

Measurement and modeling of inter-particle forces in a fluidized bed at high temperatures and high pressures

Context

Gas-solid fluidized beds are widely used in industry (combustion, gasification, FCC, solar receiver, polymerization, ...). The hydrodynamics of this gas-solid contactor is poorly known and is not well controlled because of the high intensity of inter-particle forces under extreme conditions (high pressure, high temperature). These forces greatly reduce the efficiency of the process and can cause agglomerates of particles and reactor shutdown. Mathematical models and correlations fail to correctly predict hydrodynamic parameters measured experimentally such as the minimum fluidization velocity because they don't take into account the presence of inter-particle forces [1]. There are three types of inter-particle forces known as Van der Waals, electrostatic, and material bridge [2]. The material bridge is divided into liquid and solid bridges. The liquid bridge forms when the moisture content of the fluidizing gas becomes condensed on the particles [3]. The solid bridge forms due to diffusion in solid state or other mechanisms [2]. These bridges exert an attractive force on the particles keeping them from moving.

Aims

- Experimental measurement of the material bridge force inside a gas-solid fluidized bed at high pressures and high temperatures.
- Modeling the inter-particle forces of solid and liquid bridges.
- 3D numerical simulation of solid particles behavior in a fluidized bed.



Hydrodynamics

Fluidization

CFD

Modeling

Inter-particle forces

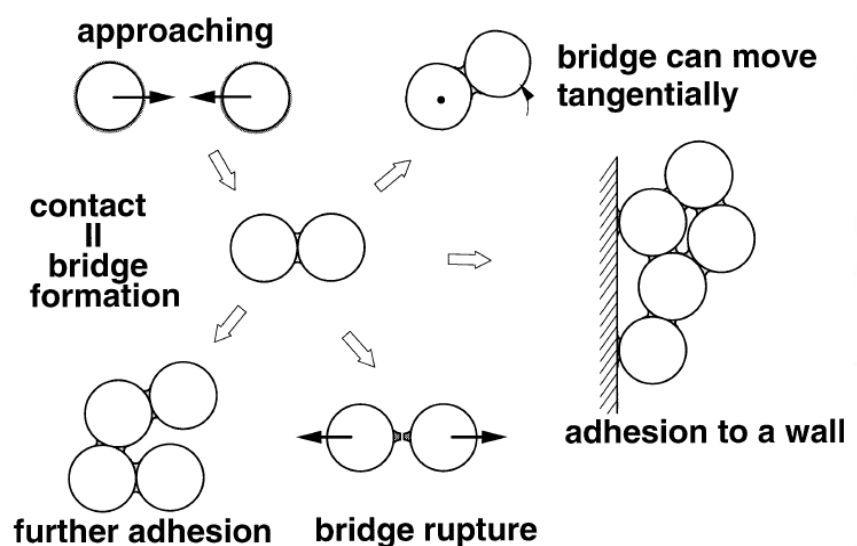
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Materials and methods

- Experimental work:
Using a gas-solid fluidization column that can be used up to 1000 °C and several tens of bars the experimental measurements will be done to investigate the effect of the inter-particle forces of solid and liquid bridges on the hydrodynamics of the bed.
- Numerical work:
A 3D numerical simulation based on Euler-Euler approach, according to the kinetic theory of granular media will be done using the numerical simulation code NEPTUNE_CFD to simulate the behavior of the particles in the bed taking into account the presence of the inter-particle forces of solid and liquid bridges.



References

- [1] N. Elahipanah. Indirect measurement of inter-particle forces in a gas-solid fluidized bed at high temperature with a simple approach. Ecole Polytechnique de Montréal. Mémoire de Master.
- [2] J. P. K. Seville, C. D. Willett, and P. C. Knight, "Interparticle forces in fluidisation: A review," *Powder Technol.*, vol. 113, no. 3, pp. 261–268, 2000.
- [3] L. F. Hakim, J. H. Blackson, and A. W. Weimer, "Modification of interparticle forces for nanoparticles using atomic layer deposition," *Chem. Eng. Sci.*, vol. 62, no. 22, pp. 6199–6211, 2007.



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