Particle dynamics in a turbulent particle-gas suspension at high Stokes number

Partha S. Goswami[1] and V. Kumaran[2]

[1] *CSIR Centre for Mathematical Modelling and Computer Simulation, Bangalore 560037, India**

[2] *Department of Chemical Engineering, Indian Institute of Science, Bangalore 560012, India*

The 'fluctuating force' model has been developed to capture the effect of turbulent fluid velocity fluctuations on the particle phase in a turbulent gas-solid suspension in the limit of high Stokes number, where the particle relaxation time is large compared to the correlation time for the fluid velocity fluctuations. The force exerted by the turbulent fluid velocity fluctuations, considered as anisotropic Gaussian white noise, is incorporated in the equation of motion of the particles. The noise amplitude is determined from the time correlations of the spatially varying and nonisotropic turbulent fluid velocity fluctuations obtained from Direct Numerical Simulations (DNS). The particle velocity distribution in the gravity driven flow in a vertical channel is analysed using a Langevin formulation for the force due to turbulent fluctuations, and the results are compared with DNS simulations incorporating one-way coupling (the force due to turbulent velocity fluctuations on the particle is incorporated, but not the reverse force due to the particle on the fluid turbulence). For monodisperse particles, there is quantitative agreement between the fluctuating force simulations (FFS) and DNS simulations, provided the time correlation of the fluid velocity fluctuations is calculated in a 'moving Eulerian reference frame moving with the fluid mean velocity. Comparisons are also made with experimental measurements of the particle velocity distributions using PIV and Particle Tracking Velocimetry. Good agreement is obtained only if the polydispersity in the particle size distribution is incorporated in the FFS. At lower mass loading (0.19), there is no significant modification of the fluid phase turbulent intensity, and the particle velocity distribution is well predicted by the FFS with one way coupling. At a higher particle mass loading of 1.7, there is a significant increase in the turbulent velocity fluctuations due to the particles. It is then necessary to incorporate the modified fluid turbulence intensity in the fluctuating force simulation.

*Electronic address: partha.sarathi.goswami@gmail.com,psg@cmmacs.ernet.in