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Influence of Technological Parameters on the Process of Azotnoic Acid Leaching of Kaolinic Clays

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ABSTRACT: The results of studies on the leaching of aluminum from calcined kaolin clays from the Angren deposit are presented. Optimum technological parameters are established, which make it possible to increase the recovery of aluminum up to 93,73%.

I. INTRODUCTION

In recent years, much attention has been paid in the Republic to the development of new industries for the production of finished products based on the deep processing of local raw materials [1].

II. LITERATURE SURVEY

One of these types of mineral raw materials are kaolin clays of the Angren deposit, the reserves of which exceed 1 billion tons [2, 3]. Kaolin clay of the Angren deposit contains 23-27% aluminum oxide and is a raw material for the production of alumina, refractories, and ceramics. However, there is no production of alumina in the Republic due to the lack of an acceptable technology for extracting aluminum from kaolin clays.

Of the developed methods for processing kaolins into alumina for the conditions of Uzbekistan, the nitric acid method is the most suitable [4, 6]. Therefore, our studies were aimed at obtaining alumina from kaolin clays of the Angren deposit by nitric acid leaching [5].

III. RESEARCH METHODS

For research, kaolin clays calcined at a temperature of 650°C were used, containing (wt.%): SiO_2 - 52.57%, Al_2O_3 - 25.00%, Fe_2O_3 - 0.50%, CaO - 0.32%, MgO - 0 ,eighteen%. The studies were carried out using a 100 ml autoclave. The temperature of the leaching process was maintained by placing the autoclave in an oven. Stirring was carried out periodically, every 15 minutes, by shaking the autoclave.

IV. EXPERIMENTAL RESULTS

Previously, the processes of calcination of kaolin clays, the effect of leaching temperature and process duration on the chemical composition of the liquid phase and the degree of aluminum recovery were studied. It has been established that the optimal temperature for the treatment of aluminum by the autoclave method is 150°C, the norm of 30% nitric acid is 130%. Next, the influence of the duration of the leaching process on the degree of extraction of aluminum from calcined kaolin was studied at optimal leaching parameters - a temperature of 150°C, a norm of 30% nitric acid 130%. The results obtained are shown in figure 1.

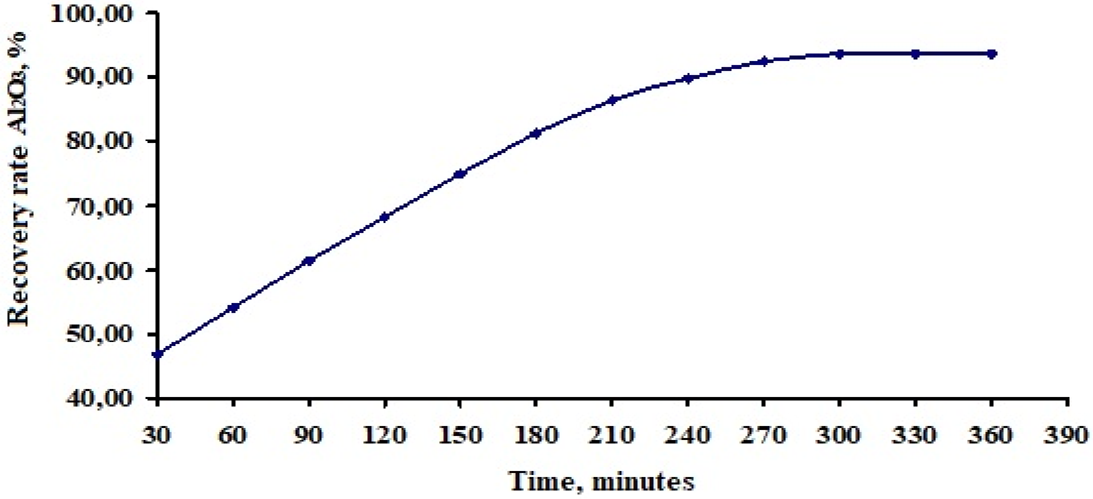

Fig. 1. Influence of the duration of the leaching process on the degree of extraction of aluminum at a temperature of 150°C, a concentration of nitric acid of 30% and a norm of 130%

The figure shows that an increase in the duration of the extraction process from 30 minutes to 5 hours contributes to an increase in the degree of aluminum extraction from 46.79% to 93.73%. A further increase in the duration of the leaching process up to 6 hours increases the degree of extraction of aluminum to 93.75%, that is, by 0.02%. Therefore, for further studies, we limited the duration of the leaching process to 5 hours.

Studies of the effect of nitric acid concentration on the degree of aluminum extraction, carried out at a nitric acid rate of 130%, a leaching temperature of 150°C and a process duration of 5 hours, showed that the degree of aluminum extraction passes through a maximum at a nitric acid concentration of 30-35% (fig. 2).

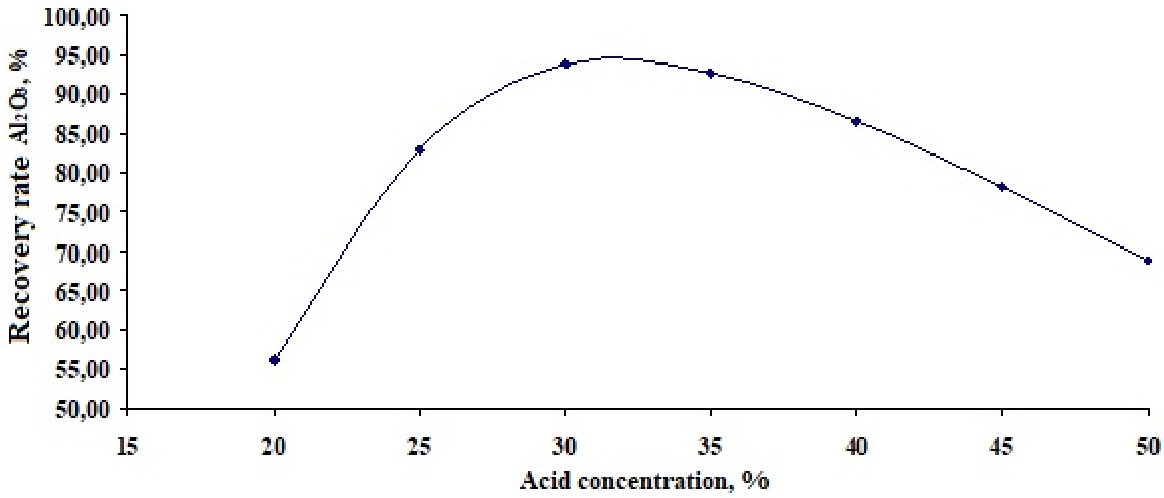

Fig. 2. The effect of nitric acid concentration on the degree of aluminum extraction at an acid rate of 130%, a temperature of 150°C and a process duration of 5 hours

For further research, we settled on a concentration of nitric acid of 30%.

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The rheological properties of leaching solutions have been studied. Table 3 shows the effect of temperature and duration of the process on the density and viscosity of the liquid phase at a rate of 30% nitric acid 110%.

Table 3. Influence of temperature and duration of the process on the density and viscosity of the liquid phase

№	Time, min.	Temperature, °C	Density, g/cm^3				Viscosity, cPa			
			20°C	40°C	60°C	80°C	20°C	40°C	60°C	80°C
1	60	90	1,215	1,209	1,204	1,201	2,218	1,525	1,090	0,863
2		120	1,223	1,217	1,212	1,209	2,233	1,535	1,097	0,868
3		150	1,245	1,239	1,234	1,231	2,273	1,562	1,117	0,884
4		180	1,232	1,226	1,221	1,218	2,249	1,546	1,105	0,875
5	120	90	1,218	1,212	1,207	1,204	2,223	1,528	1,092	0,865
6		120	1,225	1,219	1,214	1,211	2,237	1,537	1,099	0,870
7		150	1,247	1,241	1,236	1,233	2,277	1,565	1,119	0,885
8		180	1,234	1,228	1,223	1,220	2,253	1,548	1,107	0,876
9	180	90	1,226	1,220	1,215	1,212	2,239	1,538	1,100	0,871
10		120	1,233	1,227	1,222	1,219	2,251	1,547	1,106	0,876
11		150	1,255	1,249	1,244	1,241	2,291	1,575	1,126	0,891
12		180	1,242	1,236	1,231	1,228	2,268	1,558	1,114	0,882
13	300	90	1,245	1,239	1,234	1,231	2,274	1,563	1,117	0,884
14		120	1,252	1,246	1,241	1,238	2,286	1,571	1,123	0,889
15		150	1,274	1,268	1,263	1,260	2,326	1,599	1,143	0,905
16		180	1,261	1,255	1,250	1,247	2,303	1,583	1,131	0,896

With an increase in the leaching temperature from 20°C to 180°C density, the viscosity of the liquid phase increases to a temperature of 150°C and then decreases. The densities increase from 1.215 g/cm3 to 1.245 g/cm3 at a leaching temperature of 90-150°C and a measurement temperature of 20°C. Under these conditions, the viscosities rise from 2.218 cPa to 2.273 cPa. A further increase in the leaching temperature to 180°C leads to a decrease in density to 1.232 g/cm3 and viscosity to 2.249 cPa.

Increasing the temperature for measuring density and viscosity from 20°C to 80°C contributes to a decrease in these indicators. The density of the liquid phase varies from 1.215-1.245 g/cm3 at 20°C to 1.201-1.231 g/cm3 at 150°C. Viscosities vary from 2.218-2.273 cPa to 0.863-0.884 cPa.

Figures 3 and 4 show the data on changes in density and viscosity depending on the norm of 30% nitric acid at a leaching temperature of 150 °C and a process duration of 5 hours.

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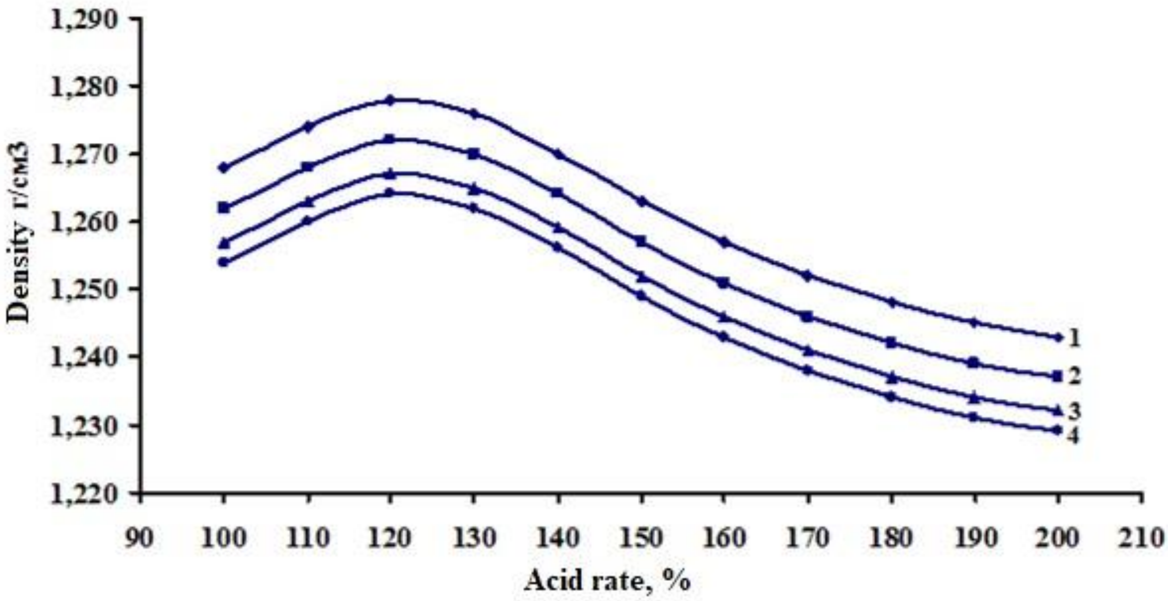

Fig. 3. Change in the density of the liquid phase depending on the norm of nitric acid at the measurement temperature of 1-20°C, 2-40°C, 3-60°C and 4-80°C.

Figure 3 shows that the plots of the density of the liquid phase, regardless of the measurement temperature, have the same form with a maximum at a rate of nitric acid of 110-130%.

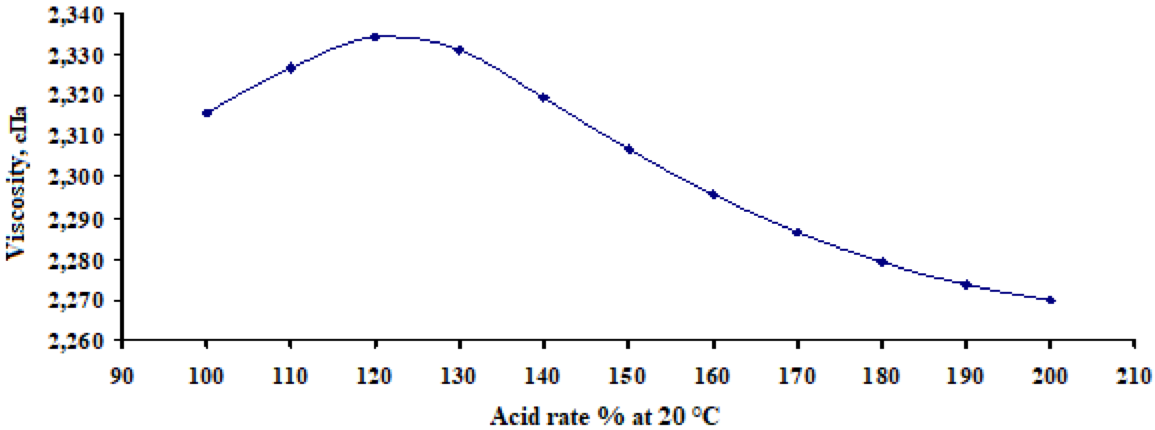

Fig. 4. Change in the viscosity of the liquid phase depending on the rate of nitric acid at a measurement temperature of 20°C

The viscosity of the liquid phase, measured at 20°C, also has a maximum value at the rate of nitric acid 110-130%.

V. CONCLUSION

Thus, the conducted studies have shown the possibility of extracting aluminum from calcined kaolin clays of the Angren deposit. The liquid phase during nitric acid leaching of calcined kaolins from the Angren deposit has acceptable rheological properties and can be pumped without difficulty. The optimal parameters of the autoclave leaching process are the concentration of nitric acid 30-40%, the norm is 110-130%, the temperature is 145-160 °C, the duration of the process is 4-5 hours. The degree of extraction of aluminum is 89.75-93.73%.

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