Filter Efficiency Translates to Water and Energy Savings

Randy Delenikos, Vice President
LAKOS Separators and Filtration Solutions, 1365 N. Clovis Avenue, Fresno, CA 93727.
randyd@lakos.com

Abstract. *Criteria for optimum filtration systems should include a focus on performance, price and pressure/water loss. Add maintenance/replacement costs to that criteria and the filtration specifier/buyer takes greater control of the selection process, maximizing the potential payback value. Today's technology provides options for operating at lower pressures, resulting in significant cost savings in terms of pump horsepower and total kilowatt consumption. A review of filter options and the keys to energy cost improvements reveal savings beyond the obvious. Determine the needs of your water system and the contaminants that need to be removed. Compare filters based on your needed criteria. Maximize the value by knowing the pressure and water loss requirements of your filter options. A simple application-based calculation reveals the potential savings. Examples show the potential savings in both water and energy costs.*

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It’s always a matter of efficiency

Competition, at the manufacturer, dealer and grower levels, fuels a never-ending drive to improve everything possible in an irrigation system. The design, materials and flow/pressure requirements are all part of the mix to improve yield with less water and pressure and more economical equipment costs. Pumps, too, have become a significant focal point for water and energy savings, with many agencies providing financial stimulus to re-build or replace inefficient pumps. And moisture-sensing technology has become both prolific and more sophisticated than ever before. To be sure, saving more water continues to be a powerful theme as both the weather and political environments increase the pressure to find even more ways to reduce loss and maximize every drop.

Water quality makes an impact

When a water source has been chosen (water well, canal, reservoir, etc.), know what potential contaminants are in that water source and plan accordingly. If you suspect bacteria or corrosive potential, a water analysis can help you properly select the downstream equipment best suited to withstand such issues.

If large debris or aquatic life must be considered, examine your options and budget accordingly. Unless the water is crystal clear (which is rarely the case), determine if the contaminants are settleable (sand, grit, scale, etc.) or suspended (algae, organics, bugs, etc.).

Compare the contaminants to the chosen irrigation technique (drip, sprinkler, etc.) and know what that irrigation technique can tolerate. This will help you select the proper filtration system. Be prepared that multiple contaminant issues may suggest multiple filter solutions, rather than forcing one type of filter to handle every situation. Such a practice often leads to greater maintenance as well as water loss.

Make intelligent filter choices

There are many filtration options available to protect irrigation systems from clogging and abrasive wear. Knowing what each filter can and can’t do is important. Adopting an appropriate list of criteria for each application gives the specifier/buyer greater control and focus for making the right selection. Here are the industry’s most common options:

- ***Pump protection sand separators –*** If coarse sand is grinding away at the impellers and bowls of a submersible or turbine pump, pump protection sand separators can keep that sand from causing excessive damage and help dramatically extend pump life. Limited by flow range and sizes that fit into the well for select flows, these units are maintenance-free and easy to install onto the pump for in-well installation. Surprisingly, separated/purged sand from the pump protection separator does not fill up the well, given the underground aquifer’s natural flow that helps minimize sand build-up in the well.

- ***Pump intake screens –*** Generally, these devices are for open water applications only and are meant to remove only somewhat larger debris or keep aquatic life from being drawn into pumps and irrigation systems. Some are simple strainers, requiring manual cleaning routines. Others are self-cleaning, employing continuous spray nozzles to clean/backwash the screens. If you choose a self-cleaning screen that deposits the contaminants into a vessel out of the water source, be prepared to routinely deal with that material. If you expect long periods of inactivity, consider techniques for pulling the device from the water in order to prevent unwanted organic growth onto the screen. See Figure 1 for example of a pump intake screen.

Figure 1: Pump intake screen
This design removes particle matter while in the water and therefore does not require methods for collection or disposal of the filtered debris from the water.

- ***Filter screens –*** Installed after the pump, screen filters are best suited for light-to-moderate loads of inorganic particle matter. Excessive loading would mean greater cleaning/maintenance routines. Choose the screen mesh wisely; fine enough to protect the irrigation system, but not so fine as to create unnecessarily excessive pressure loss and/or maintenance routines. Good for variable flow rates. Not recommended for organics, algae, etc. Some with automatic self-cleaning options.

- ***Disc filters –*** For lighter contaminant loads and predominantly inorganic particle matter, these largely automated filters are compact and effective. Requires minimum flow/pressure for proper self-cleaning. Be cautious about combinations of sand/silt/organics, which can clog these filters and become difficult to self-clean.

- ***Sand separators –*** Meant only for settleable sand and inorganics, these centrifugal-action filters are flow-sensitive, operating effectively only within specified flow ranges. Pressure loss is predictable, based only on flow (separated sand does not increase pressure loss). Easily automated for maintenance-free operation.

- ***Sand media filters* –** Best suited for the removal of organics & suspended solids. Typically automated and triggered to clean by rising pressure differential. Not recommended for sand, which could cause residual build-up of pressure loss and increased backwash routines and excessive water loss. Minimum flow and pressure requirements vary by maker for effective backwashing.

Combine filters for reduced maintenance & water loss

Applications where multiple issues and/or two or more types of particle matter are present may suggest the need for more than one filter. It is not recommended, for example, to employ a pump intake screen for fine particle removal. Choosing too fine of a screen on the pump intake can make it more difficult to clean and restricts effective flow to the pump; the potential for excessive vacuum on the screen could result in screen collapse and permanent damage. Instead, use the pump intake screen for larger debris and install a filter downstream of the pump to achieve finer filtration.

When two or more contaminants are in the water, consider employing filtration best suited for those contaminants. A good example is when both sand and organics are involved. Yes, a sand media filter can remove both types of contaminants, but heavy sand is difficult (if not impossible) to backwash effectively from the sand filter, resulting in residual build-up, higher pressure loss, more frequent backwashing and greater water loss. See Figure 2 for a graphic example of the problem.

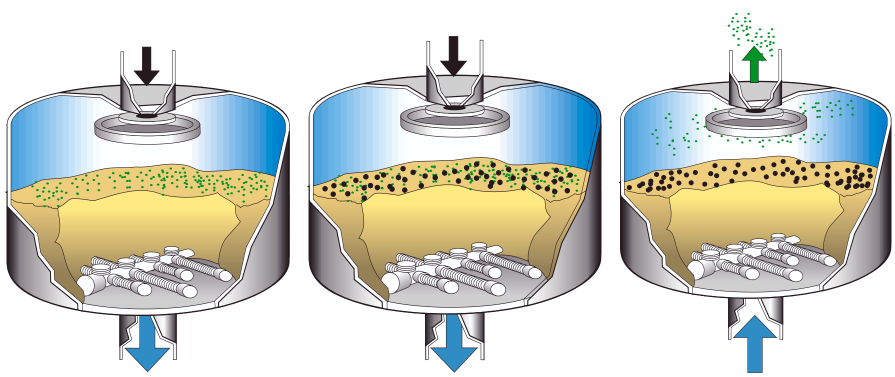

Figure 2: Organic vs. Sand Removal in a Sand Media Filter
At left, the organics are trapped on the sand media surface layer. Center, note the heavier sand particles, also trapped on the media sand. Right, the organics easily backwash, but the sand remains, adding pressure loss and causing increased backwash frequency and water loss.

If, instead, both a sand separator and a sand media filter were employed for removing the combination of sand & organics, the sand separator --- installed prior to the sand media filter --- can effectively remove the sand (and not be clogged by the organics), while the sand media filter easily removes the organics (and is not burdened by the increasing build-up of sand). See Table 1 for an example of the potential water savings.

Table 1: Sand in a sand filter

Application conditions: 650 gpm system flow; Backwashing every 15 minutes
Backwash conditions: 860 gallons per cycle; 3,440 gallons per hour
Add a sand separator as a pre-filter …

- *Backwashing reduced to every 4 hours*
- *94% reduction of backwash water*
- *Savings of 1 acre-foot of water per month*

If coarse sand is causing premature pump wear and fine sand is a problem for sprinklers, a pump protection sand separator can only protect the pump and remove only some of the fine sand. For greater protection, a filter after the pump is best for keeping the fine sand from clogging/abrading the sprinklers.

Selection criteria for filtration

Consider the following list of criteria for evaluating and comparing filters for any given application. Select those criteria which are important only to that specific application. Take control of the process for determining the best filtration for your needs.

- **Particle removal performance:**
  What is the filter capable of removing? Can the manufacturer/supplier provide test results (third party preferred) to validate the claims?
- **Pressure loss and requirements:**
  What's the expected maximum pressure loss? Will pressure loss vary or remain constant? What is the minimum required pressure to operate the filter?
- **Water loss:**
  How much water is needed for flushing/purging/backwashing? How often will flushing/purging/backwashing be necessary?
- **Replacement parts/media:**
  Which parts, if any, will be necessary to repair/replace? At what intervals? At what costs?
- **Downtime/maintenance:**
  What downtime and maintenance routines are required? Special tools or skills? Expected time requirement for servicing routines?

Challenge traditional filter logic for improved energy savings

The manufacturers of drip and micro-spray irrigation systems have developed very low pressure requirements for operating their systems. Yet, the pressure requirement for the pump to feed water and operate such systems has remained largely unchanged at 35-40 psi for many, many years. The issue is not the irrigation system, but rather the required filtration system, which demands both flow and pressure to properly operate and efficiently flush/backwash the filtered contaminants from the filter. Research and testing have shown that the popularly-known "constant" of 35-40 psi CAN and SHOULD be not only evaluated, but also challenged … and that the energy savings can be significant.

If, for example, a sand media filter can be operated at a lower pressure, it is possible that the pump requirement can be reduced, saving not only on the initial cost of the pump, but also the long-term cost of energy to run that pump for years to come. See Table 2 for examples of such savings.

Table 2: Reduced filter system pressure requirements & related energy savings

EXAMPLE 1 – Application conditions:
Central California Almond Grower; 500 acres; 850 gpm filter
Changing from 35psi to 25psi saves $3,980 annually in pump energy

EXAMPLE 2 – Application conditions:
Imperial Valley Tomato/Pepper Grower (double-crop); 1,000 Acres; 1500 gpm filter
Changing from 35psi to 25psi saves $5,660 annually in pump energy

EXAMPLE3 – Application conditions:
Northern California Grape Grower; 750 Acres; 1200 gpm Filter
Changing from 40psi to 25psi save $1,593 annually in pump energy

Sand media filters require pressure to engage the backwash valve into the backwash position. That same pressure feeds the filter's underdrain to uplift the sand media and release the suspended organics from the sand in order to be flushed away. The design of the backwash valve (more specifically, the size of the plate connected to the shaft that moves to change the backwash valve from the "run position" to the "backwash position") dictates the valve's minimum pressure requirement. A bigger plate helps operate at a lower pressure loss. In addition, the more extensive the open area of the underdrain, the more it can effectively function with less pressure, providing adequate and consistent flow to evenly lift and clean the media sand surface layer. To be sure, not all filter systems are alike. Look for these features in order to capitalize on the ability to operate at lower pressures and save on energy costs. See Figure 3 for an underdrain design comparison.

Figure 3: Underdrains are different; performance varies
Shown are two of the many designs employed by sand filter manufacturers. Note the differences in pattern, coverage and total open area. These features affect the pressure requirement and the efficiency of the backwash flow.

Conclusion

Know the water source and its potential contaminants. Use that information and your application requirements to compare filter options according to your needs. Examine every opportunity to save water and energy for reduced waste and expense. Challenge traditional thinking and pay attention to the subtle differences in products like sand media filters, which can greatly affect efficiencies. You may be pleasantly surprised at the potential savings in both upfront equipment costs and long-term operating costs.