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Getting the best possible performance from your filters can be achieved by understanding what can go wrong and keeping your system in good working order. BY NATHAN STAPLES AND RICHARD ROSS

PREVENTIVE MAINTENANCE

REAP THE BENEFITS OF WELL-MAINTAINED FILTERS

MAINTAINING WATER filtration plants can be difficult, but proper preventive maintenance procedures can prolong filter operation, enhance performance, help your utility meet water effluent goals and regulatory compliance requirements, and save money. The filtration process largely depends on the filter media, and media performance depends primarily on the media's physical condition, backwash effectiveness, and maintaining the correct media depth and retention.

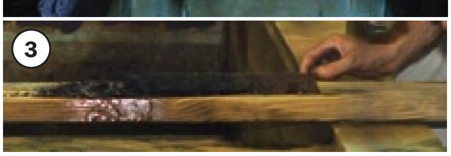
The physical condition of media is based on its size and shape. When new, media are fairly uniform in size. The appropriate size is determined by the nature of the water to be filtered and effluent quality required. In general, filter media used in potable water applications is smaller to create a tight filter bed that can trap smaller particulates.

In wastewater applications, media are typically slightly larger. In either application, media shape is ideally angular with rough edges, which allows the media to pack together and minimize voids. In addition, rough edges allow floc created during the pretreatment process to adhere to individual media grains.

PHOTOGRAPH: MELANIE SCHIFF, AWWA

Maintaining complete, thorough records of water quality, chemical feed, filter run times, headloss, flow rates, and backwash conditions will prove valuable in identifying problems.

Core sampling helps to determine media size and the extent of contamination.



Normal filter backwash operations eventually wear away and smooth media particles, so it's a good idea to periodically inspect the media. The best way to do this is to look at the media under a microscope. New media should have a rough, angular, jagged surface. Worn media appear smooth, and severe wear causes media to look like polished marbles. Media worn smooth should be replaced. Smooth media could allow floc particles to pass through the bed.

BACKWASH EFFECTIVENESS

Filter performance is affected by backwash effectiveness and media cleanliness. During operation, filtered particulates, contaminants, and chemicals attach to individual media grains. As particulates and deposits build up on the media, filter headloss increases, eventually requiring plant personnel to backwash the media. If the backwash process is ineffective, the media become fouled by particulates that remain in the filter bed and can become permanently coated. Periodic sampling and visual inspection reveal media condition. To maintain optimal filter performance, coated or fouled media should be replaced.

MEDIA SAMPLING

As shown in photographs 1–3, to sample the media core, push a piece of polyvinyl chloride pipe (PVC) down into the media bed, cover the exposed open end of the pipe to create a vacuum, and remove the pipe from the media bed. This method works best when the media are submerged in water, which creates a better vacuum. You can also obtain a sample by digging into the media with a shovel. In all cases, don't disturb the gravel support bed beneath the media.

In the sampling shown in photograph 3, media from different depths were obtained for laboratory analysis to determine media size and the extent of media contamination. To assess fracturing or deterioration, compare the size of the sampled media with the media's original size.

Photograph 4 shows anthracite media heavily coated with iron and manganese oxides. Multiple water rinses were required to remove accumulated solids and dirt, but not the coating, from these samples. Photograph 5 reveals that exposure to acid resulted in an aggressive reaction that removed the coating, indicating the coatings are highly acid soluble. The coating had accumulated to such an extent that overall media volume within the pressure vessel had increased. It was difficult to access the inside of the vessel because the media had expanded well above the access opening.

Photographs 4 and 5 clearly show the media were in poor condition before the acid washing. The backwash process in this vessel is water only. Because few records for this vessel are available to help determine backwash frequency and duration, it's impossible to determine if media fouling resulted from ineffective backwash or improper maintenance.

BACKWASH PROCESSES

Ineffective backwash allows contaminants to remain in a filter bed, shortens filter run times, and leads to media fouling and a need for replacement. There are four common types of backwash procedures: water only, surface-wash sweeps, air scour followed by water, and simultaneous air and water backwash.

Water-Only Backwash. Using water only is the simplest, most common backwash procedure. Filter flow is reversed, and clean water is sent through the filter bed at high flow rates. An ideal backwash flow will expand a filter bed 30–50 percent, allowing particulates caught in voids to be carried up and out of the filter. The process is effective in filters that primarily remove turbidity or solids and have few contaminants adhering to the media. When contaminants are stickier, more aggressive backwash is required.

Surface-Wash Sweeps. As shown in photograph 6, surface-wash sweep systems use rotating "sweeps" that spray water at high velocities at the surface of the media during backwash. The sweep causes the media grains to collide, which helps remove contaminants stuck to the media. However, these systems are effective only on the top few inches of media and require additional maintenance. If

PHOTOGRAPHS: SIEMENS WATER TECHNOLOGIES

With all systems, it's important to monitor and record pressure buildup in backwash supply lines.

surface-wash flow velocity is too low or the nozzles become plugged, the sweep won't rotate. Therefore, it's important to keep the sweeps clean and freely rotating, check the nozzles for plugging, and ensure the caps remain in place. If the caps come off, media can enter the sweep, eventually enter the bearing, and cause severe damage.

Sequential Air Scour and Water. Use of air during backwash has become more common during the last 30 years. Developed for the wastewater market, air scour reduces the amount of energy required to fluidize media and reduces the amount of backwash water and backwash rate (gpm/ft^2). For sequential and simultaneous air–water backwash, air is introduced below the media and allowed to rise through the media. The rate at which air rises through the water creates high levels of energy that provide aggressive contact between media grains. Compared with water-only or surface-wash techniques, the procedure dramatically improves the amount of adhered contaminants removed from the media.

In sequential air–water backwash, all water flow is stopped, and only air is introduced to the media bed. After a few minutes, air is discontinued, and normal water backwash begins. The additional step of air scour improves the process by dislodging more contaminants. However, a considerable amount of dislodged material remains in the media bed because the water-only backwash process can't efficiently remove all material from the bed.

Simultaneous Air Scour and Water. To improve the sequential air–water backwash process, a combined air and water backwash process was introduced. This method uses the added energy created by air and maintains water flow to carry more contaminants up and out of the filter bed. The process also allows lower backwash flow rates, and desired bed expansion is accomplished by lift supplied by the air.

MEDIA DEPTH AND RETENTION

To use combined air and water backwash, some form of media-retaining system must be installed on the backwash collection troughs. Such systems separate the flow of air and water and minimize the amount of media carried out of the filter during backwash. The figure on page 14 shows three baffle designs.

Usually, 0.5–1 in./yr of media loss can be expected. Filter media depth plays a crucial role in producing good effluent water quality. As media depth is lost, overall filtration capacity diminishes, leading to shorter filter runs and contaminant breakthrough. Therefore, overall bed depth should be measured periodically and additional media installed to maintain proper depth. In larger filter cells, measurements should be taken in several locations to confirm uniform depth across the entire filter cell.

At a facility in eastern Canada, varying effluent quality and irregular backwash frequencies led operators to investigate the filtration process. Eventually, it was discovered that overall media depth varied the length of the filter basin. Operators discovered they had lost media in these areas, allowing contaminants to break through to the effluent water. Installing additional media restored the filter bed to an appropriate depth and returned filter performance to previous levels.

UNDERDRAIN SYSTEM

Other filter maintenance components don't involve media. In some plants, particularly lime-softening facilities, the underdrain can become plugged. At a southwestern Florida lime-softening facility that used aeration, clarification, and recarbonation in a cluster gravity filtration system, an underdrain in the filter's monolithic floor became plugged. When this occurred, flow distribution during backwash and the filtering process became irregular. Backwashing was ineffective, and filtering was uneven across the basin. Although it's difficult

The media shown here (4) were in poor condition before acid washing removed the coating (5).

to see what's happening below a filter, close monitoring of the filter run and backwash frequency usually reveals the problem. Also, when visually inspecting a filter during backwash, a more aggressive action in some spots and less motion in others can usually be discerned.

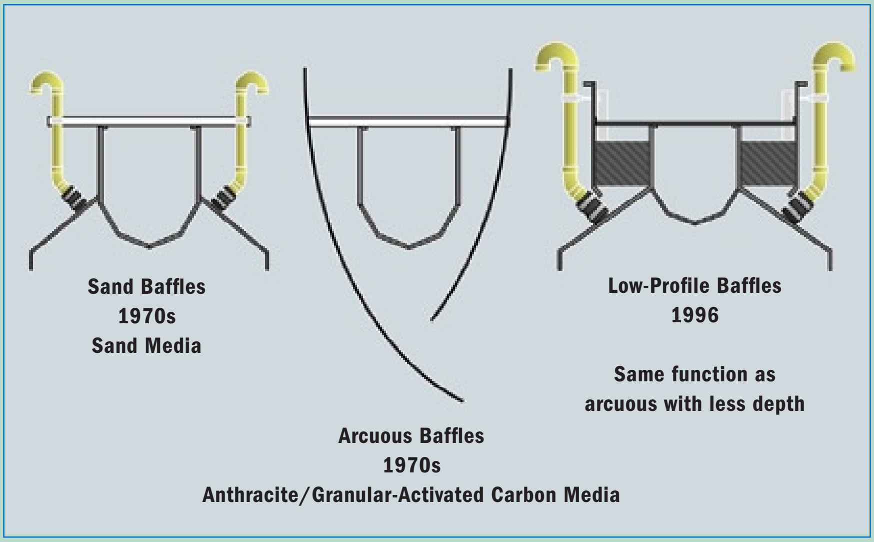
The same problem can be related to excessive chemical feeds or polymer accumulation within a basin. When a New Jersey facility with turbid river water influent experienced turbidity spikes, personnel increased coagulant and polymer chemical-feed rates to accommodate the increased solids. However, it was more difficult to predict when the solids entering the facility

Surface-wash sweeps help remove contaminants stuck to the media.

If pressure is more than it was during the last backwash or there's an increasing pressure trend, passages in the underdrain are reduced or becoming plugged.

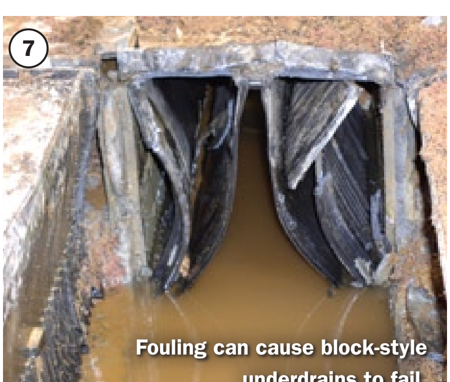
Baffle Designs Evolve With Project Requirements

A variety of systems are available to help minimize the amount of media carried out of the filter during backwash.



would diminish and fewer chemicals would be required. Because of excess chemical feed, mud ball formation and filter media cracks around the edges of the basin began to appear. An aggressive air–water backwash process was used to alleviate the problem.

When block-style underdrains with porous caps are used in this type of application, fouling is common. As shown in photograph 7, damage caused by such fouling is catastrophic and occurs over time. Biological fouling is also possible when buildup in the cap pores becomes excessive, creating problems and ultimate failure. With no clear opening, these pores are difficult to clean, and the blocks usually must be replaced. In filters with this type of underdrain system, it's important to watch for mud ball formation or surface cracking in the media, which indicate contaminant buildup. Also, algae on basin walls may indicate biological growth in the underdrain components.



Fouling can cause block-style underdrains to fail.

With all systems, it's important to monitor and record pressure buildup in backwash supply lines. If pressure is more than it was during the last backwash or there's an increasing pressure trend, passages in the underdrain are reduced or becoming plugged.

In addition, contaminated backwash water can plug underdrains on the opposite side. This frequently occurs in filter rehabilitation projects when sediment is dislodged and allowed to flow into a newly rehabilitated filter cell, quickly plugging the nozzle, header, and crevices of an underdrain. When filters are rehabilitated, thoroughly clean all backwash supply components. For further safety in systems with media-retaining underdrain components, installing a fine-mesh screen in the backwash supply lines will help protect the underdrain and minimize potential damage caused by backwash supply contamination.

RECORDKEEPING

Thorough recordkeeping is essential in identifying trends or changes occurring in a filtration system. For example, you can track backwash effectiveness by monitoring headloss vs. time or volume. If there's a continual reduction in the amount of time or water volume processed compared with headloss, solids may be building up in the media bed. Also, if records show a trend of shorter filter runs prior to breakthrough, there may be a breakdown in the treatment process. In all situations, maintaining complete, thorough records of water quality, chemical feed, filter run times, headloss, flow rates, and backwash conditions will prove valuable in identifying problems.

OPTIMIZE PERFORMANCE

Getting the best possible performance from your filters results from understanding what can go wrong and keeping the system in good working order. Here are ways to achieve optimum filter performance:

- Core sampling and media analysis can help operators determine what's going on in a filter cell.
- Effective backwashing results in optimized filter operation with long filter runs.
- Keeping filter media clean and at the proper level ensures consistent effluent water quality.
- Aggressive air–water backwash can clean filter media with less backwash water through decreased flow rates and backwash frequency.
- Maintaining good records of water quality, filter-run length, backwash frequency, and other criteria help to assess and understand what's going on and why.