America's Authority in Membrane Treatment

AMTA

American Membrane Technology Association

Improving America's Waters Through Membrane Treatment and Desalting

Membrane Filtration (MF/UF)

Water utilities nationwide are turning to advanced filtration to meet more stringent federal drinking water regulations in order to remove turbidity, precursors, and disinfectant tolerant micro-organisms from both groundwater and surface water supplies.

Low pressure microfiltration (MF) and ultrafiltration (UF) membrane filtration technology have emerged as viable options for addressing the current and future drinking water regulations related to the treatment of surface water, groundwater under the influence, and water reuse applications for microbial and turbidity removal. Full-scale facilities have demonstrated the efficient performance of both MF and UF as feasible treatment alternatives to conventional granular media processes. Both MF and UF have been shown to exceed the removal efficiencies identified in the Surface Water Treatment Rule and related rules, such as *Cryptosporidium oocyst*, *Giardia cyst*, and turbidity.

MF and UF membrane systems generally use hollow fibers that can be operated in the outside-in or inside-out direction of flow. Pressure (5 to 35 psi) or vacuum (-3 to -12 psi for outside-in membranes only) can be used as the driving force across the membrane. Typical flux (rate of finished water permeate per unit membrane surface area) at 20 degrees C for MF and UF ranges between 50 and 100 gallons per square foot per day (gfd).

Since both processes have relatively small membrane pore sizes, membrane fouling, caused by the deposition of

organic and inorganic compounds on the membrane, may occur at unacceptable levels if the system is not properly selected, designed, and operated. Automated periodic backwashing and chemical washing processes are used to maintain the rate of membrane fouling within acceptable limits. Chemical cleaning is employed once a maximum transmembrane pressure differential has been reached. Some systems utilize air/liquid backwash. Typical cleaning agents utilized include acids, caustic, surfactants, enzymes, and certain oxidants, depending upon membrane material and foulants encountered. Chemicals used for cleaning, and the method used in the cleaning process, must be acceptable to the membrane manufacturer.

Overall treatment requirements and disinfection credits must be discussed with and approved by the reviewing authority. Disinfection is recommended after membrane filtration as a secondary pathogen control barrier and distribution system protection.

MF and UF membranes are most commonly made from various organic polymers such as different cellulose derivatives, polysulfones, polypropylene, and polyvinylidene fluoride (PVDF). Physical configurations include hollow fiber, spiral wound, cartridge, and tubular. MF membranes are capable of removing particles with sizes down to 0.1- 0.2 microns. Some UF processes have a lower cutoff rating of 0.005-0.01 microns. Pressure or vacuum may be used as the driving force to transport water across the membrane surface.

Membrane filtration is also becoming popular for conventional plant retrofits, replacing sand media, for enhanced water quality and capacity increase.

When Selecting MF/UF Systems, the Following Should be Considered:

1. A review of historical source raw water quality and variability data, including turbidity, algae, particle counts, seasonal changes, organic contents, microbial activity, and temperature as well as other inorganic and physical parameters is critical to determine the overall cost of the system. The degree of pretreatment, if any, should also be ascertained. Design considerations and membrane selection at this phase must also address the issue of target removal efficiencies and system recovery versus acceptable membrane fouling rate. At a minimum on surface water supplies, pre-screening is required.
2. The life expectancy of a particular membrane under consideration should be evaluated (typically 7-10 years). Membrane replacement frequency is a significant factor in operation and maintenance cost comparisons in the selection of the process. Warranties offered by manufacturers vary significantly and should be considered closely.
3. Some membrane materials are incompatible with certain oxidants such as chlorine. If the system must rely on pretreatment oxidants for other purposes, for example, zebra mussel control, taste and odor control, or iron and manganese oxidation, the selection of the membrane material becomes a significant design consideration.
4. The source water temperature can significantly impact the flux of the membrane under consideration. At low water temperatures, the flux can be reduced appreciably (due to higher water viscosity and resistance of membrane to permeate), possibly impacting process economics by the number of membrane units required for a full-scale facility. System capacity must be selected for the expected demand under seasonal (cold and warm water temperature) conditions.
5. Backwashing waste volumes can range from 4 to 15 percent of the permeate flow, depending upon the source water quality, membrane flux, frequency of backwashing, and the type of potential fouling.
6. Membrane systems used for drinking water production should be provided with an appropriate level of finished water monitoring and a direct integrity test feature. Monitoring options may include laser turbidimeters, particle counters, and manual and/or automated integrity testing using pressure decay or air diffusion tests. The USEPA has recently published a membrane filteration guidance manual (EPA 815-R-06-009).
7. Cross-connection control considerations must be incorporated into the system design, particularly with regard to the introduction and discharge of chemicals and waste piping. Membrane systems that use chemical washing processes with harsh chemicals require additional consideration.
8. Redundancy of critical components and control features should be considered in the final design.
9. Other post-membrane treatment requirements such as corrosion control and secondary disinfection must be evaluated in the final design.
10. Other contaminants of concern such as color and disinfection by-product precursors should also be addressed.
11. Prior to initiating the design of an MF or UF treatment facility, the state reviewing authority should be contacted to determine the disinfection credits available for the membrane process, and whether a pilot plant study will be required. In most cases a pilot plant study will be necessary to determine the best membrane to use, particulate/organism removal efficiencies, cold and warm water flux, the need for pretreatment, fouling potential, operating and transmembrane pressure, and other design considerations. The state reviewing authority should be contacted prior to conducting the pilot study to establish the protocol to be followed.

This material has been prepared as an educational tool by the American Membrane Technology Association (AMTA). It is designed for dissemination to the public to further the understanding of the contribution that membrane water treatment technologies can make toward improving the quality of water supplies in the US and throughout the world.

For more information, please contact:

American Membrane Technology Association (AMTA)
2409 SE Dixie Highway
Stuart, Florida 34996
Phone: (772) 463-0820
Fax: (772) 463-0860
Email: admin@amtaorg.com

or visit our website at:
www.amtaorg.com