Optimizing Backwash and Filter to Waste for Rapid Rate Filtration

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Backwashing a rapid-rate filter.

Filter backwash is integral to the operation of a rapid rate filter. Properly operated backwash processes can significantly reduce the risk of disease-causing organisms (pathogens) passing through the filter and entering the distribution system.

During normal operations, a clean filter accumulates, and stores contaminants captured from the water as particles stick to the surface of filter grains or previously deposited material.

As this process continues, the open spaces between the grains of the filter gradually fill in and resistance to flow increases. Resistance is measured as filter headloss. Unless backwashed, filters eventually reach terminal headloss and filter breakthrough occurs—releasing turbidity and other contaminants into the water distribution system.

Backwashing cleans filters, removing accumulated contaminants and preparing the filter media physically and chemically to begin filtering again. To avoid unnecessary health risk to your customers, you should always backwash before breakthrough occurs.

Efficient backwashing removes captured particles from the filter without losing the anthracite or sand media. In actual practice, it is normal to lose up to an inch of media per year during backwashing. If backwash rates are too high, significantly more media could be lost—compromising filter performance. In any case, it is important to measure, track, and replace any missing media during your annual filter inspection and maintenance check.

Backwashing is most effective when there is adequate expansion of the filter bed. To achieve this, water must flow upward at a sufficient rate to fluidize the media bed, increasing the space between the media grains and causing the media to "expand" or occupy more volume. At this point, the filter bed is said to be fluidized. Fluidization promotes collisions of the media grains, which scours away surface deposits.

If backwashing doesn't adequately clean the filter, successive filter runs may result in a build-up of dirt and coagulant deposits, leading to problems such as mud-ball formation and cracks or fissures in the media, especially along the walls of the filter. Filter cracking promotes short-circuiting through the filter and reduces the effectiveness of the filtration barrier.

Backwashing depends on achieving a balance in factors: what works at one facility or in one season may not be ideal for another. Keeping the following guidelines in mind, you can optimize your standard backwashing procedure to produce the safest water for your community.

Guidelines for Filter Backwashing

Bed expansion. In standard practice, the optimal backwash flow rate will result in at least a 20 percent expansion of the filter bed. For example, if your filter has 30 inches of combined anthracite and sand media, the expanded depth of the media should be at least 36 inches. Less expansion may not adequately clean the filter, while more expansion may cause excessive loss in media. For information on an effective low-cost tool you can make to monitor bed expansion visit the Pennsylvania Department of Environmental Protection.

Determining optimal backwash flow rate. Backwash flow rate and water viscosity are the key factors effecting filter bed expansion. For a given flow rate, colder water results in greater filter-bed expansion because it is more viscous than warmer water. Because water viscosity varies significantly within the normal range of seasonal temperatures encountered at many water treatment plants, you should adjust backwash flow rates as temperatures change throughout the year to ensure correct bed expansion.

When temperatures go up, backwash flow rates need to go up, too. And, when temperatures go down, flow rates need to go down.

Auxiliary scouring. Air scour and hydraulic surface washers significantly improve backwashing performance. If you have problems with mud-ball formation, these tools offer a good potential solution. Contact our regional office for more information.

When is the filter clean enough? *Over-washing*, which results from backwashing for an extended period, actually increases the time the filter needs to ripen when returning to service. One way to determine when to terminate backwashing is to look at the turbidity of the waste wash-water. In general, 10 NTU (nephelometric turbidity units) is an accepted value for terminating backwashing. This turbidity level has been shown to adequately “seed” the filter, allowing it to ripen faster.

Filtering to Waste

Assuming coagulation is well-regulated, and flow rates controlled, filtered water quality will generally be at greatest risk at two points during a typical run. Turbidity breakthrough might occur in an unattended filter near the end of a long run. Excess turbidity might also occur immediately after a filter is backwashed, with the start of a new filter run. Properly operated filter-to-waste processes can significantly reduce the risk that pathogens will enter the distribution system.

To eliminate the post-backwash turbidity spike, run filtered water to waste until the turbidity drops below 0.1 NTU. This may take ten to fifteen minutes, under normal conditions. Filter-to-waste should be used after each filter backwash and, in some cases may be used before “cold” filter start-ups to prevent any initially produced, poorer quality water from reaching customers.

Filter-to-waste capability is required for all new surface water filtration plants. If you do not have filter-to-waste capability, consider installing it.

Please keep in mind that the more turbid the water is, the greater the risk that pathogens may be present. A filter-to-waste process diverts these pathogens from your system and helps protect your customers.

Guidelines for Filtering-to-Waste

Watch turbidity, not time. Following a backwash, send filtered water to waste until the turbidity is 0.1 NTU or less. Electronic particle counters may also provide important information about the water quality produced by the filters.

Mind the backflow. To prevent dirty water from entering the finished water pipe, ensure there's a proper air gap at the filter-to-waste line discharge.

Treat your filters with care. You can use many strategies to reduce the size of the filter start-up spike and the amount of time needed for the filtered water to drop below 0.1 NTU. The following approaches apply to all rapid rate facilities, but may be especially helpful if your plant is not equipped with or has undersized or marginal filter-to-waste piping and valves.

- Filter Resting—After backwash allow filters to rest or "settle in" for at least 15 minutes before filtering to waste and returning them to service.
- Slow Startup—Manage the initial turbidity spike by starting at a lower flow rate and gradually increasing the filtration rate over time.
- Feed a small dose of filter aid polymer, such as starch or polyacrylamide, to the filter inlet header.

With these tools in mind, you can modify your filter-to-waste standard operating procedure to produce the safest water possible for your community.

For More Information

Logsdon, G.S., Hess, A.F., Chipps, M.J., A.J., and Rachwal, A.J. 2002. *Filter Maintenance and Operation Guidance Manual*, Water Research Foundation, Denver, CO.

ODW Contact Information

Find more resources on our Publications and Forms webpage.

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