A Model for the Shear Thickening Effect of Raking Systems on Red Mud.

Charles Nadeau¹, Damien Boudeville², André Leclerc³, Romain Chesnaux⁴, Guy Simard⁵ and Alain Boivin⁶
1. Graduate Student,
2. Graduate Student,
3. Professor,
4. Professor,
5. Professor,
6. Senior Research Scientist,

Université du Québec à Chicoutimi, Chicoutimi, Québec, Canada
Corresponding author: aleclerc@uqac.ca

Abstract

Raking systems are commonly installed in settlers used in the mining industry. They contribute to the thickening of the mud and to its displacement towards the underflow. These effects have been known for many years, but the understanding of the compaction mechanisms is incomplete. A better understanding of these mechanisms would facilitate rake design improvements and would allow for a more accurate assessment of their efficiency. Several software suppliers propose commercial codes that simulate fluid flow, but unfortunately, no software application has been identified to simulate the compaction of mud by the shearing action of a rotating rake. Red mud compaction by shear action has been measured in our laboratory using a novel and unique experimental set-up. The observed data agree well with a semi-empirical mathematical model that we have established based on shear strain. This model has been incorporated as a compaction module into the ANSYS FLUENT fluid flow software to simulate the mud compaction by a rotating rake. The compacting performance of rake systems under various operational conditions can therefore be investigated.

Keywords: Red mud; shear strain thickening; compaction; rake.

1. Introduction

In the Bayer process, settlers are used for clarification and thickening of the bauxite residue. Thickener rakes contribute to the thickening of the slurry and to its displacement towards the underflow. Although the thickening action of a rake is a key issue, the understanding of the rake compaction mechanisms is still incomplete today. Buscall and White [1] have indicated that the permeability and the compressive yield stress of a concentrated suspension are factors contributing to its thickening. Usher and Scales [2] used fundamental theoretical models to predict the compressive dewaterability of thickener suspensions, based on the suspension compressive yield stress and hindered settling function. Discrepancies between predicted thickener performance and actual performance were attributed to shear processes such as raking. Farrow et al. [3] investigated the relative importance of compression and shear for dewatering of kaolinite suspensions. They concluded that rake action, not compression, was the dominant dewatering mechanism. Du et al. [4] studied the effect of raking on the structure of a flocculated kaolinite suspension, and stated that:

“While forming this self-supporting structure resisting the self-weight compression, this network structure is also fragile to additional applied shear stress, evidence showed by the results from Malvern Mastersizer”.