Membrane filtration and advanced oxidation processes (AOPs) are two technologies that are being increasingly used in water treatment applications. These methods are often used in tandem to treat impaired water supplies or to facilitate water recycling. However, both membrane filtration and AOPs are often characterized with high capital and operating costs and a large reactor footprint. The development of more compact, less expensive hybrid technologies could significantly contribute to water treatment and recycling applications on many levels. In this talk, I will discuss our ongoing research efforts aimed at the development, characterization, and testing of an anodic reactive electrochemical membrane (REM) for water treatment and water recycling. The REM consists of a porous substoichiometric titanium dioxide (Ti$_4$O$_7$) tubular ceramic electrode operated in cross-flow filtration mode. The REM is capable of simultaneous filtration and oxidation of biological and organic compounds, and thus is capable of merging membrane filtration with advanced oxidation. Due to the micron-sized pores of the REM, operation in cross-flow filtration mode allows charge transfer to be limited by advection rather than diffusion. A combination of electrochemical oxidation experiments, electrochemical measurements, and density functional theory (DFT) modeling was used to develop a mechanistic understanding of the oxidation of compounds at the electrode surface. Results from this work are used to develop a fundamental understanding of the REM and the various applications of this new technology will be discussed in the context of water treatment.

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