Nalco CGMax^{TM}: A tool for alumina yield improvement and product quality control

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Abstract

Alumina refinery operators have to control alumina product quality within prescribed specifications demanded by smelter operators, as well as for environmental and operational reasons. At the same time operators want the highest possible liquor productivity (alumina yield) from their precipitation circuits. Experience shows that precipitation conditions that favour good product quality are often times opposed to those that favour high liquor productivity. Nalco has developed a new generation of crystal growth modifiers (CGMax) that have high trihydrate coarsening potency and allow for both high yields to be pursued in the precipitation circuit while maintaining product granulometry within specification.

Keywords: Bayer; precipitation; crystal growth modifier; alumina quality; Nalco CGMax

1. Introduction

The Renukoot alumina refinery located approximately 160 km from Varanasi in Uttar Pradesh in India is also part of Hindalco's integrated aluminium production facility at the site. First commissioned in 1962 the facility includes bauxite mining, the Renukoot alumina plant and an aluminium smelter as well as downstream rolling and extrusion operations. The alumina refinery processes local bauxite, using conventional Bayer process technology and has a capacity of 700 000 tonnes per annum, making it the largest of Hindalco's alumina plants in India.

As with all alumina producers, optimization of operations throughout the circuit is a constant aim for the Renukoot plant. In 2014 a particular focus was achieving better performance from the precipitation area of the plant – specifically, improved control of product sizing to the appropriate specification together with enhanced precipitation yield. In discussions with Nalco staff, the potential application of a recently developed range of new crystal growth modifiers, the CGMax technology, was seen as a possible means to achieve the required goals.

While the refinery had previously used crystal modifiers from a range of suppliers, the enhanced performance and specific properties that the CGMax products offered were seen to potentially achieve a far better outcome. As a result, a process of assessment to identify the most appropriate product was instigated and plant trials were conducted over a number of months. The results and outcomes of this program are the subject of this paper.

2. Use of crystal growth modifiers

Crystal growth modifiers or CGMs were originally developed and commercialized by Nalco in the 1980's [1]. The original formulations were mainly targeted at coarsening the particle size distribution of precipitated trihydrate alumina and enhanced particle size control has continued to be the primary reason for use of CGM more broadly across the industry. More recently however, a range of additional properties and potential benefits of CGM use have been developed and recognized. These include the potential impact on oxalate stability and morphology [2], as well as the impact of reducing occluded soda [3] and enhanced particle toughness [4]. In addition, a great deal of work has been focused on obtaining a comprehensive understanding of the mechanism of the action of crystal growth modifiers [5, 6] as well as their impact under a variety of dosing regimens and process conditions [7, 8, 9]. A number of case studies outlining plant experience with CGM use have also been published [4, 10].

Building on the first generation of CGM products, Nalco has more recently developed a second generation of CGMs which, along with the original products, define the CGMax range [11]. This broader range of products means that the optimum product can be chosen for individual refineries to deliver the most effective coarsening impact, along with additional properties which may be desirable.

In general terms all the CGMax products have the same general mechanism to enhance trihydrate particle sizing. Despite their name, there is little evidence that crystal growth modifiers actually have any impact on growth of trihydrate particles. The major impacts on precipitation are improved agglomeration as well as inhibition of secondary nuclei formation [6].

It should be noted that all CGMax products can only enhance these existing mechanisms when they occur. CGMax products do not act as “glue” to promote particle aggregation in the absence of cementation via crystallization of trihydrate from solution. The liquor conditions must be sufficiently supersaturated and appropriate seed of suitable size and quantity must be present for any CGM to function. As a result, assessment of performance under lab conditions typically involves short precipitation tests using highly supersaturated (typically LTP) liquor seeded with fine seed solids. Standard test conditions have been used throughout this work [11].

The new generation of CGMax products are typically much more effective in achieving a coarser particle size distribution from precipitated trihydrate. Figure 1 shows the dose response of a conventional (first generation) CGM product versus one of the new CGMax (second generation) products in a standard laboratory test. The data is plotted as a change in the % +45 μm against the dose of modifier measured as a function of the available seed surface (mg of product per m^2 of seed surface).

As surface active agents, the dose required of any crystal modifier will be dependent on the surface area of seed material available. Typically in plant operations seed is measured on a mass basis, but for a more detailed comparison, as presented here, equivalence in terms of seed surface area is more appropriate.

Regardless of the measure, it is clear from this data that, while both products are effective in reducing fines (that is, increasing the amount of % +45μm material resulting from the crystallization process), clearly the new CGMax material is significantly more effective in coarsening the precipitated trihydrate.

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