College of Engineering
Department of
Mechanical & Industrial Engineering

Joint Sidney E. Fuchs / EPIC Seminar

3:30-4:20pm, Friday, March 27th, 2015
Frank H. Walk Room (ELAB Building)

Particle-resolved simulations of solid-liquid systems with mass transfer

by Jos Derksen*

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Many engineered processes rely on mass transfer between a solids phase and a liquid phase. Agitation and fluidization of dense solid-liquid suspensions are common ways of enhancing transfer rates. Suspensions have large interfacial area and the slip velocities between the phases help in transporting chemical species towards and away from the interfaces where in many cases surface-reactions occur. We present detailed simulations of flow dynamics and mass transfer in dense suspensions with explicit resolution of the solid-liquid interfaces. Solid and liquid dynamics are directly coupled through no-slip conditions at the solid particle surfaces and the (resolved) hydrodynamic forces and torques that translate and rotate the particles. The simulations are based on a lattice-Boltzmann scheme equipped with an immersed boundary method (the latter for imposing no-slip at solid surfaces) that captures the two-phase flow dynamics, and a finite-volume scheme on coupled overlapping domains (COD) for mass transfer. In COD, fine "inner" grids around the particles resolve the thin scalar boundary layers that are the result of high Schmidt numbers in the liquid. The inner grids communicate with a courser background grid. We show – amongst more - the intimate relation between flow conditions and local and overall mass transfer rates in fixed and fluidized beds.

* Jos Derksen has a PhD degree (1991) from Eindhoven University of Technology (Netherlands). After a short period with the National Aerospace Laboratory of the Netherlands (NLR) he joined the faculty of Delft University of Technology in 1992 as an assistant professor. He moved to Canada to become a full professor in the Department of Chemical and Materials Engineering of the University of Alberta in 2007. In 2013 he moved back to Europe, first for a position at the University of Aberdeen (UK) and currently at the Chemical Engineering Department of Delft University in the Netherlands.

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