(E) ISSN: 3030-3214
Volume 3, № 2
2025

UDC: 669.71:622.785:66.046.5 10.70769/3030-3214.SRT.3.2.2025.26

DEVELOPMENT OF TECHNOLOGY FOR OBTAINING ALUMINA FROM LOCAL RAW MATERIALS



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Abstract. *The Republic of Uzbekistan is rich in mineral ore resources and possesses significant scientific, technological, and industrial potential. Maximizing the utilization of these material and intellectual resources is a crucial task facing the mining and metallurgical sector and the scientific community of the republic. The Republic of Uzbekistan possesses sufficient reserves of aluminum-containing raw materials, which are currently utilized in the construction, chemical, and glass industries. However, these resources can and should be complemented by developing, testing, and implementing technology for obtaining metallic aluminum. This initiative would contribute to the creation of a new economic sector - aluminum electrometallurgy based on local raw materials.*

Keywords: *Aluminum production, Electrometallurgy, Alumina processing, Kaolin enrichment, Aluminum extraction, Bauxite and alunite deposits, Sulfuric acid method, Ammonium fluoride treatment, Uzbekistan mineral resources.*

РАЗРАБОТКА ТЕХНОЛОГИИ ПОЛУЧЕНИЯ ГЛИНОЗЕМА ИЗ МЕСТНОГО СЫРЬЯ

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Аннотация. *Республика Узбекистан богата минерально-рудными ресурсами, обладает значительным научно-техническим и производственным потенциалом. Максимальное использование этих материальных и интеллектуальных ресурсов является важнейшей задачей, стоящей перед горно-металлургическим комплексом и научным сообществом республики. Республика Узбекистан располагает достаточными запасами алюминийсодержащего сырья, которое в настоящее время используется в строительной, химической и стекольной промышленности. Однако эти ресурсы могут и должны быть дополнены разработкой, испытанием и внедрением технологий получения металлического алюминия. Данная инициатива будет способствовать созданию новой отрасли экономики - электрометаллургии алюминия на*

(E) ISSN: 3030-3214
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базе местного сырья.

Ключевые слова: *Производство алюминия, Электрометаллургия, Переработка глинозема, Обогащение каолина, Экстракция алюминия, Месторождения бокситов и алунитов, Сернокислотный метод, Обработка фтористым аммонием, Минеральные ресурсы Узбекистана.*

MAHALLIY XOMASHYODAN GLINOZYOM OLISH TEXNOLOGIYASINI ISHLAB CHIQISH

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Annotatsiya. *O'zbekiston Respublikasi mineral-ruda resurslariga boy, katta ilmiy-texnologik va sanoat salohiyatiga ega. Moddiy va intellektual resurslardan maksimal darajada foydalanish kon-metallurgiya tarmog'i va respublika ilmiy jamoatchiligi oldida turgan muhim vazifadir. O'zbekiston Respublikasida alyuminiy tarkibli xomashyo zaxiralari yetarli bo'lib, ular hozirgi kunda qurilish, kimyo va shisha sanoatida ishlatilmoqda. Biroq, bu resurslar alyuminiy metalini olish texnologiyasini ishlab chiqish, sinovdan o'tkazish va amalga oshirish orqali to'ldirilishi mumkin va kerak. Ushbu tashabbus iqtisodiyotning yangi tarmog'i - mahalliy xomashyo asosida alyuminiy elektrometallurgiyasini yaratishga yordam beradi.*

Kalit so'zlar: *Alyuminiy ishlab chiqarish, Elektrometallurgiya, Glinozyomni qayta ishlash, Kaolinni boyitish, Alyuminiy qazib olish, Boksit va alunit konlari, Sulfat kislota usuli, Ammoniy ftorid bilan qayta ishlash, O'zbekiston mineral resurslari.*

Introduction. The task of developing Uzbekistan's aluminum industry necessitates the creation of a raw material base for alumina production that meets the requirements of GOST 30558-2017, as well as energy and technological capacities for aluminum electrometallurgy. In the republic, deposits of bauxite, alunite, and nepheline raw materials, kaolin, clay, and coal ash have been explored and are partially being developed. The possibility of using Uzbekistan's kaolins as raw material for the production of metallurgical alumina has long been known, as have the methods for processing them.

In the 1960s-1980s, systematic research on processing Angren kaolins for metallurgical-grade alumina was conducted at the Academy of Sciences of the Uzbek SSR (Institute of General and Inorganic Chemistry, laboratory of Prof. Kh.R. Ismatov), in collaboration with colleagues from VAMI (All-Union Aluminum and Magnesium Institute) and the A.A. Baikov Institute of Metallurgy of the USSR Academy of Sciences. This research culminated in successful industrial trials of a nitric acid method for processing high-silica raw materials from Uzbekistan into metallurgical-grade alumina and other products. Unfortunately, these developments were not utilized, and the direction of industrial production of raw materials for aluminum electrometallurgy was discontinued, resulting in the loss of personnel, technologies, and research infrastructure.

Aluminum in the world and Uzbekistan. Review of information on aluminum-containing raw materials and electrometallurgy of aluminum.

Analysis of international scientific and practical experience in the field of metallic aluminum production technology.

The traditional or "classical" method of obtaining metallic aluminum - electrolytic cathodic reduction in a molten cryolite-alumina electrolyte (Hall-Héroult process) - has been known for about 100 years. Its technical characteristics are as follows:

1. High specific energy consumption (about 15 kWh/kg of Al).
2. Low energy efficiency, typically not

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exceeding 45%.

3. Low productivity per unit area of cathode and volume of electrolyzer: up to 1 kg/m^2.

4. Relatively large dimensions of the apparatus.

5. Environmental problems, high cost: up to USD 1500 (2008).

6. Feeding the electrolyzer with high-quality raw materials (alumina, carbon). High demand for aluminum has driven the growth of its production.

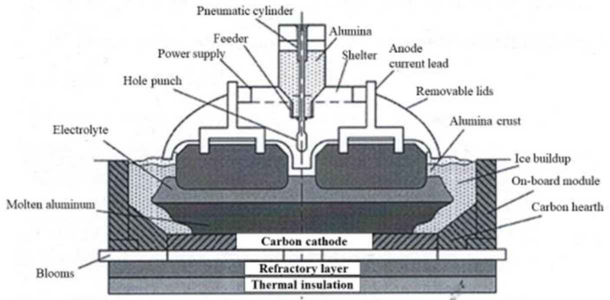

Fig.1. View of an electrolytic cell with prebaked anodes.

The distinctive features of the classical method are as follows:

- it occurs in a molten cryolite electrolyte with dissolved alumina, at a temperature of 950°C and above;

- CO and CO_2 are released at the carbon anode, while aluminum is produced at the cathode.

- the overall reaction can be expressed as:

$$1/2\,Al_2O_3 + 3/4\,\eta C = Al + 3/4\,(2 - 1/\eta)CO_2 + 1\,1/2\,(1/\eta - 1)CO \qquad (1)$$

A diagram of an electrolyzer with prebaked carbon anodes is shown in Fig. 1.

Aluminum-containing mineral raw materials characteristic of Uzbekistan: kaolins, alunites, and others. Methods of processing these materials into alumina.

In Uzbekistan, 156 deposits of kaolin clays have been recorded, with industrial reserves of 405.0 million m^3.

Kaolin is a white clay composed of the mineral kaolinite. Within the territory of the republic, there are varieties of kaolin, including kaolin agalmatolite from the Aktash deposit, which can be used for manufacturing fine ceramics. The exploration of new kaolin deposits with higher quality and improved physical, technical, and technological characteristics, as well as the development of enrichment technologies and construction of kaolin processing plants, remain relevant issues to this day.

Uzbekistan has 77 kaolin deposits, 22 of which are located in the Zarafshan Valley. The largest kaolin deposit is the Angren deposit, which ranks second in the CIS with total kaolin reserves of 394 million tons.

Kaolin deposits have been discovered in the Zarafshan oasis and the Kyzylkum Desert, with the Karnab, Alyans, Zakhkuduk, Urozali, and Altyntau

Table 1

Chemical composition of Uzbekistan kaolins, unfired samples

Chemical composition	Place of origin or birthplace						
	Angren	Alliance	Karnab	Altyntau	Zakhkuduk	Western Auminzata	Harvests
SiO_2	61,72	54,02	62,76-80,91	58,55	64,14-66,47	69,33	64,65
$A1_2O_3$	24,11	30,45	24,9-27,94	20,1	21,04-25,0	19,2	21,38
TiO_2	0,41	0,54	0,11-0,54	<0,30	0,26-1,02	0,12	0,73
Fe_2O_3	1 , 64	0,54	0,45	1,94	0,27-1,1	1,14	0,96
CaO	0,20	0,48	0,3-6,03	3,20	0,04-0,7	-	-
MnO	-	0,02	-	-	-	-	-
MgO	0,05	0,49	0,3-1,1	1,71	0,0-0,42	-	-
Na_2O	1,06	0,19	0,11-0,28	2,44	0,0-0,5	0,93	0,26
K_2O	-	1,48	1,17-6	2,69	0,0-0,5	1,7	1,39
FeO	-	0,26	2,35	-	up to 0.08	-	-
SO_3	-	0,21	-	1,04	0,0-0,23	-	-
P_2O_5	-	-	-	<0,5	-	-	-
p.p.p.	10,79	11,1	2,98-9.	7,95	8,06-9,65	7,47	7,5

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deposits being of particular importance.

According to available data, Western Uzbekistan contains several promising kaolin deposits with the following reserves:

- in the southeast of the Altyntau Range: 5,403 thousand tons;
- in the northwest of the Altyntau Range: 4,048.5 thousand tons;
- at the Zakhkuduk deposit: 123.75 million tons;
- at the Orozali deposit: 5,000 thousand tons;
- at the Alyans deposit: 1,352 thousand tons, potential - 3.7 million tons;
- at the Karnab deposit: 1,796 thousand tons, in its eastern part: 576 million tons;
- in Angren (hydroelectric power plant): the total volume of ash and slag amounts to 15 million tonnes.

Other minerals of Uzbekistan are also potential raw materials for the industrial production of aluminum.

Muscovite is a mineral of the hydrous aluminosilicate class, belonging to the mica group, specifically a potassium mica.

Sulfuric acid method. The sulfuric acid decomposition of kaolins has been well studied. The research was conducted both for the purpose of obtaining aluminum sulfate and alumina. The essence of the method consisted of treating clay calcined at 700-800°C with a sulfuric acid solution at 100-110°C for 1 hour. Sulfates of aluminum and iron formed in the solution. Iron removal was carried out by crystallization of alum, after preliminary reduction of trivalent iron to divalent. The method proposed by Yamasaki differed from those described in that the productive solution was treated with potassium sulfate to precipitate potassium aluminum alum. Aluminum hydroxide was separated from the alum solution using ammonia. The extraction rate is 90%.

Conducting laboratory research and development to create a technology for enriching aluminum-containing raw materials and subsequently producing metallic aluminum, including studies on local mineral aluminum-containing raw material samples to enrich them to the level required for cryolite-alumina electrolyte (melt) used in aluminum electrometallurgy (targeting a directive indicator of aluminum oxide (Al_2O_3) content in alumina concentrate no less than 98.7%, in accordance with GOST 30558-2017 "Metallurgical Alumina. Technical Specifications").

Kaolin samples were crushed (to 100 mm), then ground to 0.074 µm. After moistening to 25% of the sample weight, the kaolin samples were placed on trays, which were then put in a sealed container for radiation treatment with pulsed functional ceramic (PFC) emitters tuned to emit electromagnetic waves in the range of 3.3-9.6 µm. The processing time was 0.5-1 hour, with the temperature inside the container varying from 150°C to 180°C. After opening the container and cooling to 40-60°C, water was added to the sample at a ratio of 35-45% solids, and the mixture was loaded into a scrubber-trommel with sieve sizes of 1.5 mm - 0.5 mm - 0.2 mm. During separation, water was supplied to the sieves under pressure, with the final solid-to-liquid ratio of 1:3. The resulting pulp was then subjected to hydrocyclone treatment using a cyclone battery with a diameter of 75-50 mm. The analysis of the hydrocyclone overflow is presented below (Table 2).

The conducted research demonstrated high effectiveness in treating kaolin with pulsed functional ceramics (PFC) radiation. At the first stage of separation using a scrubber-trommel, concentrates containing 32% Al_2O_3 were obtained, with subsequent hydrocycloning increasing the Al_2O_3 content to 36-38%.

Conducting test laboratory studies on the processing of kaolin concentrates using ammonium fluoride. Reagents and materials used:

1. Ammonium fluoride according to GOST 4518-75;
2. Aqueous ammonia solution;
3. Distilled water;
4. "Chemapol" litmus paper;
5. "Blue Ribbon" ash-free filter papers;
6. Glassware and instruments;
7. Analytical balance;
8. Büchner funnel;
9. Experimental setup (Figure 1);
10. Porcelain dishes;
11. Round-bottom flasks with volumes of 1 and 2 liters.

Kaolinite is a finely dispersed clay rock consisting of aluminum oxide, silicon oxide, and

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water (Al_2O_3 - 39.594%, SiO_2 - 46.5494%, H_2O - 13.9694% by mass). In dehydrated kaolinite, Al_2O_3 has a content of 45.91%, SiO_2 - 54.09%. The basis of kaolin concentrates is silicon and aluminum oxides. We have proposed a method for isolating silicon oxide from kaolin concentrate using ammonium fluoride, and for removing iron impurities after the removal of silicon oxide by acid treatment.

Table 2

Chemical compositions and enrichment results of initial kaolin samples from deposits in Uzbekistan

Chemical Com-pounds	Place of origin or birthplace					
	Angren secondary kaolin		Alliance Primary Kaolin		Altyntau primary kaolin	
	before	after	before	after	before	after
SiO_2	71,17	56,69	62,76-80,91	51,96	68,55	53,55
Al_2O_3	24,3	36,4	14,9-17,94	37,2	20,1	36,60
TiO_2	0,69	0,49	0,11-0,54	0,43	<0,30	0,77
Fe_2O_3	2,2	1,2	0,45	1,36	1,94	0,56
CaO	0,39	0,27	0,3-6,03	0,46	3,20	0,21
MnO	-	-	-	-	-	-
MgO	0,39	0,19	0,3-1,1	0,3-1,1	1,71	0,71
Na_2O	0,48	0,35	0,11-0,28	0,11-0,28	2,44	0,81
K_2O	4,3	2,05	1,17-6	2,35	2,69	1,69
FeO	-	-	-	-	-	-
SO_3	-	-	-	-	1,04	-
P_2O_5	-	-	-	-	<0,5	-
p.p.p.	7,16	10,0	2,98-9	11,4	7,95	11,5

Equipment, assembly, and adjustment of the laboratory setup. The laboratory setup consists of a cylinder with a diameter of 220 mm and a height of H=520 mm, equipped for heating samples. The setup has three compartments (see Figures 2 and 3). In the lower part of the setup, we place the investigated charge, which has been previously homogenized with ammonium fluoride in a stoichiometric ratio to the silicon dioxide content according to sample analyses. The two upper, cooled compartments are designed for collecting silicon hexafluoride, which sublimes and separates during the sublimation process from the charge. The laboratory setup is also equipped with a system for capturing ammonia gases and water vapor, which are formed during the reaction (Fig. 2,3).

Procedure: A 100g sample of kaolin concentrate, which has undergone the charge preparation stage, is homogenized with ammonium fluoride in a stoichiometric ratio relative to the silicon oxide content and placed in the apparatus shown in Figure 2. At the beginning of the process, the furnace temperature is maintained at 140-150°C for 3 hours, then raised to 350-370°C and held at this temperature for 1 hour. Temperature measurement is carried out using a thermocouple. The apparatus includes a system of traps and condensers. The condenser for collecting ammonium hexafluorosilicate $(NH_4)_2SiF_6$ is equipped with a special partition to prevent the ammonium hexafluorosilicate from falling into the desilicated product. The temperature in the condenser was maintained at 250-300°C, while in the condensing unit it ranged from 220°C to room temperature (Fig. 3).

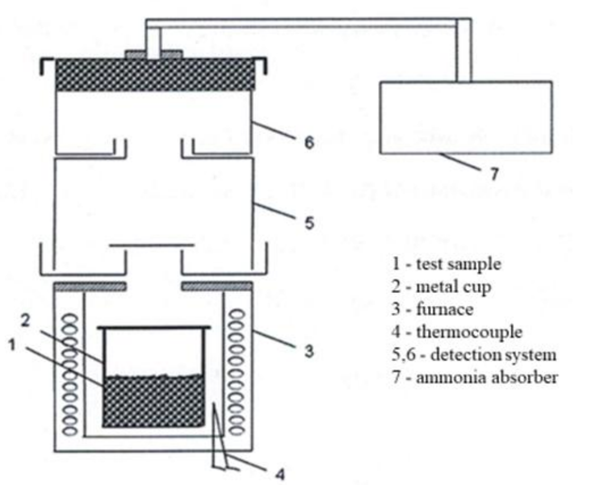

Fig.2. Schematic diagram of the laboratory setup apparatus.

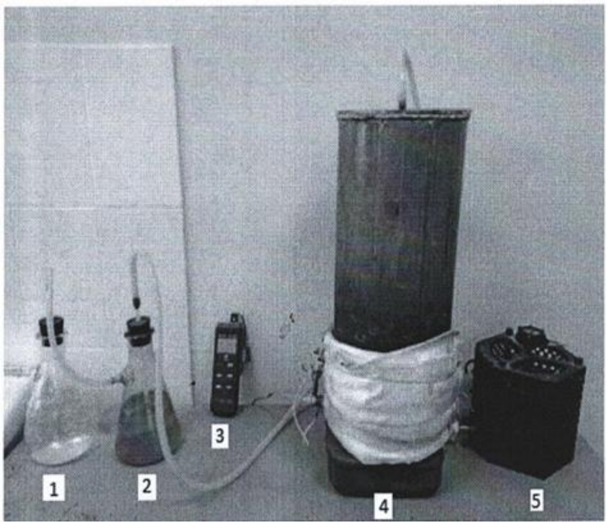

Fig.3. Overall view of the experimental apparatus.

After removing silicon oxide from the kaolin concentrate, iron is separated by magnetic separation followed by treatment with hydrochloric acid (10%). The remaining precipitate is either

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hexafluoroaluminate or aluminum fluoride, depending on the medium (oxidizing or reducing). Processing these compounds using pyro-hydrometallurgical methods does not present any difficulties.

The regeneration of ammonium fluoride is carried out as follows: using an areometer, the density of the resulting ammonia solution is measured, with its concentration being at the level of 10-12%.

Ammonium hexafluorosilicate is placed in a round-bottom flask, and a 10% ammonia solution is added with a 20% excess over the required stoichiometric amount according to the reaction:

$$(NH_4)_2SiF_6 + 4NH_4OH = 6NH_4F + 6SiO_2 + 2H_2O \quad (2)$$

The resulting mixture is stirred for 1 hour at room temperature, after which the precipitate is separated using a filter, subjected to three additional washing cycles, and dried at a temperature of 110°C. The process yields a highly dispersed product - amorphous silica known as “white carbon black.”

A kaolin concentrate with the following composition was investigated, %: 44.74 SiO_2; 37.4 Al_2O_3; 1.28 CaO; 1.06 Fe_2O_3; 0.83 TiO_2; 0.47 MgO; 0.37 K_2O; loss on ignition - 14.05. Ammonium bifluoride NH_4HF_2 was used as the fluorinating reagent. To assess the possibility of these reactions occurring - before conducting experimental work - a thermodynamic analysis was performed. Using tables of standard values, we determined the ΔG and ΔH of reactions at various temperatures. The largest negative Gibbs energy values (in absolute terms) were obtained for the reactions of kaolinite with ammonium bifluoride (Figure 1).

It has been established that with increasing temperature, the Gibbs energy values of reaction increase from ΔG_{273}=144.748 to ΔG_{973}=-1663.7 kJ/mol, indicating the highest thermodynamic probability of interaction with NH_4HF_2 upon heating, primarily for kaolinite.

During the fluorination of kaolin, the following reactions occur:

- sintering reactions:

$$Al_2O_3 + 6NH_4HF_2 \rightarrow 2(NH_4)_3AlF_6 + 3H_2O \quad (3)$$
$$SiO_2 + 3NH_4HF_2 \rightarrow (NH_4)_2SiF_6 + 2H_2O + NH_3 \quad (4)$$
$$Fe_2O_3 + 6NH_4HF_2 \rightarrow 2(NH_4)_3FeF_6 + 3H_2O \quad (5)$$
$$TiO_2 + 3NH_4HF_2 \rightarrow (NH_4)_2TiF_6 + 2H_2O + NH_3 \quad (6)$$
$$Na_2O + NH_4HF_2 \rightarrow 2NaF + H_2O + NH_3 \quad (7)$$
$$K_2O + NH_4HF_2 \rightarrow 2KF + H_2O + NH_3 \quad (8)$$
$$MgO + NH_4HF_2 \rightarrow MgF_2 + H_2O + NH_3 \quad (9)$$
$$Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O + 9NH_4HF \rightarrow 2AlF_3 + 2(NH_4)_2SiF_6 + 9H_2O + 5NH_3 \quad (10)$$

- pyrohydrolysis reactions:

$$2(NH_4)_3AlF_6 + 3H_2O \rightarrow Al_2O_3 + 6NH_3 + 12HF \quad (11)$$
$$2(NH_4)_3FeF_6 + 3H_2O \rightarrow Fe_2O_3 + 6NH_3 + 12HF \quad (12)$$

- heat treatment reactions:

$$2(NH_4)_3AlF_6 \rightarrow AlF_3 + 3NH_4F \quad (13)$$
$$2(NH_4)_3FeF_6 \rightarrow FeF_3 + 3NH_4F \quad (14)$$

- hydrolysis reactions:

$$(NH_4)_2SiF_6 + 4NH_4OH \rightarrow SiO_2 \downarrow + 6NH_4F + 2H_2O \quad (15)$$
$$(NH_4)_2AlF_6 + 3NH_4OH \rightarrow Al(OH)_3 + 6NH_4F \quad (16)$$

- reagent regeneration reactions:

$$2NH_4F \rightarrow NH_4HF_2 + NH_3 \quad (17)$$
$$NH_3 + 2HF \rightarrow NH_4HF_2 \quad (18)$$

Sintering was carried out at a temperature of 170-220°C. Pyrohydrolysis to obtain alumina was performed in the temperature range of 350-700°C, while sublimation with “dry” separation of aluminum and silicon compounds was conducted at 350-400°C. Amorphous silica was obtained by hydrolyzing ammonium hexafluorosilicate in an aqueous alkaline solution at temperatures ranging from 30 to 90°C, according to the reaction at pH 8-9. The ammonium fluoride solution was evaporated to produce an ammonium hexafluoride melt.

Calcination of amorphous silica and alumina was carried out in muffle electric furnaces at 700-1100°C. Primary aluminum can be obtained from alumina through electrolytic reduction, while polycrystalline silicon can be produced from silica.

The additional components used are easily recoverable without producing solid, liquid, or gaseous waste, ensuring a closed-loop production cycle.

Discussion of results. The degree of kaolinite conversion, based on the volume of ammonia released and the mass of the resulting sinter, is 95,59% and 95.88% respectively (Figure 2). This indicates a high degree of kaolin conversion using fluoride technology; however, the sintering was carried out without mixing the mixture, which apparently reduced the obtained results. The overall

(E) ISSN: 3030-3214
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degree of SiO_2 extraction from kaolin in our experiments ranged from 84,8 to 94,8%.

SiO_2 losses occur during sintering, as well as due to incomplete sublimation and washing of $SiO_2 \cdot nH_2O$. The resulting product has a high degree of purity (99.65%, see appendix). The extraction of SiO_2 from the sinter using the ammonia method demonstrated the possibility of separating SiO_2 from the (NH_4) $2SiF_6$ solution. The degree of Al_2O_3 extraction from kaolin was 84,8-94%.

Conclusion. Despite Uzbekistan's abundance of aluminum-containing raw materials, these resources are underutilized in aluminum electrometallurgy. This study examines methods for obtaining metallurgical alumina and, ultimately, metallic aluminum through processing local kaolin, alunite, and other aluminum-rich minerals. Historical research on processing kaolins with nitric acid yielded promising results but was not scaled up to industrial production. The traditional aluminum production method based on the Hall-Héroult process remains highly energy-intensive and costly.

The research focuses on innovative processing methods such as sulfuric acid decomposition, hydrocyclone enrichment, and fluorination using ammonium fluoride. Experimental results demonstrate effective ways to increase the aluminum oxide content in kaolin to levels meeting metallurgical standards. These findings illustrate the potential for developing the aluminum industry in Uzbekistan using local raw materials, thereby stimulating economic growth and technological advancement.

REFERENCES

1. Istanov Kh.T., Khasanov A.S., Guro V.I., Rakhimova F.E., Talyubayev K.O. va boshqalar. Alyuminiy olish texnologiyasini ishlab chiqish bo‘yicha ilmiy-tadqiqot hisobot. – Nukus: IFM RUZ, 2022. – 66 bet. – (Texnologik tadqiqot ishlari, shartnoma №1-121/2021КИ).
2. Khojakulov A., Ruziyev U., Boymurodov N., Shernazarov I., Mashaev E., Shoyimova K. Research and determination of parameters for extracting valuable components from technological waste // BIO Web of Conferences, Vol. 149, 01049. Genetic Resources 2024.
3. Turdiyev Sh.Sh., Ro‘ziyev U.M., Eshonqulov U.X. Kalsiy tarkibli qo‘shimchalar tarkibidagi alyumogetit va boksitdan glinozemni ajratib olish // Qurilish va Ta’lim Ilmiy Jurnali. – 2024. – Vol. 3, №6(12). – B. 203–210. – ISSN 2181-3779.
4. Saidaxmedov A.A., Eshonqulov U.X., Ruziyev U.M., Xaydarov I.I. Roasting of alumina-containing material in a rotary kiln // Scientific Review of the Problems and Prospects of Modern Science and Education. 1st International Scientific and Practical Conference. – Great Britain, 2024. – P. 22–28.
5. Saidaxmedov A.A., Ro‘ziyev U.M., Xasanov Sh.R. Rudadan glinozyomni ajratib olish // International scientific-online conference: Intellectual Education, Technological Solutions and Innovative Digital Tools (Part 34). – Amsterdam, Netherlands: CESS, 2025. – P. 11–14.