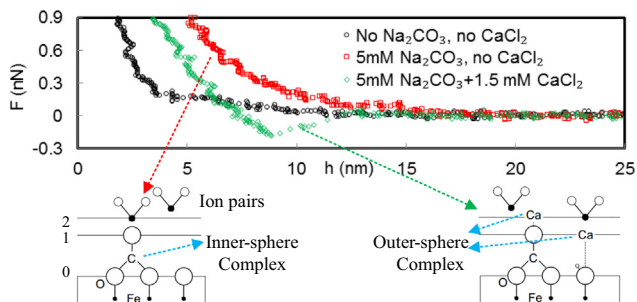


Regular Article

Red mud carbonation using carbon dioxide: Effects of carbonate and calcium ions on goethite surface properties and settling

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GRAPHICAL ABSTRACT



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ABSTRACT

Carbonation using CO_2 appears as an attractive solution for disposing of red mud suspensions, an aluminum industry hazardous waste since it also offers an option for CO_2 sequestration. Here we report the novel findings that CO_3^{2-} together with Ca^{2+} can significantly affect the surface properties and settling of goethite, a major component of red mud. Specifically, their effects on the goethite surface chemistry, colloidal interaction forces and settling in alkaline solutions are investigated. The surface potential becomes more negative by the formation of carbonate inner-sphere complexes on goethite surface. It is consistent with the strong repulsion, decreased particle size and settling velocity with increased carbonate concentrations as measured by atomic force microscopy, particle size analysis, and particle settling. Adding Ca^{2+} that forms outer-sphere complexes with pre-adsorbed carbonate changes goethite surface charge negligibly. Changing repulsion to the attraction between goethite surfaces by increasing calcium dosage indicates the surface bridging, in accordance with the increased settling velocity. The adverse effect of carbonate on goethite flocculation is probably due to its specific chemisorption and competition with flocculants. By forming outer-sphere complexes together with the flocculant-calcium bridging effect, calcium ions can eliminate the negative influence of carbonate and improve the flocculation of goethite particles. These findings contribute to a better understanding of goethite particle interaction with salt ions and flocculants in controlling the particle behavior in the handling processes, including the red mud carbonation.

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1. Introduction

In the Bayer process used in the aluminum industry, the crushed bauxite ore is digested by concentrated caustic solution

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