Prevention of bacterial slime accumulation in the supply pipes and dripperlines.
- Cleansing of drip systems from accumulated organic sediment and bacterial slime.
- Oxidation of microelements (Iron, Manganese, Sulfur) to prevent bacterial propagation.
- Improvement of main and secondary filtration under conditions of high organic load.
- Disinfection and treatment of sewage, waste, fresh, irrigation, drinking water, and swimming pools.
- Prevention and removal of water odors and interference with biological activity.
- Reduction of BOD/COD values by oxidation of the contaminating organic and inorganic materials:



Comparison of Oxidation Potentials

Oxidation Agent	Symbol	Oxidation Potential (V)
Ozone	O <sub>3</sub>	2.1
Hydrogen peroxide	H <sub>2</sub> O <sub>2</sub>	1.8
Chlorine dioxide	ClO <sub>2</sub>	1.5
Chlorine	Cl <sub>2</sub>	1.4

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



A sequence of Hydrogen Peroxide treatments followed by a Chlorine treatment can have a powerful and prolonged Oxidizing effect. Combining the two treatments is forbidden.

**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 microelements to prevent the development and reproduction of bacteria (iron, manganese and sulfur).
- Improving the efficiency of initial filtering under high organic stress conditions.
- Disinfecting irrigation, sewage, wastewater and drinking water.
- Prevention and removal of odors 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.

**NOTE:** Due to safety and cost considerations, Netafim™ recommends using a 35% or 50% concentration of Hydrogen Peroxide.

Table 5. Physical & Chemical Properties of Hydrogen Peroxide

	Concentration			
	35%	50%	60%	70%
Physical State	Liquid	Liquid	Liquid	Liquid
Color	Colorless	Colorless	Colorless	Colorless
Characteristic Odor	Yes	Yes	Yes	Yes
Molecular weight H <sub>2</sub> O <sub>2</sub>	34.01	34.01	34.01	34.01
Boiling point	108°C	114°C		125°C
Freezing point	-32°C	-51°C		-37°C
Vapor pressure at 25°C	23 mm Hg	18 mm Hg		11 mm Hg
Specific gravity (H <sub>2</sub> 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 treatment system.



The Hydrogen Peroxide requirements are high for waste and industrial waste water, and low for municipal supply water and other types of water with no 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 no biological 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 should be continuously injected throughout the whole irrigation cycle. This is the most efficient method, but Hydrogen peroxide consumption is highest.

##### 2. Selective Injection

Hydrogen Peroxide should be injected during the last hour, of irrigation. Do not forget to consider the time required to for the Hydrogen Peroxide to reach the end of the system (refer to Table 10, page 34). With this method, both the consumption and efficiency are lower than with Continuous Injection of Hydrogen Peroxide at low dosage.

**NOTE:** 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 without 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.

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

Table 7 lists the recommended levels for Hydrogen Peroxide 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 7. Hydrogen Peroxide Dosage

Injection Method/Purpose	Injected Concentration	Residual Concentration*
Continuous Injection	10 to 50 ppm	0.5 ppm
Selective 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 the following 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, the end of the dripperline must be opened to enable the flow of water for 10 seconds before taking a sample.
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.

**DETERMINING HOW MUCH OF HYDROGEN PEROXIDE TO INJECT INTO THE SYSTEM**

Hydrogen Peroxide injection can be done using:

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

The following examples show how to calculate the initial dosage for different concentrations of Hydrogen Peroxide. After injection, it may be necessary to adjust the amount for future injections based on the residual concentrations where:

V = Volume in ml of Hydrogen Peroxide that should be added to the irrigation water.

C = Desired concentration of Hydrogen Peroxide in the water, in ppm.

Q = The flow rate of the treated system in (m<sup>3</sup>/h).

✓ To calculate the required volume of Hydrogen Peroxide (35%) to be injected into the irrigation water, use the following formula:

$$V \text{ (ml)} = 2.5 \times C \text{ (ppm)} \times Q \text{ (m}^3\text{/h)}$$

✓ To calculate the required volume of Hydrogen Peroxide (50%) to be injected into the irrigation water, use the following formula:

$$V \text{ (ml)} = 1.8 \times C \text{ (ppm)} \times Q \text{ (m}^3\text{/h)}$$

✓ Calculate the required volume of Hydrogen Peroxide (50%) to be injected into the irrigation water according to the following data:

Q: = 100 m<sup>3</sup>/h

The required Hydrogen Peroxide in the water and system = 29 ppm.

The residual concentration of Hydrogen Peroxide = is 1 ppm.

C: = 29 + 1 = 30 ppm

V (ml) = 1.8 × C (ppm) × Q (m<sup>3</sup>/h)

$$= 1.8 \times 30 \times 100 = 5400 \text{ ml/h}$$

= 5.4 liters of 50% Hydrogen Peroxide per 100 cubic meters

## GUIDELINES FOR PREVENTING ROOT INTRUSION IN SDI SYSTEMS

Plant roots can penetrate drippers, causing reduced water flow and eventually blockage. This is known as root intrusion.

One main cause of root intrusion is deficit irrigation. This occurs when plant water usage exceeds irrigation. Under these conditions, roots tend to develop close to the emitter, eventually penetrating it.

If this is the cause of root intrusion, correct scheduling of irrigation can help minimize root intrusion by matching (or exceeding) irrigation to plant water requirements.

Maintaining appropriate moisture within the environment by properly scheduling irrigation allows roots to spread out and utilize all available space rather than concentrate around the emitter. Using continuous soil moisture monitoring enables better control of the wetting pattern, thus maintaining optimum soil moisture within the environment.

If a crop requires a stress period, you can implement one of the following:

- A series of short irrigations to maintain high moisture content around the dripper only.
- Inject enough herbicide to kill the roots tips without killing the plants themselves.
- For a surface system or a system under plastic covers, Netafim recommends manually shifting the dripperlines.

**NOTE:** Check all pertinent local country (state) regulations before deciding which herbicide to use.

### Root Intrusion

Root intrusion is most likely to occur during times of induced water stress. Water stress can be:

- Planned at the grower's discretion.
- Due to a fault or failure in the water supply.
- Due to an unexpected increase in the water consumption of the crop.

Chemical treatment must be performed well in advance of induced water stress.

### When Not to Use Chemical Products

Chemical treatment is not recommended under the following conditions:

- When the soil is sandy and contains less than 8% clay.
- When the soil is saturated (due to rain or irrigation).
- When plants are very young, close to planting, seeding, or when the volume of the roots is very small.
- In soil-less substrates.
- When dripperlines are not properly buried, on the surface, or under plastic covers.
- When the relevant authorities do not permit specific chemical treatment.

### Chemical Products

The following are examples of chemical products for reducing root insertion.

- Treflan (active material: 48% Trifluraline)
- Stomp (active material: 33% Pendimethalin)
- Alligator (active material: 40% Pendimethalin)

The percentage of active materials depends on the manufacturer.

To calculate how much of a commercial product to inject per dripper system:

$6 / \% \text{ active material of the commercial product} = \text{cc or ml product/dripper.}$

For example:

- Treflan:  $6/48 = 0.125$  cc/dripper. Therefore, 1 liter of Treflan is required per 8,000 drippers.
- Stomp 330:  $6/33 = 0.182$  cc/dripper. Therefore, 1 liter of Stomp 330 is required per 5,495 drippers.
- Alligator 400:  $6/40 = 0.150$  cc/dripper. Therefore, 1.5 liter of Alligator 400 is required per 10,000 drippers.

### Determining the Required Number of Chemical Treatments

The number of treatments per season depends on the soil type and length of the irrigation and fertilization season.

Table 8. Recommended Chemical Treatments According to Soil Type

Duration of Irrigation Season	Recommended Number of Chemical Treatments in	
	Light-Medium Soil	Medium-Heavy Soil
2-3 months	1	1
3-4 months	2	1
5-8 months	3	2
All year	4	3

When to Apply Chemical Treatment to Avoid Root Intrusion

Table 9. Timing of Chemical Treatments

Crop Location/Type	When to Apply Chemical Treatment/Remarks
Orchards	At least 6 months after planting any type of crop. From the second year, 4 weeks after the start of the irrigation season.
Lawns	4 weeks after planting seeds. 2 to 3 weeks after placement of grass carpets.
Field crops and perennial vegetables, e.g. Asparagus, Alfalfa	In the first year, 4 weeks after planting seedlings or 6 weeks after sowing seed. From the second year, 4 weeks after starting irrigation.
Annual field crops and vegetables	Approximately 5 weeks after starting irrigation.

### Prior to Treatment

Perform the following tests several days before the planned treatment:

- Run the water for 20 minutes. If puddles form, the soil is too moist and the plot is not suitable for chemical treatment.
- Check for leaks and breaks in dripperlines. Repair all faults before treatment.
- For lawns, check that the dripperlines are buried in the soil and not lodged between the soil's surface and the grass carpets.
- Check that the pump and head control are in correct working condition.

**NOTE:** Soil should not be too moist during treatment. Netafim™ recommends partially drying the soil by skipping one irrigation cycle prior to treatment (if necessary).

- Any fertilizer pump can be used to apply the products.

Example: Calculate the minimum quantity of Stomp 550 plus water required for 20 minutes of injection according to the injection pump specifications.

Stomp 550 required for each dripper:	$6/55 = 0.11$ cc or ml
Total number of drippers in plot:	10,000
Total required quantity of Treflan	$10,000 \times 0.11 \text{ ml} = 1090 \text{ ml} = 1.09$ liter
Injection pump flow rate	240 l/h

Total solution required for 20 minutes of treatment:  $= 240(l/h)/60(min/h) = 80$  liters

These 80 liters are composed of 78.91 liters of water plus 1.09 liters Stomp 550.

**Treatment Procedure**

1. Turn on the water and run it until the pressure in the system stabilizes.
2. Fill a clean tank with a volume of water equal to 20 injection minutes (80 liters in the example above).
3. Add the herbicide to the water in the tank immediately.
4. Inject the chemical treatment from the tank into the system for a minimum of 15 minutes but not longer than 25 minutes. If you calculated the solution quantity correctly, injection will end in 20 minutes.
5. Before turning off the system, let the water continue to run in the system for the required period of time.

**NOTE:** Running the system after injection is important. Do not delay turning off the system at the end of this period.

6. After chemical treatment, wait at least 24 hours before resuming irrigation.

**Treatment Summary**

1. Fill the system until the pressure is stable.
2. Stage A: Inject the chemical treatment for 20 minutes.
3. Stage B: Distribute the chemical product in the system.
4. Stage C: Turn off the water. Do not delay turning off the water.
5. Wait 24 hours before the next irrigation.

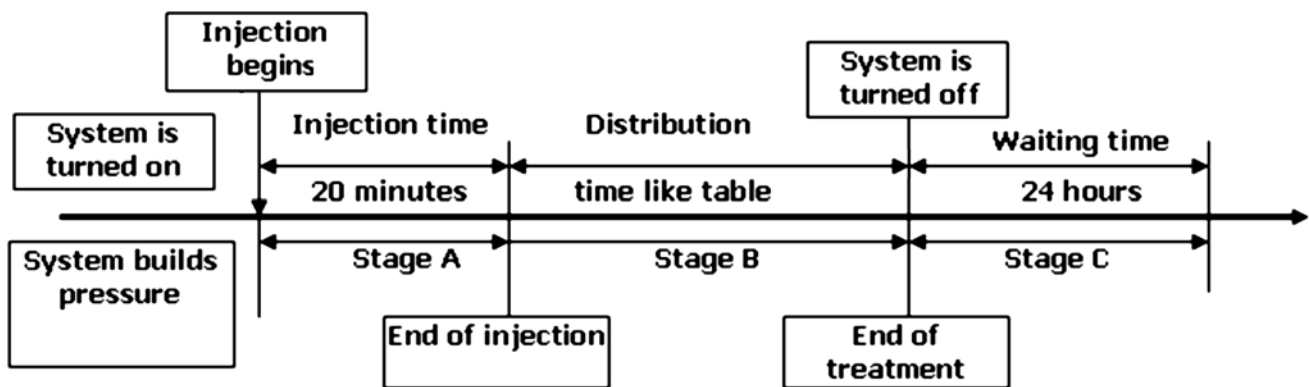


Figure 1. Treatment Summary

## INJECTION TIMES FOR CHEMICAL/FERTIGATION TREATMENT

Table 10. Dripperline Flow Time (minutes) for Chemical/Fertigation Injection

### 17 mm. OD - 14.6 mm. ID dripperlines

Distance between drippers (meter)	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 (meter)																
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

### 16.6 mm. OD - 14.2 mm. ID dripperlines

Distance between drippers (meter)	0.3				0.5				0.8				1.0			
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 (meter)																
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 (meter)	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 (meter)																
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 (meter)	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 (meter)																
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

**22.7 mm. OD - 22.2 mm. ID dripperlines**

Distance between drippers (meter)	0.3				0.5				0.8				1.0			
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 (meter)																
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 (meter)	0.3				0.5				0.8				1.0			
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 (meter)																
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



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# CHAPTER 4

# FERTIGATION & INJECTION

This chapter provides general guidelines for Fertigation.

## IN THIS CHAPTER

■ Fertigation - Technical Aspects	36
■ Acidification	37
■ Permitted Chemicals	38
■ Using Chemical Agents in Irrigation Systems	39
Fungicides - Herbicides - Disinfection	39
■ Netafim™ Products in Organic Crops Irrigation-Nutrigation™	40
Proper Nutrient Solution Preparation	40
Organic Nutrients	41
Head Irrigation Control System	41
■ Flushing	42
Chlorination	42
Acid Treatment	42
Summary	42

## 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 11. Selecting Fertilizer based on pH of Irrigation Water

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

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.

**NOTE:** 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 10, page 34 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.

## ACIDIFICATION

There are two principle reasons for using acidification:

1. To reduce the pH level to avoid mineral sedimentation.
2. To reduce the pH level to dissolve de mineral sediments, like scale.

**NOTE:** Netafim™ recommends obtaining and maintaining a pH level of approximately 2-3 for at least 5 minutes.

The following guidelines can be used to determine how often to inject the acid and in what quantities for the second target.

- Using titration, you can calculate the quantity of any acid in various types of water qualities at a given time.

✓ **IT IS USEFUL TO DEVELOP A TITRATION CURVE OR TABLE IN THE FIELD AS FOLLOWS:**

### Required Equipment:

- 1 or 10 liters bucket.
- Digital pH meter or measuring strips
- 1 to 10 liter water sample
- Concentrate or dilution Acid

### Procedure:

1. Place 1 to 10 liter of the water sample in the bucket. It's important to know the exact amount of water in the bucket.
2. Record the pH level of the water.
3. Add 1 ml of the acid concentrate and mix the solution.
4. Record the pH level of the solution.
5. Repeat steps 3 and 4 until reaching the required pH level for the targets.

**NOTE:** If the pH level changes abruptly it's recommended to dilute the acid with water.

## PERMITTED CHEMICALS

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

**NOTE:** 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

## USING CHEMICAL AGENTS IN IRRIGATION SYSTEMS

**NOTE:** Netafim™ authorizes the use of certain chemical agents. Products not authorized here must undergo a quality control examination in the Netafim™ lab before it can be authorized for safe use with our systems.

### FUNGICIDES - HERBICIDES - DISINFECTION

Products authorized by Netafim™:

- Metham Sodium
- Telone II
- Formaldehyde
- Other options exist, contact Netafim™ agronomic department for details

### Instructions

1. Read the product's instructions very carefully.
2. It is preferable to use externally rather than by irrigation.
3. Use in irrigation systems when:
  - a. There isn't any problem in using the materials with Non Compensated Dripperlines.
  - b. With Compensated systems it is necessary to continue irrigating for at least 30 minutes with chemical-free water (depending on the size of the system).
  - c. With Compensated Non-Leakage (CNL) systems it is necessary in addition to that mentioned in 'b' to open the dripperline ends for flushing.

### Possible Problems

The products in general, authorized and not-authorized by Netafim™, contain approximately the same percentage of active material. The difference between the various products is:

- The quality of the product
- The time of storage
- Country of production
- Dosage
- The quality of the emulsion (most important)

The quality of the emulsion makes the active components merge with the water without creating layers of different composition. If these conditions aren't fulfilled defacement occurs and part of the system e.g. valves, drippers, flow meters may come in contact with high active product concentrations which may cause damage. These products are very corrosive to some metals as they also react with different polymers (depending on the product).

### NETAFIM™ PRODUCTS IN ORGANIC CROPS IRRIGATION-NUTRIGATION™

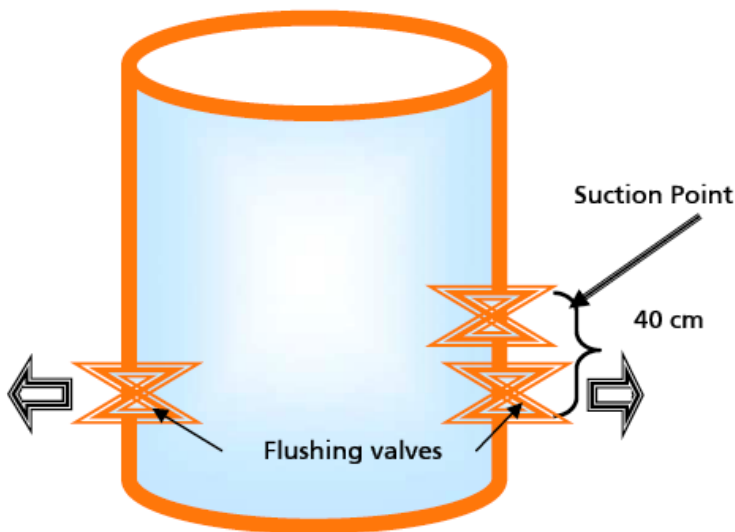
Application of organic nutrients through a drip irrigation system is possible but requires special attention.

- Organic nutrient solutions are usually less soluble in water and often contain high concentrations of suspended solids that may cause sedimentation and consequent damage to the irrigation system.
- Application of combinations of organic nutrients should be avoided and the preparation of the proper solution must be ensured.
- Effective filtration and system maintenance are pre-requisites for the success of the crop.
- System flushing and disinfection treatments using materials permitted in organic agriculture ensure the system's longevity and durability.

### Proper Nutrient Solution Preparation

Solid organic nutrients must be dissolved in water in the correct concentrations.

- Guano (seabird manure) Mix with water in 1:10 ratio: 100 liter Guano per 1000 liter of water.
- The solution should stand for sufficient time (7-10 days depending on season and material quality) until clear, sediment-free fraction is obtained.
- The pumping point must be located horizontally, no less than 40 cm. from tank bottom to avoid turbulence.
- The sediment has to be flushed or spread in the field, when the tank becomes empty.



### Organic Nutrients

The following is a partial list of permitted organic nutrients commonly applied through the irrigation system, in organic agriculture:

- Guano (sea bird manure) & Slurry Urine
- Amino Acids (from cow epithelial enzymatic hydrolysis)
- Humic Acids
- VGI's KF-20 (biological fertilizer)
- Soluble Micro-Elements: (Fe, Mg, Mn, Zn, Mo, Cu, etc.).
- Soluble Macro-Elements: Dead Sea Potassium Chlorite ('Ferti- K')

Proper filtration is normally applied to remove the suspended solids in the water. However, the application of organic material combinations is more complex.

#### For example:

HUMIC ACIDS + N = FLOCCULATION -----> CLOGS!

Humic acids applied as nutrient in agriculture, when combined with Nitrogen source (organic or inorganic) cause flocculation, also with sewage water.

**NOTE:** When Humic acids are injected into the irrigation system ensure that they reach the system free of Nitrogen to avoid clogging.

Another problematic interaction often occurs between materials injected into the system and the microorganisms living inside the system or injected into it. Organic nutrients injected into a system contaminated with bacteria are likely to develop bacterial slime" which may cause clogging of the drippers.

**NOTE:** Avoid mixing organic nutrients in the fertilizer tank.

### HEAD IRRIGATION CONTROL SYSTEM

The head irrigation control system must be as simple as the conventional one with emphasis on optimal filtration.

- Organic nutrients must be filtered before it flows into the water stream.
- Nutrient injection point must be located before system filtration to avoid clogging.

### Filtration

In order to avoid reduced dripper flow rate and clogging, proper filtration must be applied: primary black rings -100 micron (equal 140 mesh) filter with automatic cleaning flush & secondary / back-up red rings- 130 micron (equal 120 mesh) control filter –manual cleaning– in the field.

## FLUSHING

Flushing must be performed to keep the system free of nutrient residues.

- Flush the irrigation system with clean water at the end of irrigation.
- Never close the water valve and nutrient injection pump at the same time.
- Stop the injection for a known period before the end of irrigation. This period is the 'flushing time' which depends on lateral's length.
- Use collector pipes with flushing valves or Netafim™ automatic lateral flushers.

## Chlorination

When using organic nutrients Netafim™ recommends applying low-concentration chlorination at the appropriate frequency in order to disinfect the system without harming the plants. The use of sodium hypochlorite (chlorine) is permitted according to the Organic Agriculture Standard. In June 2001 the PPIS granted Netafim a special permit approving chlorination treatment used by the Israeli organic growers.

**NOTE:** Netafim™ recommends 'continuous chlorination' at the end of the irrigation. If necessary, for a few minutes or periodically as well.

## Acid Treatment

Certain organic acids are permitted for treating scale accumulation in the system. In June 2001 the PPIS granted Netafim™ a special permit approving organic acid treatment used by the Israeli organic growers. The following acids are permitted for use in Organic Agriculture:

- Acetic
- Citric
- Oxalic
- Para-acetic
- Lactic
- Glycolic
- Formic

## Summary

Using organic nutrients in the drip irrigation system is possible but requires special attention. Organic nutrient solutions are usually less soluble in water and often contain high concentrations of suspended solids which may cause sedimentation and consequent damage to the irrigation system. The application of organic nutrient combinations should be avoided and the proper solution preparation must be ensured. Effective filtration and system maintenance are pre-requisites for crop success. System flushing and disinfection treatments using permitted materials for organic agriculture ensure the system's longevity and durability.



# CHAPTER 5

# USEFUL CONVERSIONS

This chapter provides general conversion tables.

## IN THIS CHAPTER

■ General Conversion Tables .....	44
Distance .....	44
Area .....	44
Flow .....	44
Pressure .....	45
Power .....	45
Weight .....	45
Temperature .....	45
Volume .....	45

## GENERAL CONVERSION TABLES

### DISTANCE

Table 12. Distance

1	Kilometer	=	1094	Yard
1	Kilometer	=	0.621	Miles
1	Meter	=	3.281	Feet
1	Meter	=	39.370	Inch
1	Meter	=	1.094	Yard
1	Centimeter	=	0.039	Inch
1	Feet	=	0.305	Meter
1	Inch	=	0.025	Meter
1	Inch	=	2.54	Centimeter
1	Yard	=	0.914	Meter
1	Mile	=	1.609	Kilometers
1	Mile	=	1609.344	Meters

### AREA

Table 13. Area

1	Hectare	=	2.471	Acres
1	Acre	=	0.405	Hectares
1	Hectare	=	10000	M <sup>2</sup>
1	Acre	=	4046.873	M <sup>2</sup>
1	Hectare	=	0.004	Miles <sup>2</sup>
1	Centimeter	=	0.55	Inch <sup>2</sup>
1	Meter <sup>2</sup>	=	1.196	Yard <sup>2</sup>
1	Kilometer <sup>2</sup>	=	0.385	Mile <sup>2</sup>
1	Inch <sup>2</sup>	=	6.452	Centimeter <sup>2</sup>
1	Feet <sup>2</sup>	=	0.092	Meter <sup>2</sup>
1	Yard <sup>2</sup>	=	0.836	Meter <sup>2</sup>
1	Mile <sup>2</sup>	=	2.59	Kilometer <sup>2</sup>

### FLOW

Table 14. Flow

1	Meter <sup>3</sup> /h	=	264.1721	Gallons/h
1	Liter/h	=	0.2641721	Gallons/h

**PRESSURE**

Table 15. Pressure

1	Bar	=	14.69595	PSI
1	PSI	=	0.06894757	Bar
1	Bar	=	100	Kilopascals
1	PSI	=	6.894757	Kilopascals

**POWER**

Table 16. Power

1	Kilowatts	=	1.341022	Horsepower
1	Kilowatts	=	56.91965	BTU/minute
1	Horsepower	=	0.7456999	Kilowatts

**WEIGHT**

Table 17. Weight

1	Grams	=	0.0353	Ounces
1	Kilograms	=	2.205	Libras
1	Ounces	=	28.35	Grams
1	Ounces	=	0.0283	Kilograms
1	Libras	=	0.454	Kilograms

**TEMPERATURE**

Table 18. Temperature

0	Celsius	=	32	Fahrenheit
5	Celsius	=	41	Fahrenheit
10	Celsius	=	50	Fahrenheit
15	Celsius	=	59	Fahrenheit
20	Celsius	=	69	Fahrenheit
25	Celsius	=	77	Fahrenheit
30	Celsius	=	86	Fahrenheit
35	Celsius	=	95	Fahrenheit

**VOLUME**

Table 19. Volume

1	Gallon	=	4.546	Liter
1	Liter	=	0.22	Gallon
1	Pint	=	0.546	Liter



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