Liquid-solid Fluidized bed

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Abstract: This test case concerns a small scale liquid-solid fluidized bed. Two types of glass beads have been used differing by their diameter (6 mm and 3 mm). Several solid loadings have also been investigated. By using an optical technique, the trajectory of one particle has been measured. allowing to compute the statistics of the solid phase (bed height, agitation, diffusion coefficient).

1 Description

1.1 Geometry

Figure 1: global view of the experiment.

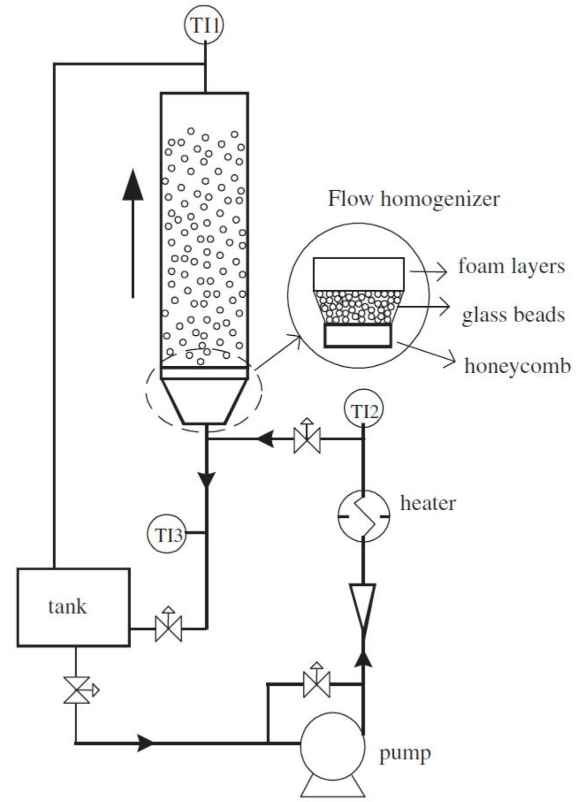

Figure 2: Sketch of the experiment loop.

The experimental set-up of the fluidized bed is shown schematically in Fig. 2. It is composed of a 8 cm diameter glass column of 60 cm in height. A flow homogenization section was mounted at the bottom of the column, composed of a honeycomb panel, a fixed bed of particles and layers of synthetic foam. With this system, the particles occupy the whole space of the fluidized bed and no stationary recirculation loop is detected, suggesting a homogeneous fluidization.

1.2 Measurement techniques

The analysis of collisions was achieved by 2-D trajectography of particles within the fluidized bed. Images were recorded with a high speed camera (Photron APX) equipped with a CMOS sensor. The test zone is an area of $8 \times 8\,\mathrm{cm}^2$ using the maximum resolution (1000×1000 pixels). A black colored particle was introduced in the bed and its trajectory was recorded at 500 frames per second.

2 Properties

The material properties of the liquid and particles are given in Table 1. Several operating points (differing by the solid loading and fluidization velocity) and particles (differing by the particle diameter and density) have been investigated. For this test case we consider monodisperse glass bead with two diameters 3 mm and 6 mm.

From the analysis of the particle trajectory, Corona et al. [3] had determined the particle-wall restitution coefficient with respect to the impact Stokes number. As expected they observed

Table 1: Material properties.

Liquid properties				
Density	$1400\,\mathrm{kg/m^3}$			
Viscosity	$3.8\,10^{-3}\,\mathrm{Pa.s}$			
Particle properties				
Density	$2230\,\mathrm{kg/m^3}$			
Diameter	3 mm			6 mm
Solid volume fraction	0.2	0.3	0.4	0.23
Fluidization velocity	0.0777 m/s	0.0531 m/s	0.0379 m/s	0.12 m/s

that the normal restitution varies with respect to the impact Stokes number. The mean value of the particle-wall restitution coefficient is 0.45 and the mean friction coefficient is 0.0855. Unfortunately we do not have access to the particle-particle restitution and friction coefficient.

3 Available data

From the particle trajectory, Corona [2] extracted several statistics. For the present test case we propose to validate the numerical simulations on global statistics meaning bed-averaged statistics. These statistics are time-averaged statistics. The duration of the average must be long enough for having converged statistics.

Finally, we will provide the experimental data of :

- the bed height,
- the bed-averaged particle agitation (also called particle kinetic energy),
- the bed-averaged self-diffusion coefficient.

Even if the experiments data are not available we propose to extract some specific quantities from the numerical simulation. These quantities will help for the physical analysis. Vertical profiles at the wall and at the centre of the bed of

- mean gas pressure,
- mean solid volume fraction.

Radial profiles at $z = 5\,\mathrm{cm}$, $10\,\mathrm{cm}$ and $15\,\mathrm{cm}$ of

- mean solid volume fraction,
- mean vertical particle and gas velocity,
- mean radial particle and gas velocity,
- mean particle agitation.

References

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