PAMM *Explore this journal >*

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Volume 13, Issue 1
December 2013
Pages 247–248
Special Issue:
84th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), Novi Sad 2013; Editors:
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Section 8

Estimation of large domain Al foam permeability by Finite Difference methods

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First published:
29 November 2013 Full publication history

DOI:
10.1002/pamm.201310119 View/save citation

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Abstract

Classical methods to calculate permeability of porous media have been proposed mainly for high density (e.g. granular) materials. These methods present shortcomings in high porosity, i.e. high permeability media (e.g. metallic foams). While for dense materials permeability seems to be a function of bulk properties and occupancy averaged over the volume, for highly porous materials these parameters fail to predict it. Several authors have attacked the problem by solving the Navier-Stokes equations for the pressure and velocity of a liquid flowing through a small domain (Ω_s) of aluminium foam and by comparing the numerical results with experimental values (prediction error approx. 9%). In this article, we present calculations for much larger domains (Ω_L) using the Finite Difference (FD) method, solving also for the pressure and velocity of a viscous liquid flowing through the Packed Spheres scenario. The ratio $Vol(\Omega_L)/Vol(\Omega_s)$ is around 10^3. The comparison of our results with the Packed Spheres example yields a prediction error of 5% for the intrinsic permeability. Additionally, numerical permeability calculations have

been performed for Al foam samples. Our geometric modelling of the porous domain stems from 3D X-ray tomography, yielding voxel information, which is particularly appropriate for FD. Ongoing work concerns the reduction in computing times of the FD method, consideration of other materials and fluids, and comparison with experimental data. (© 2013 Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim)