

James S. Linden

Mechanical Engineering, IT, 2009

Mentor: Sean C. Garrick,

Mechanical Engineering

Gas-Particle Mass Transfer in Turbulent Flows

In March of 2005 the Clean Air Mercury Rule (CAMR) was signed into legislation requiring a 70% reduction in the release of mercury into the environment by flue gasses at coal-fired power plants. Methods of mercury removal have included fabric filters, electrostatic precipitators, and desulfurization though these methods generally remove only 15% to 35% of the mercury present in the flue gas. Past investigators have proposed models which utilize the injection of activated carbon particles to absorb the chemical species but have made assumptions which lead to a theoretical absorption rate that is believed to be inaccurate. The aim of this project is to develop a better understanding of gas-particle mass transfer to more accurately predict mercury species removal. Direct Numerical Simulation (DNS) and Large Eddy Simulation (LES) methods are used to model the turbulent flow field between two fluids; one containing the particles, and the other containing the chemical species. Additionally, this project aims to relate the results of the DNS, which uses a very fine grid size and solves the full Navier Stokes Equations, with the LES, which requires far fewer Central Processor Unit (CPU) hours to compute but is limited in its ability to resolve small scale motion due to the use of model assumptions and a coarser grid. Comparisons between the methods are done through analyzation of the fluid flow field, particle trajectories, and species removal. The fluid flow field, which is governed by the incompressible Navier Stokes equations, is compared based on the average velocity and species mass fraction of the fluid in the cross-stream direction when no condensation occurs. Particle trajectories are found through equations of particle motion and are compared through probability density functions which communicate the dispersion of particles in the cross-stream direction. Mass transfer, which follows from the condensation model, is compared based on the amount of mercury removed from the fluid during the simulation.



Poster Number: Session: