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RESEARCHING ON THE PROCESS OF OBTAINING ALUMINUM NITRATE SOLUTIONS FROM KAOLINS OF THE CHILPIK DEPOSIT

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ABSTRACT

Alumina is a raw material for the aluminum industry and high-quality raw materials are used to produce it, which is not available in Uzbekistan.

There is also no alumina production. But there are raw materials in the form of kaolin clays, alunite rocks, substandard bauxite, coal ash. The richest deposits of kaolin clays suitable for processing into alumina are located in the Chilpik area, with total reserves of more than one billion tons. This rock can be mined in an open-pit manner. The thickness of the useful thickness is on average 30-40 m.

Keywords: *Chilpik deposit, aluminosilicates, kaolins, rocks, calcium, calcination.*

INTRODUCTION

Kaolin clays of the Chilpik deposit, along with ground rocks, substandard bauxites, and coal ash, are promising types of aluminum-containing raw materials for the production of alumina.

The main components of clays are aqueous aluminosilicates: kaolinite Al2O3•2SiO2•H2O, gallusite Al_2O_3•$2SiO_2$, allophane Al_2O_3•$2SiO_2$, pyrophyllite Al_2O_3•$4SiO_2$•$4H_2O$, montmorillonite Al_2O_3•$4SiO_2$•H_2O, sericite K_2O_3•Al_2O_3•$6SiO_2$•$2H_2O$ and their colloidal analogues. The known methods of producing alumina - alkaline and electrolytic - are currently not acceptable for the conditions of our country. Hence, acidic processing methods, the nitric acid method is preferred, since its production is waste-free [1-3].

According to listed methods, acidic methods for producing alumina are acceptable for the conditions of our country. Therefore, our research was aimed at obtaining alumina by nitric acid decomposition of kaolin clays from the Chilpik deposit. The chemical composition of the initial kaolin clays of the Chilpik deposit is shown tab.1.

Table 1

Chemical composition of the initial kaolin clays of the Chilpik deposit

№	Names of kaolins	Chemical composition, weight %										
		SiO_2	Al_2O	Fe_2O	Na_2O	K_2O	CaO	MgO	TiO_2	GeO_2	S	Cl^-
1	Unburnt	54,30	23,45	0,47	0,081	0,38	0,30	0,167	0,35	0,196	0,150	–
2	Burnt	57,55	25,15	0,50	0,09	0,40	0,32	0,18	0,33	0,208	0,159	

Samples of kaolin clays from the Chilpik deposit containing (wt. %): SiO_2 - 54.30; Al_2O_3 - 23.50; Fe_2O_3 - 0.47; K_2O - 0.38; CaO - 0.30.

METHODS

The raw materials, intermediates and the resulting products were analyzed for the content of aluminum, iron, silicon, calcium, magnesium, sodium, potassium, and moisture.

The determination of aluminum oxide content was established by the complexometric method based on direct complexometric determination after the destruction of aluminum and titanium trimonates with sodium fluoride with an orange xylene indicator.

Calcium and magnesium were determined by a complexometric method based on a change in the color of the indicator (fluorexone in the determination of calcium and acid chromium dark blue in the determination of magnesium) during the interaction of calcium and magnesium ions with trilon B.

The content of sodium and potassium was determined by flame photometric method.

The identification of the composition and properties of the initial, intermediate and final substances was carried out in addition to chemical analysis using methods of physico-chemical analysis - spectroscopic, X-ray phase, IR spectroscopic, derivatographic, microscopic [4-7].

RESULTS

Since aluminum oxide has had a significant impact on mining processes, research began by studying the effects of the heat treatment process on changes in the chemical composition of kaolin clays.

The studies were carried out in a muffle furnace in the temperature range of 400-800 ° C for 1 hour. The results are shown in tab.2.

Table 2

The effect of the firing temperature on the chemical composition of kaolin

№	T,°C	Weight loss, %	Content of components, weight %						
			SiO_2	Al_2O_3	Fe_2O_3	Na_2O	K_2O	CaO	MgO
1	400	1,000	54,85	23,74	0,475	0,082	0,384	0,303	0,169
2	500	1,000	54,85	23,74	0,475	0,082	0,384	0,303	0,169
3	600	5,675	57,57	24,91	0,498	0,086	0,403	0,318	0,177
4	650	5,999	57,55	25,15	0,501	0,086	0,404	0,319	0,178
5	700	6,008	57,55	25,15	0,500	0,086	0,404	0,319	0,178
6	750	6,216	57,90	25,06	0,501	0,086	0,405	0,320	0,178
7	800	6,600	58,14	25,16	0,503	0,087	0,407	0,321	0,179

It can be seen from the data in the table that the calcination temperature of 400-500 ° C practically does not affect the change in the content of components of kaolin clays of the Chilpik deposit. Starting from 600° C .The content of the main components of kaolin clays increases. The most stable chemical composition of the main components is observed at a firing temperature of 650-700 ° C. A further increase in temperature to 800 ° C leads to a slight increase in SiO_2 to 58.14% and Al_2O_3 to 25.16%. The content of the remaining components is practically maintained at the same level.

To clarify the temperature changes occurring during the calcination of kaolin clays, a derivatogram of the initial kaolin was taken under conditions of linear heating up to 1200 ° C in an air atmosphere (Fig.1).

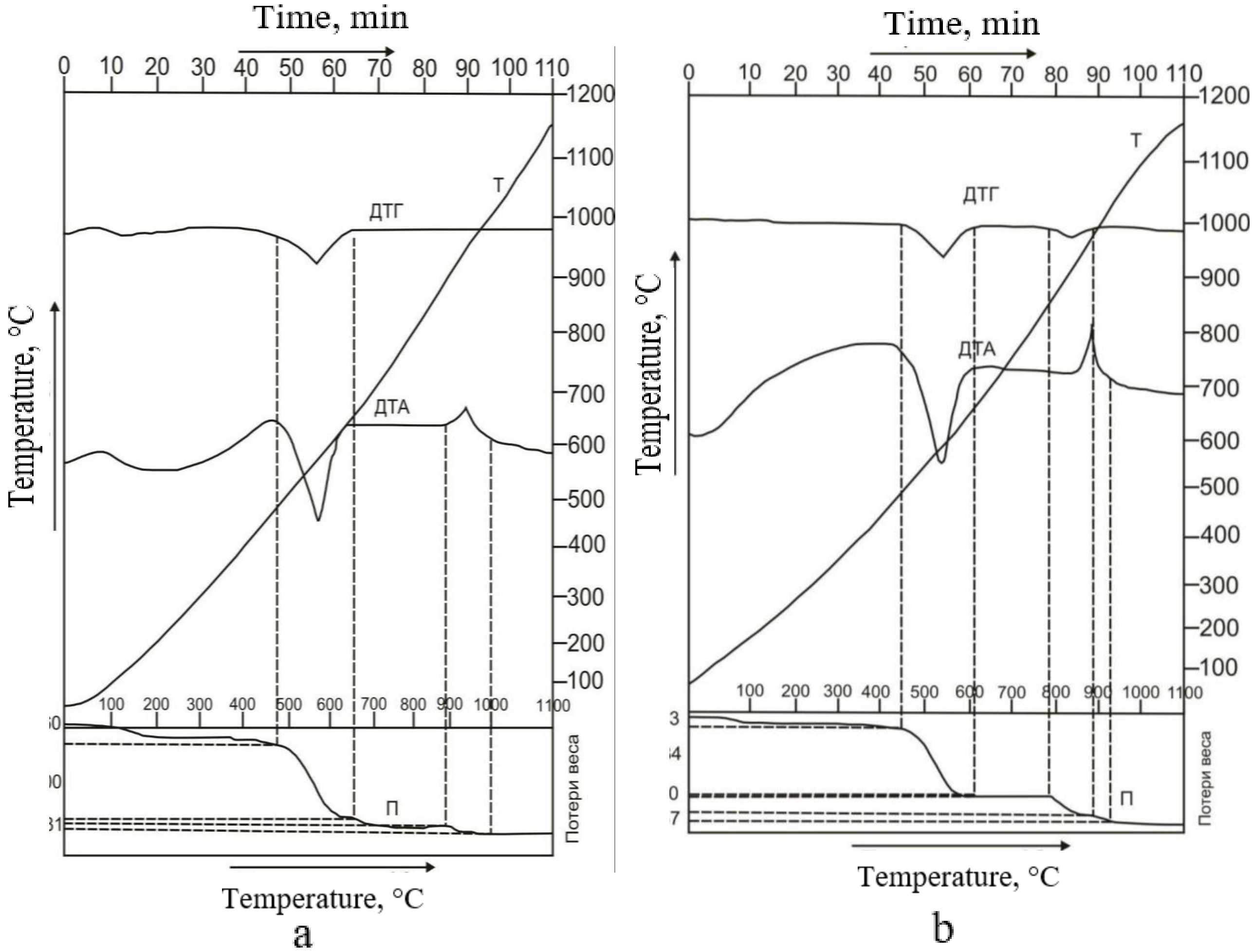
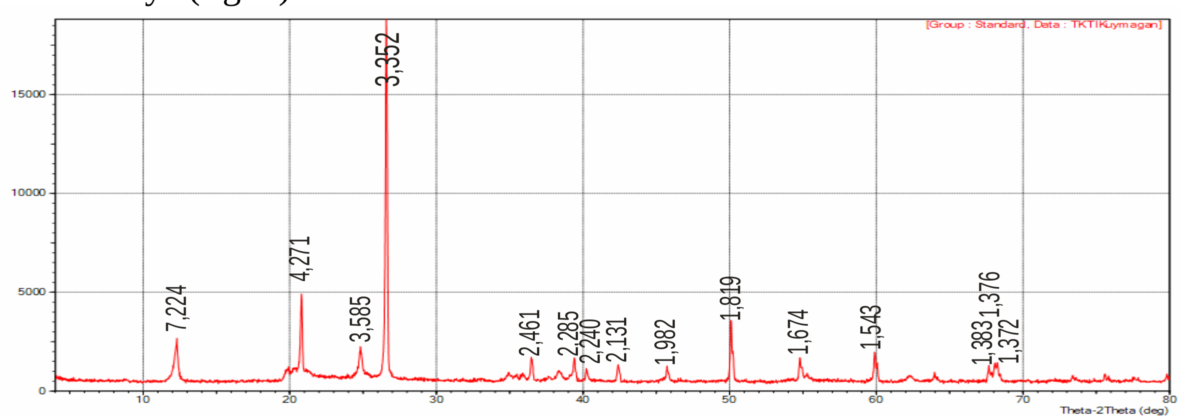


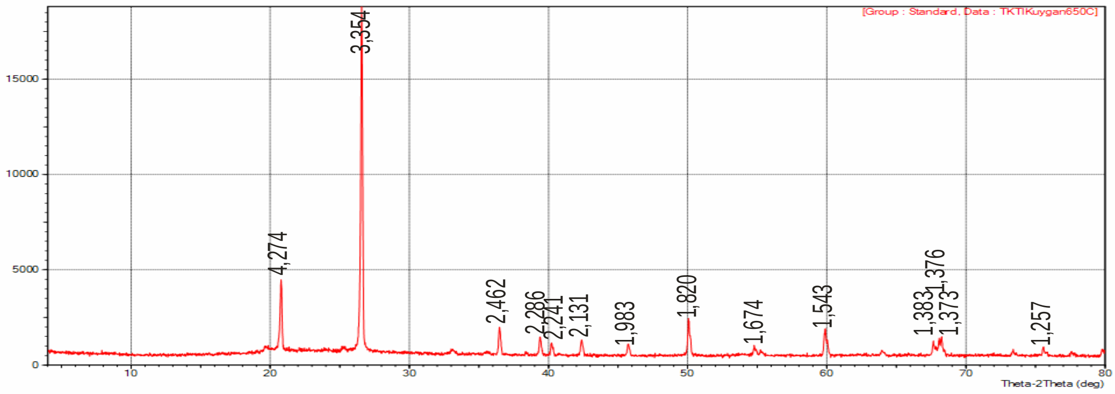
Figure 1 – Devrivatograms of kaolins of the Chilpik deposit:
a – primary, b – secondary

The devrivatogram shows an endothermic effect with an intense minimum at 550°C and an exothermic effect with a maximum at 955°C. At these temperatures, a significant loss of mass occurs, corresponding to the removal of chemically bound water, which is part of kaolinite.

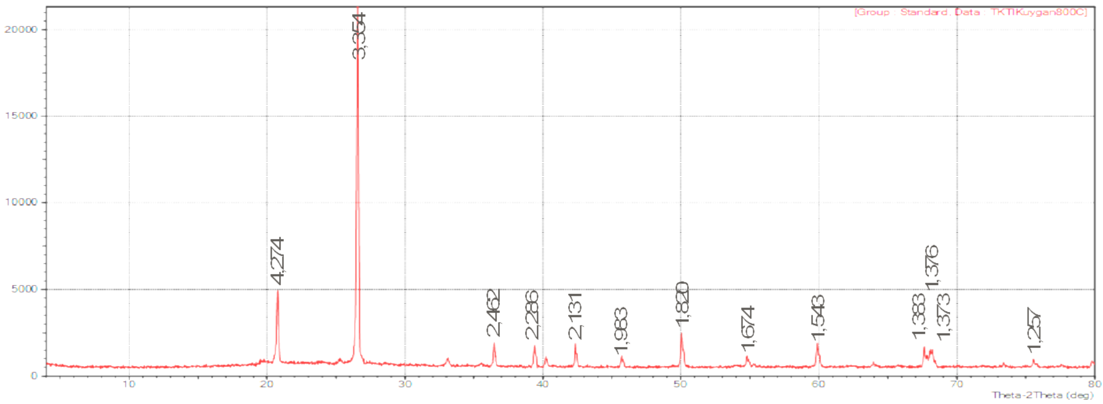
To establish the phase composition of the samples corresponding to the endothermic effect, X-ray images of the initial and burnt samples were taken at 650° from kaolin clays (fig. 2).



a



b



v

Figure 2 – X-ray images of kaolins from the Chilpik deposit.
a – initial, b – calcined at 650 ° C, v – calcined at 800 ° C.

The analysis showed that upon calcination of the initial kaolin, the peaks of 7,224 Å, 3,585 Å characteristic of kaolinite disappear on the X-ray image and a peak appears at 1,257 Å corresponding to $Al_2Si_2O_7$. It follows that when calcining from kaolinite, constitutional water is given and the crystal structure changes with the transition of hard-to-open kaolinite to the acid-soluble form of metakaolinite $Al_2Si_2O_7$ by reaction:

$Al_2Si_2O_5 \rightarrow 3Al_2Si_2O_7 + 2H_2O$ (1)

When fired above 900 °C, $3Al_2O_3 \bullet 2SiO_2$ mullite is formed by reaction

$3Al_2Si_2O_7 \rightarrow 3Al_2O_3 \bullet 2SiO_2$ (2),

which is insoluble in mineral acids.

DISCUSSION

The analysis of alumina-containing rocks of Uzbekistan shows that from a technological point of view, kaolin clays and substandard bauxites are the most promising raw materials for the aluminum industry, and alunites can serve as raw materials for the production of aluminum sulfate - coagulant.

For the theoretical justification of the rational use of kaolin clays in various industries, it is very important to know the physico -chemical processes occurring during acid decomposition.

Samples of kaolin clays from the Chilpik deposit containing (wt. %): SiO_2 - 54.30; Al_2O_3 - 23.50; Fe_2O= - 0.47; K_2O - 0.38; CaO - 0.30. Spectral analysis showed the presence of compounds of sodium, potassium, calcium, magnesium, iron and other elements in kaolin clays, the content of which is tenths and hundredths of a percent.

It can be seen from the data in the table that with an increase in the duration of the firing process, the degree of aluminum extraction increases with increasing temperature. At firing temperatures of 400-800 ° C and a process duration of 1 hour, the degree of weight loss is 1-6%. An increase in the firing time of more than 1 hour practically does not affect the degree of aluminum extraction.

CONCLUSION

For the theoretical justification of the rational use of kaolin clays in various industries, it is very important to know the physico -chemical processes occurring during acid decomposition.

The high demand for alumina, the lack of an acceptable technology for processing kaolin clays puts the problem of obtaining alumina in the category of the most urgent.

The chemical composition of the kaolins of the Chilpik deposit was studied by laboratory and modern physical chemical methods. Optimal conditions have been found to help increase the level of aluminum extraction from its composition by burning kaolin clays at a temperature of 400-800°C. The increase in the level of extraction of aluminum is caused by changes in the phase composition of kaolinites during combustion, which is caused by dehydration of soluble minerals into acid-soluble forms.

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