Disinfection in hydroponic systems and hygiene

Technical information sheet No. 6

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Soil-borne diseases

Soil-borne diseases are a major threat to prolonged horticulture and may eventually cause a greenhouse to close down when growing in soil. The most notorious are Fusarium (brown rots), Phytophtora (black rots) and nematodes. Further virus and bacteria disease play a role.

Nematodes can cause losses of over 50% of yield. Roses, tomatoes and sweet peppers are even more susceptible than other crops.

Soil or plant particles can carry spores which can remain dormant for some time before attacking crops. Spores may survive the basin as well.

One of the main reasons to change from soil to soilless is the loss in yield caused by diseases. However, in soilless systems soil-borne pathogens may appear again. There is a shift in occurrence, humid loving organisms, such as pythium and phytophthora may appear more frequently.

In Open hydroponic systems spreading of these diseases all over your farm does not happen. If you recirculate the nutrient solution to save water and fertiliser disinfection of the solution is required. Disinfection is a kind of insurance premium: you have to invest in equipment, but if you don't there is a big risk you are losing your crop and income. On the other hand there may be years that everything is going well without disinfection.

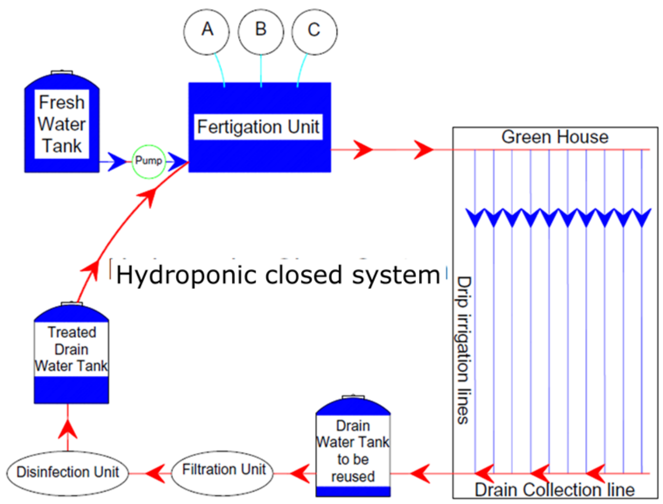

Figure 1: A disinfection unit consists of a filter, to remove all coarse particles, and an apparatus to disinfect the drain solution.

Pre-treatment: filtration

Drainwater may contain remnants of roots, leaves, or substrate and should be filtered before disinfection to size of 40 µm. No pathogens will be removed.

Figure 2: Filters for coarse materials, such as potting composts (left), sand filter (middle) and disk filter (right) to be used before disinfection.

Filtration

Below an overview is given for various filtration processes. Ultra- and micro-filtration are in use to eliminate pathogens.

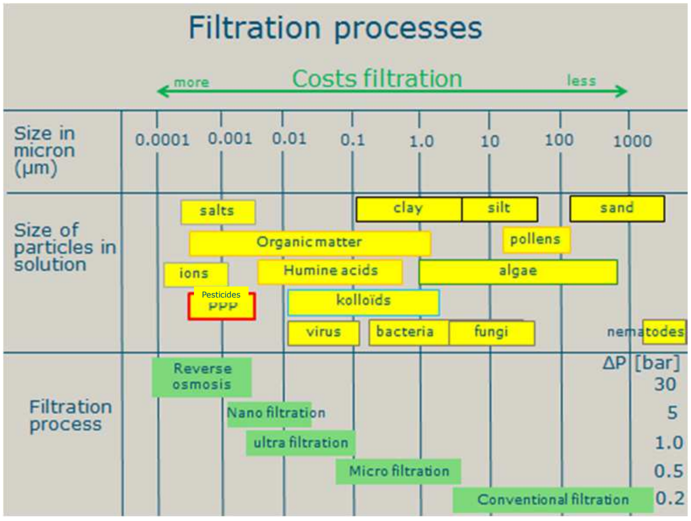

Figure 3: Relation between size of filters and substances to be removed.

Figure 4: left pythium; right fusarium.

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Methods for disinfection

Heat treatment: dosage 95ºC for 30s or 85ºC for 3 minutes. Efficient and safe system.
UV light: 100 mJ/cm² against bacteria and fungi, 250 mJ/cm² against virus. If prefiltered well a reliable system. Low pressure lamps are most suitable for small nurseries.
Ozone: redox potential of 500-800 mV must be achieved, depending organic contents of the water, reliable, but dangerous if not well applied.
Slow sand filtration: sand grain size 0.15-0.35 mm, filtration rate 100 – 300 l/m²/h, size (surface) in m² = 10x capacity in m³/h. Works satisfactory against bacteria and fungi, only partly against virus. Cheap for small farms.
Anodic oxidation: electrolysis of NaCl solution results in forming of HOCl which is pumped into the drainwater solution. Control via redox potential.
Sodium hypochlorite: well known under the name of (household) bleach as surface disinfectant, it functions variable. pH is often too high to work well, at high temperatures there is easy break-down of the substance, but it is cheap.
Hydrogen peroxide: don't use 35% pure, but use always with stabilizers as weak acids. Mostly used for cleaning biofilm in pipe work. High concentrations are also damaging the roots.
Peracetic acid: combination of peroxyacetic acid and H_2O_2 for treatment of surfaces (surfactant), side effect on pathogens in water.

Efficacy against groups of pathogens

	fungi	bacteria	virusses
Heat treatment	++	++	++[1]
UV light	++	++	++[1]
Slow sand filtration	+	+	--
Ozone	++	++	++
Anodic oxidation	+	+	--
Hydrogen peroxide	--	+	--
Sodium hypochlorite	---	+	---
Peracetic acid	+	+	+
No disinfection	-----	-----	-----

1) Higher dosage

-- bad performance

++ good performance

Figure 5: overview of disinfection methods against groups of pathogens.

Figure 6: Left Heat Treatment installation, right Low Pressure UV light installation.

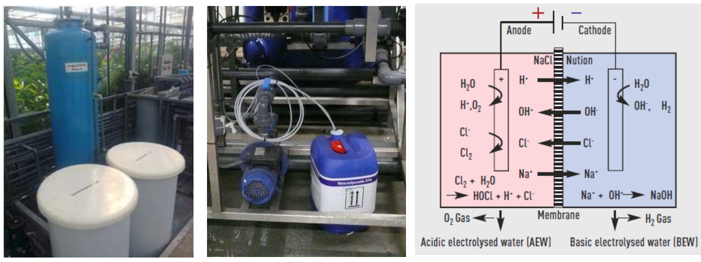
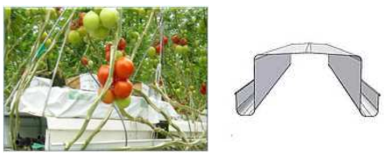


Figure 7: Left Slow Sand Filtration, middle hydrogen peroxide dosing, right principle of anodic oxidation process.

Other aspects

- Heat treatment, UV light, slow sand filtration, ozone work at the specific place. There is no effect of the treatment further in the system.
- Other substances added tot the solution may also have an effect on the biofilm, the growing bacteria at the inner sides of the pipe work. Mostly this is the main goal of application, but they may also harm the roots if they are released by the drippers.
- Disinfection may decrease the spreading of pathogens between rows. Within the row the drainwater may flow along the roots of the next plants, there infection is still possible. Fig. 7 gives a solution for distribution of pathogens within the row.



Drainwater from slabs lying upon the trough seeps along the vertical side before collected and flowing downwards in the small gutter. For roots it is too dry and they will not grow there, consequently there is no contact between one or the other plant.

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