

## GENERATION OF SIMPLE EXTENDED POROUS SURFACE EXPRESSION FROM RESULTS OF PORE-LEVEL CONJUGATE HEAT TRANSFER IN SPHERICAL-VOID-PHASE POROUS BLOCKS

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Studies of convection in porous media continue to be of scientific interest due to the increasing utility of highly-conductive porous materials in heat exchange applications. Of central interest is the ability to model flow and heat transfer through a porous material with high accuracy in a manner that is computationally inexpensive. To this end, use of thermal-equilibrium (TE) or non-thermal-equilibrium (NTE) volume-averaged techniques are of great interest, but use of such methods requires information that is averaged out to be supplied as model coefficients for simple constitutive models that characterize the physical processes. Such models and coefficients are typically derived from either experiments or calculations of pore-level activity in idealized porous materials. It is also of interest to develop simple extended-surface models of porous media that can be used in the development of specialized heat transfer elements. In the present work, a unique geometric model [1] is used to generate spherical-void-phase geometries of several porous microstructures of different porosity and pore diameter. These models are discretized and conjugate results of heat and fluid flow are produced using the commercial software CFX [2]. The results are first used to develop interstitial exchange laws and other coefficients that can be used in similar volume-averaged calculations. The results are then also used to verify a simple one-dimensional model that can be used to characterize the entire porous block as an extended surface. Such a model was originally developed in [3], but without specific verification with pore-level simulations or experiments. The comparison shows that while reasonably accurate approximations can be made of extended porous surfaces, that effects of axial conduction and porous/solid interfaces remain to be sorted out prior to complete utility of the method. Results are presented for two porosities (0.75, 0.85), two pore diameters (400, 800 $\mu$ m), four solid-phase conductivities (50, 100, 200, 400 W/mK), and over a range of Reynolds number 10-80, based on the pore diameter. The results demonstrate the viability of the simple approach for conducting heat transfer calculations. The topic under consideration fits nicely into the "Natural and Forced Convection in Porous Media" and "Advanced Mathematical Approaches to the Modelling of Porous Media" themes of the conference.

[1] N. J. Dyck, A. G. Straatman, "A new approach to digital generation of spherical void phase porous media microstructures," *Int. J. Heat and Mass Transfer*, (81), 470-477, 2015.

[2] CFX-ANSYS, Copyright 2015.

[3] C. T. DeGroot, A. G. Straatman, L. J. Betchen, "Modelling forced convection in finned metal foam heat sinks," *ASME J. Electronic Packaging*, (131), 021001-1 – 021001-10, 2009.