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Response to Letter to the Editor

Answer to "Comment on two-dimensional discrete particle model by Berrouk and Wu"

This is in response to a comment by Berrouk and Wu referring to our manuscript in this journal [1]. In Eq. (5) [1], the interaction forces between the two phases S_{p-g} should be equal and have reserve directions:

$$S_{p-g} = \frac{\sum_{i=1}^{N} f_{d,i}}{s} \tag{1}$$

where, $f_{d,i}$ is the drag force acting on a particle. s is the volume of the computational cell, and calculated by the following equation in our simulations:

$$s = \Delta x\, \Delta y d_s \tag{2}$$

Based on the gas momentum equation (Eq. (2) in [1]), from Eqs. (1) and (2) the pressure drop in the vertical direction is expressed by

$$-\frac{\partial p}{\partial y} = \left(\frac{(\pi/6)\sum_{i=1}^{Nc} d_{s,i}^3}{(\pi/6)\sum_{i=1}^{Nc} d_{s,i}^3 + \varepsilon_g \Delta x\, \Delta y d_s} \right) \rho_s g + \left(\frac{\varepsilon_g \Delta x\, \Delta y d_s}{(\pi/6)\sum_{i=1}^{Nc} d_{s,i}^3 + \varepsilon_g \Delta x\, \Delta y d_s} \right) \rho_g g \tag{3}$$

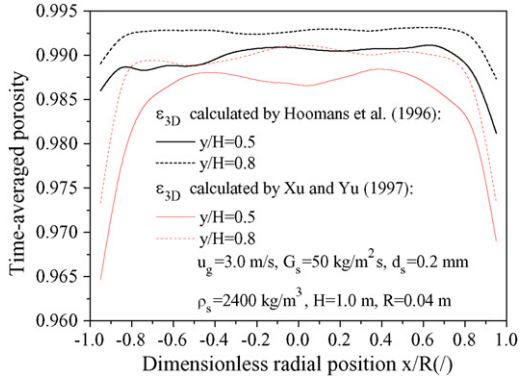

Fig. 1. Radial distribution of time-averaged porosities in a riser.

or

$$-\frac{\partial p}{\partial y} = (1-\varepsilon_g)\rho_s g + \varepsilon_g \rho_g g \tag{4}$$

Another point discussed by Berrouk and Wu is the 3D transformation of the 2D porosity in the numerical simulations. The porosity should be accurately determined since the empirical or theoretical relations of gas–solid interactions are found to be strongly dependent on it. More than two methods are used in our numerical simulations of fluidized beds. A typical simulated result is shown in Fig. 1 at two different methods in a riser. The difference between two methods proposed by Hoomans et al. [2] and Xu and Yu [3] is obvious. However, both methods give a core-annular flow structure with high concentration of particles near the walls and low in the center of the riser.

In closing, both experiments and theoretical model for 3D transformation of the 2D porosity are necessary to gain a better understanding of flow behavior of gas and particles in risers.

References

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