



Clarifying the Choices

Companies should consider such factors as space and capital requirement, desired filtrate quality, and level of automation when selecting water and wastewater filters.

Filtration is the easiest way to remove solids from water and wastewater streams.

In wastewater systems, filtration is used to decrease suspended solids entering the publicly owned treatment works or water-reuse systems or to increase solids in sludge dewatering applications.

Filter selection begins after a company determines the required level of filtration or filtered water quality; decides whether filtrate will be disposed or reused; identifies how much space is available; calculates the amount of capital available to purchase, operate, and maintain the system; decides whether the system should be automatic or manual; and considers any pertinent water conservation requirements.

The level of solids removal or filtered-water quality desired defines the type and size of filter necessary; most are available with varying automation levels and price ranges.

Proper filter size is determined by flow rate and the amount, size, and type of solids to be removed. Particle sizes and filtration levels can be determined by filtering water and solids through varying sizes of filter paper and measuring the total solids content of filtered water.

Solids remaining in filtered water will be the same size or smaller than the last filter paper used and will indicate which filter media opening size to use. (A filter manufacturer or laboratory can be hired to perform this procedure.) The quantity of solids in water or wastewater can be determined by a laboratory analysis of total solids; flow can be determined from plant records or an in-line flow meter. The following equation is used to calculate solids loadings (how quickly a filter will load with solids):

$$\text{solids (lb/h)} = \text{flow (gal/min)} \times \text{total solids (ppm)} \times (8.34/60/1,000,000).$$

After solids loading, filter area, and filter media opening size have been determined, the amount of time required before cleaning, or back-washing, should be calculated, and the fate of filtrate waste must be determined. In other words, after a filter is backwashed, where will wastewater go? Backwashing often requires up to 10% of the total filtered volume, a 10:1 ratio. For example, 379 m³

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(100,000 gal) of filtered water would generate 38 m³ (10,000 gal) of backwash that contains concentrated solid and may require additional treatment

Some wastewater must be pretreated before filtration. Oily wastewater, for example, tends to agglomerate quickly between or over filter media and requires conditioning before filtration. Fine-grade filtration systems are susceptible to fouling from biological growth, yeast, and other microorganisms; performing bench tests or consulting with filter manufacturers about specific applications is recommended.

Y-Strainers

Y-strainers are the simplest, least expensive (\$30 to \$100) filters, but they have a small filter area and require frequent maintenance. They typically are used on small pipes to protect such equipment as seals, pumps, and nozzles from solids buildup.

Bag Filters

Bag filters basically are larger Y-strainers. These filters are bags of selected pore sizes that are enclosed in a pressure housing with a removable cover for cleaning. They are easy to use, come in variable filtering sizes, and are relatively low in cost, especially for final filtration or applications with low solids loadings. Bag filters do not exceed 203 mm (8 in.) in diameter; for larger diameters, an in-line bank with multiple filters in one housing is used.

The price of carbon or stainless steel bag filter housings varies according to size, from \$100 for a 51-mm (2-in.) housing to \$3000 for a 1219 mm (48-in.) housing.

Filter bags range in price from \$6 to \$10 for pore sizes of 25 to 800 microns.

Bags are available straight or pleated. Pleated bags provide added surface area but cost more than twice as much as flat ones. The disadvantages of bag filters include high maintenance requirements for systems that are underdesigned or have high solids loads and the cost of bag replacement.

Vacuum Filters

Vacuum filters use a slowly rotating vacuum (negative pressure) drum that pulls dirty liquid from the outside of the drum and media to the inside of the drum. The vacuum filter usually is packaged with a pre-batch treatment system to coagulate the wastestream before filtration. The advantage of this filter is its ability to filter a variety of wastewaters. The disadvantages include slow system throughput and high costs associated with the filter media, which must be applied continuously to the batch pretreatment tank immediately before vacuum filtration. In addition, the

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filtering media increase total sludge volume as much as 60%. Because vacuum filter cost usually includes the pretreatment system, a unit that processes 19 m³/d (5000 gal/d) can cost \$60,000.

Cyclone Separators

Cyclone separators are relatively new. Because they have higher rotating speeds than vacuum filters, they create a significant amount of centrifugal energy to filter wastewater through various media sizes. The rotating filter uses a fixed-micron-size medium, such as diatomaceous earth, to filter the wastestream. The benefits of cyclone separators include their ability to handle variable throughputs, filter varying particle sizes, and produce drier sludge cake than vacuum filters for about the same cost (around \$60,00). Their drawbacks are similar to those of vacuum filters, namely high filter media costs and sludge volume.

Plate-and-frame Presses

Plate-and-frame presses are batch processes in which fixed plates held together in a hydraulic press are pre-coated with diatomaceous earth filtering media. The press size depends on the total solids volume per load. Liquid is loaded into the presses with an air-driven diaphragm pump in increments of 172, 345, 517, and 690 kPa (25, 50, 75, and 100 psi). The press is pressurized at 690 kPa (100 psi) causing water to be squeezed out. After water is removed, the filter is "blown down" with air and opened so sludge can be removed from the plates. The cake usually is at least 35% solids. The limitations of plate-and-frame presses include a processing time of at least 4 hours, a large footprint, an ability to dewater only the volume of the plates, and the operating time required to clean the plates. Therefore, if wastewater contains high solids levels, the press must be large. Filter presses range in size from 0.014 to more than 2.8 m³ (0.5 to more than 100 ft³). An .028-m³ (1-ft³) press costs \$3,500, and a 2.3-m³ (80-ft) press costs \$100,000. Large presses also require automatic loading controls, plate shifters, sludge carts, and other equipment that can cost an additional \$100,000. The advantage of filter presses is their ability to produce steady, dry cake, which often is required for landfill disposal.

Multiplate Spring-loaded Filters

Multiplate spring-loaded filters use specially fitted disks with machined gradations that provide the required micron-size opening. The disks, which are held together with a preloaded spring, allow water to flow through while holding back filtered particles as small as 2 microns. These filters are backwashed with water based

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on a preset pressure differential and come with an option for all- water or air-assisted backwashing, which saves water and greatly increases filter-plate scouring. These continuous on-line filters usually are configured in pairs (one for filtration, one for backwashing). The amount of water used for backwashing is about 10% of the total filtered flow. Air-assisted filter backwash saves an additional 3% to 5% of water but requires compressed air. The programmable logic control-based filters enable adjustments in the time between backwashes and backwash duration. The filters cost \$4,500 per pair, and the controller costs an additional \$5,000 but can control a bank of up to 12 filters.

Multimedia Sand Filters

Multimedia sand filters traditionally are used to treat water but also can be used to treat wastewater that has non-uniform solids loadings. These three-dimensional systems provide much greater filtering volume than other filters because they use both the bed surface and depth to remove particles as small as 0.45 microns.

An on-line suspended solids analyzer measures the amount of particles coming through the filter. As solids levels increase past, or break through, the filter, a preset suspended solids level initiates backwash. Backwash can be air assisted to save water, but care must be taken not to blow the media out with the filtrate material. These filters usually come in pairs to provide continuous on-line service. They work well as final filters for water with uniform solids. Water savings is accomplished when the right control scheme and air-assisted backwashing system are used, A 0.19-nil/min (50-gal/rnin) pair of multimedia sand filters with a controller and backwashing header assembly costs approximately \$15,000.

With the vast array of available filters and control scenarios, companies willing to perform some advance research on their wastestreams should have no difficulty finding a system to meet their needs.

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