DEPARTMENT OF HEALTH

Surface Water Filtration – Membrane Filters

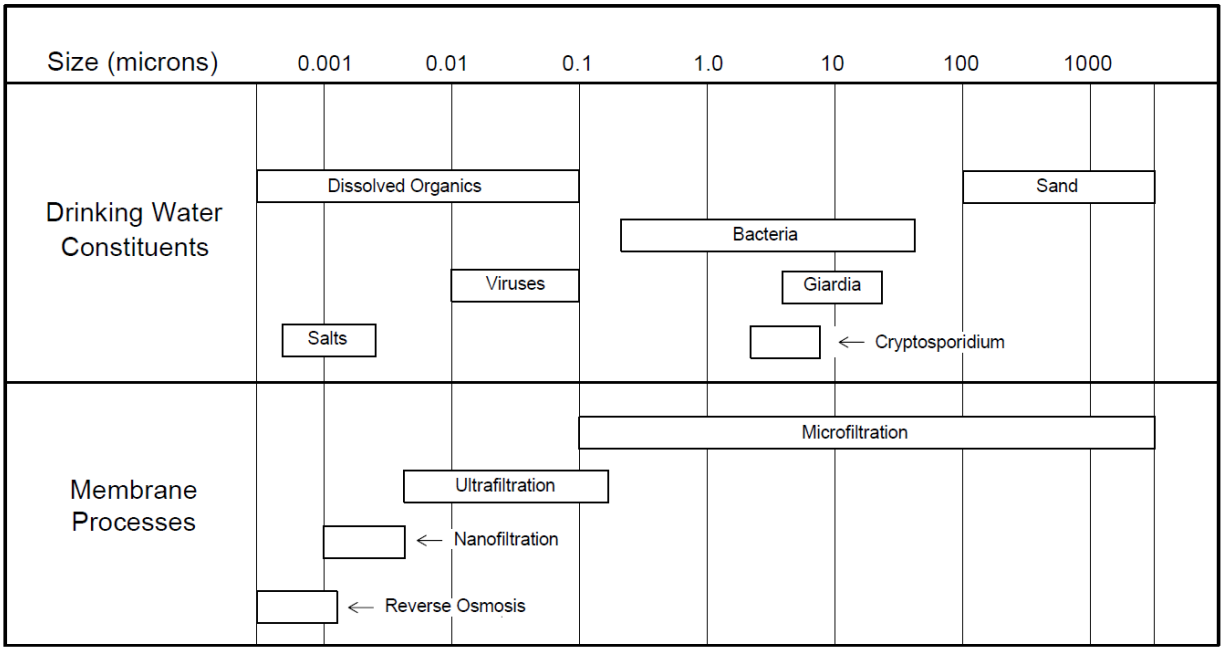
NONCOMMUNITY PUBLIC WATER SUPPLY PROGRAM

What are Membrane Filters?

Membranes are highly efficient filtration devices made from specially fabricated semi-permeable material. Water is driven across the membrane and particles are retained on the inlet side of the membrane. Over time, the membrane surface fouls and is cleaned, usually by backwashing, replenishing the filter surface and eliminating the need for frequent filter replacement encountered when using bag and cartridge filters. A properly designed and operated membrane filtration system can last many years.

Membranes are divided into several classes based on the size of the pores in the membrane material. The smaller the pores, the smaller the particles the filter is able to remove. Pore sizes are often reported in micrometers (µm), also referred to as microns. Membranes generally have pore sizes well below one micron, making them especially effective filters. Indeed, the water produced by membrane filters is usually significantly lower in turbidity and particulate content than water produced by bag and cartridge filtration. Figure 1 details the classification of membranes based on pore size. For surface water treatment applications, ultrafiltration (UF) is the most common type of membrane filter.

Figure 1: Classification of Membranes by Pore Size



Design of Membrane Filtration Systems

Membrane filtration systems require careful design in order to operate effectively in the long-term. Design should focus on minimizing fouling, a phenomenon where particles, microbes, and

organic content build up on the influent side of the membrane surface, making it harder to push water through the membrane and reducing filter flow rates. Proper design of membrane backwashing capabilities is key to ensuring that fouling is removed regularly.

In addition to ensuring that sufficient backwashing capabilities are in place, minimizing fouling can be accomplished through three primary design elements:

- Installing adequate pre-treatment ahead of the membranes,
- Increasing the amount of membrane surface area, and
- Installing chemically enhanced backwash or air-scour capabilities.

A well-designed membrane system does not necessarily need all three of these elements. For instance, if the source water quality is relatively low in particulate and organic content, having a large membrane surface area for the given flow rate along with regular backwashing may be sufficient without additional chemical cleaning, air-scouring, or robust pre-treatment. Conversely, if robust pre-treatment is in place along with a regular, automated chemical cleaning system, total membrane surface area can be reduced. To inform which of the design elements may be needed, a thorough review of any existing water treatment should accompany source water sampling prior to designing a membrane system.

Operation and Maintenance of Membrane Systems

Due to their reliance on regular cleaning cycles, membrane filtration systems usually have automated valves and a control panel. This automation allows the operator to set various parameters such as flow rate and backwash frequency and duration, as well as initiate events such as a chemical clean, an integrity test, or taking a unit offline. The operator should ensure that they have a thorough understanding of the control system and when and how to use each of its functions.

Managing fouling is the most important aspect of operating a membrane system. Fouling will be evident when the flow rate across the membrane decreases and/or when the pressure difference between inlet and outlet side of the membrane increases. As such, it is imperative that each individual membrane be equipped with its own pressure gauges and flow meters, and that these parameters be monitored at least daily. Backwashing and chemical cleaning should be scheduled to prevent fouling from becoming irreversible. Ideally the flow rate and pressures are fully restored after backwashing and/or chemical cleaning.

In the event that flow rate and pressure are not fully restored after a backwash cycle, a membrane may need to be taken offline to be chemically cleaned. Except in extreme cases, a chemical clean is generally sufficient to remove most fouling. Chemical cleaning involves the use of harsh and potentially dangerous chemicals, and the operator should consult with MDH or the membrane manufacturer before attempting a chemical clean process.

Membranes are fragile and should always be handled with care if they need to be moved. A physical shock to a membrane module, such as by dropping it, can damage the fibers and compromise the filter integrity. Such damage will not be visible on the outside of the unit and will only be detected by poor filtration performance or by failure of an integrity test. An

integrity test is a procedure during which the membrane fibers are pressurized with air. If intact, the membrane fibers should maintain air pressure. If some of the fibers are damaged, they may be able to be repaired, or the membrane module may need to be replaced. Some membrane systems have automated integrity testing built-in, while other systems require a manual test, which will be conducted annually by MDH.

Membranes may also be damaged by freezing or by drying up. If possible, membranes should be kept in place in the treatment system in a heated building and full of water. If the membranes need to be moved over the winter, they should remain wetted and stored in a heated area. All plumbing connections should be capped to prevent the membrane from drying. When the membranes are placed back online, the operator should ensure that they are functioning normally and producing high quality water.

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