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Closure Models for Turbulent Particle-laden Flows from Particle-resolved Direct Numerical Simulation[1] SHANKAR SUBRAMANIAM, SUDHEER TENNETI, MOHAMMAD MEHRABADI, Iowa State University, RAHUL GARG, National Energy Technology Laboratory — Gas-phase velocity fluctuations in fixed particle beds and freely evolving suspensions are quantified using a particle-resolved direct numerical simulation (PR-DNS). The flow regime corresponds to gas-solid systems typically encountered in fluidized bed risers, with high solid to gas density ratio and particle diameter being greater than the dissipative length scales. The kinetic energy associated with gas-phase velocity fluctuations in homogeneous monodisperse fixed beds is characterized as a function of solid volume fraction ϕ and the Reynolds number based on the mean slip velocity Re. A simple scaling analysis is used to explain the dependence of k on ϵ and Re. The steady value of k results from the balance between the source of k due to interphase transfer of kinetic energy, and the dissipation rate (ϵ) of k in the gas-phase. It is found that the dissipation rate of k in gas-solid flows can be modeled using a length scale that is analogous to the Taylor microscale used in single-phase turbulence. Using the PR-DNS data for k and ϵ we also infer an eddy viscosity for gas-solid flow. For the parameter values considered here, the level of gas-phase velocity fluctuations in freely evolving suspensions differs by only 10% from the value for the corresponding fixed beds.

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