A CFD BASED TWO-SCALE MODELING APPROACH TO PREDICT PERMEABILITY OF FIBROUS STRUCTURES

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ABSTRACT

Using *idealized modeled* geometries many authors have proposed various expressions for predicting the permeability of fibrous materials .However, all these works are based on the assumption that the material is a homogeneous medium. On the contrary, real fibrous materials are rather inhomogeneous. The inhomogeneity can be in Solid Volume Fraction (SVF), in fiber orientations, and/or in fiber diameter distribution. These inhomogeneities can cause the permeability of a given specimen to be markedly different from what the models predict. Sectioning-imaging, MRI imaging, or tomographic methods are often used to obtain a 3-D image of the real media for the purpose of calculating the permeability. These techniques, however, require extensive computational resources making the simulations limited to very small sub-domains. To circumvent this problem (required computational memory), a two-scale modeling approach is proposed that allowed modeling the entire thickness of a typical hydroentangled fabric on a personal computer. In particular, the micro-scale water permeability of a carded, hydroentangled nonwoven is computed via a finite difference CFD code, by using 3-D reconstructed microstructures obtained from Digital Volumetric Imaging (DVI). The resulting permeability tensors are then used in a lumped porous media model developed by Fluent Inc. for simulating water flow through the entire thickness of the material and the calculation of effective permeability.

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