Slow Sand Filtration Design, Construction and Use

When compared to other disinfestation methods, Slow Sand Filtration (SSF) systems can be constructed from a variety of components and without specialist skills being required. In designing the SSF, the size distribution of sand particles, the ratio of filter bed surface area to depth, the flow rate of water through the filter and penetration of light to the sand bed all affect the efficiency of the filter.

A SSF can be housed in a range of tank types and sizes from 200L up to 100,000L. The housing must be constructed of, or lined with, a non-reactive material such as plastic and able to prevent penetration of light (reduces algal growth). Constructing two units means that one unit can be stood down for repairs or cleaning, without impacting significantly on treatment capacity.

The first layer installed in the tank is a gravel drainage system to stop the movement of fine sand into the filter outlet. In the bottom of the filter, perforated drainage pipes are located in a layer of the coarsest gravel to form a network of pipes across the base. If insufficient drainage pipes are installed in this layer, or the gravel layer is too fine, the flow rate of the SSF will be reduced.

The gravel drainage consists of 3 layers of graded gravel (2-8mm, 8-16mm and 16-32mm) arranged with the coarsest grade at the bottom, and the finest gravel between the sand and coarser gravel layers. Geotextile fabric may also be used to support the sand as an alternative to some gravel layers. Granulated Rockwool may be used as an alternative media to reduce the requirement for the gravel drainage layers thus reducing filter depth. If Rockwool is used, a fine screen over the outlet is recommended to prevent Rockwool granules escaping the filter.

The SSF filter bed is composed of washed uniform fine sand (0.15 - 0.35mm) or granulated Rockwool, as these have been found to be the most effective materials in controlling diseases such as Phytophthora, Pythium and Fusarium. Sand that isn’t uniform will settle in volume, reducing the porosity and flow of water through the filter bed. The uniformity of sand particles is determined by the Uniformity Coefficient (UC) and should always be less than 3 and preferably less than 2. The filter bed is constructed to a minimum depth of 0.8m (on smaller filters) and preferably 1 - 1.5m. This allows for for losses of sand which occur during removal of algae and particulate matter from the top of the filter bed during regular cleaning.

Controlling the flow rate of water through the filter bed by the use of a regulating tap is critical to the efficiency of pathogen control of the units. Depending on the disease risk, flow rates will vary between 100L/hr/m^2 (high risk e.g. Fusarium) and 300 L/hr/m^2 (Pythium and Phytophthora). Industry best practice (NIASA) has determined that maximum flow rates must not exceed 300 L/hr/m^2 to maintain efficacy.

During operation, the SSF must have a constant depth of water of 0.5m to 1.5m above the filter bed to provide both the pressure to push the water through the filter bed, and act as a temperature buffer to stabilise the filter and stop the biologically active area from drying out or becoming stagnant. This is achieved by using a small pump from an overflow tank, or from the tank containing the filtered water to constantly pump water through the SSF. Prior to entering the SSF, a media filter should be used to remove as much particulate matter as possible from the water to be treated to maximise the interval between filter bed maintenance cleaning.

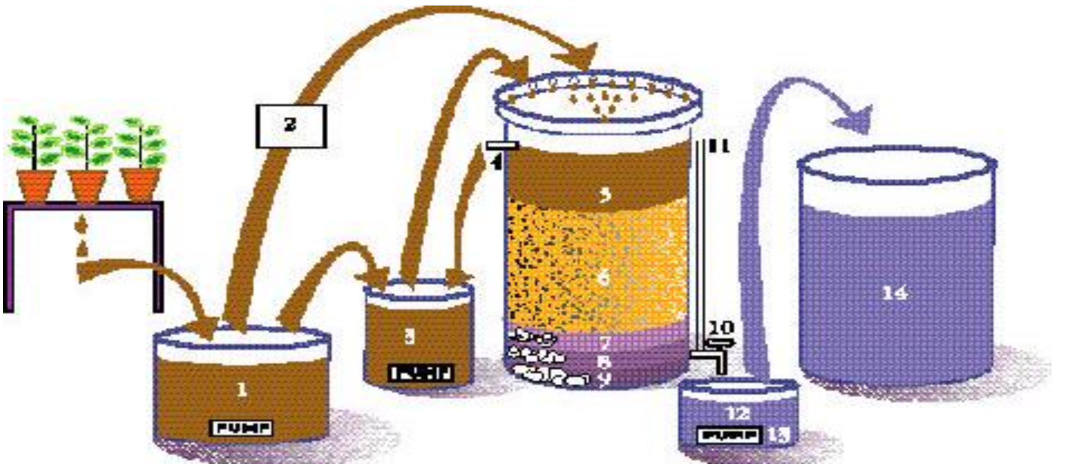

Figure 1 Slow Sand Filtration Layout – From the Nursery Paper "Slow flow Sand Filtration (SSF) for water treatment in nurseries and greenhouses".

Water drains from the crop and is collected in a catchment tank or dam (1). Water is pumped to the SSF via a holding tank (3) or through a fast media filter (2) to remove suspended material. Overflow outlet (4) back to the holding tank maintains a constant depth of the water layer. The SSF consists of: a water storage layer (5), a sand or media filter bed (6) and gravel layers (7-9) to support the filter bed. The outflow (10) may be fitted with a flow regulating valve and an open tube (11) to measure filter head loss. A small collection tank (12) lower than the SSF collects filtered water for distribution by a pump (13). An optional holding tank (14) is used for the filtered water.

Once the SSF is commissioned and water run through, microbial activity builds up quickly and the SSF will become biologically active without any special inoculation. Research suggests that water circulating through the SSF for four weeks is required to establish biological activity before the filtered water can be used for irrigation. Regular testing of the treated water to ensure it is free of pathogens is recommended. For SSF this can be done by baiting the water and using Pocket Diagnostic Kits to determine if there are any pathogens present.

With time, a build-up of material on the filter bed surface will reduce the flow through the SSF. This can be monitored by installing a clear pipe on the outside of the filter to monitor head loss, When the flow rate though the SSF reduces, the water layer above the sand is drained, and the top layer of sand containing accumulated organic matter and silt is removed. After cleaning, the SSF should be operated for a couple of days before water is put back into the treated water system.

For further information refer to "Slow flow Sand Filtration (SSF) for water treatment in nurseries and greenhouses" by Gail Barth, Senior Research Scientist, SARDI*

Lex McMullin
Farm Management System Officer
Mob: 0400 005 236
Email: fmso3@ngiq.asn.au