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Numerical simulation of particle dispersion in an acoustic field

J. CLECKLER, F. LIU, S. ELGHOBASHI, University of California, Irvine — Particles with small relaxation time, τ_p, subjected to sound waves for many acoustic periods execute both periodic motion and mean drift. Particle acceleration in an acoustic flow field is often modeled via a linearized Stokes drag law. This simple model can predict the oscillatory particle velocity amplitude for large particle-to-fluid density ratios, ρ_p/ρ_f, and small velocity-amplitude acoustic waves. However, this model is not accurate for other conditions and does not predict particle drift velocities. We present the results of two-dimensional numerical simulations in which the particle trajectories are obtained via the complete Lagrangian particle motion equation which includes the forces due to non-linear Stokes drag, Basset's unsteady viscous drag, pressure gradient, virtual mass and gravity. Particle behavior is found to depend on three non-dimensional parameters: (ρ_p/ρ_f), $(\omega\tau_p)$, where ω is the acoustic frequency, and the Mach number, M, which is the ratio of the acoustic wave velocity amplitude to the speed of sound. Results for large ρ_p/ρ_f are in good agreement with the experimental results of Gonzalez et al. (2000) for the range of frequencies tested. Results for other conditions agree with a perturbation solution of the Lagrangian particle motion equation for moderate strength acoustic waves. Particle model simplifications are recommended for important ranges of the three parameters, (ρ_p/ρ_f), $(\omega\tau_p)$ and M.

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