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Air-Assisted Backwash

Breathe New Life Into Dying Filter Beds

The costs of maintaining quality operations in a plant more than a century old called for revamping the system with major filter enhancements.

BY CURT STEFFY AND BILL LADIEU

WHEN THE PICKERING West Surface Water Treatment Plant in Phoenixville, Pa., was built in 1874, it had a capacity of about 5 mgd. By the 1960s, total filtering capacity had been expanded to about 40 mgd. Current plant demands average 32–35 mgd. Originally owned and operated by the Philadelphia Suburban Water Co., the plant is now the largest of nine surface water treatment plants owned and operated by Aqua Pennsylvania (Aqua-PA) in Southeastern Pennsylvania.

To achieve the treatment optimization goals of the US Environmental Protection Agency's Partnership for Safe Drinking Water and comply with the Pennsylvania Department of Environmental Protection's filter performance evaluations, Aqua-PA maintains an aggressive, proactive filter inspection program for all of its treatment facilities. The inspections—including media sampling, sieve analysis, auxiliary wash maintenance, backwash evaluations, and media floc-retention tests—help Aqua-PA meet the challenges of maintaining an older facility.

PLANT CHALLENGES

The Pickering plant was regularly observing filter media losses exceeding 1 in./yr due to the shallow filter boxes, which are common in older plants. In addition, rotary surface wash agitators contributed to media loss by pushing media into the filters' corners and reducing available freeboard.

The filters tended to gather solids that couldn't be removed by the surface wash–assisted backwash. The resulting chemically coagulated particulates eventually formed mudballs ranging in size from 0.5 in. to 1 in. in diameter.

Mudballs contribute to decreased effluent water quality, poor filter distribution, reduced filter run times, improper backwashes, and shorter media life. Therefore, when mudballs compromised a filter's media, the filter was removed from service for anthracite media skimming and manual cleaning with a water jet, aggressive backwashes, and chemical disinfection. If the filter media couldn't be rehabilitated in this manner, they were replaced. Anthracite capping of the filters was a common practice, and complete filter media replacement was required every five to eight years. The surface-wash agitators also required regular inspections and routine maintenance.

UPGRADE OPTIONS

Over the life of the facility, plant operators, maintenance crews, and water quality staff have operated the plant in accordance with company, state, and federal regulations. Recently, however, the financial burden of maintaining quality became a driving force to implement major filter enhancements.

In 2005, Aqua-PA retained a consulting engineer to evaluate and design an upgrade for the pretreatment and filter auxiliary wash systems at the Pickering West facility. Aqua-PA also wanted to replace the filter surface-wash agitators with air scour. The engineering design report presented two options for the upgrade, both of which were designed around standard 3 ft^3 per min/ft^2 (scfm/sf) and redundant blowers:

- Replace the existing strainer bottom underdrain with a high-density polyethylene (HDPE) combination air–water underdrain
- Install a separate air scour system above the existing filter underdrain and graded gravel support

Underdrain Replacement. The first option presented many challenges. Complete underdrain replacement would require full media removal and disposal, jack-hammering of the original bottoms, debris removal, substantial basin modifications, and purchase and installation of a new underdrain. The process would be intrusive to daily plant operations, and each filter would have to be taken out of service for several weeks. The total project would require nearly a year to complete.

The air scour system was assembled on top of the filter media beds and lowered to the gravel layer during backwash (inset).

PHOTOGRAPHS: ROBERTS FILTER GROUP

Additionally, installing an HDPE underdrain would require using a direct media retention cap to maintain media depth within the confines of the existing filter box. Aqua-PA preferred to retain the traditional graded-gravel media support system.

Underdrain replacement would also require removing and then replacing the filter media. Recent inspections had confirmed that the existing filter media were still in good shape. The sand and anthracite's angularity, uniformity coefficients, and effective sizes were all within specifications.

Air Scour System. The air scour system option presented several benefits. The existing filter media were within specifications. They wouldn't have to be changed to install the air scour system above the existing filter underdrain and graded gravel support. Thus, the option would result in significant cost savings.

Inspections performed during the filter rebuilds revealed that the underdrains were in excellent condition. There was no structural or performance justification for replacing the underdrain.

Use of separate air and water systems provided the most operational flexibility. Independent systems help guarantee proper performance and distribution, regardless of flow rates and other operational variables.

Aqua-PA selected a modular air scour system constructed of type 304 stainless steel that allows installation without filter media removal or modification of the underdrain. The air scour system was assembled on top of the filter media beds and lowered to the gravel layer during backwash. Following placement, the grids were bolted into place, and final connections to the air supply headers completed the installation.

Because underdrain and filter media replacement weren't required, the rehabilitation project cost approximately 50 percent less than was anticipated for the underdrain replacement option.

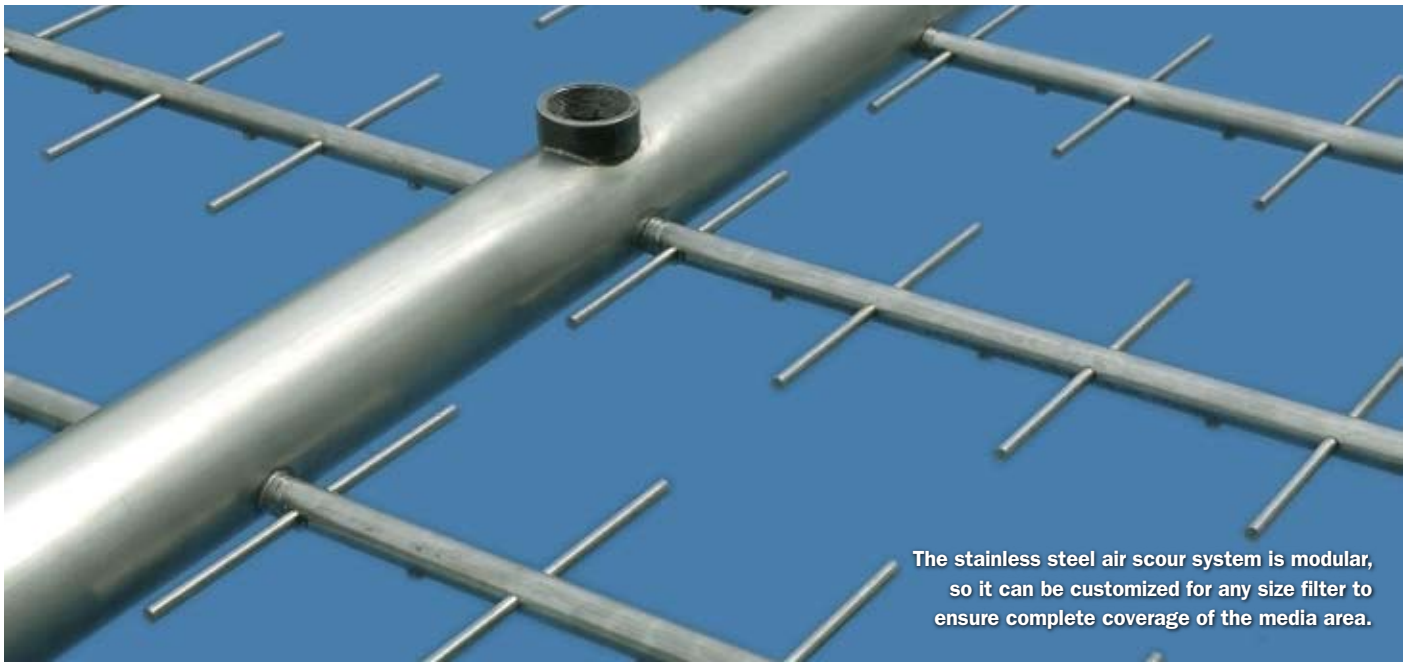
SYSTEM INSTALLATION

The air scour system was installed in all 22 filters in about two months, with final system startup in July 2006. A mechanical contractor installed process piping, the air scour system, and header piping to two new blowers. All the new supply piping from the blowers to the filters was installed before installing the air scour system. The work was completed with virtually no effect on plant operations. The surface wash system was removed and the new air grid system was installed one filter at a time. The work in each filter cell required the filter to be off-line for about 24 hr.

The filter to be rehabilitated was taken off-line and drained when the contractor arrived on the jobsite. The contractor needed about 4 hr to remove the old surface-wash system and install the new air scour system and piping. At that point the filter would be refilled, disinfected, sampled for bacteria analyses, and left out of service overnight. The following morning, the disinfected filter would be returned to service, and the next filter would be drained for rehabilitation.

ENHANCED PERFORMANCE

The filter auxiliary wash system upgrade was completed as part of a larger project to upgrade the plant's pretreatment



The stainless steel air scour system is modular, so it can be customized for any size filter to ensure complete coverage of the media area.

systems. However, the nature of the air scour system allowed it to be installed and operational long before the pretreatment upgrades could be implemented.

Filter inspections by plant personnel to track the effectiveness of the new air scour system and its effect on filter performance revealed almost immediate improvement. Backwash times were reduced from a high rate of about 3–5 min, with a flow rate of 16–20 gpm/ft^2, to 1.5–3 min, and wastewater volume per backwash was reduced from about 35,000 gal to about 27,000 gal.

The air-assisted backwash more effectively removed coagulated particulate matter from the filter media. The number of mudballs in the filters was immediately reduced and continued to diminish as the filters went through additional washes. There was no evidence of new mudball formation, and the filter media surface continues to be clean and even.

The improved efficiency of the filter backwash, along with new pretreatment facilities, has allowed the plant to gradually extend the filter run times, further reducing total backwash volumes at the plant.

Another advantage of the system is that it's 100 percent accessible for inspection and requires no routine maintenance. The plant's inspection procedure only involves evaluating the air distribution pattern. However, the ability of plant personnel to remove and inspect the units in the future, without filter downtime or filter excavation, is a big advantage.

Further filter performance enhancements have been attained through ongoing upgrades of the water treatment plant's pretreatment systems. The sedimentation basins have been reconfigured to improve basin flow and have been upgraded with plate settlers and new sludge collection.

The filters are the final barrier of protection at the treatment plant. With the air scour system maintaining the filter media in its best possible condition and pretreatment system improvements, plant performance has been optimized. Goals can be maintained more easily with considerably less investment of capital and human resources.

SUCCESSFUL PARTNERING

The success of this project can be attributed to partnering. After the air scour option was chosen, Aqua-PA established a project team consisting of representatives from its operation group, the engineering firm, and the filter equipment manufacturer. Design considerations and concerns were identified during plant visits. Plans and specifications were generated and reviewed by all parties. The project was completed without any change orders.

To further control costs, Aqua-PA procured the major pieces of equipment directly from the manufacturer, eliminating contractor markups. This approach also allowed equipment to be preselected and delivered to the jobsite almost immediately after award to the low-bid contractor.

Upgrade of the filter auxiliary wash system at the Pickering West Water Treatment Plant has reduced required filter maintenance, improved filter performance, and optimized the filter backwash procedure. As a result of the success of the air scour system at this plant, the same system is being installed in Aqua's Neshaminy Falls Water Treatment plant and is in design for installation at the company's Crum Creek Water Treatment plant.