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Research article

PRODUCTION OF ALUMINA AND BYPRODUCTS FROM THE MINERAL OF MUSCOVITE BY METHOD OF SINTERING

[1]Mirzoev P.B., [2]Ibrohim A., [3]Mirzoev B., [2]Alimov N.O., [2]Bobonazarov M.

[1]Tajik Technological University,
[2]Research Institute of industry of Ministry of Industry and New Technologies of the Republic of Tajikistan,
[3]Branch of Moscow State University in Dushanbe,
Dushanbe, Tajikistan,
E-mail: mr.muhamadi@mail.ru

Abstract

Work is devoted to the problem of obtaining alumina from mineral of muscovite sintering method. To solve this problem used the technological development for the production of alumina by sintering alumino - calcium fluorine-containing minerals and studied physical - chemical parameters of the mode of production of cryolite and technical alumina. In the present work, a series of experiments the following parameters: the weight composition ratio of the charge, the effect of temperature during the sintering process, the sintering process time , duration of the leaching process.

Keywords: alumina , cryolite, aluminum-containing raw material sintering method, leaching cake.

1. Introduction

It is known that in the industrial production of alumina is carried out essentially in several ways. Of these hydrochemical method [1] - the cheapest and most common, however, for its implementation needs high quality aluminum-containing ore. A sintering method can be applied to any high-silicon aluminum raw materials. Our studies [2] have shown that the complex processing of ore, poor content of alumina, such as field of Kurgovat (Western Pamir) sintering method is appropriate in terms of ecology and economy, because its implementation does not cause significant environmental pollution .

In our country there are huge reserves of the poor on the alumina content of raw materials: calcium carbonate, fluorine-containing minerals and industrial waste . Was tasked with the development of two technologies for the production of alumina - by the method according to the process of sintering and intensification using fluorine-containing waste and pure fluoride salts, which have not yet found industrial application, apparently due to their scarcity and high cost.

2. Experimental

For this purpose, a method of sintering as the raw material, we used: minerals containing a muscovite are obtained by enrichment of monomorphic micaceous schist, limestone, soda ash, and the chemical composition are shown in Table 1. A method for intensification of [3] with the use of fluorine-containing waste and fluorides , except for the aforementioned starting materials, the fluoride salts are additionally used which are presented in Table 2.

Table 1. Chemical composition of starting materials for sintering method

Components	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	Na_2O %	K_2O %	TiO_2 %	Na_2CO_3 %
Muscovite									
Limestone	3.6	0.88	0.62	50.5	2.65	-	-	-	-
Soda ash			0.003			0.05			98.0

Table 2. Chemical composition of starting materials for process intensification

Components	Muscovite (rich), %	Fluorite (CaF_2), %	Na_2CO_3, % (soda ash)	Coal deposits of Nazarailok, (%)
SiO_2	43.7 – 44.9	0.7-0.8	-	0.03 -0.14
AL_2O_3	31.9 – 33.9	-	-	0.8 -1.0
Fe_2O_3	5.0 - 5.6	-	0.009	0.04-0.06
CaO	0.8- 1.2	-	-	-
$CaCO_3$	-	0.8 -1.2	-	-
K_2O	8.7 -10.2	0.3 -0.5	-	-
Na_2O	0.9 -1.4	-	0.05	-
MgO	1.2 -1.3	0.2 -0.3	-	-
CaF_2		85.1- 92.3	-	-
Na_2CO_3	-	-	98.0-98.5	-
C	-	-	-	97.0 -98.4
other impurities	2.4-1.6	-	2.0- 1.5	-

Preparation of alumina and its salts from these ores requires a fundamentally new technological developments, where one of the important stages of the recycling process is the decomposition of raw materials extraction and isolation of its useful components from low- alumina- ore . To solve this problem used the technological development for the production of alumina by sintering alumino - calcium fluorine-containing minerals and studied physical - chemical parameters of the mode of production of cryolite and technical alumina. In this work, a series of experiments on the following parameters :

- The weight ratio of components in the batch ;
- The effect of temperature during sintering ;
- The duration of the sintering process ;

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- The duration of the leaching process .

Thus, we have conducted research on the above flowsheet . The effect of CaF_2 on the temperature and duration of the sintering process (Fig. 1) .

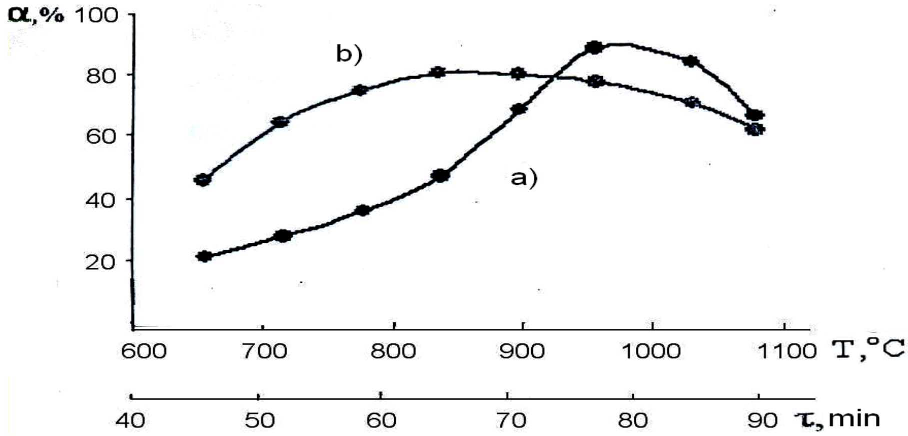

Fig.1. The degree of extraction of Al_2O_3 in the raw material depending on the temperature (a), the duration of the sintering process (b) considering the influence of CaF_2

As can be seen from the figure, the maximum yield of Al_2O_3 (92.5 – 93.2%) is achieved at a temperature of 950 °C - 960 °C and sintering duration 60-70 min. At a temperature of 700 °C in the charge begins reacting iron oxide and alumina with soda, resulting in the formation of sodium aluminate and ferrite and at low temperatures prevalent sodium ferrite formation. At 900 °C amount of sodium aluminate formed is rapidly increasing due to the direct displacement of ferrite iron oxide and aluminum oxide .

When the temperature increases the rate of reaction materials, the charge increases. With further increase in temperature above 960 °C observed decrease in yield Al_2O_3, and this is due to the fact that with increasing sintering time aluminum-containing part of the charge is converted into a form of hard- alkaline compound.

Fig . 2 shows the degree of extraction of Al_2O_3 of temperature, duration of the sintering process and the mass ratio of the components in the composition without the addition of sintering CaF_2, wherein a maximum output of aluminum oxide - 93.9 - 95.4 % (sintering temperature - 1150 ° C, the duration of sintering - -130 - 120 min.).

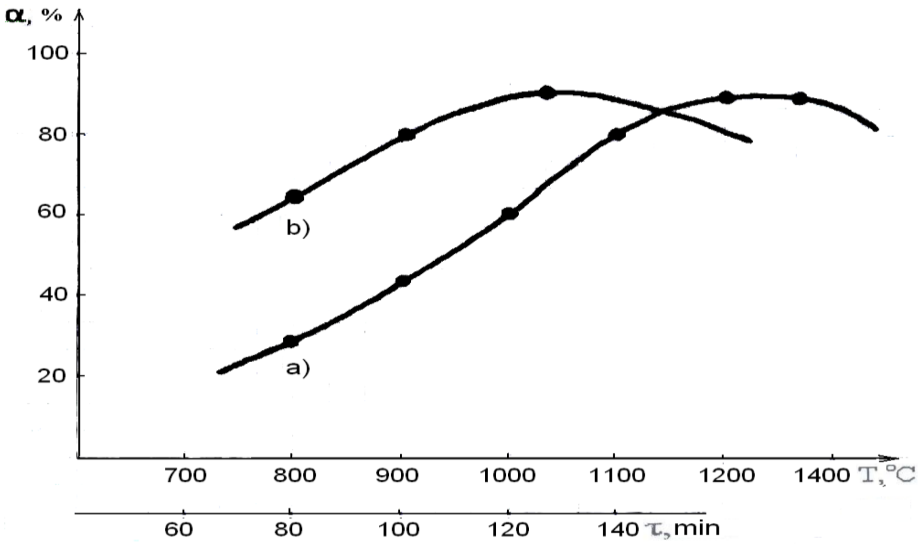

Fig. 2. Extraction degree of Al_2O_3 in the raw material depending on the temperature (a) and duration of the sintering process (b)

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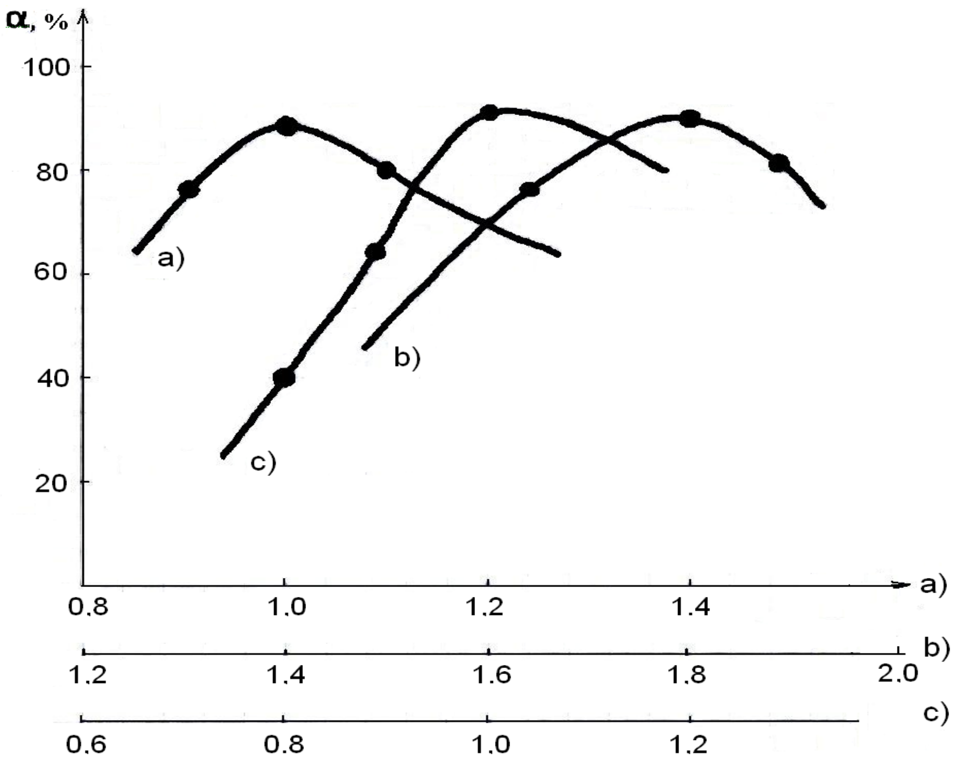

Figure 3. Extracting the degree of Al_2O_3 in the batch mass fraction of the added components: a) - $CaCO_3$, b) - Na_2CO_3 and c) - muscovite without adding CaF_2

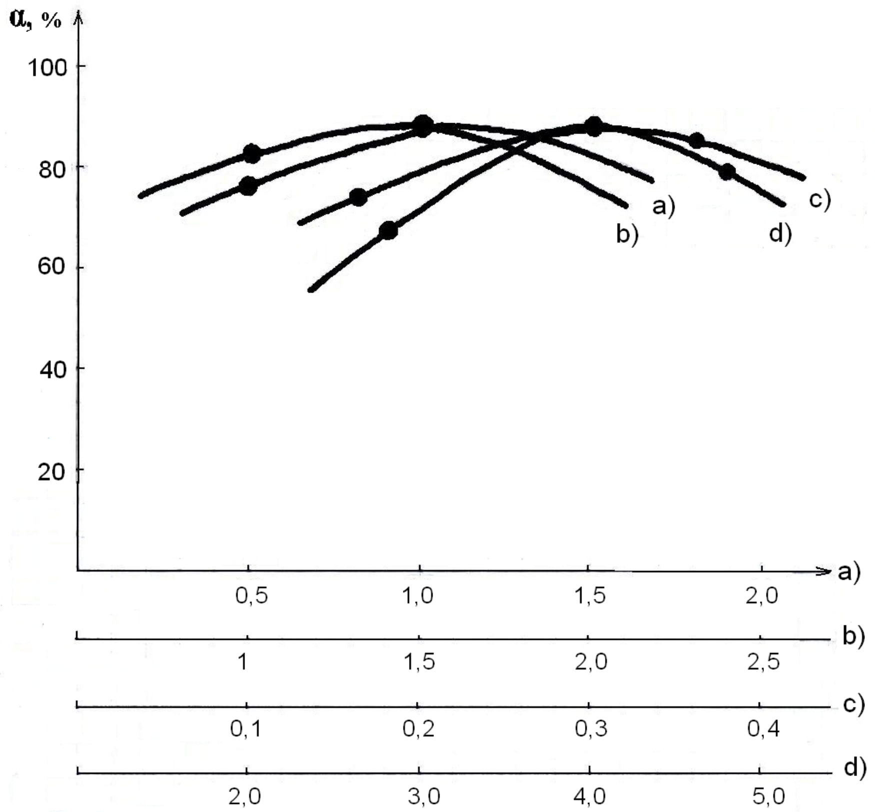

Figure 4. Extracting the degree of Al_2O_3 in the batch mass fraction of the added components: a) – muscovite, b) - Na_2CO_3, c) - C, d) - CaF_2

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Also investigated were the degree of extraction depends on the composition of Al_2O_3 charge additives of CaF_2 and without (Fig. 3 and Fig. 4, respectively), while using the following ratios of starting materials:

$$m_{CaCO_3} : m_{Na_2CO_3} : m_{muscovite} = 1.0 : 1.8 : 1.0$$

$$m_{muscovite} : m_{Na_2CO_3} : m_{CaF_2} : m_C = 1 : 2 : 4 : 0.2$$

Then us were filmed radiographs charge (Fig. 5a) and the cake obtained under optimum conditions (Fig.5b) to determine the formation of sodium aluminate and Al_2O_3 extraction and cryolite.

As can be seen from Fig. 5b, on the radiograph cake major components are $Na_2O \cdot A_2O_3$ (sodium aluminate) , indicating a relatively high level of education of the compound. Fig . 5a shows the composition of the batch additions. After receiving the cake in optimal conditions his crushing was performed on jaw crusher and then on attritor to a particle size of 0.1 - 0.63 mm.

Also studied the effect of temperature and duration of the leaching process to extract Al_2O_3, which was carried out in the temperature conditions from 10% - solution of NaOH. As is well known, as a result of chemical reactions happening extraction of valuable components of alumina into solution. The degree of recovery in the sinter depends on many factors: the chemical and physical properties of cake, leaching regime and the ratio S:L, etc.

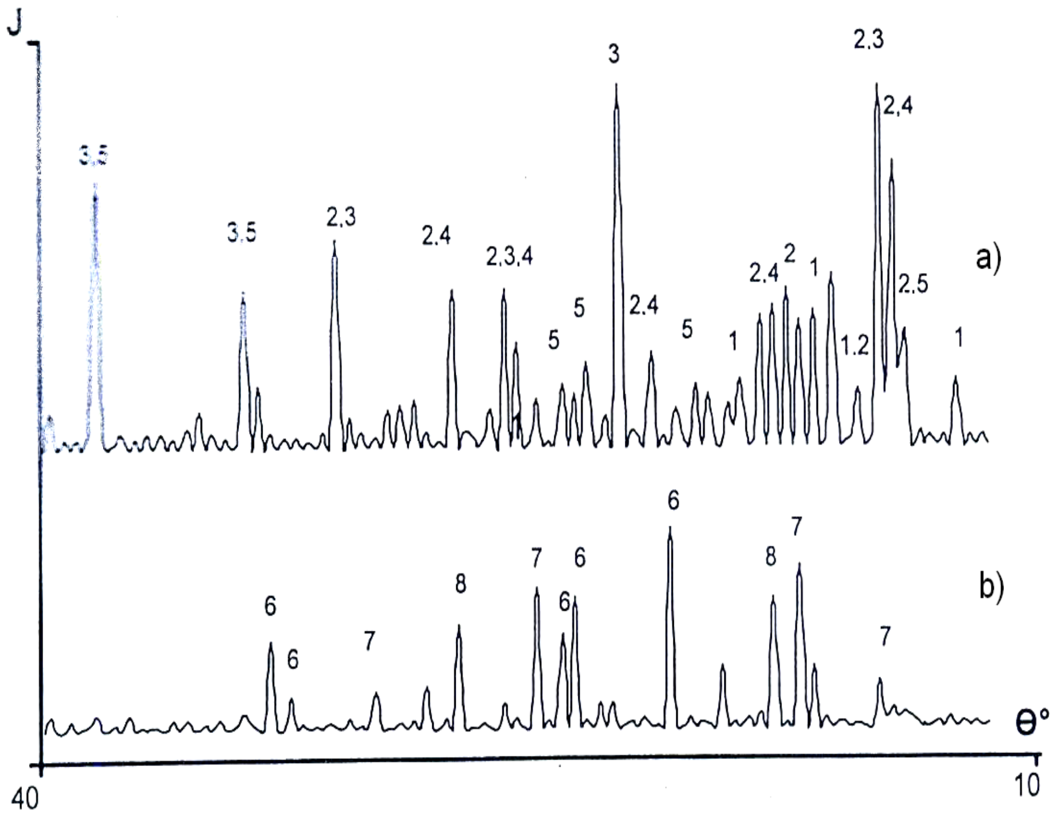

Figure 5. Radiographs: a) charge; b) cake obtained under optimum conditions. 1 - sodium carbonate (Na_2CO_3); 2 - the source material (muscovite); 3 - CaF_2; 4 - quartz (SiO_2); 5 - carbon (C); 6 - $Na_2O \cdot A_2O_3$; 7 - $CaO \cdot Al_2O_3 \cdot 2\, SiO_2$; 8 - $CaO \cdot FeO \cdot 2\, SiO_2$.

The degree of extraction of Al_2O_3 leaching temperature sintering obtained in the range from 20 ^oC to 95 ^oC is presented in Figure 6. As can be seen from Fig. 6 , if the duration of the leaching process and the sintering temperature increases the degree of extraction of the alumina varies from 18.5 % to 93.8 % (Fig. 6), respectively. With increasing duration of the leaching process, the resulting cake to 120 min, the degree of extraction of alumina increases to 94.2%. After a 2 - hour leaching extraction degree of Al_2O_3 is not changed.

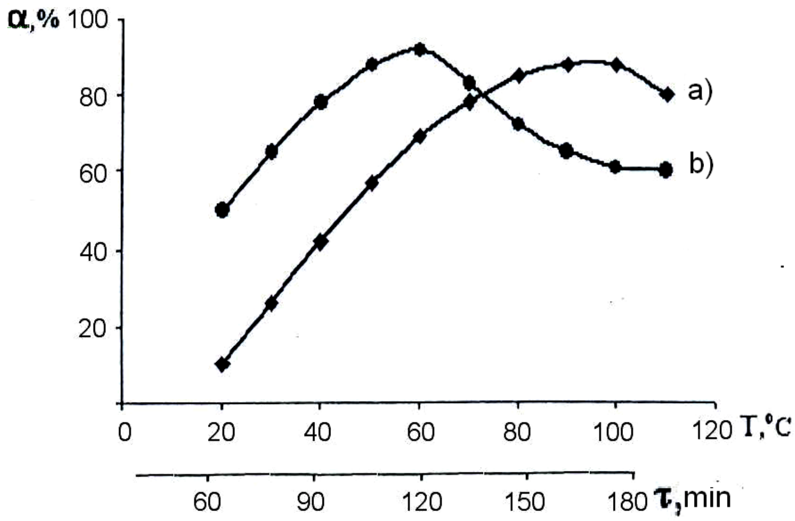

Figure 6. The dependence of the degree of extraction temperature Al_2O_3 (a) and the duration of the leaching process (b)

In addition we studied the effect of concentration ratio NaOH and S : L leaching process for the recovery of solid sintered Al_2O_3 (Fig. 7). Revealed that, with increasing alkali concentration (95-100 g/l) the degree of extraction of alumina increased to 92.4 - 95.3 %. With further increase in concentration of alkali, as in previous studies, the degree of extraction of Al_2O_3 composition varies little cake and a further increase in the concentration of NaOH is impractical. It was also studied the influence of ratio of solid phase to the liquid in the pulp for the recovery of alumina which initially increases to 93.8 % and then, practically does not change. In order to establish changes in the leaching process was carried out X-ray diffraction spec (Fig. 8), solid residue (Fig. 8b) .

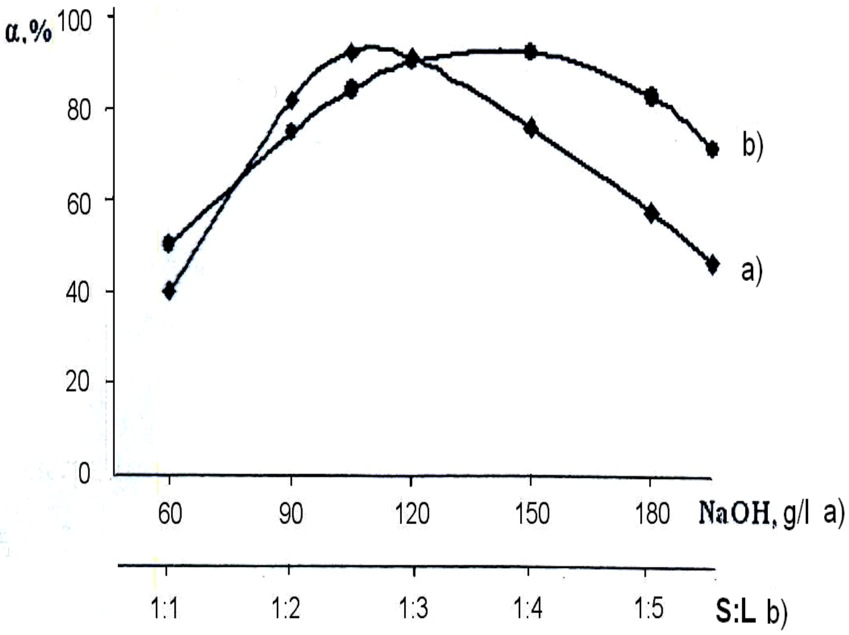

Figure 7. The dependence of the degree of extraction of Al_2O_3 concentration of the solution NaOH (a) and the ratio S: L of the leaching process (b).

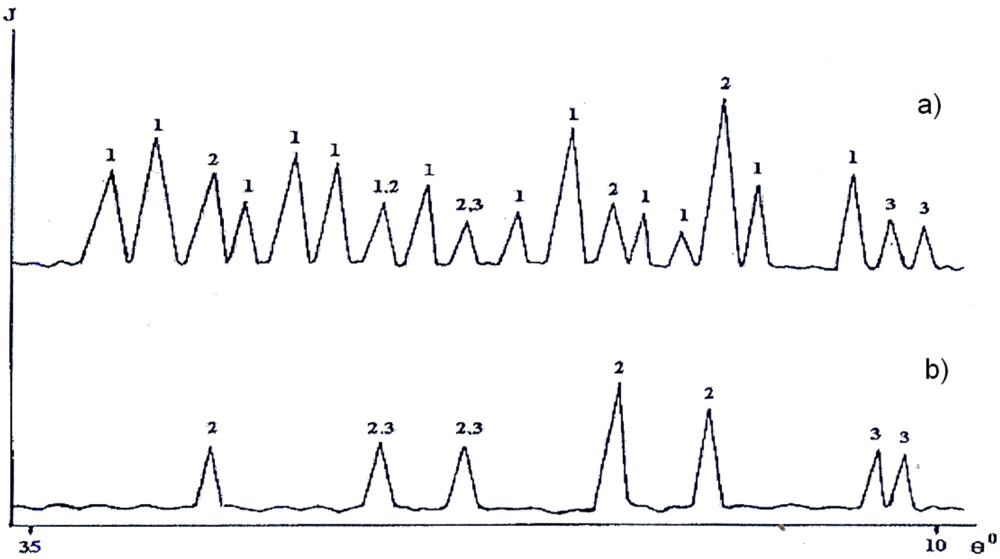

Figure 8. Radiographs : a - cake obtained under optimum conditions ; b - solid residue after leaching

The figure shows that the absence of lines of sodium aluminate in the insoluble pellet (Fig. 8b) shows an almost complete transition to a solution of sodium aluminate .

3. Conclusions

The results of leaching aluminate cake completely consistent with the results of X-ray analysis. The results of these studies show that it is possible to process local mineral raw materials - muscovite with a high degree of extraction of alumina, reduce production costs.

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