Evaluation of Rho Alumina Binder on Setting Behaviour Due to Soda Additives and Retarder

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Abstract

Rho alumina is a vacuum produced phase. It is substantially amorphous, and the surface area is around 200 m^2/g. Rho alumina reacts with water at room temperatures and hardens. Because of this bonding property of Rho alumina, in presence of water, this product is widely used as a replacement of cement bond in castables. Usage of alumina binder improves the high temperatures properties of the castables. It also improves the flow properties of the castable mix. Hence it is mostly preferred for the manufacture of No cement castable (NCC), Ultra Low Cement Castable (ULCC), especially where self-flow or pumpable properties are required. Since this is hygroscopic material, it absorbs moisture from atmosphere leading to the deterioration of setting property. In the present investigation an attempt has been made to determine the shelf life of the Rho alumina by evaluating the change in the basic properties of this material like LOI, SSA and XRD phases with the passage of time. An attempt has also been made to find a suitable retarder (with dosages from 0.05 % to 1 %) soda additive and its dosage to obtain desired setting time of this binder. Retarder additive A1 has no effect on the setting time, A2 exhibits increases is setting time at 1 % level. Retarder A3 appears to be a good retarder for this system.

Keywords: Alumina Binder, Hydratable Alumina, Retarder, Setting time, Shelf Life.

1. Introduction

Primarily Rho alumina is a vacuum produced phase [1]. It is substantially amorphous, as its X-Ray pattern shows only a few diffused bands. Its surface area is normally ≥ 200 m^2/g and micropores are not accessible to nitrogen. Rehydration of this material by water at 25°C gives very pure bayerite. It can be produced either by thermal dehydration of gibbsite at 600 °C in vacuum or by flash dehydration of gibbsite by a short time contact with hot air blast at 600 to 900 °C [2]. Rho alumina reacts with water at room temperatures and hardens by the process described by the following equation.

$$\rho Al_2O_3 + H_2O \rightarrow \underset{\text{(Bayerite)}}{Al_2O_3.3H_2O} + \underset{\text{(Boehmite gel)}}{Al_2O_3.1-2H_2O} \quad (1)$$

Because of this bonding property of Rho alumina, in presence of water, this product is widely used as a replacement of cement bond in castables. Usage of alumina binder improves the high temperature properties of the castables. It also improves the flow properties of the castable mix. Hence it is mostly preferred for the manufacture of No Cement Castable (NCC), Ultra Low Cement Castable (ULCC), especially where self-flow or pumpable properties are required.

Prior to 1996 this product was commercially available with Almatis (Alphabond) and Alteo (Actibond). Considering the increasing acceptance of this product by refractory industries, Hindalco developed the material (RH01) and decided to enter commercial market. Since literature on Rho alumina is limited and its production process as well as techniques of evaluation are patented, very little information is available on its basic properties, like shelf life, consistency (water requirement), setting time, etc. Hence Hindalco felt the necessity of generating basic data on this material to provide application support to its customers.

In the present investigation, an attempt was made to determine the shelf life of RH01 by evaluating the change in the basic properties of this material over time. Attempt has also been made to find a suitable retarder and its dosage to delay the setting time of this alumina binder.

2. Materials Used

The physical and chemical properties of RH01 used for the study are presented in Table 1. The calcination of this material was done in BRDC Pilot Flash Calciner (PFC) and milled in pilot ball mill as per the conditions mentioned in Section 3.1. Like other hydratable alumina binder [3], the material has high SSA (196 m^2/g) as well as high LOI (8.2 %). As usual the soda content of this material is also high (Table 1). The Sedigraph analysis shows a wide particle size distribution (Figure 1) with a d_{50} of 3.8 µm.

Table 1. Analyses of the RH01 used for the study.

Properties	Units	Values
XRD		Amorphous (Trace gibbsite)
SSA*	m^2/g	196
LOI	%	8.2
d_{50}	µm	3.8
Consistency	%	36
Initial Setting Time	min	5.5
Final Setting Time	min	9.5
SiO_2	%	0.014
Fe_2O_3	%	0.013
Na_2O	%	0.62
CaO	%	0.026

** Degassing temperature: 300 °C*

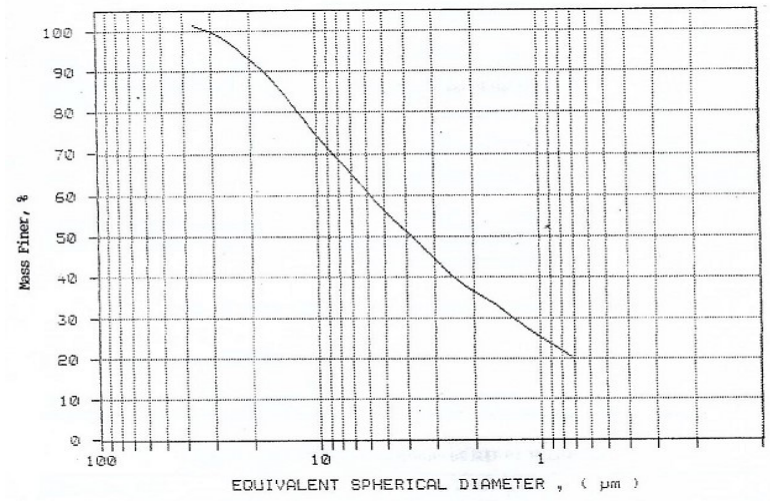

Figure 1. Particle size distribution of RH01 used for the study.

2. Anantha Krishnan, S.K., Indian Aluminium Company, Limited, Belgaum R&D Centre, 'Development of an Alumina Binder for No Cement Castable Application', *Report No. BRDC-96/10*, September 1996.
3. Hongo, Y., 'ρ-Alumina Bonded Castable Refractories'*, Taikabutsu Overseas,* Vol. 9, No. 1, p. 35-38, 1988.
4. Kapuri, N., Installation and Commissioning of Pilot Flash Calciner, *Indian Aluminium Company, Limited, Belgaum R&D Centre Report No. 2000/11*, August 2000.