MN DEPARTMENT OF HEALTH

# Surface Water Filtration – Pressure Media Filters

NONCOMMUNITY PUBLIC WATER SUPPLY PROGRAM

## Purpose of Media Filters

Pressurized media filters typically serve as initial pre-filtration near the beginning of the treatment plant. They are useful for removing larger particulates from the water source and extending the operational lifespan of the final filters downstream.

## Types of Media Filters

All pressure media filters consist of a pressurized filter vessel (usually fiberglass) filled with a granular media. Water passes through this media and particles in the water both stick to the media granules and are strained out by the media. After a period of time, the media can no longer hold more particles and the filter is backwashed, removing the particles, and regenerating the media's ability to filter the water.

Different types of filter media may be used depending on the desired filter characteristics. Silica sand is typical. Additional layers of anthracite or garnet sand may be added for increased filtration efficiency. Proprietary filter media may offer enhanced filtration ability or higher flow rates.

Other types of treatment devices such as softeners and anion exchange units rely on reactions between chemicals in the water and a specialized reactive media to remove dissolved contaminants. However, these fall outside of the needs of most surface water treatment processes and are not covered here.

## Design of Media Filters

There are several design elements common to most pressure media filters. The filter media is supported by several other layers of media and gravel. The densest media is generally the bottommost layer, followed by the next most dense media and so on. The base layers of most media filters are gravel arranged with the largest diameter gravel towards the bottom. The gravel prevents finer filter media from entering the plumbing system and helps distribute flow evenly across the filter during backwash. Most filters are also equipped with a distributor, a special plumbing manifold or end-piece that collects filtered water and distributes backwash water evenly across the filter. Finally, the upper portion of pressure media filters is left empty. This area, called freeboard, should be deep enough to allow for the media bed to expand when it is backwashed without the media overflowing into the plumbing system. Figure 1 shows a cutaway view of a typical sand filter.

## Operation and Maintenance of Media Filters

As media filters operate, their ability to filter particles effectively changes. This is because the primary mechanism for filtration is adsorption; particles in the water stick to filter media, which subsequently becomes "stickier" and more effective at filtering, until eventually the media can no longer hold more particles. The point at which the filter begins to allow the free passage of particles is known as breakthrough. Figure 2 shows a graph of these phases of filter operation, beginning after a backwash and extending until breakthrough. Effectively operating a media filter in practice involves regularly backwashing the filter before it reaches breakthrough and instituting a filter-to-waste period after backwashing to avoid the initial period of poor filtration.

In order to backwash a media filter effectively, the media bed needs to fluidize and expand by 50% of its settled volume. For instance, a filter with a media depth of 30 inches should expand to 45 inches during backwash. This expansion is most easily monitored if the filter vessel is constructed of a transparent material such as fiberglass. Shining a light behind the vessel allows the depth of the media to be seen during normal operation and during backwash. The flow rate of backwash can then be adjusted to achieve the desired media bed expansion.

The most effective filtration will be achieved by maximizing the total surface area of the media filters.

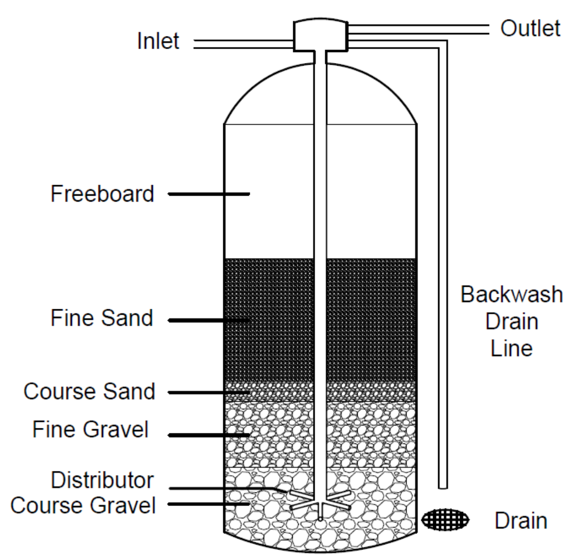
For sand filters, the flux rate (flow rate per surface area of the filter) should not exceed 3 gallons per minute (gpm) per square foot ($ft^2$) of media. For instance, four filters with one square foot of surface area each would be needed if the desired flow rate is twelve gallons per minute.

$$\frac{12\ \text{gpm}}{4\ \text{ft}^2} = 3\ \text{gpm}/\text{ft}^2$$

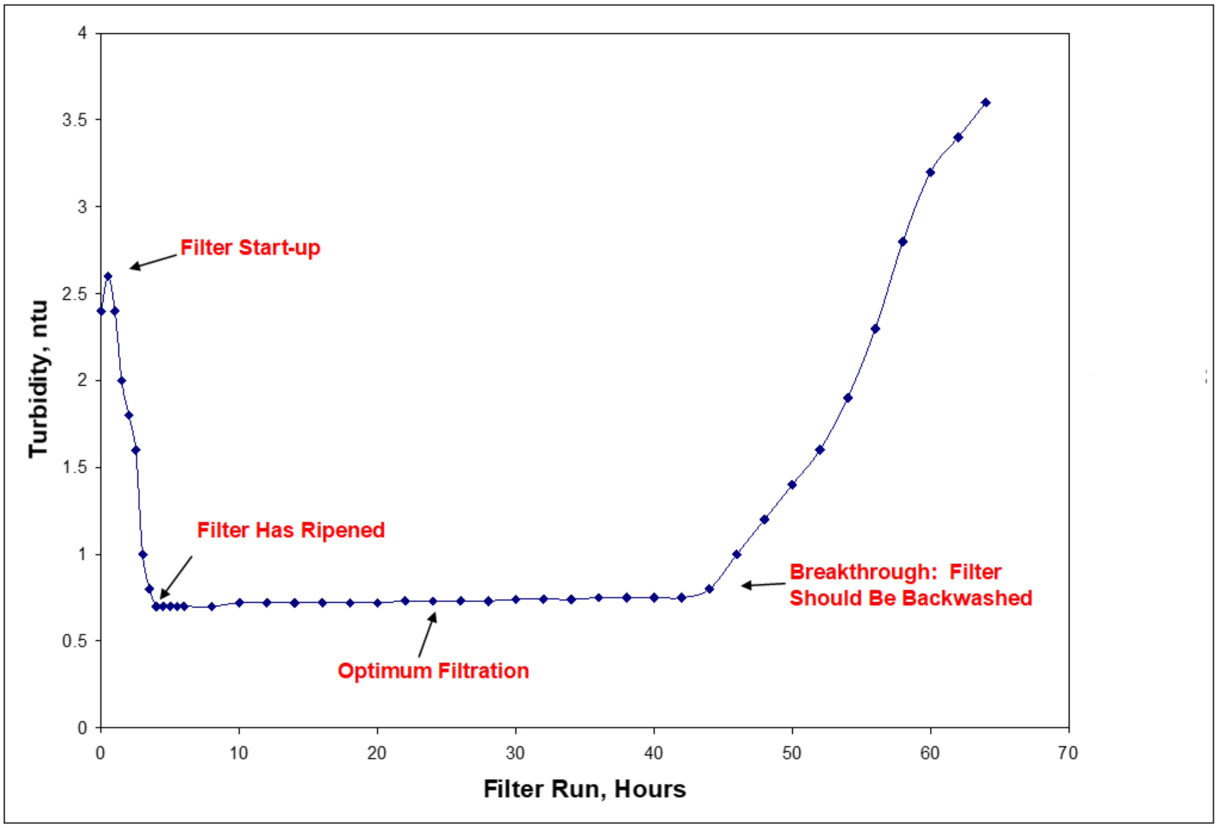
The allowable flux rate may be different for proprietary or synthetic medias.

Long-term operation at high flow rates or failure to effectively backwash media filters results in decreased filter efficiency. Improperly backwashed media will exhibit hardening and clumping. The condition of the media can be checked by unscrewing the top of the filter vessel and visually inspecting the media. It should not look cracked, hardened, clumped, slimy, or full of mud-balls. When scooped, it should be clean and granular. If the media is in poor condition, it can be replaced without replacing the entire filter vessel. Properly operated filter media can last many years.

## Figure 1: Cutaway View of a Pressure Media Filter



## Figure 2: Media Filter Performance Over Time

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