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An Artificial Compressibility Algorithm for Modelling Natural Convection in Saturated Packed Pebble Beds: A Heterogeneous Approach

***A. G. Malan[1], C. Visser[2] and J. P. Meyer[3]**

[1] CSIR
P.O. Box 395, Pretoria, 0001, South Africa
http://www.csir.co.za
amalan@csir.co.za

[2] Department of Mechanical and Aeronautical Engineering, University of Pretoria, Pretoria, 0002, South Africa
Coert.visser@postiono.up.ac.za

[3] Department of Mechanical and Aeronautical Engineering, University of Pretoria, Pretoria, 0002, South Africa
jmeyer@up.ac.za

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ABSTRACT

This work is concerned with the modelling of heat and fluid flow through saturated packed pebble beds. A volume-averaged [1] set of local thermal disequilibrium governing equations is employed to describe the latter as a heterogeneous porous medium with porosity varying from 0.39 to 0.99. The thermal disequilibrium approach, together with stated porosity upper limit, allows for the modelling of wall effects such as wall channeling and wall-bed radiative heat transfer. The resulting set of coupled non-linear partial differential equations is solved via an artificial compressibility-split method [2,3], where spatial discretization is effected with a compact finite element edge-based discretization scheme. The latter was done in the interest of accuracy. Stabilisation is effected via JST scalar-valued artificial dissipation. This is the first instance in which an artificial compressibility type algorithm is applied to modelling heat and fluid flow through heterogeneous porous materials. The developed technology is validated by application to the modelling of a number of benchmark test cases.

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