Contribution ID: **792** Type: **Poster (+) Presentation**

Experimental analysis and modeling of non-isothermal transient flows in granular porous media at large Biot numbers

Tuesday, 1 June 2021 20:00 (1 hour)

Numerous green technologies are based on heat and mass transfer in porous media at high temperatures : heat exchangers for thermodynamic solar power plants, biofuel production from biomass, etc.
This type of transfer often involves several non-Darcian effects such as inertial [1], compressibility and unsteadiness effects, and, most importantly, local thermal non-equilibrium effects between the gas and the solid [2] but also sometimes within the solid itself (high Biot number) [3]. Upscaling models have been proposed [4] and have shown to provide acceptable results for an intermittent energy storage system [5]. The complexity of real granular packings and coupled non-darcian effects with non-equilibrium heat transfer in the transient regime require experimental measurements to accurately identify homogenized model parameters. We have developed an experimental setup to measure the non-Darcian parameters in centimetric granular porous media. It consists of a 20 cm diameter, 1 meter long, tube filled with the granular porous medium of interest. Hot gas is blown at the required flow rate and temperature at the inlet of the tube (in the current version, up to 0.5 m/s and 800 K). The temperature evolution of the gas and of the grains are monitored during dynamic heating, steady state and cool-down.
Macroscopic models proposed in the literature [2, 4] have been implemented in the Porous Material Analysis Toolbox based on OpenFoam (PATO) [6], which is released Open Source (www.pato.ac). Parameter estimation is done using advanced multi-objective optimization, coupling Dakota [7] with PATO. This work illustrates the strategy and presents results in the case of a high temperature, compressible, inertial, and transient flow in a pebble packed bed.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

[1] JC Ward. Turbulent flow in porous media. Journal of the hydraulics division,90(5):1–12, 1964.
[2] Michel Quintard and Stephen Whitaker. Local thermal equilibrium for transient heat conduction: theory and comparison with numerical experiments. International Journal of Heat and Mass Transfer, pages 2779–2796, 07 1995.
[3] D Handley and PJ Heggs. The effect of thermal conductivity of the packing material on transient heat transfer in a fixed bed. International Journal of Heat and Mass Transfer, 12(5):549–570, 1969.
[4] N. Wakao, S. Kaguei, and T. Funazkri. Effect of fluid dispersion coefficients on particle-to-fluid heat transfer coefficients in packed beds: Correlation of nusselt numbers. Chemical Engineering Science, 34(3):325–336, 1979.
[5] Thibaut Esence. Étude et modélisation des systèmes de stockage thermique de type régénératif solide/fluide. PhD thesis, Grenoble Alpes, 2017.
[6] Jean Lachaud, James B. Scoggins, Thierry E. Magin, M. G. Meyer, and Nagi N. Mansour. A generic local

thermal equilibrium model for porous reactive materials submitted to high temperatures. International Journal of Heat and Mass Transfer, 108:1406–1417, May 2017.
[7] B.M. Adams, W.J. Bohnhoff, K.R. Dalbey, M.S. Ebeida, J.P. Eddy, M.S. Eldred, R.W. Hooper, P.D. Hough, K.T. Hu, J.D. Jakeman, M. Khalil, K.A. Maupin, J.A. Monschke, E.M. Ridgway, A.A. Rushdi, D.T. Seidl, J.A. Stephens, L.P. Swiler, and J.G Winokur. Dakota, A Multilevel Parallel Object-Oriented Framework for Design Optimization, Parameter Estimation, Uncertainty Quantification, and Sensitivity Analysis: Version 6.12 User' s Manual. Technical Report SAND2020-12495, Sandia, November 2020.

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