Making the Right Filter Decisions for Landscape Irrigation

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Abstract. *In today's rapidly changing landscape irrigation environment, water is becoming more scarce, and usage regulations becoming stricter. Providers of domestic, potable water – from public municipalities to private water purveyors – are imposing restrictions to limit the amount of potable water that is used to irrigate the turf and landscaped plantings of commercial properties, golf courses and athletic fields, right-of-ways, and private residences. In many cases, particularly in arid climates where rainfall is scarce, water providers simply do not allow irrigation with potable water.*

As a reaction to this trend, many landscape irrigation systems are turning to alternative sources of water such as private wells, on-site lakes and streams, and captured storm water runoff from roofs, parking lots, and other hardscapes. Additionally, some municipalities are providing pressurized distribution systems of treated wastewater for irrigation use.

The water quality of these untreated alternative sources differs greatly from potable water. Typically, alternative sources contain contaminants such as sand, grit, silt, and algae that can cause damage and wear to the components of a landscape irrigation system. As a result, one of the most important components of these irrigation systems is the filtration used to protect the pump, piping, valves, sprinklers, and drip components from damage and clogging due to the contaminants found in these alternative water sources.

Choosing the right type of filter can be a daunting task, particularly for those whose previous experience had them working exclusively with potable water, and as a result have no prior filtration experience. The following discussion will identify the common types of filtration that are used in landscape irrigation: screen filters, sand media filters, and centrifugal separators. The advantages and disadvantages of each type of filtration will be examined; as well as the criteria to use when selecting the right filter.

Keywords. Landscape, irrigation, filter, filtration, well water, surface water, screen filter, disk filter, sand media filter, centrifugal separator, sand separator, down-hole separator

Typical Irrigation System Issues Caused by Contaminants

When unfiltered water from an alternative source is used in an irrigation system, several problems can present themselves. Large contaminants such as sticks, rocks, coarse sand, and even fish can enter the pump and cause damage to impellers, bearings, and other internal components. When pulling water from a deep well, sand abrasion on the submersible pump can cause the pump to lose its efficiency over time, resulting in a decreased water volume yield, which in turn affects the performance of the irrigation system. Also, wear on a submersible well pump can lead to higher electrical operating costs due to the pump not operating at peak efficiency.

Another common issue caused by unfiltered water is the malfunction and failure of electric control valves. Large particles can become lodged in the area where the valve diaphragm normally seals when the valve is closed, causing the valve to remain open even after the solenoid is deactivated. This is commonly referred to in the irrigation industry as a "stuck valve." A stuck valve has the potential to waste thousands of gallons of water and cause damage to the landscape; particularly if it goes unnoticed for an extended period of time.

Even if the particles are small enough to pass through the valve diaphragm without becoming lodged, they can still cause abrasion on the diaphragm as they are passed. This abrasion damage prevents the diaphragm from sealing properly when the valve closes, allowing a small amount of water to pass through into the lateral lines. This is commonly referred to as a "weeping" valve. The most common symptom of a weeping valve is large wet areas around each sprinkler head, which may spill out into sidewalks and roadways after a period of time.

Unfiltered water also causes problems with the system's emission devices – rotor sprinklers, fixed spray sprinklers, microsprays, and driplines. With gear-driven rotor sprinklers, particles can prematurely wear out the gear drives, causing the sprinkler to stop rotating. This is particularly common with the new style of matched precipitation rotary nozzles that many manufacturers have introduced in recent years. Contaminants can cause rotor sprinklers and fixed spray sprinklers to remain in the extended "up" position after the zone is finished watering. This can lead to damage, particularly from mowers and pedestrians.

With all types of emission devices, contaminants can clog the emission orifice, and prevent water from passing. Not only does this risk damage to the landscape due to underwatering, but it can affect the distribution uniformity of the entire station.

Common Contaminants

In order to select the proper filter, an understanding of the common types of contaminants found in alternative water sources must be established. There are two main properties of contaminants that should be taken into consideration when selecting a filter type: **particle size** and **particle weight** (also referred to as specific gravity).

The unit of measure used most often in irrigation to describe the size of a particle is the **micron**. A micron (or more properly, a "micrometer" as it is used in scientific circles) is the equivalent of 1×10^{-6} of a meter, or one-thousandth of one millimeter (.001mm). See Figure 1 below for the micron size of common contaminants found in irrigation water.

Material	**Size (Microns)**
Coarse Sand	500-1000
Medium Sand	250-500
Fine Sand	100-250
Silt	2-50
Clay	< 2

Figure 1. Source: Irrigation Association, 2000-2002, 2006. Drip Design in the Landscape. Table 8-1, pp. 119.

The weight of the contaminant is another important property to take into consideration. For the purposes of selecting a proper filter, particle weight can be simplified to two categories: **settleable** and **non-settleable**. Settleable particles are heavier than water and will fall to the bottom of a sample jar; while non-settleable particles are lighter than water and will remain suspended in the water. Typically, inorganic substances such as sand, silt, grit, and pipe scale are settleable, while organic contaminants such as algae are non-settleable.

The easiest method to distinguish settleable material from non-settleable is to take a sample of the source water in a jar, shake it up vigorously, and set it down. Any material that settles to the bottom of the jar in approximately three minutes is heavier than water and therefore settleable; any material that remains floating is non-settleable. This simple test is commonly known as the "**Three-minute test**."

Screen Filters

Perhaps the most commonly used filter type in landscape irrigation is the screen filter. Screen filters capture contaminants by providing a physical barrier (the screen) that the water is passed through. The screen element is designed with a particular **mesh size –** the number of holes per linear inch. For example, a 100 mesh screen has 100 holes per liner inch. The larger the mesh size, the finer the screen. Any contaminant larger than the mesh size of the screen will be removed by the filter.

Figure 2. A typical screen filter

In addition to mesh size, “**micron rating**” is another term used to describe the size of a filter’s screen. Micron rating is the smallest size particle (in microns) that the filter will remove. It is important to understand both terms and how they relate to one another. Different manufacturers may use different terms, and understanding both is necessary to make adequate comparisons. Figure 3 shows common mesh sizes with their micron rating equivalents. As the mesh size increases, the micron rating gets smaller.

MESH SIZE	**MICRON RATING**
30 MESH	600 MICRON
60 MESH	250 MICRON
100 MESH	150 MICRON
200 MESH	74 MICRON

Figure 3.

Screen filters are recommended when the amount of contaminants in the water is light to moderate, and the contaminants are both settleable and non-settleable solids. An important aspect to keep in mind when selecting a screen filter for a given application is that the screen will require periodic cleaning and maintenance. As contaminants accumulate on the screen, the pressure loss across the filter increases. It is recommended that the screen element be cleaned when the pressure differential reaches 5-7 psi.

Many types of screen filters require manual disassembly to clean the screen element. Others provide self-cleaning options, such as manual backwashing or automatic cleaning based on pressure differential. It is important to consider the feasible maintenance routines available when selecting a screen filter. If the filter is on an irrigation system in a remote area, it is wise to choose an automatic or easily cleanable filter.

Disk Filters

Another type of barrier filter is the disk filter. Disk filters are very similar to screen filters, but instead of a flat screen element, they have stackable “disks.” This creates three-dimensional filtering, and allows buildup of debris on the both the outside of the disks and on the surface area in between the disks.

Figure 4: A typical disk filter element

Disk filters are a good choice for systems that cannot be serviced frequently, as the extra surface area allows more contaminants to accumulate, resulting in longer allowable intervals between cleanings. As with screen filters, disk filters are available with both manual and automatic cleaning options. Again, the expected maintenance routine should be a major factor in deciding whether to install a manual or automatic disk filter.

Selecting the Right Mesh Size for a Screen Filter

There is no "scientific formula" to determine which mesh size is right for a particular application. It can depend on several variables, including the size of the contaminants of the water, the end use of the water (ie. rotor or drip irrigation), and the available maintenance routine.

A general guideline for drip irrigation is to keep the micron rating to $1/10^{th}$ or less of the smallest emission orifice on the drip tubing. For example, if the smallest orifice on a drip tube is 1 mm, the micron rating should be equal to or lower than .1 mm, or 100 microns. For microsprays and microjets, the rule can be expanded to $1/7^{th}$ due to those types of emission devices having a more laminar flow than drip emitters.

Sand Media Filters

Sand media filters are tanks typically constructed from stainless steel or coated carbon steel. The tanks are filled with a fine crushed silica sand, or "media." Water is pumped into the tank, and downward through the media, where contaminants become caught and are removed from the water. The clean water then flows into a slotted pipe (referred to as an underdrain), where it flows out to the system.


Figure 5: A well pumping water into sand media filters.

Sand media filters are especially advantageous when used in water sources that have a high concentration of organics, such as a stagnant pond or canal, because the three-dimensional filtering process can remove high loads of organics.

The micron rating of sand media filters depends on the size of the media used. The smaller the media, the finer the rate of filtration. Figure 6 shows commonly available media sand sizes and their micron equivalents.

Sand Size	**Micron Equivalent**
#12	150
#16	105
#20	75

Figure 6.

Sand media filters are cleaned by a process known as backwashing. During a backwash cycle, the normal water flow is reversed and pushed back up through the underdrain. The media bed is fluidized, and suspended contaminants removed. A hydraulically operated valve closes off the inlet to the tank, and the contaminants and backwash water exit through a separate pipe and are piped away to an acceptable discharge point. The flow of the backwash water is regulated by a “throttling valve” on the backwash pipe (typically a standard gate valve) to ensure that just enough flow is available to remove the contaminants and backwash water, but not enough to remove any media. Figure 7 below illustrates the differences between normal operation and a backwash cycle.

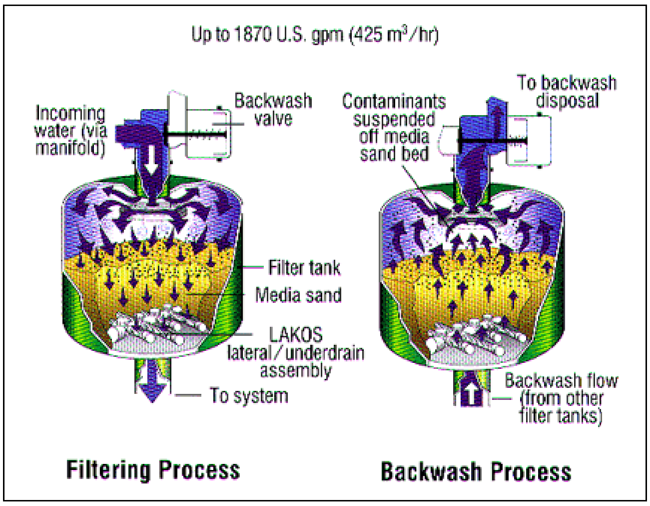

Figure 7.

The backwash process is automated by a controller, and can be triggered based on elapsed time or pressure differential. As with screen filters, it is recommended that media filters be cleaned when the pressure differential across the filter exceeds 5-7 psi.

Although sand media filters are typically seen more in agricultural irrigation, they are a good fit for a landscape irrigation system, especially if the incoming water source is high in suspended organic material.

Centrifugal Separators

When the contaminants in the water are settleable (ie. pass the "three minute test" as discussed previously), often the best filtration choice is a centrifugal separator. Separators employ centrifugal action to separate settleable solids from water. See Figure 8 below for a cutaway drawing showing how a separator works.

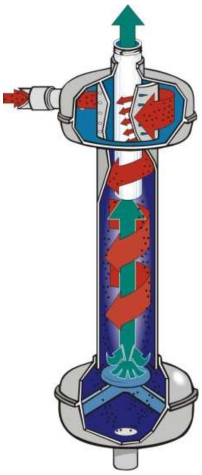

Figure 8.

Water is pumped into the side of the separator's upper chamber and through tangential acceleration slots, which set up a centrifugal action spin. As the water moves in to the middle chamber (known as the "separation barrel"), the particles are influenced by centrifugal action and thrown the perimeter. The particles then gradually lose velocity and fall to the bottom chamber (the "collection" chamber). A vortex forms in the center of the separation barrel, centered on a "spin plate" located just above the collection chamber. This vortex is a low pressure center, similar to the eye of a hurricane, and is the easiest path for the clean water to follow up through the outlet on the very top of the separator. Accumulated particles are then purged periodically from the separator by opening a valve on the bottom "purge exit" of the separator.

Properly designed separators are highly efficient, removing up to 98% of settleable solids 74 micron and larger. Pressure losses are low and steady (typically 3 to 12 psi). Unlike screen filters, which experience an increasing pressure loss as the screen becomes full, a separator will always have the same pressure loss.

The purge of a separator can be automated with an automatic valve for maintenance free operation. This a good option when the system is in a remote location that is not readily accessible for service.

All separators operate within a prescribed flow range that must be adhered to for proper performance. A common misconception is to oversize the separator, or to base the size of the separator on the system pipe size. The separator must have a specific flow in order to achieve the centrifugal action necessary to separate the particles from water.

Pump Intake Filtration

All filters previously discussed are designed to be installed after the pump to protect the irrigation system components. However, it is also critical to use some sort of filtration device on the intake of the pump to protect the pump from damage.

Surface Water Intake Screens

In surface water applications, it is necessary to use an intake screen filter to prevent large particles such as sticks, algae, fish, and other organics from entering the pump and causing damage. The screen is installed in the water at the end of the suction line, below the foot valve.

As with inline screen filters, intake screens are available in a wide variety of mesh sizes. Typically a coarse mesh (10-30 mesh) is used in order to reduce the amount of buildup on the outside of the screen, and therefore reducing maintenance. It should be noted that when a coarse mesh is used, a finer inline filter must be used after the pump to further remove smaller particles before they enter the irrigation system.

There are many different models of intake screens available from various manufacturers. They can range from simple slotted PVC with a nylon mesh covering; to steel self-cleaning models that offer a pressurized backwash line (supplied form the pump) with internal nozzles that rotate the screen to constantly clean the screen and therefore reduce maintenance. Figure 9 below shows an automatic self-cleaning model.

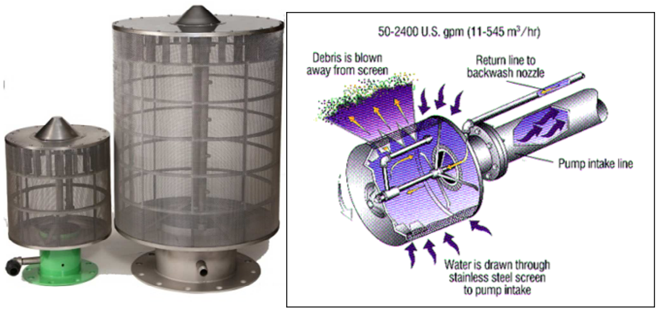

Figure 9.

As with all other filters, the available maintenance routine and budget should be taken into consideration when selecting an intake screen.

Down-hole Separators

If a well pump is suffering damage from heavy abrasive sand particles, a down-hole separator can protect the pump from this abrasive wear. Down-hole separators use the same principle of centrifugal action as above ground separators. The submersible pump is enclosed in a shell, and the separator is attached to the bottom of the shell. The shell acts to isolate the pump intake and force water to enter through the separator before entering the pump.

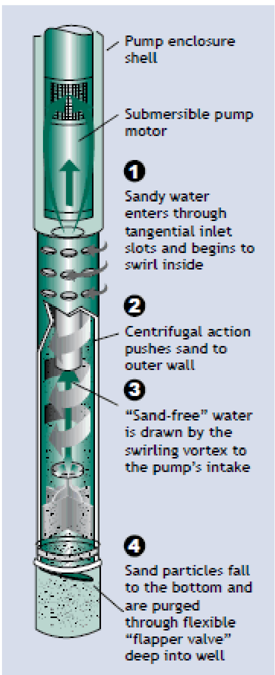

Figure 10. A cutaway diagram of a down-hole separator.

Water is forced into the tangential inlet slots of the separator by head pressure from the well. This sets up the centrifugal action spin which throws the heavy sand to the outer wall, where it loses velocity and falls to the bottom of the separator and accumulates on top of a “flapper valve.” A vortex forms in the middle of the separator, and the clean water follows this path up into the enclosure shell and into the pump’s intake. When the pump shuts off, the flapper valve opens to discharge accumulated sand deep into the well.

As with above ground separators, down-hole separators depend on operation within a prescribed flow range for optimum performance. In addition to flow rate, several other criteria are required to properly select and install a down-hole separator: The inside diameter of the well casing must be known to ensure the separator will fit into the well. Down-hole separators also require a minimum submergence below the drawdown (pumping) water level to ensure enough head pressure is provided to force the water into the inlet slots. Finally, a certain amount of clearance is required between the bottom of the separator and the bottom of the well to allow for discharged sand to accumulate.

Using a down-hole separator can greatly extend the life of the well pump, and keep it running at optimum yield and efficiency. This can save electrical operating costs over time and maintain optimum irrigation system performance.

A common objection to using down-hole sand separators is the perception that the separator will fill the well up with the discharged sand. It must be noted that the aquifer is not a static body of water, and accumulated sand can leave a well just as easily as it can enter.

Conclusion

One of the most important elements of an irrigation system that draws its water supply from a non-potable source is the filtration. Proper filtration is critical to protect all components of the system: from the pump to the emission devices.

Proper selection of a filter involves taking into account the types of contaminants found in the source water, the frequency and availability of maintenance service to the filter, and the type of emission devices used in the irrigation system.

A properly selected and installed filtration system will protect your irrigation system investment, and ensure its proper operation and performance for years to come.

References

Irrigation Association, 2000-2002, 2006. Auxillary Components. Chapter 8 in Drip Design in the Landscape. Pp. 118-121.