



Ben's Design Tip Corner

By: Ben Movahed, PE, BCEE

If you have a tip or a suggestion for a future design article, please contact Ben Movahed.
(240) 780-7676
movahed@watek.com

Effective Recycling and Reuse Options for Membrane Plants

Water quality and quantity challenges combined with population increases, uncontrolled urbanization, aging infrastructure, and climate change have highlighted the critical role of water reuse in developing an effective and sustainable water management portfolio. Waste reduction, reuse, and recycle opportunities at membrane facilities can add significant value in overall plant operation and address regional water scarcity.

The primary discharge from high pressure membrane system (NF and RO) is the concentrate, while the residual of low pressure membrane (MF and UF) plants is primarily the volume of backwash water.

Membrane bioreactor (MBR) systems are used for direct wastewater treatment and are capable of achieving very high quality effluents. As a result, the entire plant could be considered a "Reuse/Recycle" facility. Since most MBR plants utilize high Return Activated Sludge (RAS) rates, there is minimal liquid waste, except the Waste Activated Sludge (WAS), which is handled in sludge processing facilities.

In almost all membrane plants, the second type of waste results from cleaning the membranes, referred to as Clean-In-Place (CIP) waste. The CIP solution is usually pH neutralized and disposed into the sanitary sewer, regardless of which membrane technology is used. Due to the low volume and high concentration of CIP chemicals and potential membrane foulant contaminants, there is typically no incentive to recycle this stream. In many MBR plants, the CIP is performed in the process tanks and the biological process consumes the chemicals. Some MBR plants send the CIP waste to sludge handling.

Backwash water from MF/UF plants primarily consists of the naturally occurring feed water solids retained by the membranes. It may also contain coagulants, oxidants, adsorbents, and any other chemicals used for pretreatment. The volume of waste depends on the system recovery which is dictated by the feed water characteristics and system design. Typical backwash waste volume for municipal applications varies from 4 to 12% of the filtrate water produced. This could be a significant volume for large systems and therefore, a good candidate for recycle, reuse or at least responsible discharge back to the surface waters. The majority of membrane filtration plants discharge backwash to either surface waters or sanitary sewers. Before discharging to surface waters, backwash waste is typically processed for turbidity removal through settling ponds, decant systems, plate settlers, or other solids removal mechanism. A recent survey of MF/UF plants in the U.S. showed that approximately 50% discharge to sewers and 40% to surface water. As low pressure membrane systems become larger and larger, a subsequent increase in surface water discharge is anticipated. The National Pollutant Discharge Elimination System (NPDES) sets the minimum treatment standards for surface water dischargers and establishes the framework for setting additional discharge standards under Section 402 of the Clean Water Act. These regulations are typically enforced by all states and compliance is mandatory.

Some MF/UF plants utilize a secondary membrane system to concentrate the backwash from the primary treatment system and return the filtrate of the

secondary system to either the headworks or to a finished water tank. It is critical to evaluate the risk of re-introducing increased concentrations of pathogenic contaminants such as *Cryptosporidium* and *Giardia* to the drinking water supplies. USEPA Long Term Enhanced Surface Water treatment and Filter Backwash Rule also require self-assessment concerning the impacts of recycling the recovered waste streams.

Recycle and reuse of NF/RO concentrate is much more complex. It is highly dependent on the feed water chemistry and recovery of the system. For example, if the RO/NF plant recovery is 82%, essentially all dissolved substances in the feed water will have a concentration of approximately 5.5 times the feed water concentrations. In many cases, this high concentration cannot be discharged to surface water supplies, except ocean or tidal waters. Many brackish water RO plants send their concentrate to the ocean or impaired tidal waters with minimum treatment. Sometimes just adding dissolved oxygen to the concentrate is all it takes to prove that we are actually "improving" the impaired waters. In addition, reuse/recycle at NF/RO plants could be limited by the potential contaminants, which may be present in the source water, such as: Nitrate, Arsenic, Fluoride, Radionuclides, and other contaminants of concern.

In summary, there are a number of effective methods to reduce/recover/reuse liquid waste from all types of membrane facilities. These opportunities should be carefully evaluated for their benefit, cost, and environmental impact and discussed with regional regulatory agencies, especially when the plant is large and the locality has limited water supplies. ■