Selecting Filtration Systems

Nursery & Garden Industry Queensland

Choosing appropriate filtration equipment for an irrigation system can be a complex process. The selection of a filtration system should be a considered and measured purchase, utilising information collected and analysed on the irrigation system, the irrigation disinfestation system type and location, the topography, cropping systems and water quality.

The decision on which filtration system to install is dependent on:

- *a grower's budget,*
- *irrigation water quality,*
- *type and level of contaminates,*
- *required filtration flow rates,*
- *emitter requirements,*
- *the level of automation required,*
- *filter service and maintenance requirements,*
- *filter availability, and*
- *support and complexity of the system.*

Often the answer is a combination of filter types located at strategic points throughout the irrigation supply and distribution system.

In making these decisions it's imperative that an irrigation specialist is employed to ensure the filtration system performs efficiently. An irrigation professional will sample the irrigation water source and endeavour to identify any seasonal changes that may occur, as well as calculate the irrigation system flow, the disinfestation system requirements, and the level of filtration required for the various emitters.

Table 1. Filtration size equivalents

micron	mm	Mesh
80	0.08	200
100	0.1	150
130	0.13	120
150	0.15	100
180	0.18	80
200	0.2	75
250	0.25	60
300	0.3	50

Information on available water quality and the required water quality has to be assessed before the appropriate options can be considered. It is generally recommended to incorporate the highest level of filtration that is practical based on the emitters and solenoid valves operating, keeping in mind that greater levels of filtration require more frequent filter backwashing, consuming both water and energy.

When selecting a filtration system consider the advantages and disadvantages of each system as understanding the equipment's capabilities and limitations will help to maintain the efficiency of the entire irrigation system.

***Filter performance,** or the level of filtration, is measured in microns, or 'mesh' size for some imported filter systems— see table 1. Irrigation professionals will often select a filter micron level four to seven times smaller than the emitter or valve requirement to prevent clogging from the accumulation of small particles and algae within the irrigation system.*

The specification sheet for each sprinkler or dripper will outline the filtration requirements and from this the level of filtration can be determined.

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Some common filtration systems used in production nurseries include:

Pump intake screens *are predominately used to prevent larger aquatic animals and weed from entering an irrigation system from surface storages. These screens are attached to the suction side of the pump and primarily provide protection for the pumping system. Self cleaning pump intake screens are available utilising water pressure to clean the filter screens.*

Fish traps/leaf strainers *are often installed to remove small aquatic animals, trash and leaf litter to protect the pumping system, and reduce the demands on the filtration system.*

A centrifugal sand separator or hydro-cyclone *is most commonly used when pumping from wells and bores that contain large amounts of sand. The filter is installed on the suction side of the pumping system to prevent damage to pumps and valves, and also acts as a pre-filter to reduce the filtration requirement from other filters in the system. Centrifugal sand filters should be monitored regularly, but are usually self cleaning and trouble free.*

Screen or mesh filters *are historically the most common form of filtration used in production nurseries. Screen/mesh filters have been popular because they are inexpensive, versatile, easy to install, are compact in size when compared to other filter types and have options for semi or fully automated cleaning. Screen/mesh filters continue to be a popular choice with production nurseries, particularly in smaller irrigation systems, and as a backup or final filter in the field with drip irrigation, or to provide secondary filtration with media filtration systems.*

Screen filters can remove medium loads of inorganic hard contaminates, however high loads of organic material such as algae, mould and slime, along with chemical contaminates can cause problems with these filters. Chemical contaminates, such as iron or calcium can cause problems, as these single surface filters have a limited capacity to store contaminates before cleaning is required. Organic contaminates present in the water often embed themselves into the filter mesh and do not readily release from the filter screen, particularly during automated cleaning processes, causing frequent and excessive flushing, and time consuming manual cleaning.

Manufacturers of screen filters offer a variety of screen/mesh options. Screen/mesh filters typically have screen opening dimensions ranging from 75 to 600 microns.

System specification requirements for screen/ mesh filters include:

- *Where the filter is located within the irrigation system.*
- *The system flow rate and pressure at the proposed filter location.*
- *The type of water disinfestation system and location within the system.*
- *The level and type of contaminates and seasonal changes encountered in the water supply quality.*

Screen filters collect debris on the screen surface, which is a stainless steel screen or fabric sock, until most of the available mesh openings are filled. At this point the system pressure starts to fall as the screen becomes increasingly clogged with debris or, in automated systems, the pressure differential across the filter initiates the flushing mode at a pre-set differential pressure.

Screen filters are cleaned by flushing with a stream of water or removing the screen and cleaning it by hand. Small screen filters that are typically used in the field with drip irrigation systems or with smaller sprinklers in protected cropping, are simply pulled apart and the screen hosed by hand and maybe scrubbed until all the waste material trapped in the screen is removed. Slightly larger units often have a flush valve at the bottom of the filter casing that can be opened to direct water across the screen to dislodge trapped particles and flush them away, extending the periods between manual cleaning. Larger more expensive screen filters flush the screen by forcing the water backwards through the screen for very effective cleaning. Larger screen/mesh filters have *been designed to allow for continuous flow of water to the irrigation system during the flushing process. Automatic screen filters contain moving parts and can be costly, however, they can handle more challenging water quality applications.*

The screen/mesh may periodically require hand cleaning to remove contaminates not removed by the normal manual or automated cleaning processes.

***Disc filters** can successfully remove inorganic contaminates, and if sized, operated and maintained correctly will also remove some organic materials. Disc filters are available in a range of sizes, levels of filtration and flow capacities. They are sometimes used as a primary filter in small irrigation systems, but frequently these filters support other filtration systems, and often provide the final filtration in drip irrigation and propagation mist systems. Disc filters can be installed upright or inverted, are considered highly effective, and are able to stop or retain large amounts of debris and impurities from the water due to the depth of the disc filtering element. Disc filters generally have a greater holding capacity than similar sized screen or mesh filters, and therefore require less frequent cleaning.*

Disc filters consist of a series of ribbed discs packed tightly on each other and compressed in a cylinder. The tapered diagonal grooves on the face of the stacked discs run opposite to each other, and when compressed together create a three dimensional crosshatched groove design filtering water through the entire depth of the disc or ring, not just at the surface. This design feature provides a large filter area allowing longer periods between cleaning, with high filtration efficiency, less maintenance and extended product life. The plastic discs or rings are often colour coded to identify the level of filtration provided.

Each rib on the disc contains a series of sharp points capable of catching organic contaminates. In operation, water is forced between the discs, and contaminates are filtered out when they are unable to pass through the gaps with the organic material collecting on the sharp points of the ribs. During filter operation, dirty water enters the filter housing and increases pressure on the outside of the filter element, compressing the discs or rings tightly together.

Disc filter cleaning can be achieved by isolating the filter from the irrigation system, removing the filter element from the filter housing, loosening the compression on the discs, and using a jet of water to hose away the previously trapped particles from between the discs or rings. Larger more expensive disc filters may have a backwashing capability that releases pressure on the discs allowing the discs to separate and spin during the backwash cleaning cycle, ensuring all debris is removed from between the discs. For automated cleaning, the filter discs are separated from each other, allowing the filtered contaminates to be flushed out through a flush outlet.

***Media/sand filters** are fast becoming the central feature of many nursery irrigation systems, particularly systems that utilise recycled irrigation water. These filters are suited to removing fine sediments and suspended organic material, and are generally backwashed automatically.*

Media filters are an efficient type of filtration for water heavily contaminated with algae, organic matter and inorganic contaminates often found in nursery recycled water. They have a large filter area and depth of filtration providing a huge holding capacity, requiring less regular filter cleaning when compared to other filter types. This holding capacity provides longer system run times between flushing, gives more filtration area, easier organic contaminate release from the filter bed, and a finer level of filtration.

Media filters are recognised as being reliable and require little maintenance when installed correctly. Proper sizing of media filters is crucial to system performance, with over-sizing of the filter causing channelling in the filter bed, and under-sizing causing coning in the filter bed, where the high flow of water scours the sand away from the filter wall and deposits it underneath the deflection plate. Water introduced into the media/ sand filter at too high a velocity can remove the *sharpness from the media reducing its effectiveness over time.*

Media filters installed in production nurseries are often located between the dam storage and the holding tanks to ensure only clean filtered water enters the tanks, or between the water source and the pressurised irrigation system.

System specification requirements for media filters include:

- *The preferred location of filtration within the total irrigation system.*
- *The system flow rate at the filter location.*
- *The system pressure at the filter location.*
- *The water disinfestation system and location within the system.*
- *The level of contaminates in the water and seasonal variations.*
- *The filter media type required.*

Media filters operate by directing the pressurised water into the top of the filter tank or tanks. A diffusion plate in the top of each filter tank reduces the water velocity and distributes the water evenly across the top of the media bed, a 400 – 500mm depth of graded media. The media bed can consist of a variety of materials; e.g. crushed sharp edged silica sand, quartz sand, anthracite, garnet, or magnetite. The water percolates through the filter bed and passes through the open spaces between the media particles in the filter tank where the impurities and contaminates are trapped in the filter bed. The filtered water then flows into the discharge manifold located in the bottom of each filter tank, before exiting the filter ready for use. The discharge manifold in the bottom of each tank consists of a series of sophisticated nozzles or 'mushrooms' (see photo) designed to prevent the media from the filter bed entering the irrigation system.

Contaminates caught in the filter bed are regularly removed by backwashing. Backwashing the media filter flushes the impurities and contaminates removed from the water and trapped in the filter bed to waste. During the backwashing process, flush water flows evenly through the entire filter bed to ensure no pockets of contaminates are left behind. The flush water enters the filter through the mushroom shaped outlets (see photo) on the bottom of the tank and lifts and separates the filter media as the water moves through the filter bed, and dislodges any contaminates trapped during the filtering process.

Backwashing of the media filter system is usually designed to operate one unit at a time using the clean water from the other units to backwash each filter unit in sequence, while maintaining irrigation system operation. Often a number of media filters are installed together to provide the required irrigation flow rates and to ensure system pressure is maintained during cleaning sequences. Single media filters with automated backwash may pass unfiltered water through the irrigation system during this process if not designed correctly.

The process of media filter backwashing can be initiated manually, or automatically via a pressure differential switch or by time. An automated backwash system may measure the difference in pressure between the filter inlet and outlet to trigger the backwash cycle. When the pressure between the inlet and outlet increases to a pre-set level, a differential switch initiates the backwash process, and the process of flushing the contaminates from the filter bed continues for a pre-determined time period. Automated backwash systems can also be initiated using a time clock. For systems with more than one media filter tank, the flushing process then proceeds sequentially until all the tanks have been backwashed.

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Membrane filtration *such as micro, ultra and nano filtration, and reverse osmosis are tailored to specific applications. The main benefit from membrane technology is in its successful operation without the addition of chemicals, and its relatively low energy use with minimum waste.*

Membrane filtration is a term used to characterise a number of different processes, all of which utilise membranes. There are four types of technologies, depending on the size of the impurities which are to be removed;

- *microfiltration,*
- *ultrafiltration,*
- *nanofiltration, and*
- *reverse osmosis.*

Micro filtration is used to filter small particulate matter, while ultra and nano filtration is primarily used in filtering pathogens and particulates. Reverse osmosis is mostly used to remove salts.

Membrane filtration is based on the presence of a semi-permeable membrane, which permits water to pass through while catching suspended solids and other substances. The membrane's permeability is determined by the size of the pores in the membrane, which act as a barrier to particles that are larger than the pores themselves, while the water can pass freely through the membrane.

Pre-treatment is required for membrane filtration to operate successfully and economically. Suppliers of membrane filtration systems recommend pre-treatment based on water quality sampling, along with water quantity requirement calculations.

Microfiltration is used over a wide range of applications such as potable water purification, sewage and wastewater treatment, and as a pre-treatment to advanced water treatment processes. Microfiltration requires the least amount of energy to pass water through the membrane, however it does not screen out most pathogens, and therefore requires additional sanitation treatments.

Ultrafiltration is often used to remove particles and microbiological contamination, and provide a water free of turbidity and pathogens. Ultrafiltration, when used with appropriate pre-treatment, is recommended as a suitable disinfestation process for production nurseries when recycling irrigation wastewater or collecting surface runoff. Ultrafiltration can provide a constant filtrate quality using minimum energy, low water consumption, with minimum or no addition of chemicals. Latest generation ultrafiltration systems are compact, stand alone systems often supplied with pre-, post- and waste water treatment systems.

Nano filtration and reverse osmosis are used for removing salts from water. These filtration systems operate by using higher pressures to diffuse the purified water through the membrane. Nanofiltration is most often used with water containing low levels of dissolved solids such as ground and surface water.

Reverse osmosis (RO) membrane filtration is used for the desalination of water containing high levels of dissolved solids, such as brackish water and seawater. Desalination of brackish water for irrigation, particularly from bores, is designed to achieve a considerable reduction in the salt content, with little wastewater and minimal operation costs. New generation reverse osmosis units are reliable and efficient, with relatively low operation costs. These units are microprocessor controlled, simple to operate, with reduced maintenance and service costs.

All membrane systems require periodic flushing of membranes, the frequency of which depends on the quality and quantity of the water being treated. Waste residues collected from filter membrane flushing require disposal, and filter membranes must be replaced periodically.

The following table gives an overview of different filtration types used in nursery irrigation. For more information refer to "Managing Water in Plant Nurseries".

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Filter Type	Micron size range	Cleaning system	Flow rate range L/hr	Applications	Relative capital cost	Maintenance and running cost	Comments
Fish traps/ leaf strainers	>3000	May require manual cleaning		Removal of small amounts of large particles	Very Low	Very low	Often installed to protect the pumping system and reduce filtration requirements on the balance of the system
Self cleaning pump intake screens	800-2000	Continuous cleaning	9000-525000	Pre-filtration in water with large particulate matter e.g. water weeds.	Low	Low	Uses water pressure from irrigation system to clean a rotating screen. Backwash pressure 380-550 kPa. 720-11500L/hr backwash flow required.
Centrifugal sand separator (Hydro-cyclone)	Down to 75	Manual or automatic	3600-80000	Pre-filtering of water with large amounts of sand and suspended particles.	Low	Low	Installed on the suction side of the pump to protect pump, or on delivery side as a pre-filter.
Disc	20-400	Manual or automatic	3600-80000	Pre-filtering and/or main filtration.	Low	Low	Disc filters are ideal for removing large particles to reduce filtration requirements on the rest of the system.
Screen/ Mesh filters	75-600	Manual or automatic	3600-80000	Pre-filtering and/or main filtration.	Low	Low	Some sprinklers have integrated mesh filters.
Media filters (sand or gravel filters)	30-50	Automatic - time and/ or pressure differential	3600-80000	Able to remove fine sediments and suspended organic material. May require pre-filtration.	Medium	Medium	Regular back flushing and media replacement critical. Performance depends on the media type used and flow rates (10-13L/sec/m²). Can be used to improve water quality e.g. greensand for iron removal. A secondary filter is recommended to prevent solids entering irrigation water. These are not slow sand filtration which is primarily a disinfestation system.
Sock filters	1-800	Manual	Up to 37000	Pre-filtration for ultra filtration and reverse osmosis.	Low	Low	
Cartridge filters	1-100	Manual	800-33000	Pre-filtration for ultra filtration and reverse osmosis.	Low	Low	Often used as the final filtration system when high quality water is required e.g. fog systems
Ultra filtration	0.005-0.1	Automatic	1500-8000	Pathogen removal.	High	High	Pre-filtration required to maximise filter life.
Reverse Osmosis	< 0.005	Automatic	600-6000	Removal of salts and pathogens.	High	High	Pre-filtration essential. Disposal of waste water must be considered. Back blending may be necessary.

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