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After Backwash

Controlling the Initial Turbidity Spike

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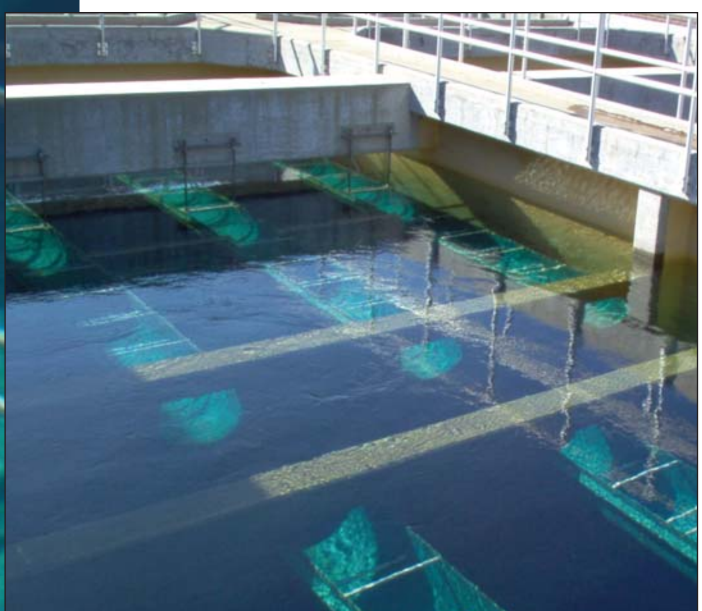
A turbidity peak frequently occurs in filtered water just after a new filter run begins following backwash, but quality improves as the run progresses. When water utilities provided information for the Awwa Research Foundation's *Filter Maintenance and Operations Guidance Manual*, many reported using more than one approach for controlling this initial turbidity spike.



Greenville Water System's Witty Adkins Water Treatment Plant in South Carolina participated in a study on control of a turbidity spike following a filter's return to service after backwash.

At 37 of the filtration plants participating in the AwwaRF study, the initial turbidity spike nearly always was held to 0.3 nephelometric turbidity units (ntu) or lower, a Partnership for Safe Water goal and indicative of good practice. Several utilities actually held the turbidity to an even lower level. Some reported they did not end filter-to-waste until the filtered water turbidity was less than 0.1 ntu. Eight plants reported their filtered water turbidity declined to 0.14 ntu or lower within 10 min, and another five reported reaching this turbidity within 20 min.

Techniques used for controlling initial filtered water quality included

- discharging filtered water to disposal (filter-to-waste),
- holding the filter out of service for a while after backwashing,
- increasing the filtration rate gradually when the filter is returned to service, and
- conditioning the backwash water or influent settled water after backwash with a polymer or with a coagulant chemical.

Some plants used none of the above techniques, and some used more than one (Table 1). Only three plants placed all their reliance on filter-to-waste, while at 15 plants, filter-to-waste was used

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Turbidity (from page 1)

in combination with one or more other methods for lowering turbidity when the filter run began. Nearly all 18 plants using filter-to-waste reported that they monitor filtered water turbidity or particle counts to determine when filter-to-waste should end. Notably, only nine plants used a single approach to controlling the initial spike, whereas 26 plants used various multiple approaches. This article discusses the most common water utility practices used to minimize an initial turbidity spike.

	Nearly always control initial turbidity to 0.3 ntu or less	Not consistently controlling initial turbidity to 0.3 ntu or less
Filtration plants reporting information	37	7
Plants using coagulation	35	4
Plants using lime softening	2	3
Filter-to-waste (FTW) only	3	0
Rest filter (delayed start) + FTW	4	0
FTW + gradual rate increase (gradual start)	3	0
Delayed start + FTW + gradual start	6	0
Chemical in backwash + FTW + gradual start	1	0
Chemical in backwash + delayed start + FTW	1	0
Rest filter (delayed start) only	4	2
Gradual rate increase only	2	1 (with no success)
Delayed start + gradual start	6	1
Chemical in influent water + rest filter	1	0
Chemical in influent water + gradual start	2	0
Chemical in backwash + rest filter	1	0
Chemical in backwash + gradual start	1	0
Plants doing nothing	2	4
Plants using only 1 method	9	2
Plants using combination of 2 methods	18	1
Plants using combination of 3 methods	8	0

Table 1. Techniques to control turbidity in filter effluent at start of filter run.

Filter-to-Waste

Filter-to-waste, sometimes called rewash, entails wasting the first portion of water from a filter run instead of conveying it to the clearwell, thus preventing discharge into the clearwell of initial high-turbidity water produced by the filter. Some plants carry out the filter-to-waste procedure for a fixed period of time, but this practice isn't recommended because it might not meet the goal of filter-to-waste.

The goal is to attain satisfactory filtered water quality — not to end the filter-to-waste process according to a set time period. The length of time for filter-to-waste is site-specific and may vary with source water quality or pretreatment. One way to manage filter-to-waste is to monitor the filtered water turbidity and waste filtered water until the turbidity meets a specific goal, at which time the filtered water is discharged into the clearwell. Another option for determining when to terminate filter-to-waste is particle counting.

At some filtration plants, the filter-to-waste piping may be inadequate for carrying away the wasted filtrate when the filter is operated at the full filtration rate. If piping is undersized and cannot carry the full flow from a filter, the filter must be operated at a reduced rate during filter-to-waste. If the rate increase after filter-to-waste

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Peak Turbidity During Starts		
	Without added alum	With added alum
Number of starts	28	29
Smallest peak	0.07 ntu	0.07 ntu
Lower quartile	0.145 ntu	0.09 ntu
Median	0.195 ntu	0.11 ntu
Upper quartile	0.27 ntu	0.14 ntu
Largest peak	0.64 ntu	0.32 ntu

Table 2. Comparisons of turbidity peaks during filter starts with and without added alum.

is abrupt or large, it could cause a turbidity spike. Renovation with piping large enough to handle filter-to-waste water at its design flow is worth considering, because a plant upgrade can eliminate the need for raising the filtration rate when filter-to-waste ends.

A brief deterioration of filtered water quality may occur at the end of filter-to-waste, even if filter-to-waste was conducted at the full filtration rate, because of the change from wasting filtered water to directing the filtered water to the clearwell. A well-designed system should ensure a smooth transition between the filter outlet valve opening and the filter-to-waste valve closing, without a rate change for water coming from the filter, minimizing flow-change shocks on the filter.

Delayed Start

Some plants allow filter media to "settle in" for a fixed time after backwashing, from 15 min to 48 hr, to help minimize the initial turbidity spike when the filter is started. In this strategy, settled water is introduced to the filter box after backwashing is completed and the filter is held off-line for a set time (or until another filter is removed from service for backwash) before filtration begins.

A delayed start may improve initial filtered water quality by allowing the filter media to consolidate slightly after backwashing, tightening the pore structure. Also during the delay, floc particles that were not washed out of the filter box during backwash would have the opportunity to settle to the top of the filter media, and floc that wasn't removed from the expanded filter bed during backwash (backwash remnants) could attach to the filter media.

Thames Water Utilities in Reading, UK, studied resting rapid gravity filters for the AwwaRF project. Filters with delayed starts ranging from 46 min to 144 min produced lower turbidity than a filter with no delay on startup (Figure 1 on page 6). Delays of 95 min and 144 min yielded better results than a 46-min delay. Particle counts for the filter with the 144-min delay were lower than counts for the filter with no delay, particularly during the first half-hour of filter operation (Figure 2 on page 6).

Delaying the start does not require special equipment or filter-to-waste piping. But, the procedure is applicable only when plants have sufficient filtration capacity so all filters do not need to be in service at the same time. In plants where all filters must be in service during maximum water production, it may be impractical to delay the start much longer than a half hour.

Nor can filters be rested for an unlimited length of time, even at plants with excess capacity where the practice of keeping backwashed filters on standby for future service might be common, because microbiological problems can develop if filters that are out of service for an excessive time period are returned to service without another round of backwashing. When a filter has been out of service too long, backwashing the filter before returning it to service is the surest way to avoid water quality problems that can be associated with chlorine depletion and bacterial growth. At plants where free chlorine is added before filtration, a rested filter can be tested for a free chlorine residual; an absence of residual would indicate the need to backwash before the filter's return to service.

Slow Start

At some filtration plants, the initial turbidity spike is managed by starting the filter at a low filtration rate and gradually increasing the rate over a period of time, such as 15 to 30 min. Using multiple rate increases, but limiting the magnitude of each rate change, decreases the "shock" on particles remaining in the filter bed after backwash. For this procedure, the filters must have rate-control valves that can be increased gradually. This approach would not be applicable at declining-rate filtration plants unless the filters are equipped with rate-control valves that can be used at the beginning of the filter run to limit the filtration rate.

Using the slow start approach for limiting turbidity spikes at the start of a filter run may not be effective if a plant has old rate-control valves that cannot be opened slowly, in multiple steps, rather than all at once from closed to fully open.

Coagulant or Polymer in Backwash Water

Adding coagulant chemical or polymer to backwash water during filter backwash has been practiced for about three decades (Contra Costa County Water District in California was doing this to improve turbidity removal in the early 1970s). The coagulant or polymer may help condition both the suspended solids that are not washed out of the filter media during backwash and the suspended solids that remain in the water above the filter media before backwash completion.

Timing of the chemical addition to

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Turbidity (from page 5)

backwash water is important. At the end of a filter backwash, unused backwash water with low turbidity remains in the filter underdrain, under the media.

If the dosing of coagulant chemical or polymer is not stopped for a short interval before the end of backwashing, some chemically conditioned backwash water will remain in the piping and underdrain cavity. At the start of the next filter run, a small volume of finished water containing polymer or coagulant will be discharged to the clearwell as finished water. This is not desirable because coagulants and polymers are supposed to be removed with particulate matter in clarification and filtration, and not pass into the finished water.

How long the coagulant or polymer feed should be stopped before the end of backwash depends on the backwash water flow rate and the water volume that the piping and underdrain hold. This can be calculated from filter construction plans and backwash flow rate data.

Water filtration plants that successfully minimize the initial turbidity spike after backwash typically use multiple approaches to help control turbidity at the start of a filter run. Four techniques were described in this article; one more will be presented next month.

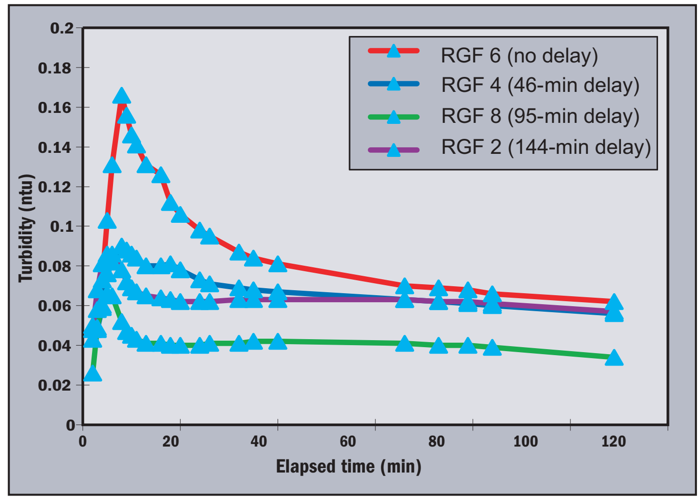

Figure 1. Delayed Start Trial 1: Turbidity Data
(RGF is rapid gravity filter)

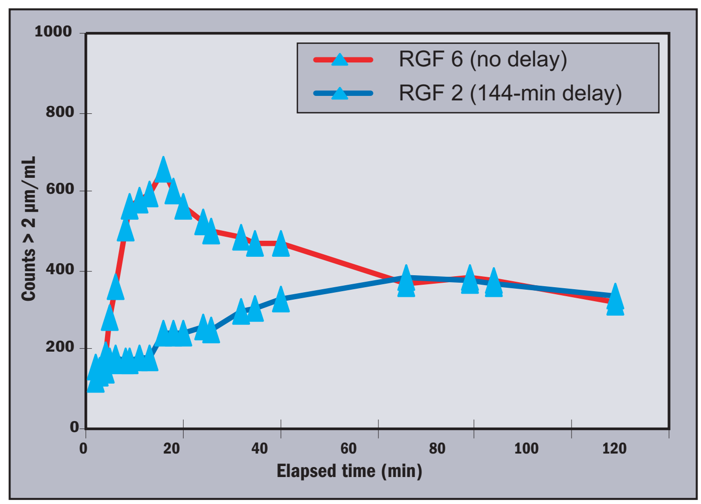

Figure 2. Delayed Start Trial 1: Particle Count Data
(RGF is rapid gravity filter)

This is the first of a two-part series on minimizing the initial turbidity spike after filter backwash. Information from water utilities was initially obtained for the Awwa Research Foundation's Filter Maintenance and Operations Guidance Manual *and supplemented by testing at a Thames Water Utilities filtration plant. Part 2, which will be published in the November* Opflow, *will focus on adding coagulant chemical or cationic polymer to the settled water as it fills the filter box after backwash is terminated.*

Acknowledgments

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