High-Resolution Numerical Simulation of Multiphase and Granular Flows through Microfiltration Membrane Obtained from FIB-SEM

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Abstract

This talk will introduce numerical modeling for analyzing the permeation behavior of particle dispersions and emulsions through microfiltration membranes. Recently, computational fluid dynamics simulations at the particle and pore scales have been used to understand the detailed membrane permeation behavior of various dispersion systems. In these reports, detailed dynamics have been visualized and the evaluation of performance such as permeability and rejection has also been performed, suggesting the usefulness of the numerical simulation approach. However, in conventional simulations of membrane separation, the microstructure of the membrane is simplified to a cylindrical pore. Porous membranes currently in practical use as microfiltration membranes are fabricated by phase separation or ceramics, and have complex microporous structures. The difference between the microstructures used in practical membranes and those used in conventional simulation studies may affect the permeation behavior. Thus, it was necessary to investigate numerical modeling of the microstructures of actual porous membranes. We used FIB-SEM (Focused Ion Beam Scanning Electron Microscopy) image analysis to describe the actual membrane microporous structure. We developed a method to coordinate the obtained three dimensional membrane microstructures with computational fluid dynamics simulations. Here, we describe the several models we have developed to represent complex membrane pore geometries during simulations, and present representative results of membrane permeation simulations of particle dispersions and emulsions.