30c Modeling Flow through Microfiltration Membranes Using Data from High-Resolution 3d Imaging

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The internal structure and flow patterns within microfiltration membranes impact the transport and retention of solutes and foulants. Recent advances in high-resolution imaging allow us to quantify various membrane structures at the sub-micron scale. These data can then be used directly for flow modeling, although this process presents many challenges because of the complex structure of the membranes and the correspondingly large computational problems that are generated.

In this work, we present high-resolution 3D images of a 0.65 micron Durapore membrane obtained using two independent techniques: laser scanning confocal microscopy and x-ray nanotomography. We then present results from flow modeling through the imaged membrane structures using two different computational techniques. The first technique is the lattice Boltzmann method, which recovers the Navier-Stokes equation and advection-dispersion equation, and therefore allows for rigorous modeling of transport within the complex pore space. The second technique is network modeling. It too operates using the 3D data, but incorporates approximates to the pore structure and governing equations in exchange for computational efficiency. Together, the two modeling techniques are complementary: the rigor of LBM is appropriate for fundamental modeling and for validation of the approximations made in network modeling. Network modeling provides better opportunities for upscaling, which is important in many engineering applications.