**8th. World Congress on Computational Mechanics (WCCM8)**
**5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)**
**June 30 – July 5, 2008**
**Venice, Italy**

# PERMEABILITY PREDICTION: PORE LEVEL SIMULATION OF FLUID FLOW IN RECONSTRUCTED POROUS MEDIA

***Aydin Nabovati[1], Antonio C M Sousa[1, 2]**

[1]Department of Mechanical Engineering, University of New Brunswick, Fredericton, NB, Canada

[2]Department of Mechanical Engineering, University of Aveiro, Aveiro, Portugal

a.nabovati@unb.ca

**Key Words:** *Pore Level Analysis, Permeability Prediction, Lattice Boltzmann Method.*

## ABSTRACT

In order to predict the bulk properties of porous media, viscous fluid flow was simulated at pore level in reconstructed porous media using the lattice Boltzmann method (LBM) for porosities ranging between 0.07 and 0.98. The pore level structure of the porous media was estimated by random packing of spheres of fixed diameter with free overlapping; the centers of the spheres were placed in the computational domain using a uniform random distribution with no spatial correlation., The fluid flow was solved in the pores of the reconstructed medium by using the LBM-equivalent to the Navier-Stokes equations for a constant pressure gradient; the permeability of the medium was determined using the Darcy law [1]. As the validation step, fluid flow in three different ordered packings of spheres - Single Cubic, Body Centered Cubic, and Face Centered Cubic, were simulated. A sample of the predicted values of the permeability is shown in figure 1 as a function of the porosity; the agreement between the predicted values and the analytical correlation of Sangani and Acrivos [2] is excellent. At low porosities, the expanded series representing the analytical solution fails to accurately predict values of the permeability [2].

The predicted permeability for the random packing of spheres is in good agreement with the Kozeny equation [1] for moderate values of the porosity, but deviates at both the high and low ends of the porosity. Different sphere diameters were employed to investigate the effect of the spheres' diameter on the permeability of the medium; it was observed that greater is the sphere diameter, higher is the calculated permeability at constant porosity. Normalization of the permeability by the square of the sphere diameter causes the permeability data to collapse on a single curve as a function of the medium porosity. Figure 2 shows the predicted normalized permeability for the random packings of spheres for three different spheres' diameter- 25, 50 and 100 μm- and comparison with the Kozeny [1] and Koponen et al. [3] correlations.

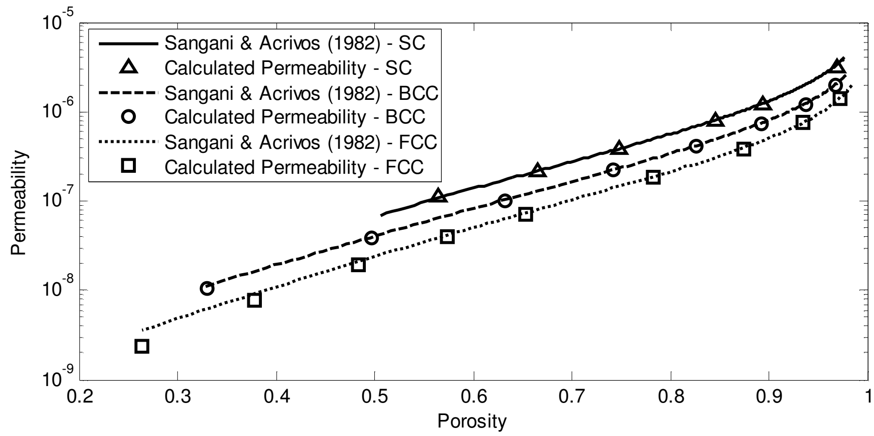


Figure 1. Calculated permeability and comparison with the correlation of Sangani and Acrivos (1982) for three different ordered packings: Single Cubic, Body Centered Cubic, and Face Centered Cubic.

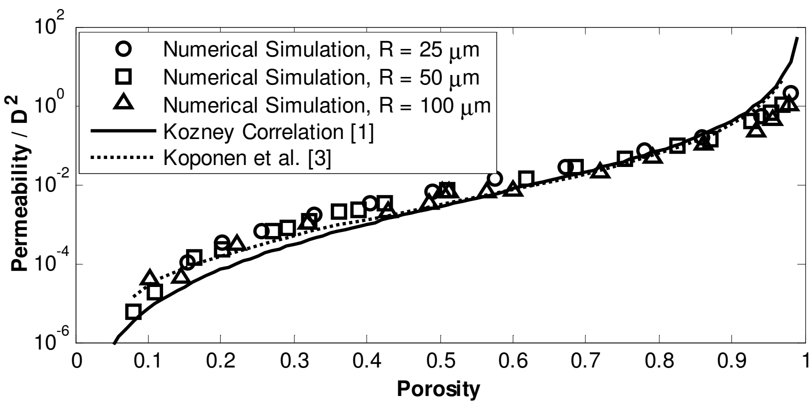


Figure 2. Normalized predicted permeability for the random packings of spheres and comparison with the Kozeny [1] and Koponen et al. [3] correlations.

## REFERENCES


[1] M. Kaviany, *Principles of Heat Transfer in Porous Media*, Springer - Verlag, New York, 1991.

[2] A.S. Sangani and A. Acrivos, "Slow flow through a periodic array of spheres", Int. J. Multiphase Flow, Vol. 8(4), pp. 343-360, (1982).

[3] A. Koponen, M. Kataja, and J. Timonen, "Permeability and effective porosity of porous media", Phys. Rev. E, Vol. **56**(3): 3319- 3325, (1997).


## ACKNOWLEDGEMENTS

The authors acknowledge the support received from NSERC (Natural Sciences and Engineering Research Council of Canada) Discovery Grant 12875 (ACMS) and from the Foundation for Science and Technology (FCT, Portugal) through the research grant POCTI/EME/59728/2004 (ACMS).