Carbon Footprint Reduction in Alumina Calciners

Pungkuntran Jaganathan
Global Product Line Manager, Alumina Calcination
FLSmidth Private Limited, India
Corresponding Author: jp-in@flsmidth.com

Abstract

This paper outlines several design changes in the Gas Suspension Calciner. The design changes presented include: 1) a change in cyclone dimensions with the aim to lower the gas velocity to thereby reduce pressure drop & wear on vortex finder and to reduce particle breakdown, 2) improved refractory design to minimize radiative heat losses, thereby reducing the thermal energy consumption and, 3) other improvements in the calciner such as an optimized hot vessel design, start-up burner relocation and a plant layout with a lower building height. Also keeping with our Mission Zero goals, the introduction of these latest technologies, and aided by digital solutions, help customers move towards greener processes by reducing thermal energy and power consumption as well as CO_2 emissions.

The paper also presents some details of hydrogen firing for alumina calcination following a research and development program.

Keywords: Alumina, Calciners, Thermal energy consumption.

1. Introduction

FLSmidth has experience with Gas Suspension Calciners (GSC) over the past 40 years from different hydrate sources calcined in both pilot and full-scale Gas Suspension Calciners of various design and capacity.

Calcination is the final step of the Bayer process where alumina is produced from aluminum trihydroxide (Hydrate, Gibbsite). After calcination, alumina is sent to a smelter where pure aluminum is produced.

In 1976 FLSmidth had commissioned the first industrial Gas Suspension Calciner (GSC) technology for the pre-calcination of raw meal (~70 % limestone fines) in a new 4600 tpd cement clinker production line in Japan. The pre-calciner operating temperature was about 950 °C with few seconds of solid retention time.

Since the basic research and development work and prototyping of the gas suspension calcination technology was developed and done for cement raw meal it was relatively straight forward for FLSmidth to adopt this calcination furnace/reactor technology for alumina production (in 1976).

The timing of this technology spin-off was very fortunate as FLSmidth had lost its dominating world market position for supply of rotary kilns for production of sandy or floury alumina when the last rotary kiln for alumina was contracted in 1974.

Ten years after FLSmidth started the development with pilot plant testing in 1976, the first GSC unit with a calcining capacity of 1000 tpd and calcination furnace temperature around 1050 °C for Smelter Grade Alumina (SGA) was commissioned at Hindalco [1], India in 1986, replacing three old FLSmidth rotary kilns.

2. Gas Suspension Calcination (GSC)

The First GSC technology had a vertical arrangement (refer to Figure 1) and comprised of the following main sections:

- Drying and Pre-heating/Pre-Calcination of feed material in cyclones
- Calcination Furnace and Furnace Cyclone
- Direct Heat Recovery from alumina by cooling with Air in Four (4) stage Cyclone cooler.
- Indirect alumina cooling with water in a Fluxo Cooler.

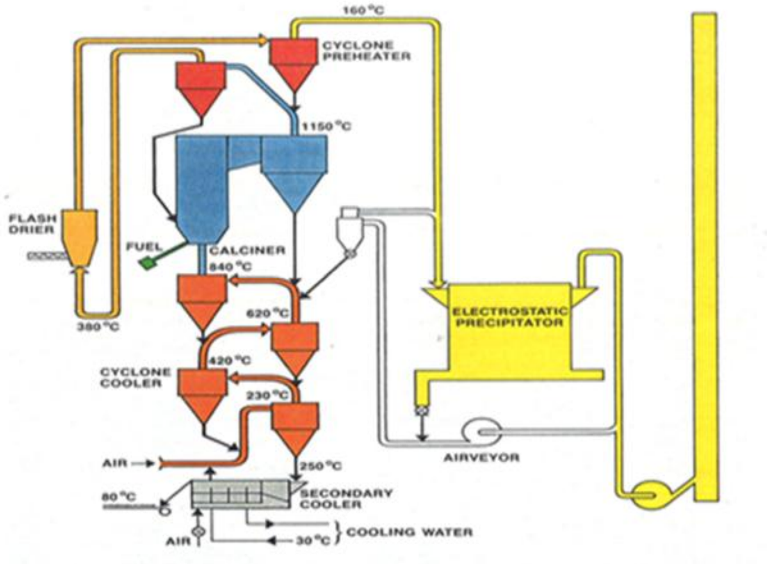

Figure 1. Gas Suspension Calciner vertical arrangement.

In 1986, Eurallumina, Italy, decided to retrofit one of three Ø3.95 × 107 m long rotary kilns producing 900 tpd sandy alumina with an oil fired GSC unit to produce 1550 tpd SGA. The specific energy consumption was reduced to 3100 kJ (LHV) per kg SGA from about 4100 kJ (LHV) per kg with the kilns. The alpha-phase content was reduced from about 18% to 2–5% in the SGA for the same SSA, furthermore the LOI (300–1000 °C) was reduced from 0.8% to 0.55–0.65 wt%.

The use of oxygen to allow for operation at lower flash calciner velocity levels while maintaining the production rate did result in stable operation, a reduction in the fuel consumption and a reduction in the < 45 microns fines content in the alumina product.

There was no evidence of moisture condensation or bag cleaning issues in the jet pulse bag filter at any time during the pilot program. The bag filter was cleaned with compressed air at ambient temperature.

A significant reduction in NOx emissions were observed during steam-based calciner operation versus NOx emissions measured during air-based operation.

Based on the successful trials, FLSmidth has engineered a plant (Confidential Client) which is expected to be commissioned shortly.

4. Conclusions

This paper has presented details on some key design changes introduced to the FLS GSC to improve performance and reduce energy consumption and particle breakdown. The main improvements described were:

- Redesign of riser ducts in GSC
- Improved refractory design
- Optimization of hot vessel
- Redesign of distribution box
- Cyclone design optimization

These design changes are expected to have the potential to lower the specific fuel energy consumption to 2650 kJ/kg. Most of these changes were implemented in Utkal Alumina India Line-3 and have been running satisfactorily since the last 2 years.

Based on pilot testwork FLS is ready to supply calciners based on hydrogen firing.

5. References

1. Raahauge, B. E. et all,”Experience with Gas Suspension Calciner for Alumina”, Light Metals 1991.
2. S. Wind and B.E. Raahauge, “Development of Particle Breakdown and Alumina strength during calcination”, AQW, 2012.
3. Wind, S. and B.E. Raahauge, Energy efficiency in gas suspension calciners (GSC). Light Metals (Warrendale, PA, United States), 2009
4. Raahauge, B.E. "Smelter Grade Alumina Quality in 40+ Year Perspective - Where to From Here?" Proceedings of the 10th International Alumina Quality Workshop pp.xx-yy, 2015
5. Raahauge, B. E. and Niranjan,”Experience with Particle Breakdown in Gas Suspension Calciners”, ISCOBA 2015.
6. S. Wind and B.E. Raahauge, “Experience with Commissioning New Generation Gas Suspension Calciner”, TMS, 2013
7. Raahauge, B. E.,”Thermal Energy consumption in Gas Suspension Calciners”, ISCOBA 2017.