AA05 - Design and Analysis for the Optimization of Synthesis Technological Conditions of Tricalcium Aluminate Hexahydrate

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Abstract

Tricalcium aluminate hexahydrate (TCA) is widely used as a filter aid during purification of unpolished pregnant liquor within the security filtration, whose physical properties (like particle size, specific surface area and so on) directly affect filter efficiency and filter cloth life. Based on the process of alumina production, TCA was prepared using sodium aluminate solution and hydrated lime. In addition, the effect of caustic soda concentration (N_k), temperature, duration time and C/A molar ratio on TCA particle size and specific surface area were analyzed. At the same time, orthogonal experiments were designed to analyze the influence sequence of various factors, which can provide us with guidance for preparing TCA that meets different requirements.

Keywords: Tricalcium aluminate hexahydrate, particle size, specific surface area, orthogonal experiments.

1. Introduction

Compared with sintering process when dealing with bauxite bearing low silicon, Bayer process has some merits, like simpler process, less energy or production cost and so on, thus about 90% or more alumina and aluminum hydroxide product obtained from Bayer process all over the world [1].

Tricalcium aluminate hexahydrate (TCA) act as an important role within a Bayer refinery, which comes from the reaction between sodium aluminate and lime within the Bayer process. TCA has amount of functions, like reducing soda lost during pre-desilication and digestion process, being used as filter aid. Among above functions, the main role is using as a filter aid, in which it assists with the removal of impurities from polished liquor before the precipitation process and enhances the filtration efficiency, and prolong leaf filter duration time [2-6].

Typically, TCA is prepared by the reaction of lime or slaked lime with sodium aluminate solution, in which spent liquor or polished liquor are usually used as reaction solution. Major reaction equations are as follows [7]:

$$3\mathrm{CaO} + 2NaAlO_2 + 7H_2O \rightarrow 3CaO \cdot Al_2O_3 \cdot 6H_2O + 2NaOH \quad (1)$$

$$3\mathrm{Ca}(OH)_2 + 2NaAlO_2 + 4H_2O \rightarrow 3CaO \cdot Al_2O_3 \cdot 6H_2O + 2NaOH \quad (2)$$

Above reactions are idealized, while the actual reaction process is complex. Based on theory analysis and experimental investigation, it can be seen that reaction conditions involved in this synthesis process, like caustic soda concentration (N_k), reaction temperature (T), duration time (ɵ) and C/A molar ratio, will have an influence on the TCA production especially its morphology,

which may affect its physical property such as filtration efficiency, leaf filter duration time and so on.

Given the importance of synthesis for TCA on its chemical and physical properties, the impacts of synthesis technological conditions on Tricalcium aluminate hexahydrate were investigated. In addition, based on the theory analysis and orthogonal experiments, the optimization of process conditions was explored.

2. Experiment

2.1 Raw Material

Plant lime (alumina refinery, Shan xi, available CaO 89.26%), spent liquor after precipitation (SLP), cycling liquor (CLP), the total caustic (NT) and caustic soda concentration are expressed in gpl Na_2O. Sodium Aluminate (AO) is expressed as g/l Al_2O_3. The liquor analysis is displayed in Table 1.

Table 1. Composition of various liquor used.

liquor type	NT	AO	NK	ak
SLP	194.19	91.37	162	2.92
CLP	271.46	130.18	228	2.88

2.2 Equipment and Methods

Tests were performed in the laboratory to simulate the preparation of TCA. In order to control reaction temperature and agitation efficiency properly, an oil bath was used during the preparation of TCA (Figure 1).

To obtain the information about particle size distribution (PSD) in the TCA products and evaluate the percentage of particles less than 5μm and average size, Particle size distribution analysis were performed using light scattering equipment (Mastersizer 2000 da Malvern).

To better understand the morphology of TCA product, BET specific surface area was also measured and analyzed based on nitrogen adsorption method.

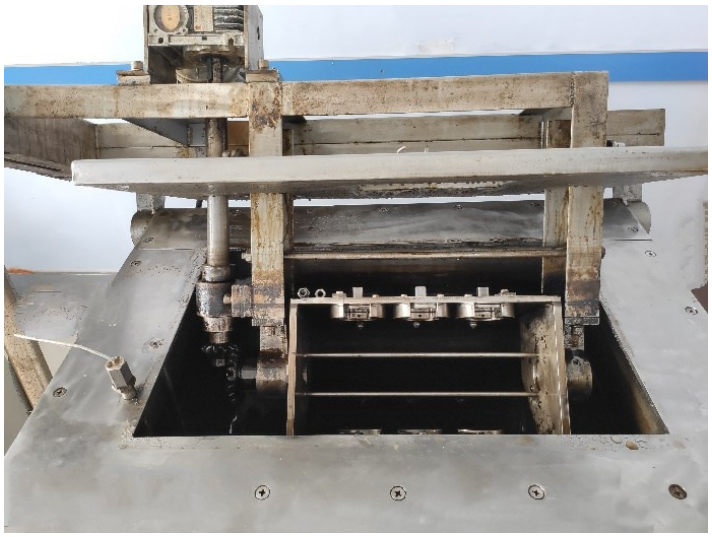

Figure 1. Oil bath equipment.

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