

Accepted Manuscript

A reduced-order model for porous flow through thin, structured materials

Scott A. Roberts, P. Randall Schunk

PII: S0301-9322(14)00145-1

DOI: <http://dx.doi.org/10.1016/j.ijmultiphaseflow.2014.07.013>

Reference: IJMF 2085

To appear in: *International Journal of Multiphase Flow*



Please cite this article as: Roberts, S.A., Randall Schunk, P., A reduced-order model for porous flow through thin, structured materials, *International Journal of Multiphase Flow* (2014), doi: <http://dx.doi.org/10.1016/j.ijmultiphaseflow.2014.07.013>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

A reduced-order model for porous flow through thin, structured materials.

Scott A. Roberts*, P. Randall Schunk

Engineering Sciences Center, Sandia National Laboratories, PO Box 5800, Albuquerque, NM 87185-0836

Abstract

Darcy's equations are frequently used as a coarse-grained numerical expedient for modeling multiphase flow through complex porous materials. In some applications, the porous material may be quite thin, allowing the possibility of further simplification of the equations. In this paper we derive a reduced-order shell finite-element model for flow through thin porous materials using an approach similar to that taken to derive the Reynolds' lubrication equation. We advance first a formulation that addresses generalized unstructured porous materials and then specialize the equations for certain structured cases. We also extend the model to account for multiphase, confined lubrication flow in an adjoining layer and gas transport within the pores. We apply the model to several problems of topical interest in micro- and nano-manufacturing processes.

Keywords: porous media, lubrication, reduced-order model, shell element, finite element method, nano-manufacturing

1. Introduction

Building predictive computer-aided models for multiphase flow through a porous medium is a multiscale challenge, with most work focused on the largest scales by invoking the theory of interacting continua [1]. The most common approach on this scale is to deploy what is known as Darcy's law [2, 3]. Darcy flow simulations in three-dimensions are used extensively in geologic applications (groundwater flows) [4, 5] and in chemical process modeling [6]. The underpinning concept of the Darcy formulation is that the flow is pressure driven and its

*Corresponding author

Email addresses: sarober@sandia.gov (Scott A. Roberts), prschun@sandia.gov (P. Randall Schunk)

Download English Version:

<https://daneshyari.com/en/article/7060380>

Download Persian Version:

<https://daneshyari.com/article/7060380>

[Daneshyari.com](https://daneshyari.com)