Key Technologies for Energy Consumption Reduction of Aluminium Hydroxide Calciners

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Abstract

This paper outlines the development and technological advancements in the calcination of aluminium hydroxide to produce Smelter Grade Alumina. It provides a detailed explanation of the physical and chemical reactions involved in the calcination process of aluminium hydroxide. In-depth research is conducted on improving separation efficiency, with a particular focus on analysing the inlet gas velocity of the cyclone separator and the insertion depth of the vortex finder. By optimizing the refractory lining design and materials, heat losses are reduced. Additionally, a novel low-temperature calcination technology is developed, which extends the residence time of the alumina in the high-temperature zone, thereby achieving reducing specific fuel energy and resulting carbon emissions.

Keywords: Calcination, Separation efficiency, Residence time, Energy consumption.

1. Introduction

Shenyang Aluminum & Magnesium Engineering & Research Institute (hereinafter referred to as SAMI) has accumulated extensive experience in the design, R&D, and production of alumina calciners through nearly 30 years of development and technological innovation. Currently, SAMI possesses the capability to design and develop alumina calciner equipment with capacities ranging between 500 and 6000 t/d (tonnes per day).

2. Development History of Alumina Hydrate Calciners

In the early stage of alumina production, rotary kilns were primarily used. Since rotary kilns have relatively high heat losses, high energy consumption and failure rates, they have gradually been replaced by gas suspension and circulating fluidized bed calciners [1].

The world's first gas suspension calciner for alumina was put into operation in 1986 by Denmark's FLSmidth at Hindalco Industries Limited, with a daily capacity of 1000 tonnes, replacing three rotary kilns [2]. China's first gas suspension calciner was introduced in 1987 by SAMI. After years of technological innovation, SAMI has improved their technological capabilities and developed their independent intellectual property. Currently, the largest single-capacity calciner in domestic production is 4000 tonnes per day, designed by SAMI and has been implemented in the Chongqing Jiulong Wanbo Project.

The first generation of alumina hydrate calciners adopted a vertical arrangement, as shown in Figure 1.

It mainly consists of four parts:

(1) Drying and preheating of raw materials (PO1, PO2)
(2) Calcination of raw materials (PO3, PO4)
(3) Primary air-cooling system (CO1-CO4)
(4) Secondary water-cooling system (KO1, KO2)

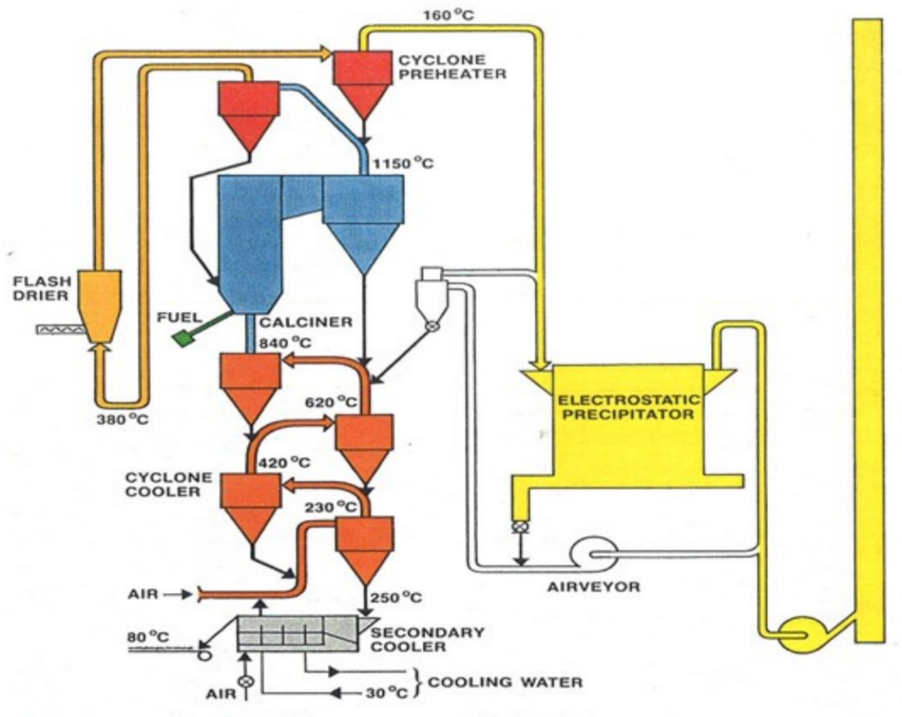

Figure 1. Vertical layout diagram of alumina calciner [2]**.**

Although most of rotary kilns have been replaced, some refineries have still implemented improvements on rotary kilns, as shown in Figure 2, to enhance heat recovery efficiency and reduce energy consumption.

With the advancement of design and technology, a calciner with a horizontal arrangement has been successfully developed, which significantly reduced the overall height of the calciner (as shown in Figure 3) and lowered the investment costs.

By 2013, with the increase in single production line capacity of alumina refineries, the demand for large-scale calciners became urgent. In 2015, SAMI successfully developed a 3500 tpd calciner with the largest single-unit capacity in China, which was successfully applied at Chalco Shanxi Huaxing Refinery and Xinfa Xiaoyi Refinery in 2016.

With the implementation of China's "Dual Carbon" strategy, energy-saving and carbon reduction objectives have become key directions for further research and development for alumina calciners.

Currently, the studies on reducing energy consumption at home and abroad mainly includes partial modifications and waste heat utilization. Among these, partial modifications mainly include the following aspects.

6. Conclusion

This paper provides a brief overview of the history of the development of SAMI's alumina calciners, analyzes and summarizes the mechanisms of the calcination process, and focuses on the study of gas-solid heat transfer technology, heat transfer efficiency, the influence of refractory lining on heat dissipation losses, as well as energy-saving and carbon reduction technologies.

Through research and analysis, it has been found that adopting a multi-layer optimized refractory lining design can reduce heat loss by approximately 15 %. A technology for low-temperature calcination has been proposed, which can lower the calcination temperature by 100 °C, demonstrating significant energy-saving and emission reduction effects. Based on the results presented in this paper, the proposed technologies present substantial economic benefits for both new calciners and for retrofit projects.

7. References

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