Comparison of Hematite Coagulation by Charge Screening and Phosphate Adsorption: Differences in Aggregate Structure

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Abstract: The formation and structure of hematite aggregates were examined by dynamic and static light scattering techniques. A large range in coagulation kinetics was studied by varying either indifferent electrolyte (KCl) concentration or surface complexing anion ($H_2PO_4^-$) concentration, P_T, at pH 6.0 ± 0.1. Diffusion limited aggregation (DLA) was induced by counterion screening at [KCl] > 80 mM or by surface charge neutralization at P_T = 31 μ*M* (and ionic strength = 1.0 m*M*). In DLA, the fractal dimension, d_f, of aggregates formed by either surface charge neutralization or counterion screening was 1.7 ± 0.1. A reduction in the rate of coagulation in KCl for [KCl] < critical coagulation concentration (CCC) produced an increase in d_f to 2.1 ± 0.1. For aggregation induced by phosphate adsorption at constant ionic strength, there was no apparent trend in d_f with coagulation rate. The value of d_f was consistently less than 1.8 when reaction limited aggregation (RLA) resulted from surface charge neutralization rather than counterion screening. TEM observations of aggregates formed in the presence or absence of phosphate confirm that, when RLA is induced by phosphate adsorption, resulting aggregates are much looser in structure than those formed by counterion screening. The results suggest that the high-affinity binding of phosphate to hematite may result in a nonrandom distribution of surface charge that facilitates the coalescence of positive and negative charge crystal faces.

Key Words: Coagulation Kinetics • Fractal Aggregate • Hematite • Light Scattering • Phosphate Adsorption

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