Improving the Alkali Recovery Efficiency of Red Mud Sedimentation System

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Abstract

The principle of soda recovery in a clarification and red mud washing system has been studied, and the traditional settling process has been systematically modified. A new type of high-efficiency settler has been developed, which can significantly improve the settling efficiency and increase the soluble soda recovery from red mud. A DSP (DeSilication Product) soda recovery process has been added to the red mud washing system to substitute and recover DSP soda from red mud by adding lime. Multi-scenario simulations of varying the red mud washing stage, at which the DSP soda recovery process is implemented, have been performed using SysCAD simulation software to identify the configuration with the lowest soda losses. These simulations including the laboratory tests have shown that a reduction of the DSP soda losses by more than 53.8 % and a reduction of the soluble soda losses by about 40 % can be achieved with the modified clarification and red mud washing system. This new type of clarification and red mud washing system can significantly reduce the soda consumption and provide important guidance to alumina plants.

Keywords: Red mud, Soluble soda recovery, High-efficiency settler, DSP soda recovery, Process simulation.

1. Introduction

Clarification and red mud washing is a key process in alumina production, and settlers are the most commonly used equipment for red mud solid-liquid separation in modern alumina refineries. The diluted digested slurry enters the clarifiers, where, under the effect of a certain amount of flocculant, the solids sink rapidly by gravity, and the overflow with low turbidity goes to the downstream process, while the compacted underflow slurry goes through several counter-current washing stages to minimize soluble soda losses with the discharged red mud.

Red mud soda losses mainly include DSP soda losses (mainly sodium aluminium silicate) and soluble soda losses. DSP soda losses mainly depend on the bauxite composition and the digestion process. Soluble soda losses are mainly affected by the red mud washing water flow, the number of washing stages and the individual washing efficiencies. Based on the composition and character of a given bauxite, the most suitable process parameters are selected to optimize operating costs. The DSP soda losses and red mud wash water flow are a result of this economic optimization. The soluble soda losses can be reduced either by increasing the number of washing stages and/or improving the red mud washing efficiency. To do the latter one, a possible pathway is to improve the performance of the settler. DSP soda losses can be reduced via a DSP soda recovery process which can displace soda from red mud into the liquor. The economics of the inputs and outputs of the DSP soda recovery process should be evaluated, though.

2. Study and Application of a New Type High-Efficiency Settler

Alumina refineries primarily utilize flat-bottom and conical settlers. Conical settlers are commonly used in greenfield and brownfield alumina refinery projects for the significant advantages they present, which are a higher settling efficiency and a smaller footprint. If clarifiers and washers have the same diameter, due to the relatively difficult settling conditions in clarification, typically two settlers are put in parallel to receive diluted digestion slurry, and the rest of the settlers operate in series as washers, with the settling performances getting gradually better after each stage. Typically, four to six washing stages are necessary to achieve the target soluble soda losses.

Red mud decantation in settlers is divided into four zones, as shown in Figure 1: the clarification zone, the settling zone, the transition zone and the compression zone. When the settler is operating at a steady state, the feed mass flow equals the discharge mass flow, the interface height of each zone remains unchanged, and red mud is continuously decanting in the settler. The red mud slurry enters the settling zone from the bottom of the feed well and starts gravity settling. Red mud particles in the settling zone bear less resistance, and the settling speed is high. Red mud particles in the transition zone are subject to increased resistance, and the settling speed is gradually reduced. Red mud particles in the compression zone are piled up layer by layer, gravity does no longer play a dominant role, and active settling switches to passive compression.

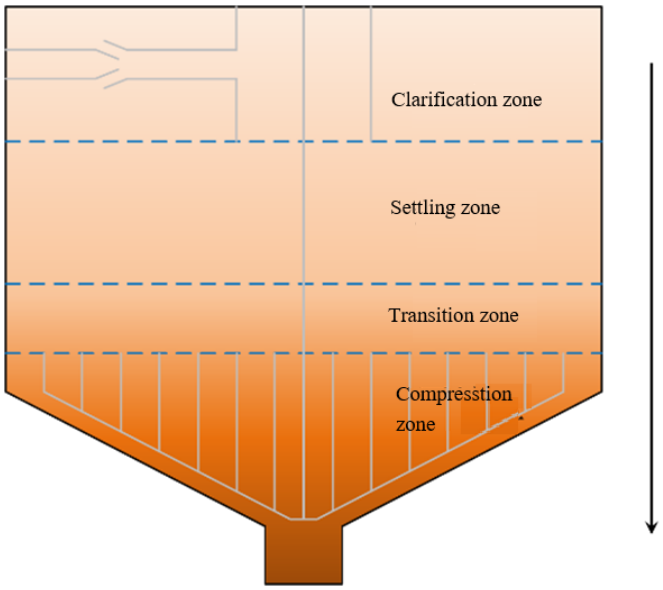

Figure 1. Red mud solid distribution in the settler.

Furthermore, the settling character of red mud from different bauxites varies greatly. In alumina refineries, increasing the flocculant flow normally allows to achieve higher red mud settling performances, including treating capacity and washing efficiency, but the effect is limited. Developing high-efficiency red mud settling technology and equipment that is capable to achieve higher compaction rates allows for an increase in the unit area's solids throughput capacity and underflow solids contents.

The use of lime milk is currently one of the main technologies for red mud DSP soda recovery in alumina refineries. Through experiments on red mud generated from gibbsitic bauxite with the aim to select the optimum reaction conditions, it is recommended to target a C/S value = 2.0–2.1, a residence time of not less than 3h, so as to achieve a DSP soda recovery efficiency above 53.7 %.

The clarification and red mud washing process has been digitally modelled using simulation software, and multi-scenario simulation has been performed. With improved high-efficiency settlers, an additional washing stage can be obtained, and, in combination with the DSP soda recovery process, the total red mud soda losses can be reduced by about 48 %.

The new high-efficiency settlers and DSP soda recovery process has been applied in some refineries, the total soda consumption has been reduced by about 30 %, which is less than the modelled result. Lime addition should be optimized relative to the costs of soda, alumina, lime, steam and electricity to maximize economic profit.

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7. References

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