Pore Network Modeling of Drainage in Highly Porous, Nonwoven Fiber Materials

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ABSTRACT: Simulating fluid flow through thin, unstructured highly-porous media has been a challenging problem in multiphase flow modeling. Because of high porosity, extracting an appropriate pore network based on the exact orientation of solid matrix is particularly difficult. In this study, we developed a 2D quasi-static pore-network model for drainage in a 95%-porous nonwoven fiber structure. In order to generate a realistic pore network while retaining the topological and statistical properties of the porous media, we employed the medial axis transform and skeletonization. The pixel-based distance transform was used to determine the medial axis of the fiber. To overcome uncertainties in fiber structure, GeoDict software was used to generate several virtual fibers and to study the effect of fiber orientations on capillary pressure-saturation and interfacial area-capillary pressure curves. In this 2D model, several assumptions were made to compensate for the loss of information in the 3rd dimension, and to include the effect of 3D geometry on the 2D model.