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Is your water-filtration system doing an adequate job?

Most growers' efforts to filter potentially harmful microorganisms from their irrigation water are inadequate.

By Peter Konjoian and Landon Merrill

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One of the most common flaws encountered in growing operations is inadequate water filtration. A more effective job must be done to filter irrigation water if microbial contamination and algae are to be managed effectively.

Growers drawing water from surface ponds, particularly those capturing irrigatior runoff, face the greatest challenge. Additiona filtration will reduce biological loads, which can include algae, duckweed, bacteria, fungi crop debris and growing media components allowing chemical treatments to solve contamination problems at acceptable costs.

Accomplishing this task will cost more money than growers spend on water filters. A cost-benefit equation suggests that better irrigation-system management will result in reduced crop shrinkage, reduced dependence on chemicals to treat crop problems and overall healthier crops. Each benefit contributes to higher profit margins. In particular, reducing crop shrinkage can restore profit more quickly than most production cost-cutting measures.

The purpose of filtration is to remove all unwanted particles, including living and non-living ones, from the water stream. Non-organic particles include sand, perlite and

This Massachusetts greenhouse operatior uses a 2-inch screen filter for municipal water. A spare filter screen stored in water allows the grower to quickly change cartridges, minimizing the interruption of water.

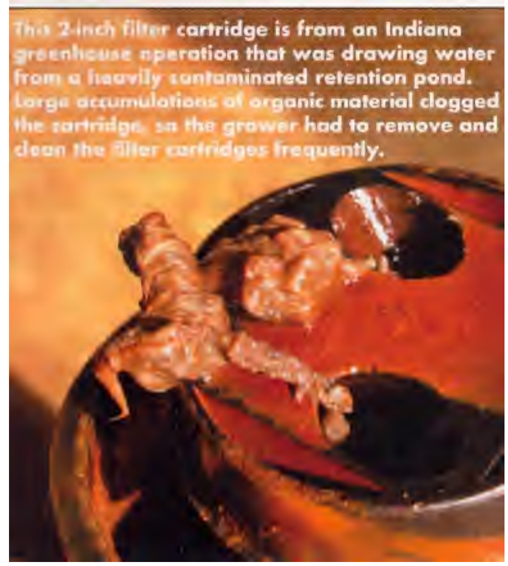
A common first stage of filtration for an ebb-and-flood bench system is a small piece of wire mesh that provides a 1-inch mesh level of filtration.

A close-up of the inside of a filter screen shows fine particles that should be flushed from the surface before it is reused.

Common particles and organisms to filter

Type of particle, organism	Particle size*	Micron size (diameter)	Mesh size (approx.)
Water molecule	0.4 nm	0.0004	
Ralstonia spp.	2.5 pm	2.5	
E. coli	8 pm	8	
Pythium zoospore	15 pm	15	
Eucaryotic algae	25 pm	25	
Largest bacteria	500 pm	500	40
Oxalis seed	1.2 mm	1,000	20
Pansy seed	2.0 mm	1,500	15
Frog egg	2.0 mm	2,000	10
Fungus gnat larva	5.5 mm	5,500	4

* nm = nanometer, pm =micrometer, mm = millimeter



This 2-inch filter cartridge is from an Indiana greenhouse operation that was drawing water from a heavily contaminated retention pond. Large accumulations of organic material clogged the cartridge, so the grower had to remove and clean the filter cartridges frequently.

vermiculite. Organic particles include plant debris, peat moss, bark, algae and pathogenic and non-pathogenic organisms.

Causing a mesh size

When choosing a mesh size for an irrigation system filter, be aware of pressure loss, flow capacity and cost. Many filtration specifications have been calculated and can be used to properly size the equipment that is needed.

Most growers are familiar with mesh size as the primary characteristic of a filter cartridge. As irrigation water quality has declined, it is now necessary to be more accurate about filtration. Rather than referring to mesh size, it is important to know the particle sizes that need to be filtered out.

When discussing water filtration and particle size, it is easiest to refer to the micron. A micron is one millionth of a meter and a nanometer is one billionth of a meter.

A water molecule is invisible to the human eye; a fungus gnat larva is easy to see. Filtering fungus gnat larvae from water can be accomplished quite easily with a mesh size of four. The most common mesh size used in greenhouse filters is 200.

The 200-mesh size commonly used by growers is capable of filtering particles down to about 75 microns. Based on our studies, irrigation water is not being filtered enough. It needs to be filtered to a level below 75 microns.

Mesh sizes of 270 and 400 filter about 50 and 35 microns, respectively. Growers seeking to more effectively filter their irrigation water should consider adopting a new target range of 50 microns as minimal. Growers experiencing irrigation system problems may need to increase filtration down to 30 microns or more.

Some of the largest bacteria are 500 microns in size and can be removed with a 40 mesh filter. It is possible to filter *Pythium* zoospores as well as some types of algae. Eucaryotic algae usually develop in pond water by teaming up with bacteria to form

Progressive filtration offers options

With new filtration goals come other needs. You need to determine the best way to size the most efficient, least expensive system so that the water flow and pressure drop don't limit the irrigation capacity.

The most efficient process for separating various particles removes them by size starting with the largest ones. This progressive filtration system is similar to a coin separator that takes coins and neatly separates them by size into quarters, nickels, pennies and dimes.

Here are examples of the stages:

Stage one. The use of sand filters as one stage of filtration is increasing, particularly in operations drawing water from ponds.

Stage two. Finer-cartridge filters provide a second stage of filtration.

Final stages. There are a few choices for the last stage.

- **Belt or paper.** Relatively new for greenhouse operations is a belt or paper filter. Water is dropped onto a slowly advancing sheet of finely woven material. Particles are removed, water passes through the woven material, and the advancing sheet removes the particles and debris from the water stream. This filter system is very effective and can filter down to levels of 10 microns, depending on the weave of the material.
- **Sock options.** A sock is another choice. The final filter is traditional in concept but new in cartridge design. Water enters a metal filter and passes through a woven "sock," and then exits the filter. The weave of the sock determines the filtration level. As with the paper or belt filter, some socks are capable of filtering to below 10 microns.

Use of sand filters is increasing, particularly in operations drawing water from ponds.

Belt and paper filters are relatively new for greenhouse operations.

A close-up of a disc cartridge filter shows the uniformly spaced channels that allow water to pass through as particles are caught.

Water enters into a final metal filter that passes through a woven "sock." The weave of the sock determines the filtration level.

Some cautions

To remove particles from a water source, a grower would not want to rely solely on a 10-micron filter to remove everything from a water stream. It would continually clog removing both large and small particles. This is why a staged filtration system is more effective.

large, visible complexes called biofilms that represent a significant microbial contamination load. While it is not reasonable to assume all algae can be filtered out, their association with biofilms in the water results in particles, some of which can be removed by filtration. A reduction in the water's microbial load makes chemical treatment more effective and less costly.

Standard mesh and metric sieve designations and associated sieve openings

Sieve designation		Sieve opening		
Standard (mesh)	Metric (millimeters)	Inches	Millimeters	Microns
1 inch	25.4	1	25.4	25,400
1/2 inch	1 2.7	0.5	1 2.7	1 2,700
1/4 inch	6.35	0.25	6.35	6,350
No. 10	2	0.0787	2	2,000
No. 20	0.841	0.0331	0.841	841
No. 40	0.420	0.0165	0.42	420
No. 60	0.25	0.0098	0.25	250
No. 80	0.177	0.007	0.177	1 77
No. 100	0.149	0.0059	0.149	1 49
No. 120	0.125	0.0049	0.125	1 25
No. 140	0.105	0.0041	0.105	1 05
No. 200	0.074	0.0029	0.074	74
No. 270	0.053	0.0021	0.053	53
No. 400	0.037	0.0015	0.037	37

The shaded areas contain the most popular filter sizes in greenhouses.

Water sources matter

Municipal water sources don't usually cause filtration problems. Well water is more challenging, depending on particulate matter.

The most challenging source is pond water. Most ponds are significantly murkier than municipal water, wells, rivers and streams. Murkiness can result from the suspension of inorganic particles such as silt and clay in solution or from organic particles such as algae, bacteria, fungi and biofilm. If a pond is serving as a collection and containment area for greenhouse runoff, the problem is magnified exponentially.

As more growers consider using water from collection and retention ponds in recirculating irrigation systems, microbial contamination will continue to cause crop health problems. Managing irrigation systems more effectively will require a significant effort that integrates system design, filtration and water treatment.

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