Supporting Information for:

Pore scale study of fluid flow and drag force in randomly packed beds of different porosities

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S.1 Prediction of the drag forces on individual particles

For the accuracy of the predicted drag forces on individual particles, the percentage error of an example case by the present model is given here (Figure S1). The calculation is similar to the work of Rubinstein et al.,[1] thus it can be compared with other models as discussed in Figure 4 and Table 1 of their paper. It is shown the error at probability distribution function (PDF) maximum is about 10%, which is very low compared with other models. However, the average error is 32.7%, which is higher than that predicted by Rubinstein et al.[2], but lower than that predicted by van der Hoef et al.[3]

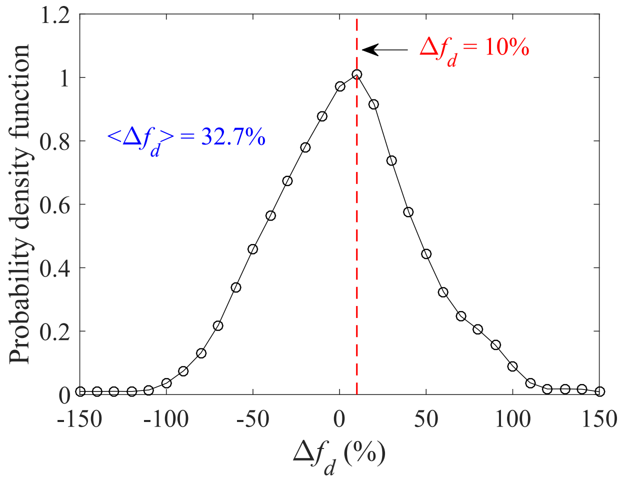

Figure S1. The probability distribution functions (PDF) for the percentage error Δf_d ($=100 * \left(F_d^{pore} - F_d^{actual}\right)/F_d^{actual}$), where the actual drag force F_d^{actual} on individual particles are obtained by LBM simulation. The bed porosity is 0.761 and *Re* is 0.1 for this case.

In fact, the present pore network model owns its advantages and limitation in calculating the particle scale drag forces. On the one hand, this model can consider local structures and fluid flows on the drag forces of individual particles, which may account for the low error at PDF maximum for this model. On the other hand, the accuracy of the individual drag force is limited due to the difficulty in the realistic description of pore geometry, thus the relatively average error is high. But since the average error is comparable to some current drag formulations like the one by van der Hoef et al.,[3] it is feasible to use the present pore network model for simulating particle-fluid flows.

As the model owns its advantage in considering the local structure and local fluid flow, it is expected to predict more accurate drag forces on individual particles, if a better description of pore geometry can be established in the future.

References

(1) Rubinstein, G. J.; Ozel, A.; Yin, X.; Derksen, J. J.; Sundaresan, S., Lattice Boltzmann simulations of low-Reynolds-number flows past fluidized spheres: effect of inhomogeneities on the drag force. *J. Fluid Mech.* **2017,** *833*, 599.

(2) Rubinstein, G. J.; Derksen, J. J.; Sundaresan, S., Lattice Boltzmann simulations of low-Reynolds-number flow past fluidized spheres: effect of Stokes number on drag force. *J. Fluid Mech.* **2016,** *788*, 576.

(3) Hoef, M. A. V. D.; Beetstra, R.; Kuipers, J. A. M., Lattice-Boltzmann simulations of low-Reynolds-number flow past mono- and bidisperse arrays of spheres: results for the permeability and drag force. *J. Fluid Mech.* **2005,** *528*, 233.