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HYDRANAUTICS

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Removal of Virus and Bacteria for Hydranautics RO Membranes

Surface water treatment, wastewater treatment, and potable reuse applications are increasingly utilizing reverse osmosis (RO) technology to remove dissolved solids, color, organic material, constituents of emerging concern, and pathogenic microorganisms. RO treatment can exceed the regulatory requirements for the removal of viruses, bacteria (e.g. *Salmonella, E. coli*), and protozoa (e.g. *Cryptosporidium*, *Giardia lamblia*) in drinking water applications. Viruses, the smallest of the regulated pathogenic microorganisms, typically are greater than 20 Angstroms in size and have a molecular weight in the range of 100,000 Daltons.

Hydranautics' polyamide RO membranes are manufactured with a pore size less than 5 Angstroms and a molecular weight cut off less than 100 Daltons. These membrane characteristics help to explain the good virus log removals achieved in the field and in laboratory studies. Furthermore, the RO membranes are also tested on a salt solution (NaCl) and achieve between 99.0% to 99.8% rejection of the salt ions, depending on the specific membrane model being tested. For reference, a dissolved sodium ion (Na^+) has an atomic radius of 1.9 Angstroms and the chloride ion (Cl^-) has an atomic radius of approximately 1.0 Angstroms.

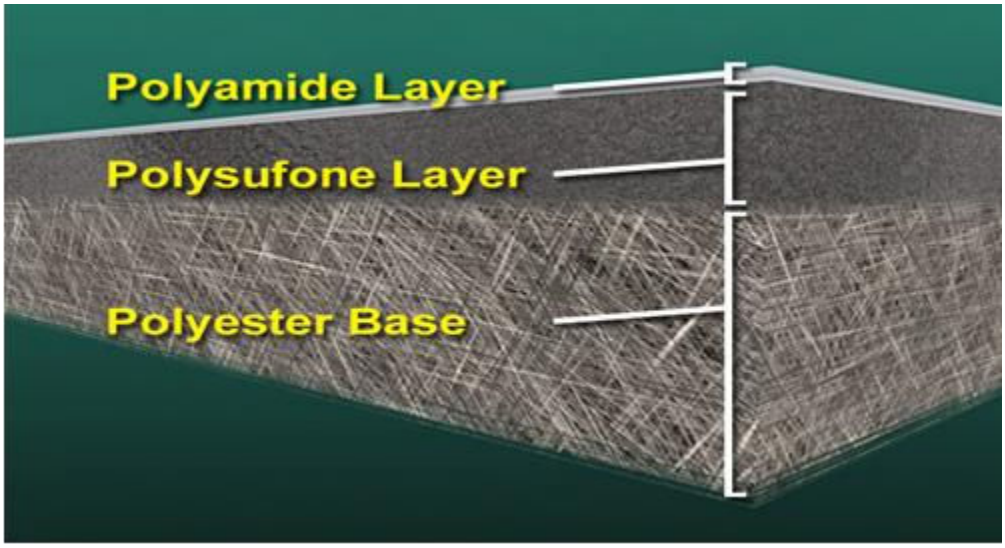

Figure 1. Cross-section depicting an RO membrane leaf, showing the polyamide RO membrane layer over the polysulfone UF layer and the polyester support layer.

Independent microbial challenge studies have been conducted by municipalities and private researchers have shown that polyamide reverse osmosis and nano filtration membranes can provide an effective barrier against pathogens [1,2,3]. Included in these

[1] Gagliardo, P., Olivieri, A., Eisenberg, D., Soller, J., Daniston, R., Cooper, R., Adham, S., Microbial Challenge Studies at the AQUA 2000 Advanced Research Center (1997).

studies are different Hydranautics low pressure brackish membranes. Based on these studies, RO membranes consistently achieve greater than 4-log removal (>99.99%) when challenged with microorganisms such as the MS-2 bacteriophage.

The passage of pathogens has been shown to primarily occur from contaminated feedwater bypass of the RO membrane. For example, pressure vessel adaptor disengagement, damaged O-rings, glue-line leaks, or permeate backpressure damage, all allow the contaminated feedwater to pass the membrane barrier. Membrane damage from oxidation or minor particle damage may cause an increase in salt passage, but still may not allow pathogens to pass the membrane. The polyamide RO membrane layer is supported by a UF-polysulfone membrane support layer, which also provides a barrier to pathogens. A large increase in salt passage should be investigated to ensure no pathogen bypass has occurred[4].

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[2] Acker, C., Colvin, C., Marinas, B., Lozier, J., Assessing the Integrity of Reverse Osmosis Spiral Wound Membrane Elements with Biological and Non-Biological Surrogate Indicators, American Water Works Association – Membrane Technology Conference, San Antonio, TX, March 4-7, 2001.

[3] Kitis, M., Lozier, J.C., Kim, J.H., Mi, B., Mariñas, B.J. (2003). Evaluation of Biologic and Non-Biologic Methods for Assessing Virus Removal by and Integrity of High-Pressure Membrane Systems, Water Science and Technology: Water Supply. 3.

[4] Vickers, J.C., Dummer, M., Le, T., and Lee, K., Overcoming Compliance Challenges for RO Pathogen Removal Using Conductivity Profiles, American Water Works Association – Membrane Technology Conference, New Orleans, LA, February 25-28, 2019.