EUROMECH COLLOQUIUM 513
Udine, Italy, 06. – 08. April, 2011

Lattice Boltzmann simulations for characterizing the behaviour of agglomerates with different morphologies

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Keywords: Lattice Boltzmann method (LBM), agglomerates, porous particles, drag coefficient, fractal dimension

ABSTRACT

Porous particles are present in various technical applications throughout many branches of process industry as well as in the field of medical treatment. Particle properties such as the aerodynamic diameter, the particle shape and the morphology highly influence their transport behaviour. Besides experiments, numerical simulations are capable of providing information about the physics that influence the dynamical behaviour of porous particles in fluid flow. Understanding and predicting the corresponding multiphase flows requires the study of the relationship between particle structure and particle motion. By performing fully-resolved direct numerical simulations (DNS) of single complex particles correlations between particle properties and their fluid dynamic behaviour are to be established to improve existing numerical models such as the Euler/Lagrange approach.

In this work, the lattice Boltzmann method (LBM) is used to simulate the flow around porous spherical agglomerates. Based on a random-driven distribution of the primary particles different agglomerate structures are realized. By modifying number, size or size distribution of the primary particles the porosity of the agglomerates is adjusted. Additionally, the mass distribution inside the agglomerate can be influenced to provide either a constant or a varying particle porosity along the agglomerate diameter. The characterization of the particle morphology is done using the radius of gyration, the fractal dimension and the porosity based on a convex hull around the particle.

From the flow simulation with LBM the fluid dynamic forces acting on the agglomerates can be determined (Dietzel and Sommerfeld 2008, Hölzer and Sommerfeld 2009). Thereto, the agglomerates are introduced into a laminar flow at different low Reynolds numbers (Figure 1). The particle boundaries are resolved using local grid refinement (Crouse 2003) realizing a high discretization near the particle surface and a coarser grid far from the particle. Based on the calculated forces as well as on equivalent diameters drag, lift and momentum coefficients are derived and compared for different particle

morphologies. Correlations incorporating structural characteristics of the agglomerates on the one hand and the fluid dynamic coefficients on the other hand are to be established.

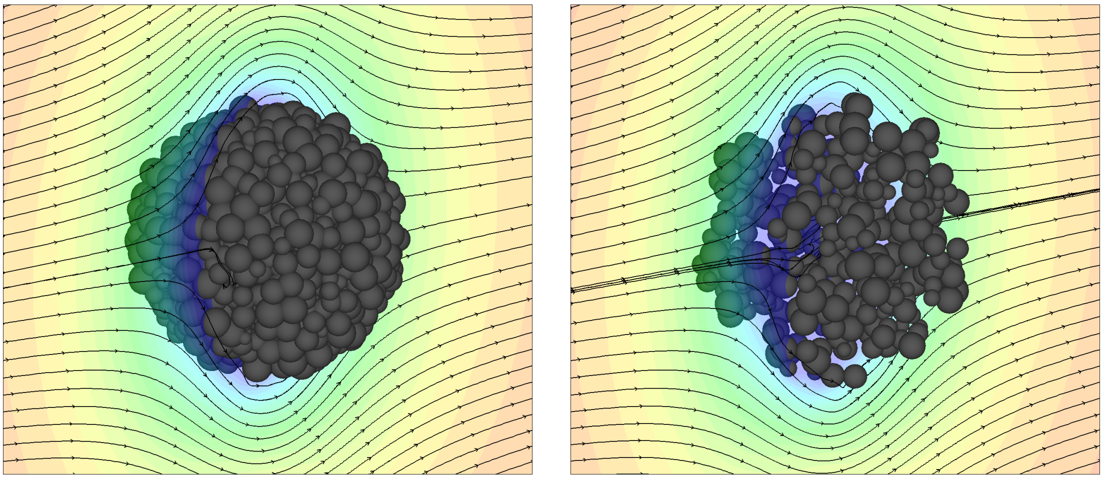

Figure 1 Comparison of fluid velocities in main flow direction at a cross-sectional plane through spherical agglomerates at Reynolds of 0.3:
left: 1400 primary particles, 30 % porosity; right: 350 primary particles, 80 % porosity

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