HYDRODYNAMIC STUDY OF HEAT TRANSFER IN A FLUIDIZED BED BY DISCRETE PARTICLE SIMULATIONS

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In recent years, gas-solid fluidized beds have been extensively used in the process industries. Fluid catalytic cracking (FCC) is one of the most important conversion processes used in the biobased feedstock refinery. The FCC process vaporizes and breaks the long-chain molecules of the high-boiling hydrocarbon liquids into much shorter molecules by contacting the feedstock at high temperature, with fluidized powdered catalyst. Gas-particle heat transfer is a crucial element of the process. To numerically study three dimensional fluidized beds is still a challenge, due to the high computational cost, whereas flow visualization and measurements are difficult to perform in 3D fluidized beds.

In this work, the CFD–DEM approach, a computational fluid dynamics (CFD) model for gas-phase flow combined with a discrete element method (DEM) for particle motion (see review articles of Deen et al (1); van der Hoef et al (2)), was used to study the influence on fluidized bed thermal behavior of particles depending on the particle size and the superficial gas velocity. CFD-DEM simulations are performed on a pseudo 2D fluidized bed (shown in Figure 1) with spherical particles (d_p = 1 mm, ρ_p = 667 kg/m^3). The thermal energy equation of the particles contains a source term to mimic heat production due to exothermic chemical reactions. Instantaneous snapshots of the voidage in the fluidized bed as shown in Figure 2 shows the effect of inlet gas velocity. The simulations are carried out with an open-source package, OpenFOAM-CFDEM-LIGGGHTS, and will be compared to results obtained with an in-house CFD-DEM code.

REFERENCES

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2. Van der Hoef, M.A., Annaland, M.V., Deen, N.G., Kuipers, J.A.M., Numerical simulation of dense gas–solid fluidized beds: a multiscale modeling strategy. Annual Review of Fluid Mechanics, 40: 47-70, 2008.

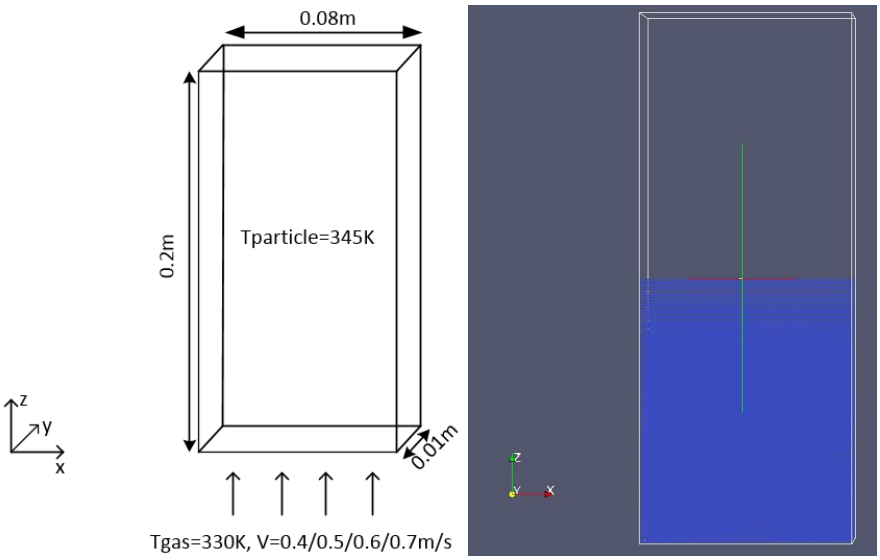

Figure 1. Schematic overview of the pseudo-2D fluidized bed

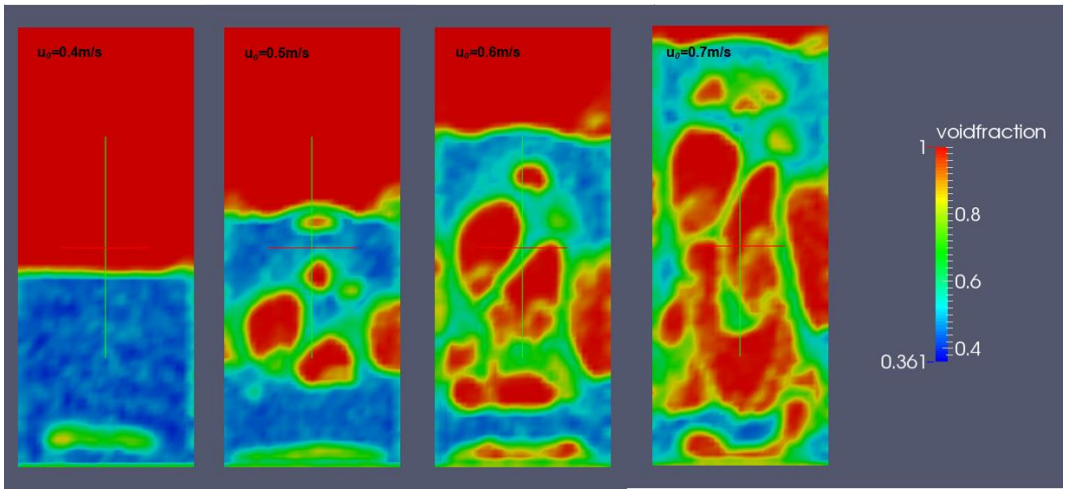

Figure 2. Snapshots of instantaneous voidage patterns as a function of u_0