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Kinetics of Agglomeration of Gibbsite $Al(OH)_3$ Crystals in the Precipitation Stage of the Bayer Process

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In the Bayer process, the crystallization of the aluminum hydroxide is one of the most important stages, which allows under specific conditions of operation to get production levels and specific quality features of the final product [1]. At C.V.G. Bauxilum, the crystallization stage includes a process of agglomeration, which consists in the crystallization of the solution of sodium aluminate (liquor) with fine hydrates previously classified as seeds required to get crystals of strong gibbsite and with the distribution of appropiated size [2].There are diverse factors that affect the agglomeration, the suspension temperature, the oversaturation and the liquor impurities levels, which condition the agglomeration efficiency [3-4].

The growth kinetics of the aluminum hydroxide crystal is slow in the agglomeration phase is the mechanism responsible of the crystals production with appropiate caracteristics. The crystallization proceeds in three stages: a first stage of encounter among the particles due to the hydrodynamic fluid. This stage is defined as collision frequency, subsequently a phase of association among particles that is a function of particule global interaction, and finally, a phase of consolidation also called cementation due to the crystal growing [5]. In this work ,was studied the kinetics of the gibbsite agglomeration which is fundamental to understand the mechanism (s) of crystallization that allows to optimize the alumina quality [6-7].

The tests of agglomeration were executed using the batch laboratory precipitators, with a temperature controller. For the realization of the agglomeration tests, one liter of process liquor was preheated 15 minutes at 72±2 ^{o}C, after that 80 g of wet seed with preestablished granulometry was added remaning for 1, 3, 5 and 7 hours of residence time. Four samples were taking under these conditions and analized by electronic microscopy. The liquor and the seed were obtained from C.V.G. Bauxilum plant.

For the caracterization by Scanning Electron Microscopy, it was used a HITACHI S-2400, the samples were prepared dusting on a aluminum portasample covered by a double tape of coal, following were introduced in a unit of metallic covering and they were covered with gold-palladium.

In the micrography corresponding to the seed, very small particles were observed on the crystals formed, coming from the solution of sodium aluminate, which adhere too well between the crystal borders on the flat surface of the same one. At the first hour of residence time the structures were observed in blocks shapes and small crystals adhereded among them, as it is appreciated in the Figure (1b), which illustrates a morphology of a high index of agglomeration. The micrography (1c) obtained at the 3th hour, shows more defined blocks with hexagonal morphologies, it is inferred that during this stage it exist a diffusion among the crystals and form new blocks of small dimensions. For the 5th hour of residence time the micrography (1d) evidences the presence of blocks of bigger size and beveled in the vertexes, due to the continuous diffusion process among them, that allows a bigger growth in the agglomerate. The micrography (1e) illustrates the kinetics for the 7th hour of residence time, the blocks are bigger that the observed in the previous stages, evidencing the phase of consolidation of the agglomerate by cementation.

The predominant mechanisms proposed for the kinetics of agglomeration process under the studied isothermic condition are the following : first, the particles migrate or move due to the concentration gradient of existent alumina in the solution, followed by the association among them. Later on the alumina crystals associated arrive to the surface of the seed and combine with others to produce crystals of bigger size, in pseudo hexagonal shape to form platelets by means of Van der Waals forces. Finally, the small crystals are incrusted by diffusion (cementation) and the seed particles together with to get the agglomerates grow good sizes.

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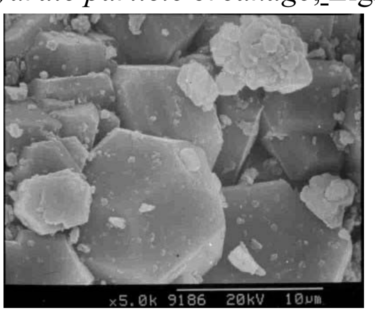
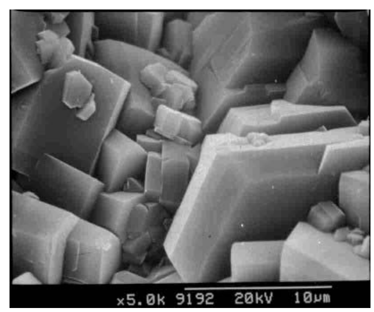
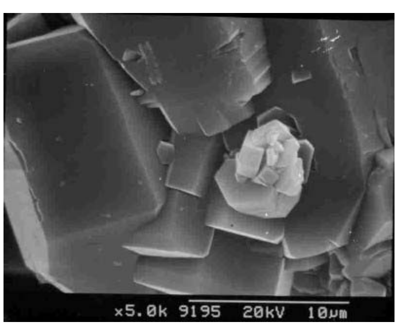


a) Initial seed

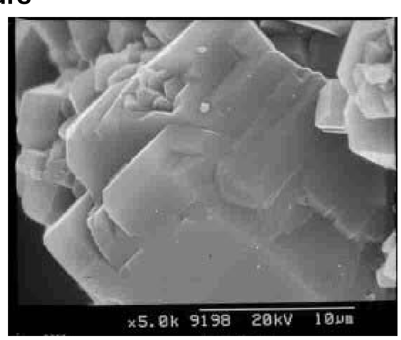
b) 1th hours



c) 3th hours



d) 5th hours



e) 7thhours

Fig.1. micrography for SEM, corresponding to the Figures 1 (a, b, c, d, e), illustrate the kinetics of gibbsite agglomeration with load of seed of 80g/l and temperature of 72 ± 2 ^{o}C

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