Abstract

Two numerical models were developed in this Ph.D. project to simulate the dispersion of particles in turbulent gas flow in which the influence of the particles upon the turbulence was not considered. The turbulent 'base' flow was simulated by both Kraichnan's method of Fourier modes and a two-equation turbulence model using the Reynolds-averaged Navier-Stokes(RANS) equations for comparison. The motion of the particles in the turbulent flow was described by a Lagrangian approach, and an ensemble of 2000 particle trajectories were generated for evaluating various statistics. In order to distinguish between the effects of inertia and gravity on the dispersion statistics, simulations made with and without the gravitational force were conducted for comparison purposes using the Kraichnan's method. Also, simulations were made with both linear and nonlinear drag formulations to analyse potential prediction enhancements.

In this study, both analytical and numerical analyses for the time step required in the integration of the equations describing particle motion were conducted. Their findings indicate that the integration time step plays a crucial role not only in terms of stability but also in computer round-off errors in the modelling of particle dispersion. A stability criterion was established through these analyses.

Computed results were compared with experimental and theoretical data available in the literature for the particle mean square dispersion, mean square relative

velocity, particle velocity decays, particle velocity autocorrelations, and particles settling velocity. Based on these comparisons, the reliability of the Kraichnan's method and the two-equation turbulence model based on the RANS, as well as, the particle-eddy interaction model were determined. Suggestions for future work on this project were also given.