DIRECT SIMULATION MONTE CARLO EXPLORATION OF CHARGE EFFECTS ON AEROSOL EVOLUTION

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ABSTRACT

Aerosols are potentially generated both during normal operations in a gas cooled Generation IV nuclear reactor and in all nuclear reactors during accident scenarios. These aerosols can become charged due to aerosol generation processes, radioactive decay of associated fission products, and ionizing atmospheres. Thus the role of charge on aerosol evolution, and hence on the nuclear source term, has been an issue of interest. There is a need for both measurements and modeling to quantify this role as these effects are not currently accounted for in nuclear reactor modeling and simulation codes.

In this study the role of charge effects on the evolution of a spatially homogenous aerosol was explored via the application of the Direct Simulation Monte Carlo (DSMC) technique. The primary mechanisms explored were those of coagulation and electrostatic dispersion. This technique was first benchmarked by comparing the results obtained from both monodisperse and polydisperse DSMC evolution of charged aerosols with the results obtained by respectively deterministic and sectional techniques. This was followed by simulation of several polydisperse charged aerosols. Additional comparisons were made between the evolutions of charged and uncharged aerosols. The results obtained using DSMC in simple cases were comparable to those obtained from other techniques, without the limitations associated with more complex cases. Multicomponent aerosols of different component densities were also evaluated to determine the charge effects on their evolution. Charge effects can be significant and further explorations are warranted.