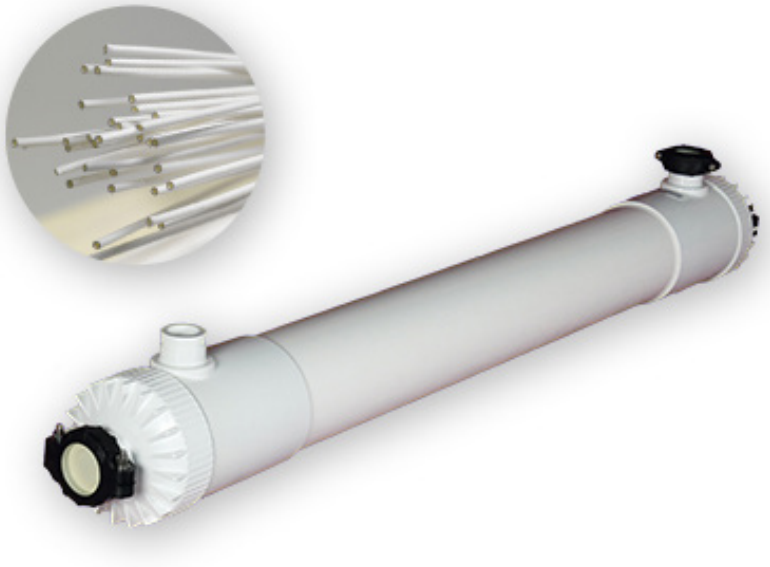
How UF Membrane Fiber Strength Impacts Reuse Success

Advanced technology and more widespread acceptance are driving a growing number of municipalities across the country to adopt the practice of wastewater reuse.



Wastewater treatment is demanding under normal circumstances, but even more so for reuse, which often requires linking multiple high-tech systems to accomplish the necessary purification. Ultrafiltration (UF) has been proven a key technology in this process.

Within UF, the strength of hollow-fiber membranes is critical to both optimal performance and the lowest possible long-term operations and maintenance costs. Municipalities using older, less durable membranes are likely experiencing breakage issues as well as other problems such as increased water turbidity. Significant breakdown of those fibers can also impede the ability of water systems to meet requirements for log removal credits, which signify that standards for removal of biological contamination have been met.

Many reuse plants were launched more than a decade ago, when UF technology was much less sophisticated, leaving current operators struggling to keep up with repairs or having to replace their hollow-fiber membranes. Recent advancements in manufacturing have produced more durable membranes that accomplish the task at a lower cost based on the total lifecycle.

Behind The Technology

The organic fouling in wastewater is typically worse than other water feed sources, such as rivers or surface water, and one of the best cleaners in that situation is sodium hypochlorite. The downside is that a chemical such as this can damage the hollow-fiber membrane fibers, which can be labor-intensive to repair or costly to replace. Air scouring, the process in which the system constantly shakes the membranes to rid them of organic foulants collected on the exterior, also takes its toll. A system that initiates air scouring every 30 minutes translates into hundreds of thousands of cycles of bending over the course of a decade.

Fibers produced using advanced materials and manufacturing processes are more resistant to chemicals and demonstrate superior bending and tensile strength. Toray, for example, took this approach when it was looking to field a membrane that would last a decade or more.

For its material, Toray selected PVDF — short for polyvinylidene fluoride, a specialty plastic — because of its chemical resistance. That's especially important in wastewater, where there is likely to be chlorine residual. Toray then runs the PVDF through a spinning process, based on

thermally induced phase separation, that results in one of the most durable tensile strengths in the industry. The spinning method controls the even distribution and size of the pores, which helps increase fouling resistance.

While this is the costliest approach, as more of the PVDF material ends up deposited in the finished product, the resulting hollow-fiber membranes will perform longer and more optimally under wastewater conditions.

Additionally, the outside-in flow direction permits higher flux for extended periods, which is better for dirtier water conditions because it keeps foulants on the outside where they are more easily released during air scouring and backwash. An inside-out flow fiber is less expensive, but more suited for cleaner source water applications.

Building The Business Case

Municipalities may find themselves in a difficult position — especially in low-bid situations — when trying to quantify the advantages of purchasing a membrane containing a more expensive and higher-quality fiber. However, it's critical for wastewater plant operators and consulting engineers to conduct a thorough analysis of capital and operating costs for new or replacement hollow-fiber membranes.

Newer, stronger fiber membranes with a 10-year warranty are lasting so long that the capital expenditure over time becomes relatively low. For example, the operator of a UF system designed for a 20-year life span will only need to purchase the higher-quality membranes twice: once at the start of the project and once as a replacement. Lower-quality budget membranes can cost approximately 30 percent less, but may only last four to seven years. Additionally, operational expenses for labor for constant repairs as those less-expensive membranes age can wipe out any savings. By comparison, membranes with superior fiber quality tend to come with a warranty that covers a certain number of breakages.

It's important that consulting engineers account for historical data when prequalifying hollow-fiber UF membranes. Consulting engineers can protect those municipalities to ensure only advanced fibers are specified and prequalified for new projects or replacements. ■