Desalination and Water Treatment
www.deswater.com

34 (2011) 277–283
October

1944-3994/1944-3986 © 2011 Desalination Publications. All rights reserved
doi: 10/5004/dwt.2011.2802

Permeability calculation of sphere-packed porous media using dissipative particle dynamics

Yong Shi[a], Yong Taek Lee[b], Albert S. Kim[a,b,*]

[a]*Department of Civil and Environmental Engineering, University of Hawaii at Manoa, 2540 Dole Street Holmes 383, Honolulu, Hawaii 96822, USA*
[b]*Department of Chemical Engineering, College of Engineering, Kyung Hee University, Gyeonggi-do 4460701, Korea*
Tel. +1 (808) 956-3718; email: albertsk@hawaii.edu

Received 3 September 2010; Accepted 3 January 2011

ABSTRACT

In this study we developed a fundamental method to directly calculate hydraulic permeability and tortuosity relative to the Happel cell model [AIChE J. 4 (1958) 197–201] without any macroscopic assumptions. No transparent structural dependence was observed in hydraulic permeabilities from simulation results of parallel dissipative hydrodynamics. The Happel cell model constantly underestimates, by a minimum of volume fraction 0.524, the permeability of sphere-packed porous media using simple cubic, body-centered cubic, face-centered cubic, and random cake structures. Accurate uses of the Happel cell model and Carman-Kozeny equation are limited to a narrow range of dense volume fractions from 0.524 to 0.64, above which the true depiction of the permeability from dissipative particle dynamics (DHD) provides lower permeability than that estimated using conventional theories.

Keywords: Hydraulic permeability; Hydraulic tortuosity; Random packing structures; Solid state structures; Stokesian dynamics; Dissipative hydrodynamics

*Corresponding author.

Presented at the AMS6/IMSTEC10, The 6th conference of the Aseanian Membrane Society in conjunction with the 7th International Membrane Science and Technology Conference, Sydney, Australia, November 22–26, 2010