Implementation of Thickener Feedwells Upgraded Using CFD-PBM Method at UC RUSAL

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Abstract

Gravity settling of the slurries in the thickeners is a common process solution at alumina refineries. Thickener efficiency influences the potential capacity of the entire refinery. Upgrade of the feedwell design is one of the means to enhance the performance and improve slurry separation providing for the better mixing of the slurry with reagents to stimulate residue settling. For this task UC RUSAL's specialists use computational modelling with a verified in-house method of slurry flocculation modelling, i.e. CFD-PBM. The paper discusses the method of slurry flocculation modelling and elaborates on the approaches and criteria for designing the feedwell of the thickener. Furthermore, it presents the results of testing the thickener design options at UC RUSAL's alumina refineries.

Keywords: CFD, PBM, Thickener, Feedwell, Flocculation.

1. Introduction

In hydrometallurgy, of great importance in separation of suspension into liquid and solid components is a thickener. Thickener efficiency influences the potential capacity of the entire refinery and cash cost of the products. Therefore, one of the ways to raise efficiency of a thickener is to upgrade feedwell design. A feedwell is one of thickener structural units where feed flow energy is dissipated and a feed slurry is mixed with chemical reagents, i.e. a flocculant or coagulant to improve the settling rate of the slurry in the thickener. Flocculation is essentially a process of particles aggregation in flocs accompanied by simultaneous growth and breakage for the account of shear stress in liquid. It is a dynamic process with the rate depending on properties of particles, flocculant and mixing conditions. Improper flocculation process decreases the efficiency of solids settling thus degrading the quality of the overflow and deteriorating the sand compaction. The prevailing means to improve thickener performance at alumina refineries is increasing the flocculant dosage, as it is the commonly available solution. However, as experience shows this method does not necessarily improve the sedimentation process, leads to excessive floc consumption (expenses for the flocculant can amount to up to USD > 1.5 per 1 tonne of alumina), and can result in excessive foam formation in the feedwell.

This paper presents the methods of studying the flocculation process and analyzing the performance efficiency of the thickener feed unit using mathematical modelling. Besides, the paper elaborates on the approaches and criteria for selecting/determining the design of a thickener feedwell. Finally, it discusses the results of testing the upgraded thickeners at UC RUSAL's refineries.

2. Laboratory Study of the Flocculation Process

As has been mentioned before, flocculation is promoted by the shear stresses in the flow. Shear stresses provide for thorough mixing and high probability of collisions between particles and, therefore, rapid growth of flocs.

One of the most efficient methods of flocculation monitoring is Particle Track tool with FBRM technology. This tool provides for online monitoring of changes in particle size and structure in the system, thus enabling to get more insight into the behavior of the system and impact of various process parameters on flocculation efficiency. FBRM tool uses a rotating laser beam to contact the particles. Figure 1 shows a principle of FBRM functioning. References [1, 2] give a detailed description of FBRM technology.

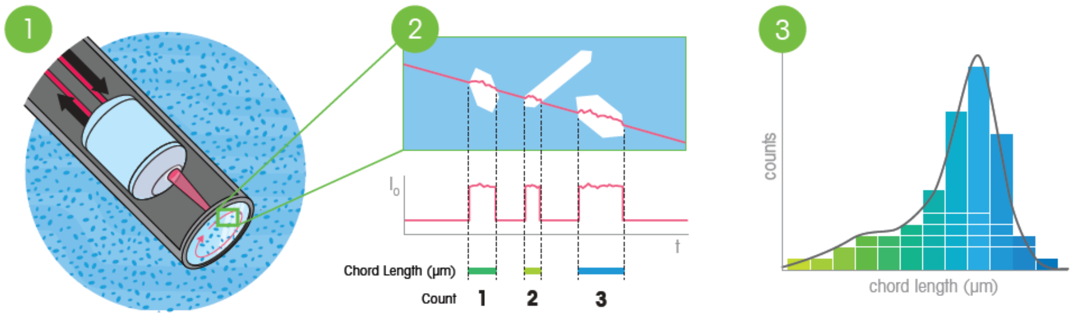

Figure 1. Principle of FBRM functioning.

FBRM technology was used to study the flocculation of the nepheline mud slurry from JSC RUSAL Achinsk. Flocculation process was simulated in a 250 ml beaker equipped with a FBRM probe and a mixer to improve the mixing of the slurry with the flocculant (Figure 2). The impact of shear rates on the floccule growth and breakage was investigated. Figure 3 shows the dependences of changes of the mean lengths of chords under different flocculation conditions. The graphs demonstrate two stages of the flocculation process, i.e. in the beginning of the flocculation process particles quickly aggregate, however, when flocs become larger, their susceptibility to breakage increases. The data presented indicate that the largest flocs were obtained at the shear rates of 50–100 s^{-1}. As can be noted, floccule active growth lasted for a little over 20 s.

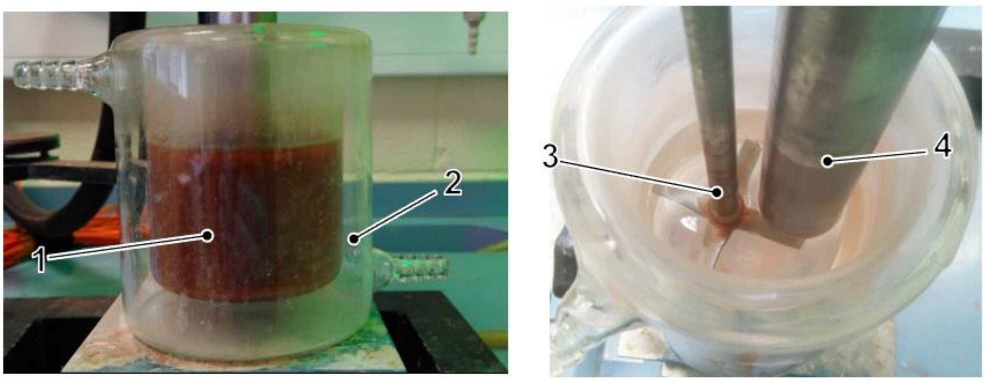

Figure 2. The laboratory set-up for the mixing of the slurry and flocculant.
1 – slurry, 2 – container, 3 – impeller, 4 – FBRM probe.

7. References

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