

# Clogging Factors in Drip Irrigation Systems





# Agenda

 Clogging factors and treatments

 Physical factors

 Biological factors

 Chemical factors

 Fertigation





# Clogging Factors & Treatments

# Clogging factors in Drip Irrigation Systems (DIS)



A combination of these 3 factors poses the greatest risk to DIS

# Treatment types

## Preventive

Prevents clogging of the dripper irrigation system.

## Corrective

Consists mainly of removal of the clogging already present in the dripper irrigation system.



Which  
treatment  
is that?



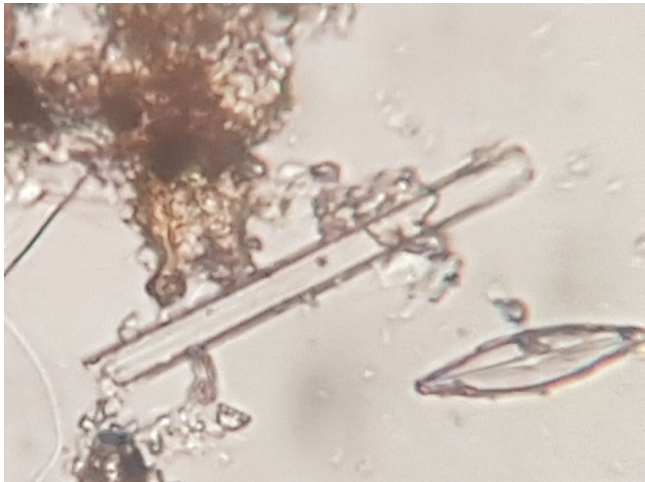
# Physical Factors

# Physical factors



## Inorganic

- Sand
- Silt
- Clay
- Stones
- Mud
- Salts
- Iron
- Manganese
- Asbestos fibers



## Organic

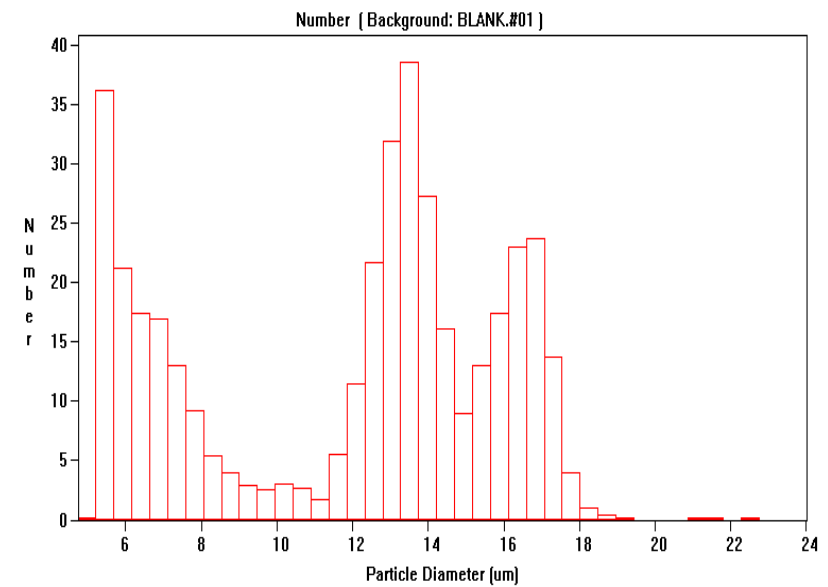
- Plankton and zooplankton
- Algae
- Fish
- Roots
- Insects
- Worms
- Bacterial slime

# Physical factors

Particle	Particle diameter (mesh)	Sedimentation time (1m)
Sand	10 - 75	6 seconds
Silt	75 - 290	66 seconds
Clay	<3000	21 hours
Bacteria	<6000	55 hours
Color	<60000	230 hours



## Particle Size Distribution:



# Physical factors – sand

- Sand is insoluble and almost impossible to remove from the drippers.
- Identify the source of the sand infiltration:
  - Defective filter
  - Water source
  - Deep pumping – turbulence flow at the suction point
- Soil suction drippers – fixed system time
- Impure fertilizers (low quality)

**The best treatment is prevention**



Sand inside of the dripper labyrinth

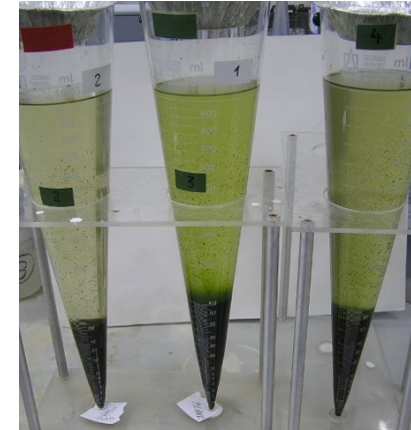
# Physical factors



Clogging of driplines from physical factors



Clogging of filters from physical factors



Physical factors concentration in the water (TSS test)

# Physical factors – treatments

Suction point location

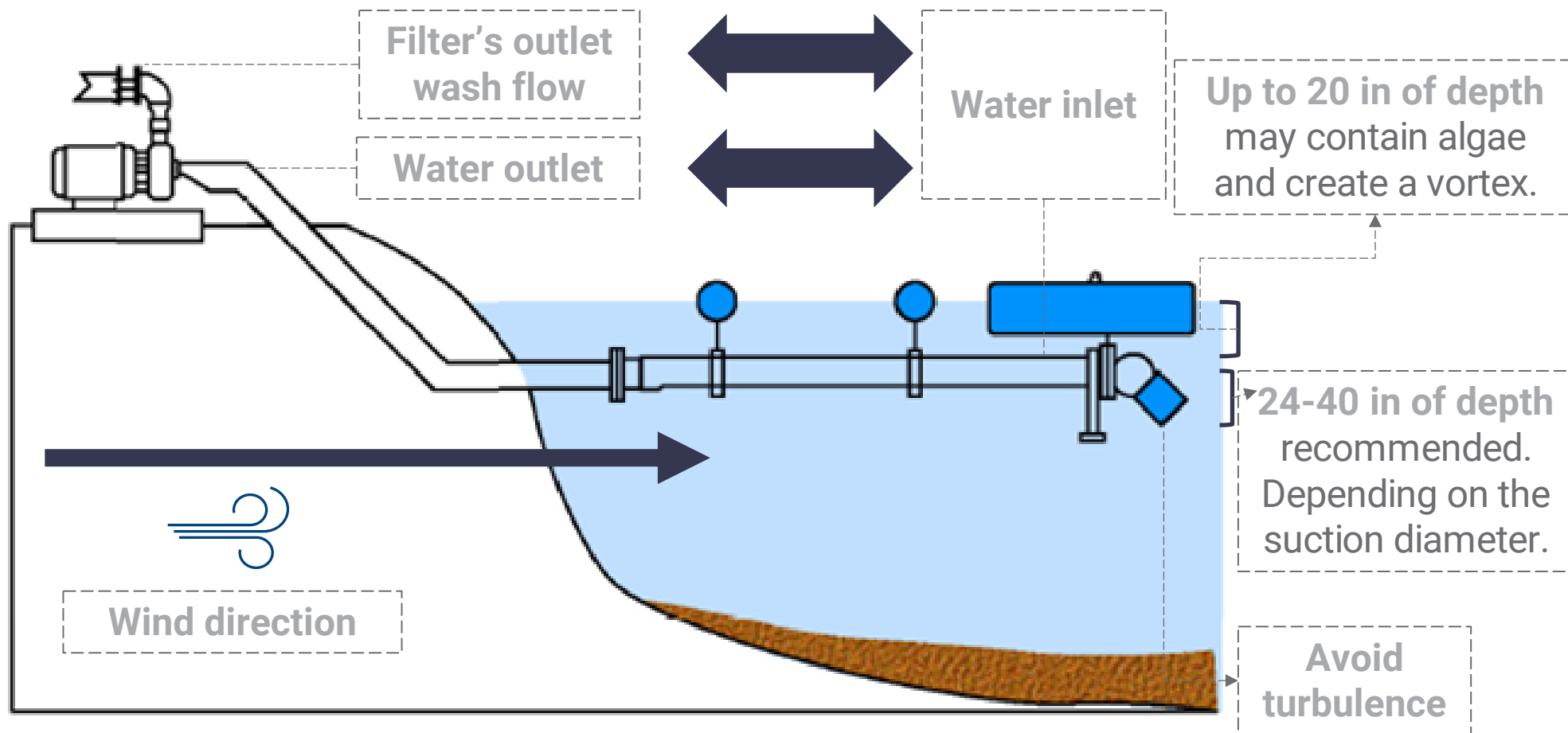


System flushing



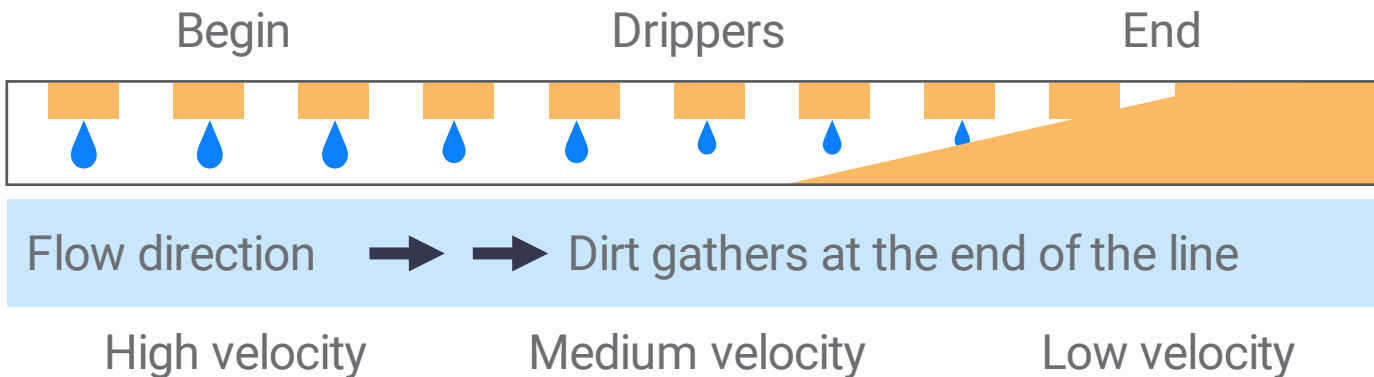
# Suction point location

The importance of the suction point location:



# System flushing

- Flushing the irrigation system reduces to minimum the accumulation of pollutants.



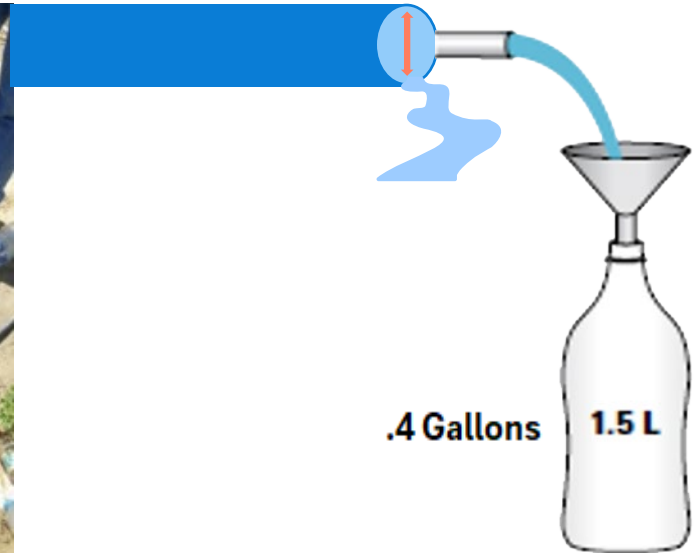
- Flushing of the irrigation system is comprised of 3 processes:
  - Filter back-flushing
  - Flushing main and sub-main lines
  - Flushing driplines

# System flushing

How to measure water flow velocity in the dripline during flushing?

Measure the filling time of a 1.5-liter bottle with the water at the end of the lateral.

**Minimum velocity required:  
0.5 m/sec or 1.6 ft/sec**



Dripline ID (in)	.465	.559	.638	.689	.819	.874	.984	1.378
Quantity of water per 3.28 feet of dripline length (ounces)	3.7	5.3	7.0	8.1	11.4	13.1	16.6	32.5
For velocity of at least 0.5 m/sec (1.6 ft/sec), the bottle must be filled in less than ___ sec	28	19	15	13	9	8	6	3

# System flushing



0 seconds



After 30 seconds



After 60 seconds



Flushing time test until clean water is obtained.



# System flushing

## Advancement time (minutes) in driplines – Time III

**16mm**  
diameter  
dripline:

Distance Between Drippers (in)	11.9				19.7				31.5				39.4			
Nomial Flow rate of the dripper (G/H)	0.21	0.29	0.42	0.71	0.21	0.29	0.42	0.71	0.21	0.29	0.42	0.71	0.21	0.29	0.42	0.71
Total Length of lateral (feet)																
328	29	21	14	8	36	26	18	11	51	37	25	15	64	47	32	19
656	32	23	16	9	40	29	20	12	57	41	29	17	73	53	36	22
984	33	24	17	10	43	31	21	13	61	44	30	18	77	56	39	23

**20mm**  
diameter  
dripline:

Distance Between Drippers (in)	11.9				19.7				31.5				39.4			
Nomial Flow rate of the dripper (G/H)	0.26	0.42	0.61	0.93	0.26	0.42	0.61	0.93	0.26	0.42	0.61	0.93	0.26	0.42	0.61	0.93
Total Length of lateral (feet)																
328	28	17	12	8	42	26	18	12	62	39	27	18	75	47	33	21
656	31	19	13	9	47	30	21	14	70	44	31	20	85	53	37	24
984	32	20	14	9	50	31	22	14	75	47	33	21	91	57	39	26
1312	34	21	15	10	52	33	23	15	78	49	34	22	95	59	41	27
1640	35	22	15	10	54	34	23	15	81	51	35	23	98	61	43	28



# Biological Factors

# Biological factors

- Bacteria which create bacterial slime (Iron, Manganese and Sulphate)
- Fungi
- Roots

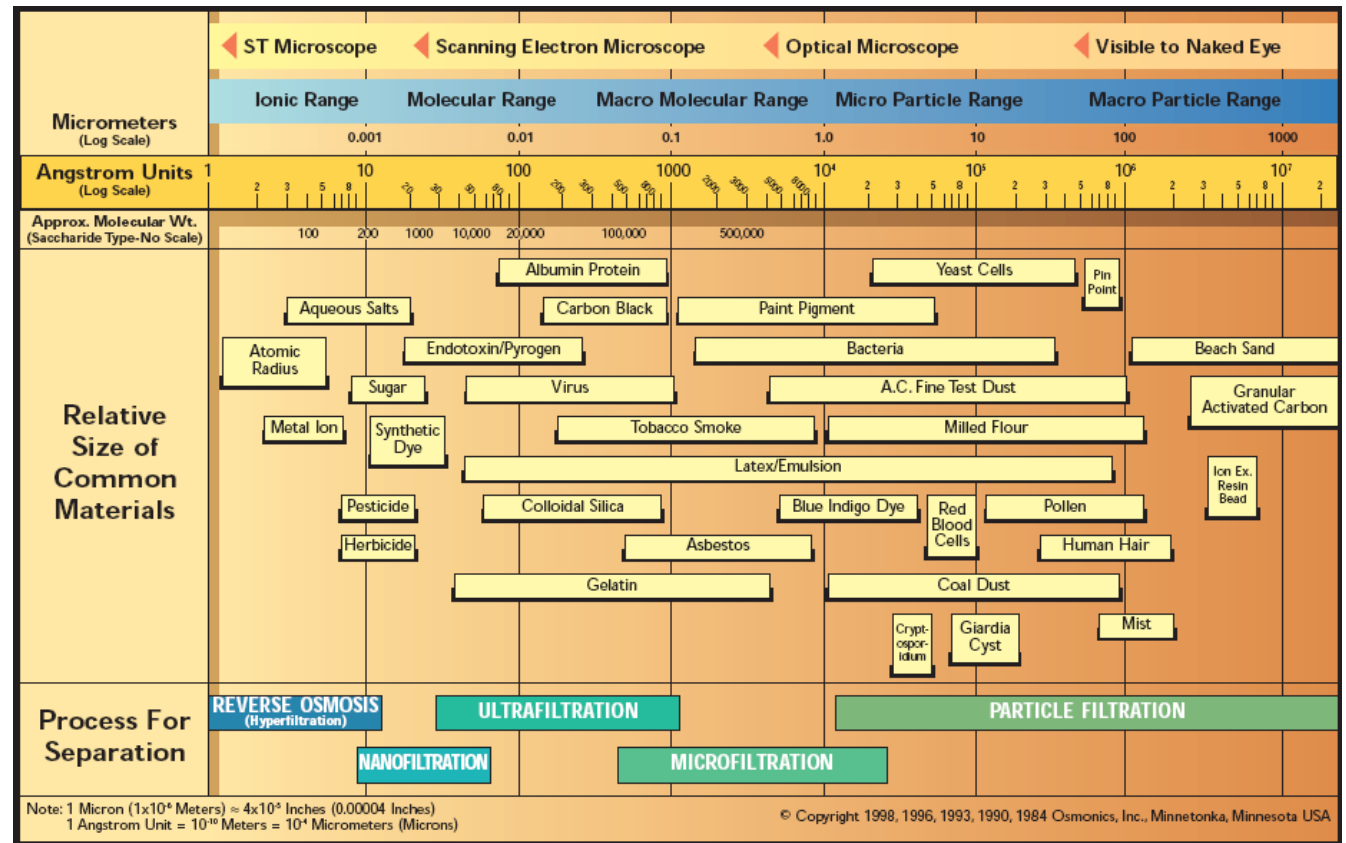


Biological factor	Size
Viruses	0.02 - 0.3 micron
Bacteria	0.5 - 5 micron
Protozoa	1 - 200 micron / 15,000 - 75 mesh
Algae	1 - 1000 micron / 15,000 - 15 mesh
Zooplankton	0.1 - 2 mm

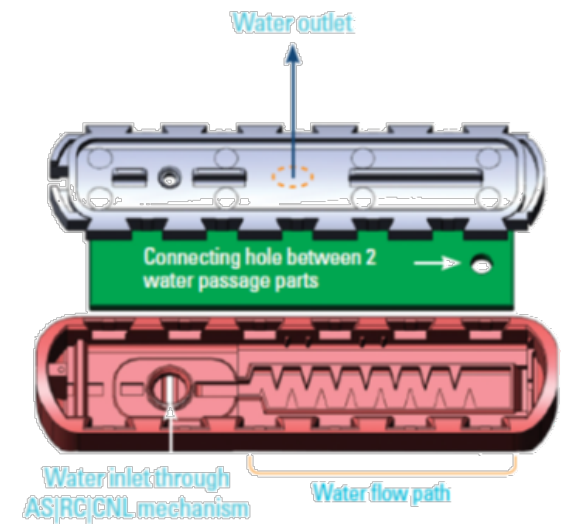
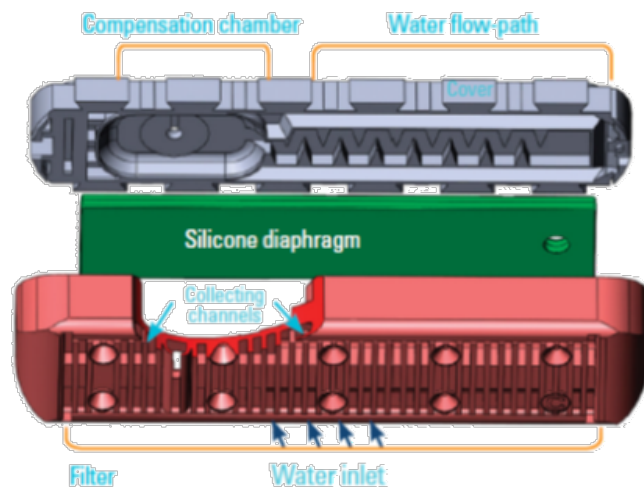
# Biological factors

There is no life without water.

Where there is water, there are living organisms.



# Biological factors



# Biological factors – treatments

## Disinfection and oxidation treatments

(Chlorine, Hydrogen peroxide, Oxygen, Air, Permanganate)

HOW?

**Chemical injection**

# Chemical injection

The aims of the chemical injection treatments are to:

Prevent

Eliminate

Dissolve

Remove

Solve

## Clogging drippers

### The injected substances

- Fertilizers
- Insecticides
- Fungicides
- Nematicides
- Herbicides
- Oxidizers
- Disinfectants
- Etc.

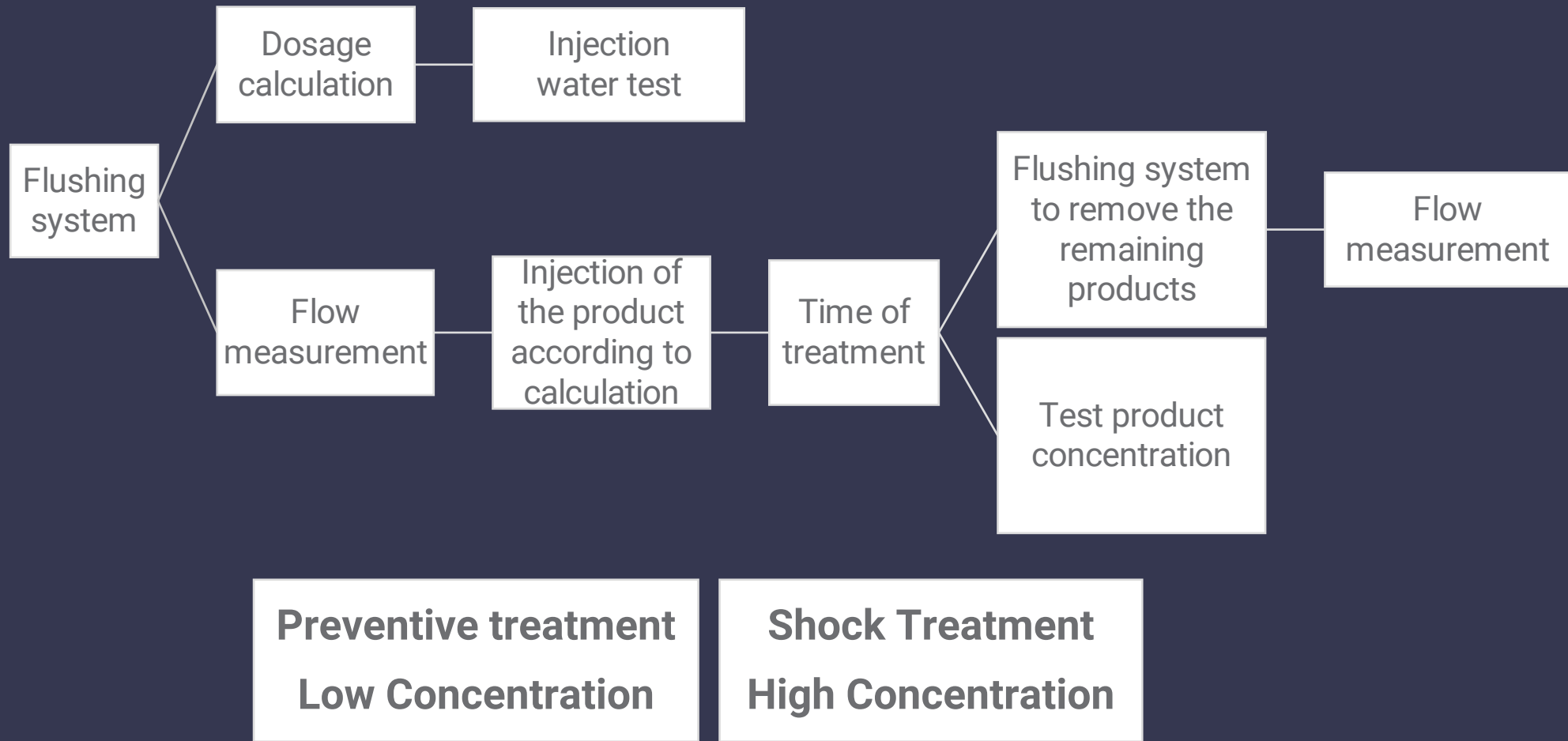
The substances must be  
**totally soluble in the water**  
in order to inject them into the system.

### System wash

When chemicals are injected, irrigation must continue **only with water** in order to remove all the product from the system.

# Chemical injection

## Flowchart – product injections



# Biological factors – treatments

## Disinfection and oxidation treatments

### Iron Bacteria

Fe<sup>+2</sup> is soluble in water

Fe<sup>+3</sup> settles in water



# Biological factors – treatments

## Oxidation Treatment

### Treatment's aim:

- Prevention of bacterial slime build-up in main lines and driplines.
- Cleaning drip irrigation system with organic sediments and bacterial slime.
- Micro-element oxidation for killing bacteria ( $\text{Fe}^{+2}$ ,  $\text{Mn}^{+2}$ ,  $\text{S}^{-2}$ ).
- Improving filtration efficiency under high organic matter present.



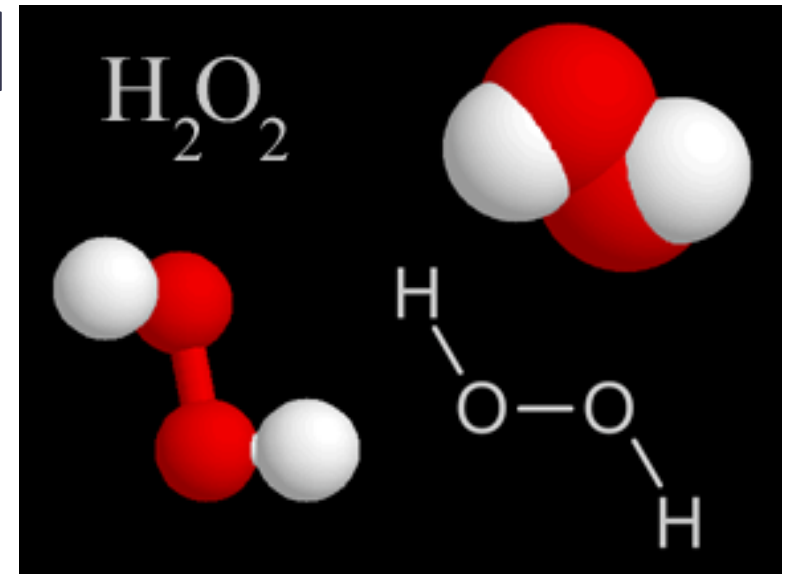
# Biological factors – treatments

## Hydrogen Peroxide Treatment



### H<sub>2</sub>O<sub>2</sub> vs. Chlorine

Oxidant agent	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



# Biological factors – treatments

## Hydrogen Peroxide Treatment

### Advantages of H<sub>2</sub>O<sub>2</sub> use:

- Non-carcinogenic molecules develop (trichloromethane).
- It does not pollute the environment (oxygen and water).
- In soils with anaerobic conditions, oxygen supply.
- It has a fast reaction, does not need prolonged contact.
- Residual Chloride does not remain in the water or/and soil.
- Its use is allowed in all countries.
- It is used for the disinfection and oxidation of fruits and vegetables before storage.



# Biological factors – treatments

## Hydrogen Peroxide Treatment

### Advantages of H<sub>2</sub>O<sub>2</sub> use:

- It is used for all types of wastewater, gray water, drains, drinking water, as well as for maintenance of swimming pools and Spas, medicinal use.
- Its use in nurseries, greenhouses is common due to its strong, fast and non-polluting reaction characteristics.
- Prevents and reduces odors of contaminated water and lowers the concentrations of BOD and COD.
- **Does not harm silicone membranes.**



# Biological factors – treatments

## Hydrogen Peroxide Treatment

### Formula for calculation:

- **C** = Desired concentration of Hydrogen Peroxide in water, in ppm.
- **V** = Amount of Hydrogen Peroxide in ml that must be injected into the system.
- **Q** = The water flow of the system to be treated (GPM)

$$325.7 \times C \text{ (ppm)} \times Q \text{ (GPM)} =$$

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This formula shows that 35% Hydrogen Peroxide should be injected in ounces.



# Chemical Factors

# Chemical factors

- Scale sediments
  - Phosphates
  - Hydroxides
  - Gypsum
  - Low dissolution salts
- The formation is dependent on different chemical and physical factors in the water.
  - **LSI, ZI, AI, RSI indices measure sediment potential.**



Filtration does **not** remove dissolved substances

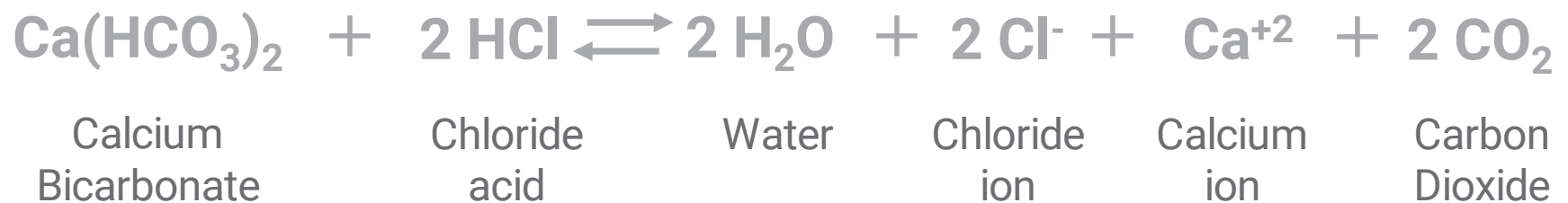
# Chemical factors – treatments

**Treatment aim:** To adjust physical-chemical influences affecting sediment creation.

For example: **Acid treatment**

- Aim of acid treatment: Dissolve and prevent scale sediments.
- To reduce water pH: inject low dosage acid solution continuously including pH controller.
- Chemical reaction (scale):

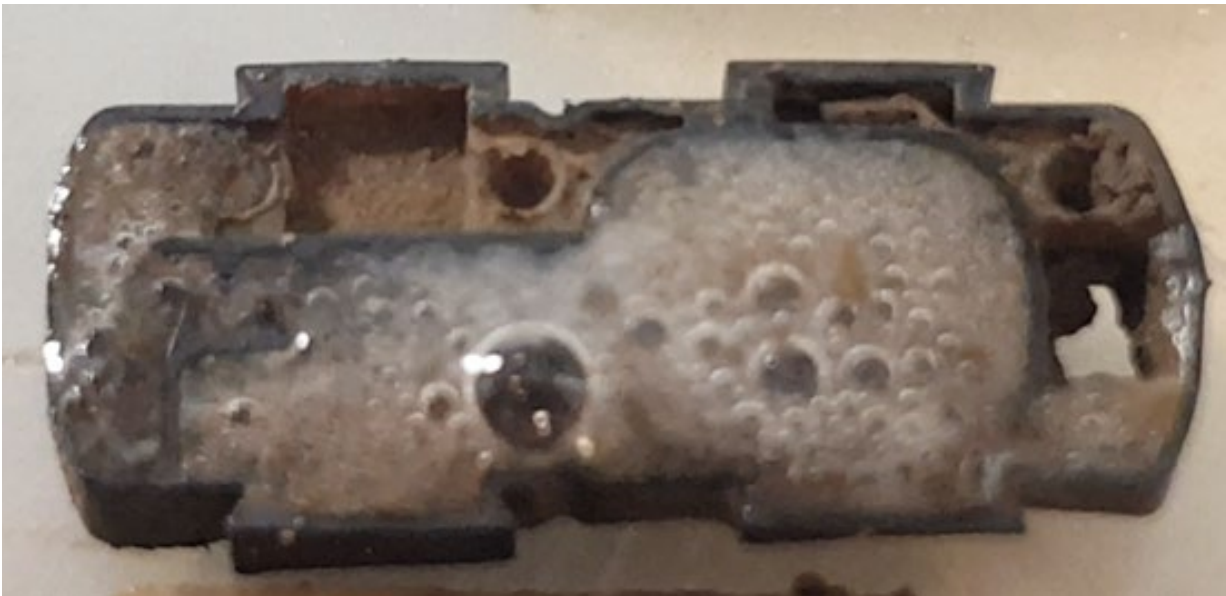
Acid type to be applied:	
Chloride Acid	HCL at 33%
Phosphoric acid	H <sub>3</sub> PO <sub>4</sub> at 85%
Nitric acid	HNO <sub>3</sub> at 60%
Sulphuric acid	H <sub>2</sub> SO <sub>4</sub> at 98%



# Chemical factors – treatments

## Recommendations for the acid injection process

- The pH of the water must be reduced continuously or at a predetermined frequency.
- In order to calculate the required pH, it is recommended to titrate the irrigation water with the acid to be used.



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# Chemical factors – treatments

## Recommendations for the acid injection process

Determining the titration curve or table:

### Required equipment

- Bucket
- pH digital meter or litmus paper
- 1 liter of irrigation water
- Acid

### Procedure

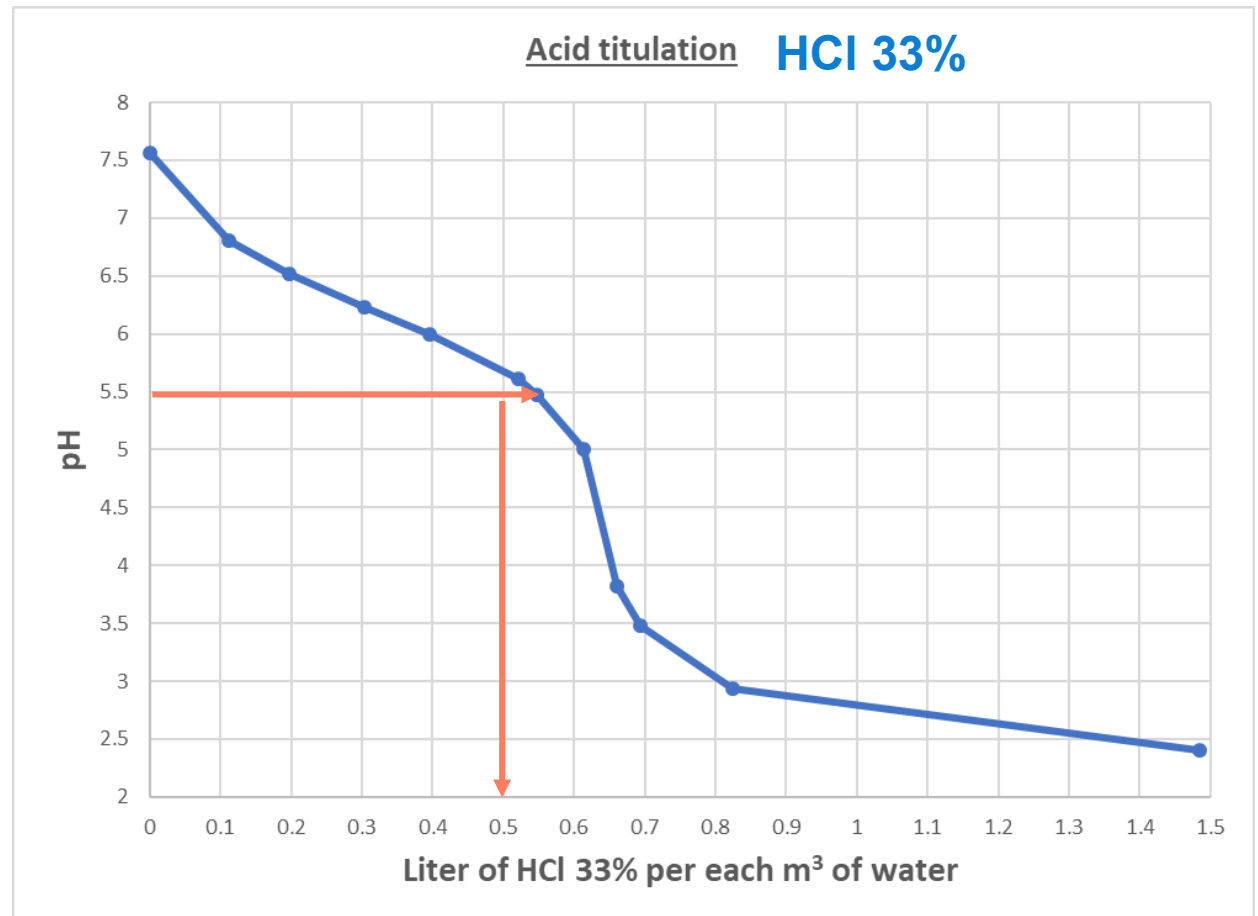
1. Fill 1 liter of irrigation water in the bucket
2. Record the pH level of the water
3. Add 1cc of the acid and mix the solution
4. Record the pH level of the solution
5. Repeat steps 3 and 4 until reaching the desired pH level

### Note:

- If the pH level changes abruptly, it is recommended to dilute the acid with water or use a higher volume of water.
- The result will provide an approximation of the amount (in cc or ml) of acid per liter of water needed to reduce the pH to the required level.
- **1cc or ml of acid per liter of water = 1 liter of acid per m<sup>3</sup> of water**

# Chemical factors – treatments

Liter of HCl 33%	pH
0.00	7.56
0.11	6.81
0.20	6.52
0.30	6.23
0.40	6
0.52	5.61
0.55	5.47
0.61	5
0.66	3.82
0.69	3.48
0.83	2.94
1.49	2.4



## According to the titration result:

In order to drop the pH level from 7.5 to 5.5, the need is for 0.5 liter or (500 ml) of acid HCl 33% per m<sup>3</sup> of irrigation water

# Fertigation

# Fertigation

- Ensure that the fertilizer is free from impurities and sediments.
- Filter fertilizer from tank exit before injection into system
- The injection of fertilizer containing Iron ions is prohibited.
- High concentration of phosphates is not recommended.

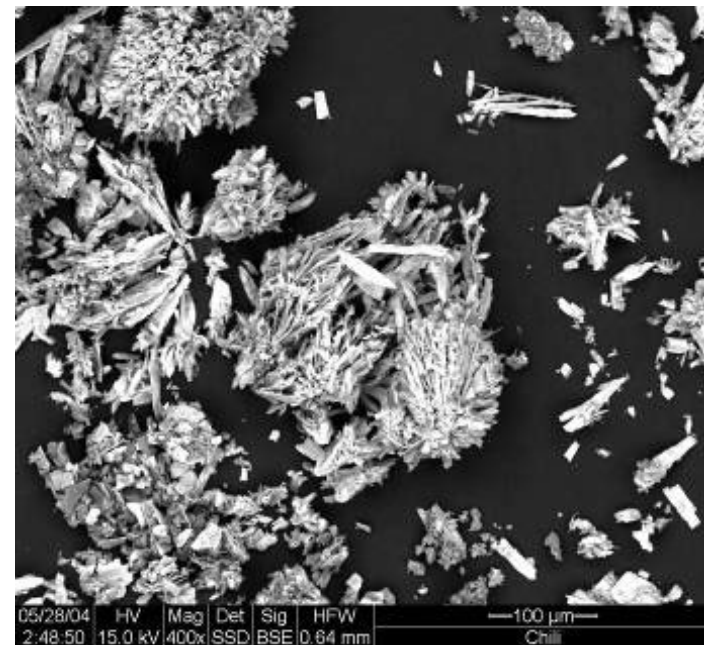


# Fertigation

- Whenever the irrigation water has high pH or a high level of hardness, the injection of acid is recommended.
- The use of fertilizer with a high Calcium content through a drip system is not advised.
- **Shutting off water and fertilizer at the same time is dangerous.**

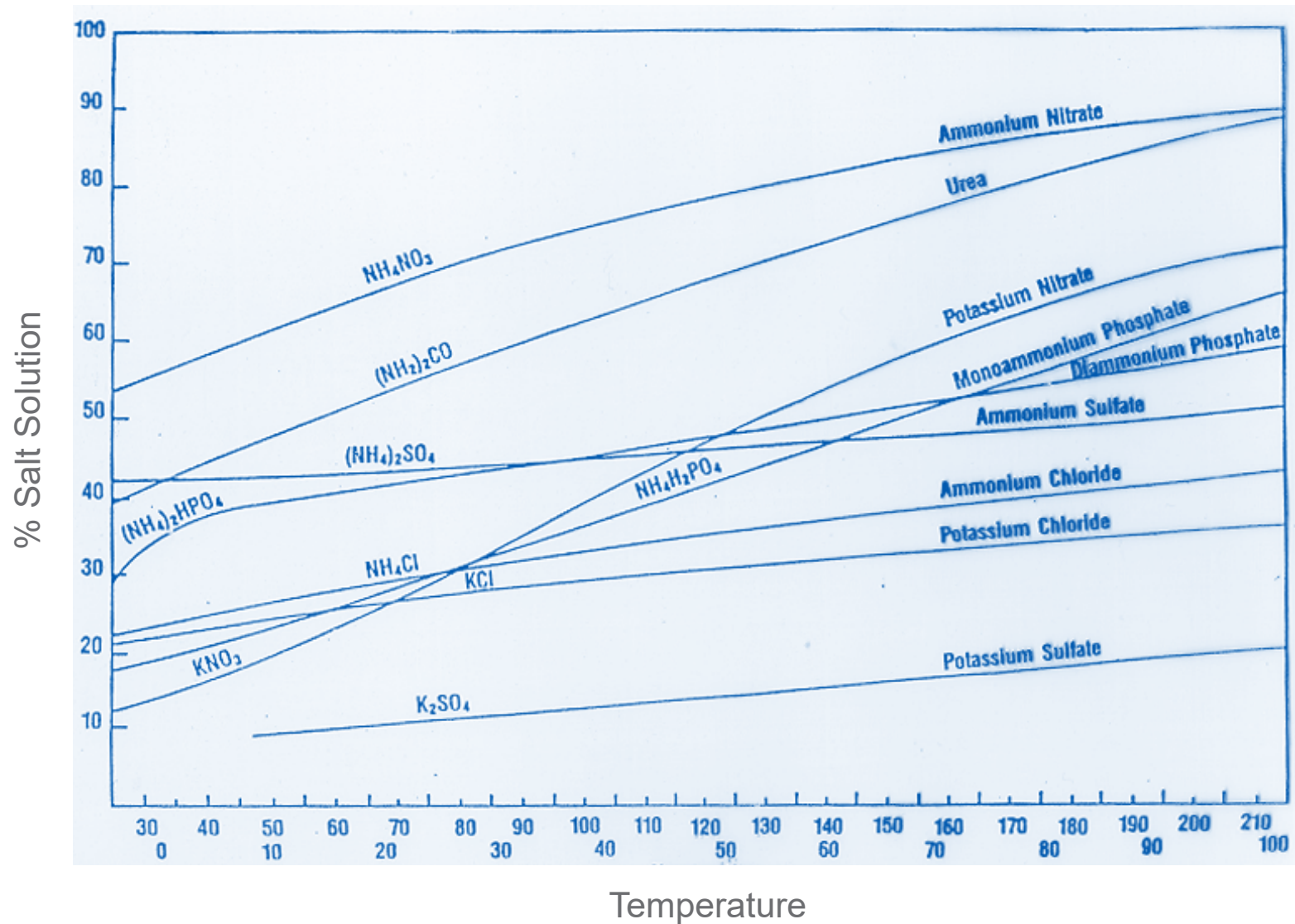
## Analysis SEM

Ion	Atomic (%)	Weight (%)
Al	28.67	24.71
Si	9.92	8.9
P	41.52	41.08
Cl	4.86	5.5
K	2.46	3.08
Ca	10.96	14.03
Ti	0.66	1
Fe	0.96	1.7
<b>Total</b>	<b>100</b>	<b>100</b>



# Fertigation

Fertilizer solubility:

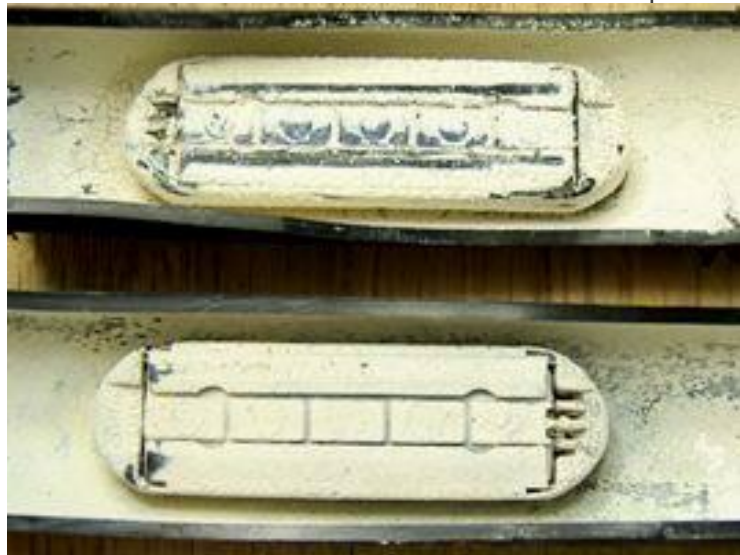


# Fertigation

## Fertilizer solubility:

I = Incompatible  
C = Compatible

$(NO_3)_2Ca$	$NO_3NH_4$	$PO_4H_3$	$NO_3K$	$PO_4H_2K$	$SO_4K_2$	$SO_4Mg$	
C	C	I	C	I	I	I	$(NO_3)_2Ca$
	C	C	C	C	C	C	$NO_3NH_4$
		C	C	C	C	C	$PO_4H_3$
			C	C	C	C	$NO_3K$
				C	C	C	$PO_4H_2K$
					C	C	$SO_4K_2$
						C	$SO_4Mg$



# Fertigation

## Tank A

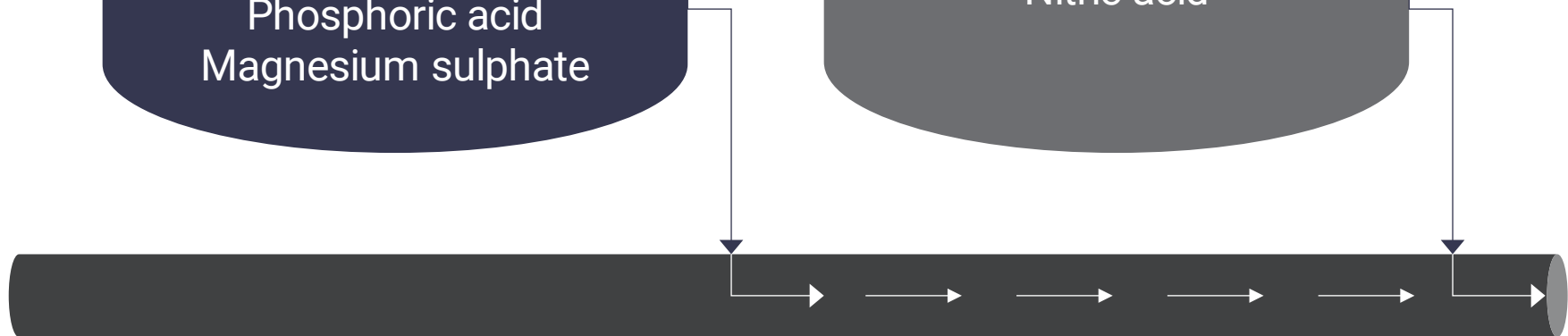
No fertilizers containing Calcium

Multi-K  
Multi NPK  
MAP  
MKP  
Urea  
Ammonium nitrate  
Potassium sulphate  
Phosphoric acid  
Magnesium sulphate







## Tank B

No fertilizers containing Phosphates and Sulphate

Multi-K  
Multi-K+Mg  
Magnisal [ $\text{Mg}(\text{NO}_3)_2$ ]  
Urea  
Calcium nitrate  
Ammonium nitrate  
Nitric acid



# Fertigation

Time	Mother solution	
	1	2
1 minute		
10 minutes		
30 minutes		

In the stock solution of fertilizers number 2, the ammonium sulfate was changed to ammonium nitrate and thus it was possible to avoid the sedimentation of calcium sulfate salts (gypsum), as can be seen in the tank of the stock solution of fertilizers 1.

# I wanted to ask you...





What is the difference between **preventive and corrective treatments**?

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The main objective of preventive treatment is to prevent problems in the irrigation system. Corrective treatment consists mainly of removing clogging or problems already present in the dripper irrigation system.

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Can algae and organic matter be classified as **physical clogging factors**?

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Yes, Even living organisms and organic matter can clog the irrigation system in physical form.





How long do **clay** particles take to settle at a 1 m water depth?

< 2 hrs.

2-5 hrs.

5-12 hrs.

12-24

>24 hrs.

Depending on the specific size of the clay, it may take a day or more.



Is it possible to dissolve **sand** particles stuck inside drippers, and if so, what product should be used?

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Sand particles embedded in drippers cannot be dissolved with products allowed in agriculture.





Where is the ideal installation location for the **pump suction point** in a reservoir?

- Fixed surface point
- Fixed 8" above the bottom
- Fixed 20" below the surface
- Fixed 60" above the bottom
- Floated 8" below the surface

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The best pumping control.





What is the ideal **flushing velocity** through dripperlines? (more than one correct answer is possible)

< 0.66 ft/sec

1.0 - 1.3 ft/sec

1.3 - 1.6 ft/sec

1.6 - 2.0 ft/sec

> 2.0 ft/sec

The flushing velocity starts being efficient at 1.6 ft/sec or more.



When referring to **travel time** in drip irrigation systems, which of the following situations takes less time?

- A – Dripperline 0.540" ID, length 984 ft, DD 12" spacing, dripper flow 0.79 gph
- B – Dripperline 0.690" ID, length 984 ft, DD 39.4", dripper flow 0.26 gph

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Although the diameter is different, the flow is much greater for the same length of pipe. The travel time for A is 9 minutes and is 90 minutes for B.





Put the following into the correct sequence  
(each can be used more than once).

Product  
Injection

Flushing

Flow  
Measurement

Treatment  
Advance Time

Flushing

Flow  
Measurement

Product  
Injection

Treatment  
Advance Time

Flushing

Flow  
Measurement



Name 3 advantages of using  $\text{H}_2\text{O}_2$  instead of **Cl** for drip irrigation maintenance treatments.

- Does not harm silicone membranes.
- Non-carcinogenic molecules are developed (trichloromethane)
- It does not pollute the environment (oxygen and water).





For what type of sediment is **acid treatment** intended?

- Organic sediments
- Mineral sediments**

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Acid generally dissolves mineral salts.





What is the main goal of the following **acid treatment** types?

- Shock acidification
  - Continuous acidification
- 
- The shock treatment is carried out to dissolve salts already embedded in the system.
  - Continuous acidification is performed to prevent the formation of low solubility salts.





If acid titration is not possible, approximately how many ounces of **33% HCl acid** are needed for 4.4 gpm of irrigation water, in order to dissolve sediment in the system?

3.4 ounces of acid

8.5 ounces of acid

25.4 ounces of acid

34 ounces of acid

1 gallon of acid for every 16.7 gpm of water creates an efficient solution in most cases.



Since the **solubility** of fertilizers varies with temperature, what solubility data would you use to calculate the preparation of fertilizer solution for temperatures ranging between 5°C and 40°C over a 24-hour period?

Solubility at 5°C

Solubility at 20°C

Solubility at 30°C

Solubility at 40°C

It is preferable to prepare the solution at a low temperature, since if it rises, it will be more soluble but will not precipitate.



With which fertilizers can  $\text{Ca}(\text{NO}_3)_2$  be mixed without forming sedimentation?

A	$\text{KNO}_3$	Potassium Nitrate
B	$\text{K}_2(\text{SO}_4)$	Potassium Sulphate
C	$\text{NO}_3\text{NH}_4$	Ammonium Nitrate
D	$\text{MgSO}_4$	Magnesium Sulphate
E	$\text{SO}_4(\text{NH}_4)_2$	Ammonium Sulphate

A & C

Neither of these two will create precipitates.







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