

Aggregation Kinetics of Soot Nanoparticles in Wet Environments

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Soot nanoparticles produced from incomplete fuel and biomass combustion are often of <100 nm and possess health hazard as they may enter respiratory systems of human and animals. When these airborne particles enter atmospheric system, their fate and transport are governed by aggregation kinetics and their interactions with the ambient atmospheric environment. In this study, we examined interactions of soot nanoparticles under aqueous condition in an effort to elucidate the fundamental processes that control particle-particle interactions under wet or rain droplet conditions. We have investigated the influence of different types of electrolytes and aqueous pH on the colloidal stability of diesel soot nanoparticles by measuring their aggregation kinetics in different aqueous solution conditions. Our results showed that the soot nanoparticles have negatively charged surfaces and exhibited both reaction and diffusion limited aggregation regimes with rates depended upon solution chemistry. The experimental data for aggregation kinetics were in good agreement with the classic Derjaguin-Landau-Verwey-Overbeek (DLVO) theory. We quantified the critical coagulation concentrations (CCC) and derived the Hamaker constant for the tested soot nanoparticles. Our study indicated that, depending upon the local solution conditions, single soot nanoparticles could remain stable against aggregation in wet or aquatic environments, but will likely aggregate in dry and salty aquatic conditions.