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Regular Filter Cleaning Improves Bottom Line

Filtration systems—a utility's first line of defense against contamination—are usually the most complex part of a water system. Regular filter maintenance extends equipment and facility life, decreases labor and repairs, and can reduce energy and chemical costs. BY BOB CASHION AND JASON PETERS

Editor's Note: *This is the first in a three-part series about the importance of regular infrastructure cleaning and maintenance for equipment life and functionality, overall treatment performance, water quality, chemical requirements, and primary and secondary disinfection as well as disinfection by-product control.*

IN NORMAL OPERATION, filter media and underdrains eventually become encapsulated and clogged with foreign matter, resulting in high head loss, short filter run times, more frequent backwashing, and decreased water quality and system performance. Keeping media underdrains, troughs, and sidewalls clean of organic and inorganic intrusion improves operations and water quality.

Further, regularly inspecting media for density, particle size, and uniformity coefficient is critical. Encapsulated filter media reduce adsorption, overall effectiveness, and filterability. Encapsulation also changes media densities, causing an interface loss or media mixing. The results are often confused with media rounding, which may lead to premature media replacement. Microscopic analysis may reveal the angular media surface areas are filled in, giving the appearance of rounded media. As the process of encapsulation continues, several problems can arise, ranging from short filter run times and high head loss to lower filtration rates and inadequate bed expansion during backwash. Filter performance continues to diminish until the problem is corrected.

FILTER MAINTENANCE OPTIONS

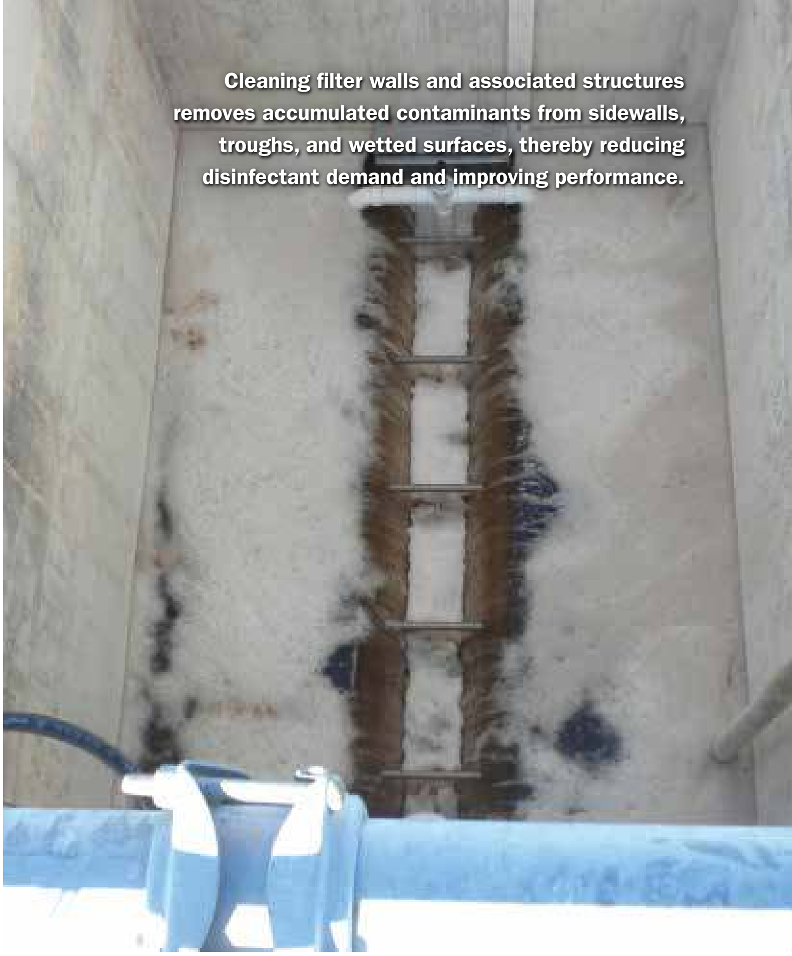
Several filter media cleaning and maintenance options are available.

Do Nothing. Because filters are omnipresent, operators tend to let filter systems operate until problems of turbidity breakthrough, high head loss, excessive backwash water, long ripening times, or short filtration runs cause operational problems. For pressure and gravity filtration units, operators often resort to increasing the rate of flow through the remaining filter surface area or operating longer run times to make up for production loss in emergency conditions. This can lead to exceeding approved filtration rates. Facility personnel who take this action are reactive rather than proactive and often change out media at extraordinary expense, instead of determining if there's a problem with the media and underdrain.

Problems continue to increase until water production is limited to making backwash water and starving the distribution system at critical times of the day. Operating filter systems in this manner is extremely expensive. In most cases, preventive maintenance and media optimization could have eliminated the problems. Proper maintenance also allows a system to stagger over several years the costs associated with media management. Budget cuts and delayed maintenance can lead to filter failure and a full-fledged emergency. Doing nothing is the worst option.

Media Replacement. Media are usually replaced because wear or rounding is evident on inspection. This observation is based on the media being encapsulated with organic and inorganic accumulations that inhibit flow or cause backwash problems in underdrain systems. Pretreatment chemistry, such as with coagulants or pre-oxidants can amplify the effect. Such interpretation may lead operators to incorrectly assume the media are worn out and should be replaced.

During the last few years, media replacement costs have increased because of costs associated with the media itself, handling and shipping, disposal of old



Cleaning filter walls and associated structures removes accumulated contaminants from sidewalls, troughs, and wetted surfaces, thereby reducing disinfectant demand and improving performance.

media, confined-space labor, and equipment. Downtime and the amount of required backwash water alone are reasons enough for operators to look at alternatives to complete replacement.

Media replacement involves more than job costs. Replacement takes filters off line, at times for days or weeks. During replacement, other equipment—particularly underdrains—is at risk. Coatings in bays can be damaged, and other parts of the systems may have to be repaired, further delaying a return to service. The table below compares the costs of replacement and cleaning.

Simple Media Cleaning. Various chemical approaches have been used to clean filter media with less than stellar results. Insufficient testing, misapplication, and use of experimental processes result in cleaning that's inferior to that performed by trained personnel.

One such approach is to attempt media cleaning through oxidization by increasing prechlorine feed rates or simply adding chlorine on top of the filters. This may improve filterability but can cause DBPs to form in the finished water. Sodium hydroxide and simple acids—such as citric, phosphoric, hydrochloric, and sodium hypochlorite—have been used but are mostly ineffective at removing years' worth of organic and inorganic constituents accumulated from raw water.

Coagulants and pH adjusters also limit cleaning efficiency by encapsulating the media, preventing penetration of the cleaners. Further, the cleaning acids are hazardous, require special handling, and can cause filter problems. For example, if hydrochloric acid and stainless steel come in contact, the stainless steel will become brittle and failure prone. After cleaning, it's also critical to prevent the acids from neutralizing in the filter bay. The extreme heat produced by neutralization can damage the media by causing breakage or changing the media's hardness specification.

Simple cleaning is often chosen because it uses commodity chemicals and local personnel and appears inexpensive. In the end, however, expected savings don't materialize because this method is rarely effective. Although simple cleaning creates the appearance of proactive maintenance, it temporarily masks the real problems.

Advanced Chemical Cleaning. Advancements in cleaning processes and chemistries have generated more specialized NSF 60-certified formulations specifically designed for cleaning most filter media types and underdrain systems. These cleaners penetrate the stratified layers of media, support gravel, and underdrains.

Chemical cleaning should always start with a customized laboratory filter media

Media Replacement vs. Cleaning Costs/ft^2

Media replacement often costs more than the cleaning cost.

Media Type	Replacement Cost*	Cleaning Cost**
Filter sand	$40	$23
Anthracite	55	23
Greensand	70	30
Zeolite	110	30

*Includes average labor and shipping costs
**Includes catalyst, neutralization process, and average shipping

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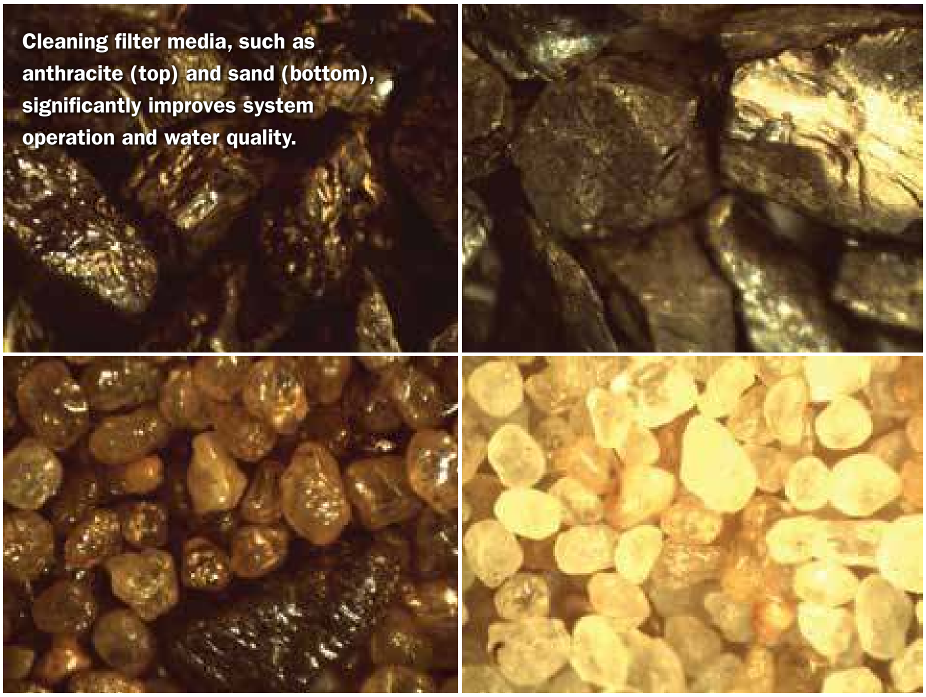

Cleaning filter media, such as anthracite (top) and sand (bottom), significantly improves system operation and water quality.

analysis that defines the best application rate for a specific filter and analyzes the amount and type of contaminants to be removed so the waste can be well understood. Based on this analysis, a two-step cleaning process uses appropriate concentrations of a powdered formula that has a slow dissolution rate and an activation catalyst.

In the first step, the powder formulation is mixed with water and pumped as slurry on top of the filter media bed. This allows the cleaner to cover the entire filter surface area and penetrate the depth of the media. In step two, an activation catalyst is added and mixed by an air scourer or surface sweep. The catalyst starts the cleaning reaction and allows organic breakdown to speed up the removal process. The entire process usually takes less than 24 hours per filter, unless the media is excessively fouled.

The amount of time the cleaning chemistry stays in contact with the media is critical, because the slurry must have time to penetrate down through the underdrains. This process usually can be accomplished in a 24- to 48-hour period,

CASE STUDY

ADVANCED CHEMICAL CLEANING STREAMLINES OPERATIONS

The case for advanced chemical cleaning was demonstrated recently at an 8-mgd surface water treatment facility in New Braunfels, Texas. Commissioned in 1991, the facility treats Guadalupe River water with ten 128-ft^2 conventional dual-media gravity filtration units.

Because of the media's age and loss of water flow through the units, the treatment facility experienced higher-than-normal head loss and short run times. Personnel suspected the media and underdrains were encapsulated and clogged with raw water organic and inorganic constituents and chemicals that had been added during coagulation and sedimentation and for pH adjustment. Visual inspection of the media showed significant mudballs and heavy buildup of organic and inorganic matter on unit walls and troughs.

Two mitigation options were considered by the New Braunfels Utilities (NBU) engineering staff. The first option was to remove and replace all media and support gravel and clean the underdrain system. The second option was to clean the media in place to dissolve, dislodge, and clean the mudball formations and deposits encapsulating the media and underdrain.

To determine the composition of contaminant buildup, as well as the most effective treatment strategy, laboratory analysis of the constituents was performed. The weight loss difference is a direct correlation of the total constituents removed from the media. Further, the analysis revealed the makeup of the constituents and volumes being removed using inductively coupled plasma testing, an important step in waste disposal. Preliminary testing indicated the media could be effectively cleaned in place instead of replaced.

Regardless of the selected option—replace or clean in place—such analysis provides valuable information and should be

Constituents Removed

A significant amount of material was removed from one of NBU's filters during standard laboratory cleaning.

Parameter	Mixed Media	Sand
Dry weight loss	2.9%	1.4%
Total weight removed	61 lb	184 lb
Magnesium removed	658 ppm	623 ppm
Calcium removed	2,075 ppm	1,009 ppm
Total lb removed	245 lb	

Most filters, when cleaned regularly, can be maintained for years.

but residence time depends on fouling severity. A catalyst, which is more effective with air agitation or mixing, increases cleaning efficiency and helps remove organic and inorganic contaminants from the encapsulated media.

This approach has proved to be more effective than simple acids, because it better penetrates the entire filter bed, underdrains, and walls (see Advanced Chemical Cleaning Streamlines Operations, below). The result is optimal contaminant removal, reduced costs, and improved filter and underdrain performance.

COST AND VALUE

Some filters are allowed to degrade to a point that media replacement is the only choice; however, most filters, when cleaned regularly, can be maintained for years. Although a utility may elect to clean its own filters with basic acids, specifically developed formulations may be worth higher up-front costs.

After cleaning, there's a clear separation of the interface between different layers of media.

In most cases, advanced chemical cleaning on a turnkey basis costs less than half the cost of media replacement and is considerably faster and less complex. A lower total cost frees resources to support other utility projects.

performed regularly. This analysis provides a baseline that will identify optimal intervals for media replacement or cleaning and inspection. The analysis can also provide treatment insights by indicating, for example, changes in coagulant feed rates to improve filter performance or the efficiency of the sedimentation process and system loading. For overall operational control, results can be compared year-to-year.

Based on laboratory testing, cleaning of the NBU facility's media removed about 245 lb of deposits from just one filter, including 3,084 ppm of calcium and 1,281 ppm of magnesium. These results were repeated with each of the facility's 10 filters for two weeks until all filter units had been cleaned and topped off with filter media.

Before the cleaning, a filter interface couldn't be located in the filters because the sand and anthracite were mixing and because of similar specific gravities. After cleaning, there was clear separation of the interface.

After the cleaning, operational improvements included increased flow production (more than 1 mgd), reduced head loss, reduced effluent turbidity averages (from 0.2 ntu to 0.03 ntu), and improved media stratification and interface. Filter run times were extended from 50 hours to an average of 95 hours, which improved backwash flow and reduced backwash water by 50 percent.

In addition, cleaning reduced energy costs for recycle pumps, chemical costs of re-treating the recycle water returning to the head of the facility, and chlorine demand through the filter bed. The cleaning also removed mudballs and other particulates and extended media life. Based on the media analysis and report, it was recommended to clean the filter media every three years for optimal filter performance.

The filter walls and associated structures were also cleaned to remove accumulated contaminants from the sidewalls, troughs, and wetted surfaces. This additional work enhanced the staff's ability to inspect the concrete surface and improved the appearance of all wetted surfaces. As a result, the staff reduced disinfectant demand, prevented material from sloughing off into the filter bed, and improved performance and operation.

Based on these results, NBU has budgeted funds to adopt the media and surface cleaning procedures as part of its standard operating procedures. The practice is paying dividends in improved operations and cost savings.

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