HEAT TREATMENT REGIME OF THE INITIAL ALUMINUM HYDROXIDE TO FORM MODIFICATIONS OF Γ AND A-AL_2O_3

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Abstract: *To obtain high-quality ceramics, it is necessary to grind the raw material and obtain a fine-dispersed structure. This problem was solved by converting aluminum waste and its alloys into nanostructured aluminum hydroxide, which allows obtaining ceramics with high properties. The heat treatment regime of the original aluminum hydroxide in air (1350 ^{0}C, 1 hour) was developed to convert it into aluminum oxide (γ and α - modifications), ensuring the preservation of high activity of the aluminum oxide powder for heating and bonding.*

Key words: *ceramics, fine-dispersed structure, aluminum, nanostructure, aluminum hydroxide, aluminum oxide, hydrogen generator, precursor, powder, heat treatment, γ-Al_2O_3, temperature, α-Al_2O_3, isothermal, furnace, modification.*

In the world of modern materials, ceramics play an important role due to a wide range of their properties. Interest in structural ceramics has grown so much that we can speak of research in this area as the most important direction of modern materials science.

To obtain high-quality ceramics, it is necessary to grind the raw materials and obtain a finely dispersed structure. This is a labor-intensive and energy-intensive process. This problem was solved by converting aluminum waste and its alloys into nanostructured aluminum hydroxide, which allows obtaining ceramics with high properties.

The selected technological scheme for the production of aluminum oxide material (Figure 1) used $Al(OH)_3$, a waste product of the hydrogen generator operating cycle, as a precursor. The technological stages and equipment used are standard and widely used in industry.

It is worth noting that an important advantage of the presented technology (compared to similar powders with nano-sized particles used as raw materials) is a much higher productivity of aluminum hydroxide powder production. Heat treatment of the original $Al(OH)_3$ powder in air (operation 1) is a mandatory technological operation in this process. Its purpose is to dehydrate aluminum hydroxide and convert it into γ and α - Al_2O_3 modifications (these are the two main modifications of corundum).

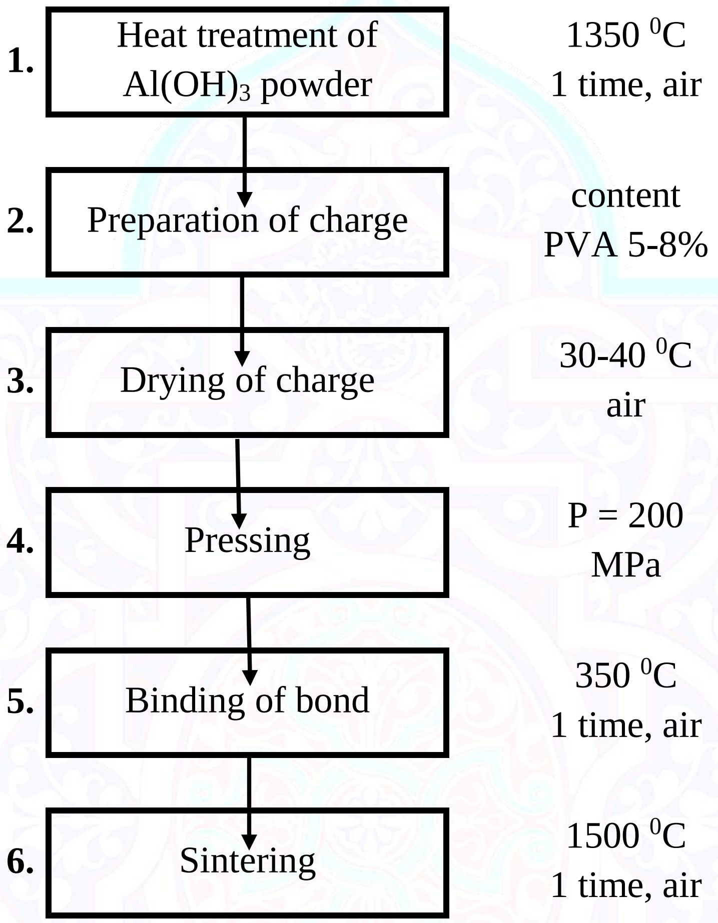

Figure 1. Type and sequence of technological operations for the production of aluminum oxide ceramics from $Al(OH)_3$.

It is known from experimental practice that the transition of aluminum hydroxide to γ-Al_2O_3 occurs in the temperature range of 290 - 550 ^{0}C, and the transition of γ-Al_2O_3 to the high-temperature α-Al_2O_3 modification occurs at temperatures above - 1200 ^{0}C. As a rule, after heating $Al(OH)_3$ with a certain isothermal effect in the temperature range of 1200 - 1350 ^{0}C, a mixture of γ and α - Al_2O_3 modifications is formed.

The importance of such heat treatment is associated with the need to partially or completely carry out the shrinkage processes in the bulk of the powder (the volume reduction of Al_2O_3 during the γ → α transition is 14.3%). If the volume reduction of the powder does not occur sufficiently, the hot-bonding obtained as a result of this pressing can lead to the destruction or deformation of the product. In this case, due to even slight unevenness of the compact volume reduction, local areas of the hot-bonded material can tear, breaking its continuity.

It is impractical to use a heat treatment regime in which the γ → α transition in the initial powder is completely completed. This is because the thermal bonding activity of the powder then decreases sharply, resulting in a low strength of the thermally bonded product. It is clear that in order to obtain satisfactory indicators of the mechanical properties of the material, it is necessary to try to maintain the optimal activity of the powder, complete the γ → α transition in the product during thermal bonding and final baking.

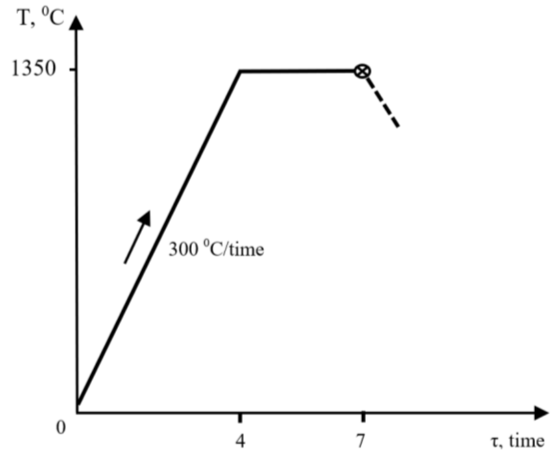

Figure 2. Heat treatment regime for aluminum hydroxide powder: T - temperature, t - time ⊗ - furnace shutdown.

Thus, in this part of the work, it was necessary to choose a heat treatment regime for $Al(OH)_3$ powder that would provide a sufficient reduction in its volume and provide optimal thermal bonding activity. Finding such a compromise is possible only experimentally. At this stage of the study, the technological regime (Fig. 2) of 1350 ^{0}C and an isothermal holding time of 1 hour were selected.

The process of mixing the powder with the binder was carried out in a SAND - 3 mixer. The resulting wet mixture was placed on a stainless steel tray and dried in a SNOL - 3.5 drying oven at a temperature of 30-40 ^{0}C. Samples (diameter 20 mm and height 5 mm) were pressed in a steel mold under a pressure of 200 MPa.

1. Based on preliminary experiments, the possibility of obtaining aluminum oxide material (using conventional ceramic technology operations) from aluminum hydroxide, which is a waste product of the hydrogen generator operating cycle, was demonstrated.

2. The heat treatment regime of the original aluminum hydroxide in air (1350 ^{0}C, 1 hour) was designed to convert it into aluminum oxide (γ and α - modifications), ensuring the preservation of the high activity of the aluminum oxide powder for heat bonding.

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