

411b Competition between Mixing and Gelation in Continuous Processing of Nanoparticle Dispersions

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Control of aggregation and gelation is among important issues in processing of nanoparticle dispersions. Aggregation of nanoparticles to clusters with desired size and structure can be achieved in continuous processing, assuming that colloidal stability of primary particles can be manipulated by mixing with an appropriate coagulant, while at the same time gelation of the bulk dispersion is avoided. On the other hand, gelation might be desired in order to obtain gelled domains of appropriate size, while keeping the resulting solids in suspended state. Since at small particle sizes and large concentrations, typical for industrial conditions, timescales of mixing, aggregation and gelation are comparable, one needs to account for interplay of these processes in order to understand effects of mixing on gel formation in nanoparticle dispersions.

Gel formation during continuous coagulation was studied experimentally and modeled using a combination of computational fluid dynamics with population balance equations. Several different geometries for mixing of nanoparticles with coagulant were considered. Three distinct regions, resulting from an interplay between mixing and aggregation, were found in the parameter space of the solid volume fraction and the primary particle diameter: 1) gelation occurs through space filling due to Brownian aggregation, 2) gelation occurs through runaway growth due to shear aggregation, and 3) no gelation occurs before mixing of dispersion and coagulant streams is completed.