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Technological Scheme and Material Balance for Processing Kaolin Clays of the Angren Deposit for Aluminum Hydroxides by Nitrogen Acid Leaching

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ABSTRACT: Angren kaolin clay is one of the largest deposits in Central Asia. The high demand for alumina, the lack of an acceptable technology for processing aluminum-containing raw materials in the Republic makes the problem of obtaining alumina from kaolin a topical issue. Therefore, our research was aimed at obtaining alumina by decomposition of kaolin clays of the Angren deposit with nitric acid. For research, we used kaolin clays calcined at 650-700°C. The basic technological scheme of alumina production from calcined kaolin clays of the Angren deposit and the material balance of kaolin processing into alumina are presented.

I. INTRODUCTION

The Republic of Uzbekistan pays great attention to the development of the chemical industry, which makes a significant contribution to the development of the economic state.
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II. LITERATURE SURVEY

Aluminum sulfate and nitrate are effective coagulants for the treatment of industrial wastewater and drinking water [1, 2]. Aluminum hydroxide is a valuable raw material for the production of aluminum oxide and salts. Currently, aluminum-containing reagents and other materials are imported from outside Uzbekistan for hard currency.

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Uzbekistan has the richest reserves of aluminum raw materials with a low aluminum content in the form of kaolin clays, alunite rocks, ash from thermal power plants. The largest developed deposit, the reserves of which exceed 1 billion tons, is the kaolin clay deposit located near the city of Angren [3].

Despite the large deposits of kaolin in the Republic there are no production of sulfate, nitrate, aluminum hydroxide. This is primarily due to the lack of acceptable technologies for processing kaolin clays to obtain hydroxide and aluminum salts.

Therefore, the development of domestic technology for the processing of kaolin clays of the Angren deposit into hydroxide and aluminum salts is very urgent.

For a long time, the authors have carried out studies to establish the optimal technological parameters for extracting aluminum from kaolins of the Angren deposit with the production of hydroxide and aluminum salts by nitric acid decomposition [4-6]. The results obtained made it possible to draw up a basic technological scheme for obtaining alumina from calcined kaolin clays of the Angren deposit and the material balance of processing kaolin into alumina.

III. EXPERIMENTAL RESULTS

The technological process for producing aluminum nitrate consists of the following stages:

- drying of kaolin clays;
- leaching of aluminum with nitric acid;
- pulping of the leach solution;
- separation of liquid and solid phases;
- sludge washing;
- residue;
- crystallization.

The process of obtaining aluminum hydroxide consists of the following stages:
- drying of kaolin clays;
- leaching of aluminum with nitric acid;
- ammonization of aluminum nitrate solution;
- separation of liquid and solid phases;
- sludge washing;
- drying of aluminum hydroxide.

Early research established the optimal parameters for calcining the kaolin clays of the Angren deposit - a temperature of 650-700°C, a time of 1 hour. The optimal technological parameters for the decomposition of kaolins with nitric acid are: the concentration of nitric acid is 30%, the rate is 130%, the temperature is 150°C, the duration of autoclave leaching is 5 hours. After separation of undecomposed sludge, a liquid phase was obtained, the composition of which is shown in table 3.1.

Table 3.1. Chemical composition of the liquid phase and the degree of extraction of aluminum from kaolin after autoclave leaching

Chemical composition of the liquid phase, wt. %						Al_2O_3 recovery rate, %
Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	
4,85	0,099	0,185	0,051	0,039	0,088	93,73

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To isolate aluminum hydroxide, the clarified nitric acid extract was neutralized with gaseous ammonia to pH 4.5, the precipitate of aluminum hydroxide was separated, and the precipitate was washed with water. Table 3.2 shows the compositions of the washed sediments.

Table 3.2. Chemical composition of washed sediments

pH	Composition of aluminum hydroxide after washing, wt. %	
	$Al(OH)_3$	$Fe(OH)_3$
3,9	97,88	1,86
4,5	98,07	1,72
5,0	98,06	1,71
5,5	98,03	1,70
6,0	98,00	1,70

The content of aluminum hydroxide is 97.88-98.00%, the content of iron hydroxide is 1.70-1.86% in terms of dry matter. This indicates that the precipitate consists mainly of aluminum and iron hydroxides.
The laboratory and pilot tests on leaching of fired kaolins with nitric acid on a model unit made it possible to develop a process flow diagram, material flow diagram and material balance for the processing of kaolins from the Angren deposit into alumina.
Figure 3.1 shows a basic integrated technological scheme for obtaining nitrate, aluminum hydroxide and liquid nitrogen fertilizers from kaolin clays of the Angren deposit by nitric acid decomposition.

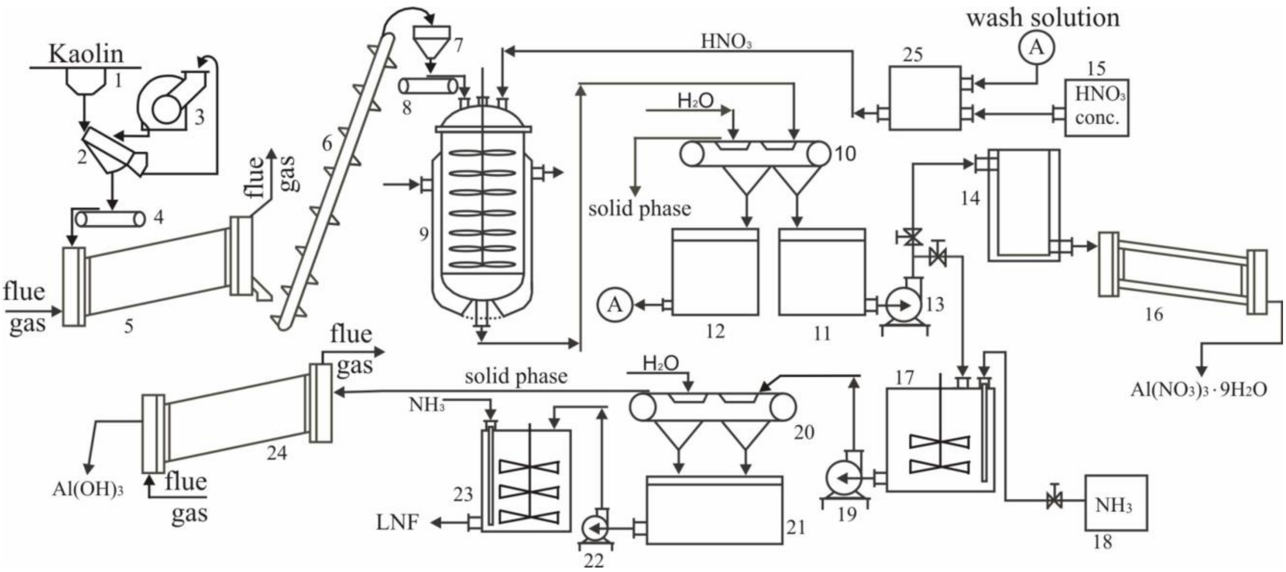

Fig 3.1 Basic technological scheme of complex processing of kaolins of the Angren deposit for nitrate, aluminum hydroxide and liquid nitrogen fertilizers: 1, 7 - bunkers; 2 - sieves; 3 - crusher; 4, 8 - dispensers; 5 - calcining drum; 6 - elevator; 9 - reactor (autoclave); 10, 20 - filters; 11, 12, 18, 21, 25 - containers; 13, 19, 22 - pumps; 14 - evaporator; 16 - crystallizer; 17, 23 - ammonizing reactor; 24 - drying drum

Kaolin from the receiving hopper (pos. 1) enters the sieves (pos. 2) and through the dispenser (pos. 4) is fed into the calcining furnace (pos. 5). The coarse fraction of kaolin is fed to the crusher (pos. 3) and returned to the sieves (pos. 2). The calcined kaolin is fed by the elevator (pos. 6) into the receiving hopper (pos. 7) and through the dispenser (pos. 8) into the reactor (pos. 9), where nitric acid is simultaneously supplied. Decomposition products are fed to the filter (pos. 10). The solid phase - slag is removed, and the liquid phase - nitric acid solutions of aluminum and iron are fed to the

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ammonizer (pos. 17) and further to the filter (pos. 20). The solid phase is washed with water and fed into the drying drum (pos. 24).

When receiving aluminum nitrate, the liquid phase from the vessel (pos. 11), pumps (pos. 13) is fed to the evaporator (pos. 14) and then to the drum crystallizer (pos. 16) and is cut off in the form of crystalline aluminum nitrate.

When receiving aluminum hydroxide, the liquid phase from the container (item 11) is fed by the pump (pos. 13) to the ammonizer (pos. 17) and then to the filter (pos. 20). the solid phase is washed with water and fed into the drying drum (pos. 24).

The liquid phase consists mainly of aluminum nitrate. It is ammoniated to a pH of 7-8 and receives (LNF).

Figure 3.2 shows a diagram of material flows and a material balance for obtaining aluminum hydroxide from kaolins of the Angren deposit at a rate of N_{HNO3} = 130%.

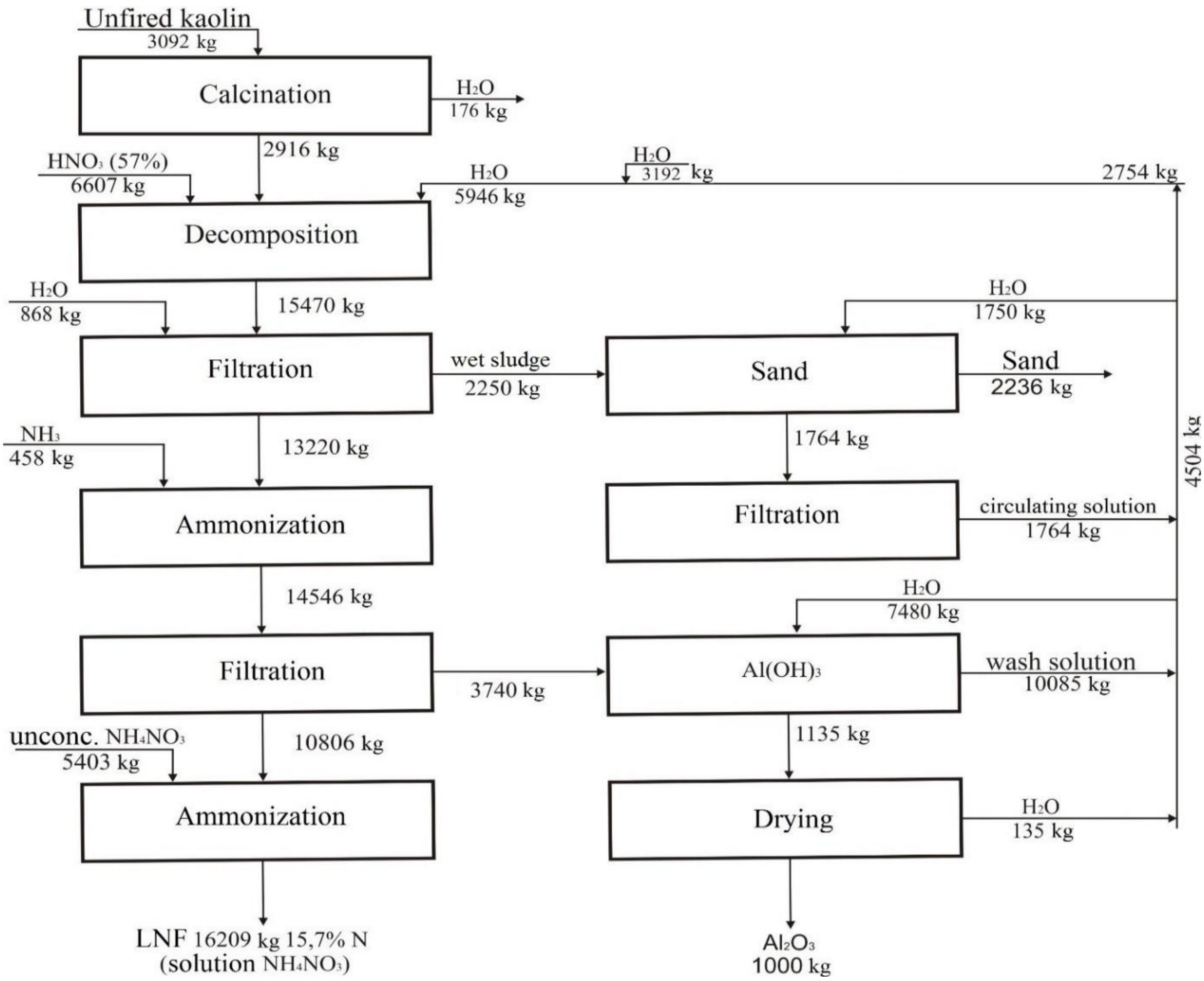

Fig 3.2 Block diagram of material flows and material balance of processing of kaolin from the Angren deposit into aluminum oxide and liquid nitrogen fertilizers (N_{HNO3} = 130%).

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To obtain 1000 kg of aluminum oxide, it is necessary to calcine 3092 kg of kaolin at a temperature of 650-700°C and decompose 6607 kg of 57% nitric acid in the presence of 5946 kg of water. The resulting mass is diluted with 868 kg of water, the solid phase is separated - sand, the filtrate is ammoniated with 458 kg of gaseous ammonia, the precipitate of aluminum hydroxide is separated, washed with 7480 kg of water, dried, calcined and 1000 kg of aluminum oxide is obtained. The sand is washed with 1750 kg of water. The wash water is fed for sand washing and nitric acid dilution.

IV. CONCLUSION

Thus, the studies carried out have shown the possibility of obtaining aluminum nitrate, aluminum hydroxide and oxide from calcined kaolin clays of the Angren deposit, and processing leaching solutions into liquid nitrogen fertilizers.

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