

New environment friendly technologies for processing alunite ores

Chemistry and chemical technology

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In 1965, Ganja Alumina plant (GAP) started the implementation of an reduction – alkaline technology of alunite ore processing on an industrial scale. The technology disadvantages together with design errors led to the unprofitable production. Since the start-up of the plant, studies have been conducted to eliminate the shortcomings of the reduction - alkaline technology and hardware design. It was developed the so-called “reversed” scheme for hydrochemical processing of alunite restored with the conversion of the sodium sulphates with a solution of KOH. Despite the elimination of a number of disadvantages of reduction-alkaline technology, the following mistakes have not been eliminated: 1) significant removal of gas and dust from the kilns “fluidized bed furnace” firing and recovery, 2) insufficient time for recovering of alunite dust, which complicates and worsens the technological and economic indicators of the process, 3) passivation of alumina in the firing and reduction processes, 4) low yield of alumina in the commercial product ($\leq 75\%$), 5) a significant amount of solid waste– 4 - 5 tons of red sludge per 1 ton Al_2O_3 and others. As result, the alunite ore processing line stopped its operation in 1992 and does not operate until now. This article is devoted to the development of new technologies and improvement of a new potash-alkaline method and new soda -alkaline technology for processing alunite ores. It is proposed to replace potash with soda (sodium carbonate) in new soda-alkaline technology. Obtained from the first leach solution and sodium sulphate by the method of conversion with KCl was transferred to K_2SO_4 and NaCl. In soda-alkaline technology we obtain the same products as in potash-alkaline technology with an additional product – table salt. The fluidized bed furnace is replaced by a new type of kiln.

Keywords: reversed scheme, alumina, coagulant, potassium sulphate, quartz sand, table salt, conversion, potassium chloride, soda, potash.

Introduction

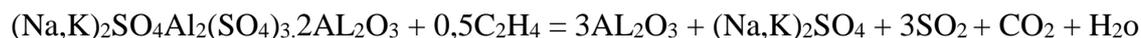
Alunites are used as a raw material both in aluminum production and in chemical industry. Alunite ores may serve for production of alumina, sulphate of potassium (SOP), sulphuric acid, elementary sulphur [1], alum [3], coagulant [2], quartz sand and other products.

Alunite ores in a mineral form are always accompanied by waste rock, consisting mainly of quartz and small quantities of other minerals – alumosilicates and hematite. Ganja Alumina Plant (GAP) used a technology of processing of alunite ores with production of alumina and other components, using ore from alunite deposit of the Republic of Azerbaijan. This was the first example of use of the technology for massive production in the world.

Integrated processing of alunites from Zaghlik deposit at GAP was based on reduction alkaline process with further production of potassium sulphate and table salt by conversion of sulphate waste with potassium chloride [4, 5] Conversion with KCl led to production of K₂SO₄ and salt (NaCl). However, the salt could not be used in food industry, because poisonous V₂O₅ (0.05% in contents of alunite ores) was accumulating in the reusable aluminate solution in form of sodium vanadate and further interfused with a mixture of potassium and sodium sulphates.

The method involved release of SO₃, bound to alumina in alunite, at the beginning of the technological process.

Release occurs by the following reaction in process of recovery of alunite rock with sulphur vapor or gaseous reducing agent:



This process makes it possible to avoid conversion of caustic alkali into a low value product - sodium sulphate - during leaching. For compensation of losses of caustic alkali during the technological cycle of alumina production, part of sulfate salts was subjected to thermal kaustification (Penyakov method).

The project was aimed at processing of alunite ores from Zaghlik deposit, which contained 51% of alunite and 49% of waste rock. The ore contains 0.05% of V₂O₅. Averaging of contents of alunite in the ore (50%) was made by visual-mechanic enrichment of alunite ores in the mine.

Table. Average chemical composition of alunite ore from Zaghlik deposit (weight, %)

Al ₂ O ₃ al	Al ₂ O ₃ non-al	SO ₃	Na ₂ O	K ₂ O	SiO ₂ quartz	Fe ₂ O ₃	other
19.2	2.5	20.0	1.5 – 2.0	3.5 – 4.0	42-43	4 - 5	7.3 –4.3

Despite some advantages, this technological scheme had a number of significant shortcomings, which together with some plant design errors, complicated the production process and led to its unprofitability, as the plant could not operate at full capacity.

Statement of the problem

“Reversed” scheme - a method of eliminating some of the shortcomings of the GAP technology. Search for ways of overcoming the drawbacks of reduction alkaline technology and hardware design errors began almost immediately after start of production (1965). In order to eliminate certain technological shortcomings, the plant switched to a new, so-called “reversed” scheme of hydro-chemical processing of recovered alunite with conversion of alkali sulphates by KOH solution. This technology uses desilicated aluminate solution for evaporation (instead of mother liquor) in special evaporators, thus closing the water balance and separating sulphate salts. After evaporation and separation of sulphate salts the aluminate solution is diluted to necessary concentration prior to decomposition by filtered wash water from washing of alunite mud and wash water from washing of aluminum hydroxide. Alunite is leached by mother liquor, taken from decomposition process.

To compensate loss of alkali, alkali sulphates are converted by potassium alkali, instead of sintering of hydrate-sulphate burden. All the alkali sulphates in the alunite, extracted during evaporation of desilicated aluminate solution, are converted into potassium sulphate and NaOH according to the reaction:



In this case almost all sodium sulphate is used for compensation of losses of caustic alkali during production. The bulk of potassium sulphate from the alunite will be extracted into the final product - fertilizer.

Conversion of alkali sulphates with KOH allowed us to eliminate certain shortcomings of reduction – alkaline technology:

1. Semi-finished product $\text{Al}(\text{OH})_3$ does not have to be returned to the starting stage for sintering.
2. Energy-intensive process of sintering of hydrate-sulphate burden with emission of SO_2 into atmosphere is completely eliminated from the scheme.
3. Unprofitable production of inedible table salt is also eliminated.
4. Mixture of potassium and sodium sulphates is extracted from the alumina solution before decomposition, thus speeding up decomposition process, decreasing level of pollution of aluminium hydroxide by sulphates, and also reduced dilution rate of aluminum solution.

Previous reducing agent (diesel fuel) was replaced by elementary sulphur, thus solving the issue of production of clear sulphuric acid. However, production was complicated by a necessity to organize separate production of potassium alkali or its procurement from third parties.

Still, certain important issues remained unsolved even in the improved technology.

Major error in furnaces design, as it resulted in significant discharge of dust and gas from the fluidized layer furnaces during roasting and reducing, as well as an insufficient dwelling time for the dust in reduction furnace. As result, degree of dust recovery is low. Dust from the furnaces was transferred to a recovery furnace, and captured dust was circulating between electrical filter and furnace. As result, its concentration at the entry to electrical filters was increasing. Use of fluidized layer furnaces for processing of alunite dust significantly complicates the technology and worsens the technical - economic results, despite the fact, that concentration of Al_2O_3 in the dust is 1.5 times higher, then in other types of rock. Due to a low degree reduction of aluminium sulphate in the dust, significant part of NaOH goes into Na_2SO_4 during leaching. Besides, alunite dust for fluidized layer furnaces (FLF) is enriched by kaolin, which leads to formation of insoluble sodium aluminosilicate $\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3 \cdot 2 \text{SiO}_2 \cdot 2\text{H}_2\text{O}$.

In other words, a significant part of unrecoverable (sodium aluminosilicate), as well as recoverable losses (sodium sulphate) of caustic alkali is caused by processing of alunite dust at FLF.

As result of passivation and other losses during processing of the recovered alunite in hydro-chemical part of Bayer process, share of alumina in the final product did not exceed 75%.

In an improved hardware scheme, pulp from leaching of alunite rock is fed to a hydro-separator, where the insoluble residue is separated into two parts: fine, sludge fraction and larger, sand fraction of the mud. The sludge mud fraction is thickened in five-chamber thickeners, washed with a counterflow, then separated from alumina solution, repulped by water and sent to a mud lake in form of a pulp (500-600 grams of solid matter per liter).

Sand fraction of the mud is separated from alumina solution by filtration and rinsing at carousel vacuum filters, then also sent to a mud lake. Waste for each ton of alumina produced is equal to 4–5 tons of red mud, including 1.5-2.0 tons of sludge fraction and 2.0-3.0 tons of sand fraction.

Purification of aluminate solution from dissolved silica is performed by process of one-stage desilication, where as result of reaction:



sodium hydroaluminosilicate is precipitated and further disposed after separation and rinsing.

Thus, the following significant technological issues have remained unsolved.

1. Issue of roasting and reduction of alunite in FLF and related shortcomings.
2. Low share of alumina in the final product (not more than 75%).
3. Significant unrecoverable and recoverable losses of alkali, related to hydro-chemical processing of alunite dust and ore, not fully recovered previously.
4. Significant quantities of disposed mud (white mud, sludge fraction, sands).
5. Significant consumption of scarce and expensive additional raw materials – elementary sulphur, potassium and sodium alkali. Scarcity of additional raw materials led to numerous month-long stops of GAP operation in 1990-1992.

Solution of the problem

Use of sulphur as a reducing agent led to increase of production of sulphuric acid (almost 2 times), and complications related to its disposition. Long-distance transportation of sulphuric acid is unprofitable.

In 1992, due to a number of unresolved technological issues, production of alumina from alunite at GAP was stopped and has not commenced until now. Researchers have also excluded process of alunite reducing from the technological scheme.

Attempts to use raw alunite ore in technology. Raw alunite readily and rapidly degraded by solutions of caustic alkali. This property of a mineral was first used in 1930-ies in technology “Mineral” by S.P. Kametsky [6], and, more recently, by G.Z. Nasyrov [7]. However, these methods were not applied in production, since they have the following shortcomings:

1. Alkali consumption for leaching of raw alunite increases 2 times.
2. Leaching of alunitized rock requires use of highly diluted solutions of caustic alkali. With concentration of NaOH $\geq 10\%$, solutions become almost saturated by sulphates.
3. In case if 10% solution of concentrated caustic alkali is used for leaching, concentration of Al_2O_3 in aluminate solution is around 50 grams/l. The decomposition processes for such concentration are ineffective, and the carbonization process is used instead.
4. Compensation of losses of alkali by diaphragm electrolysis of potassium chloride, resulting in production of KOH and chloride – is an inefficient and expensive process, which also requires side-line processing of chloride on spot 5. Low-temperature ($\leq 85^\circ C$) process of leaching of pre-crushed ore (-8 mm) decreases excited of alumina in the solution and increases leaching time.

Possibly, due to this reason China refused to build a plant after pilot testing of Nasyrov’s technology (which were performed over 20 years ago).

Potash-alkaline method for processing alunite ores and its improvement. Team of researchers at Moscow Institute Steel and Allows (MISiS), led by Professor A.I. Layner, has developed a potash-alkaline technology of alunite ore processing [8]. This technology, further improved by us [9-11] (Fig.1), was offered for reconstruction of a technological scheme of alunite ore processing at Ganja Alumina Plant (GAP). Besides increase of productivity up:

1. To 150 thousand tons of Al_2O_3 per year, it allows side-line production of.
2. Chloride-free fertilizer – potassium sulphate – 315 thousand tons per year.
3. Coagulant (solid) for purification drinking and sewage water – 49.5 thousand tons per year;
4. Quartz sand for production of molding and core mixtures for iron and non-ferrous casting, production of packing glass and construction materials – 300 thousand tons per year.
5. Pure carbon dioxide without harmful additions, which can be used for carbonating of mineral waters, electrical welding in protective environments, in metallurgy, ecology and other areas – 60.0 thousand tons of CO_2 per year.

We offered certain improvements in hardware scheme, aimed at increase yield of alumina, extracted from alunite ore. In particular, we offer to perform fine crushing to 2-3 mm. After roasting in rotary tube furnaces roasted alunite should be subjected to wet grinding in ball mills (40-50 mesh) with solution of potash-carbonate mixture. Advantages: a) fluidized bed furnace are not used for roasting, thus avoiding losses of dust, 6) fine dry grinding is also not used with the same positive effect.

Due to high contents of alumina in the sand fraction after 1st leaching (up to 15-20%), we recommend to transfer the pulp, resulting after 1st leaching, sludge and sands are fed together to the 2nd leaching by circulating aluminate solution. In this case, output of Al_2O_3 in solution may reach up to 97 %. After 2nd leaching the pulp is fed to a hydro-separator for separation into sludge and sands. Due to low contents of solid matter in the sludge fraction pulp, the speed of deposition of the pulp in thickeners and washers may increase 3-4 times. Hardware scheme of potash-alkaline technology of alunite processing, proposed by us, eliminates almost all the shortcomings of reversed and reductive – alkaline technologies. It also creates conditions for little waste processing of alunite ore [13] The technology uses the existing equipment of GAP. We refused from use of FLF roasting, because alunite and waste rock will be grinded differently, due to differences in their hardness: alunite – 3.5-4.0, a quartz – 7.5-8.0 on the Mohs scale. As result, contents of alumina in the dust are 1.5 higher, than in the ore.

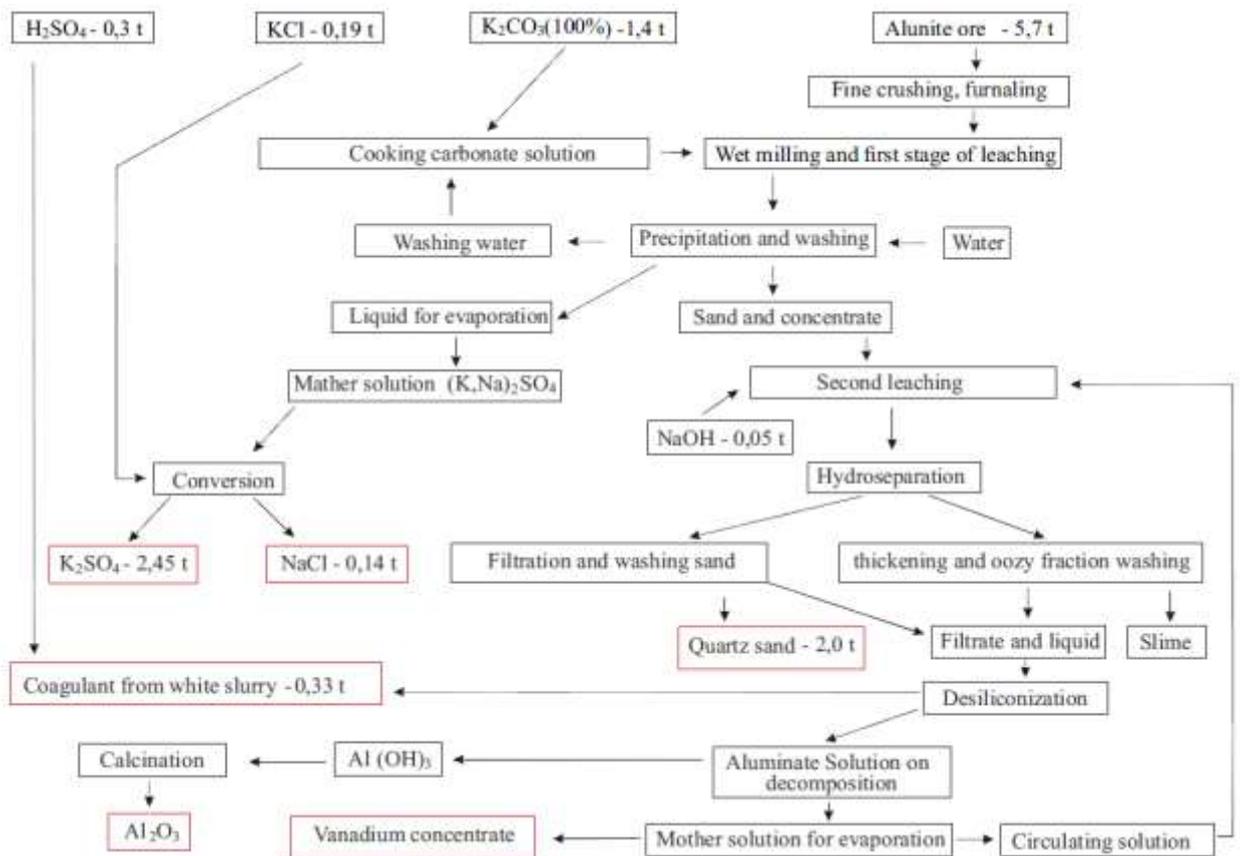


Fig.1. Scheme of potash-alkaline technology processing of alunite ore

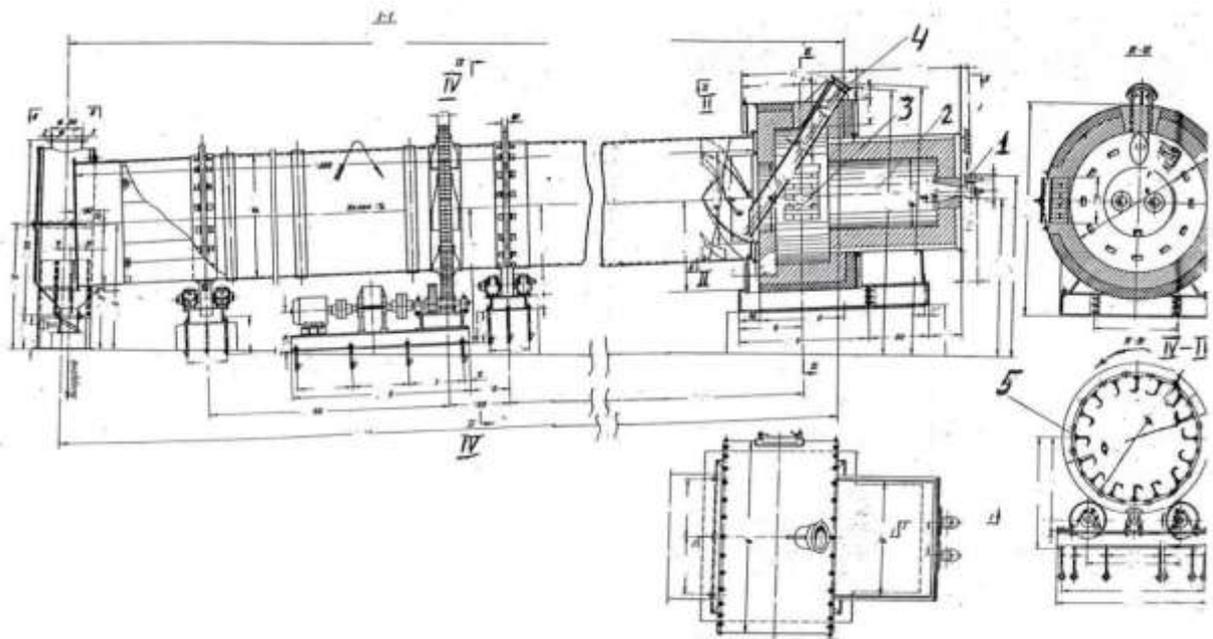


Fig.2. Tubular rotary furnace for roasting of alunite ore:
 1 – Fuel and air injector; 2 – Combustion chamber; 3 – Output of combustion products to the furnace and regulation of gas temperature by air supply;
 4 – Feed point for finely crushed alunite; 5 – Section of the furnace (IV-VI)

In laboratory tests share of alkali and SO₂, extracted into solution at 1st leaching, was 90-95%, and for alumina - not more than 2%. Insoluble residue from 1st leaching of roasted alunite - concentrate, contains, in average, (% weight):

SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	K ₂ O	Na ₂ O	SO ₃	LOI	Others
35-36	33-34	3.0-4.0	1.5-1.8	0.4-0.5	0.1-0.2	0.2-0.3	15-20	4.0-5.1

Whereas, share of Al₂O₃ in the initial alunite ore from Zaghlik deposit did not exceed 19-20%.

Share of major components of concentrate in the solution after 2nd leaching by the recycled aluminate solution is, %: Al₂O₃ – 93-94; K₂O – 52-53; Na₂O – 34-35; SO₃ – 46-47. Share of alumina in the resulting product is not less than 90%.

Technologies of processing of solid waste: white sludge, quartz sand, and clay fraction of mud were tested on the pilot plants at GAP, at the foundry of Baku Engineering Plant, Salyan station of water purification etc. (positive results of the tests were officially confirmed).

Potash -alkaline technology (roasted alunite at T- roast = 520 – 530°C treatment by potassium carbonate solution) allows you to convert the sulphuric acid radical and alkali of sulphate alunite into solution with obtaining potassium sulphate (chloride-free potassium fertilizer). Almost all the alumina from the ore (98%) remains in insoluble residue and after 2nd leaching made by recycled aluminate solution, goes into solution with formation of sodium aluminate. In other words, insoluble residue after 1st leaching can be easily and profitably processed by Bayer out-of-autoclave process with a number of benefits:

- share of alumina recovery in the product is up to 90%;
 - we exclude a complicated process of reduction of alunite by elementary sulfur, causing passivation of alumina, emission of gas and dust, and losses of alkali and sulphur;
- also we avoid:
- production of sulphuric acid;
 - the need for imported additional raw materials– elementary sulphur, potassium alkali;
 - we exclude unrecoverable losses of alumina in production of coagulant for purification of drinking and sewage water due to use of sodium aluminosilicate (white sludge);
 - accumulation of large quantities of alkali sulphates in hydro-chemical part of Bayer process.

Significant shortcoming of potash-alkaline technology are high cost and scarcity of additional raw material – potassium carbonate K₂(CO₃)

For countries, processing nepheline by sintering with receiving potassium carbonate as by-product, and having large of alunite ore (China, Iran, Russia), potash-alkaline technology will be the most effective. Potassium carbonate, obtained from processing of nepheline, is used in potash-alkaline technology for processing of roasted alunite.

For the majority of countries, having large deposits of alunite ore, potassium carbonate (potash) is a very scarce and expensive product, and this limits its use for large-capacity production of alumina.

A number of foreign research papers on technology of alunite ore processing [11] consider potassium carbonate technology an optimal strategy of choice [12].

The soda – alkaline technology. In order to avoid the above shortcoming – use of scarce and expensive potassium carbonate – we offered a soda-alkaline technology for processing of alunite ore [15]. On a first stage of leaching of roasted alunite we use soda (Na₂CO₃) instead of potash. (Fig.3)

This drawback is avoided in the soda-alkaline technology [Fig.2]. 1st leaching of roasted alunite with solution of sodium carbonate, results in production of potassium and sodium sulphates, and vanadium pentoxide remains in an insoluble residue. Further on, during 2nd leaching of the insoluble residue by recycled aluminate solution, V_2O_5 goes into solution in form of sodium vanadate and then is accumulated in a recycled aluminate solution, until, after several cycles, it reaches a certain concentration and turns into concentrate of vanadium pulp during evaporation. Major products of soda-alkaline technology processing of alunite ore are: metallurgical alumina, sulphate of potassium (SOP), coagulant for water purification, edible table salt, quartz sand, pure carbon dioxide, and concentrate of vanadium sludge [17].

To reduce the capital costs of technology implementation, the author proposes to divide the implementation process into two stages.

The first stage is to introduce a part of the technology with the first leaching of the burnt alunite with a solution of soda (Na_2CO_3) with the separation of the insoluble residue (concentrate) for storage. The resulting solution of a mixture of sulphates of potassium and sodium to apply for a conversion of potassium chloride with obtaining sulphate of potassium (SOP) and sodium chloride ($NaCl$). The profit from the sale of products of the first stage of introduction into production will go to the construction of the alumina part of the introduction of the proposed soda-alkaline technology.

Conclusion

Advantages of potash-alkaline and soda-alkaline technologies in comparison with available “inverted” and alkaline reduction technologies:

1. Excited of alumina in the final product increases to 90%.
 2. Processing of alunite ore is made in an integrated manner with production metallurgical alumina, potassium sulphate, coagulant for water purification, quartz sand, edible table salt, clean CO_2 , which can be used in carbonating of mineral water and other areas an .
 3. Roasting of finely crushed ore (2 – 3 mm) and use of tubular rotary furnace excludes pollution
 4. Roasting of alunite at $T = 520 - 530$ °C with excessive air (in an oxidizing atmosphere) excludes release of SO_2 alunite during roasting, as well as passivation of alumina.
 5. Application of wet grinding of roasted alunite with potassium carbonate solution (potash-alkaline method), or sodium carbonate solution (soda-alkaline method) with simultaneous 1st leaching excludes pollution of dust during grinding in a drum mill.
 - 6 After 1st leaching in the insoluble residue remains of the concentrate (33 – 34 % Al_2O_3) are processed in a Bayer out-of-autoclave process.
 - 7 White sludger from desilication is used for production of solid coagulant for purification of drinking and sewage waters from mechanical impurities.
 8. Edible salt – one of the outputs of potash-alkaline and soda-alkaline technologies - does not contain any vanadium pentoxide. Pulp, containing whole of vanadium pentoxide, is separated from it.
 9. Red mud– quartz sand (contents of SiO_2 up to 92%) is used as a component of molding or core sand mixtures for iron or non-ferrous casting, as well as production of construction materials and bottle glass.
 10. Soda-alkaline technology uses easily accessible and inexpensive sodium carbonate (soda) and potassium chloride instead a rare and expensive potassium carbonate (potash).
- Comparative technical and economic estimations for soda-alkaline and potash-alkaline technologies, under expected productivity of 150 thousand tons of Al_2O_3 per year, demonstrated:
- A. The annual efficiency of soda-alkaline technology – USD 200.902 mln per year.
 - B. The annual efficiency of potash-alkaline technology – USD 159.571 mln per year.
- Note: the USA is the second largest producer of soda ash (Na_2CO_3) in the world, and Canada, is the world's largest producer of potassium chloride (KCl).

References

1. Labutin G.V. Alunites. // Metallurgy. – M., 1965. – Pp.34-90.
2. Lainer U.A. Integrated processing of aluminum-containing raw materials by acidic matters. – M.: Nauka, 1982. – Pp.18-23.
3. Nasyrov G.Z., Nemets N.V. Method of processing of alunite ore to potassium alums and aluminum sulfate. – 2005.
4. Labutin G.V. Technology of alunite recovery. / USSR author certificates 9911 and 108947. – 1948.
5. Agranovsky A.A., Kaganovich U.Ya., Labutin G.V. / USSR author certificates № 106048, Discoveries and Inventions, №26.
6. Smirnov-Verin S. Alunites and their use. // ONTI. – 1938. – P.114.
7. Sizyakov V.M., Nasyrov G.Z. Effective methods for the integrated processing of non-bauxite aluminosilicate raw material on alumina and side-line products. // Tsvetniye Metally. – 2001, №12. – Pp.63-69.
8. Lainer A.I., Zakharova V.I., Popelukhina M.I., Lainer A., Taghiyev E.I. and Pevzner I.Z. // USSR author certificate 460709, October 21. – 1974.
9. Taghiyev E.I. Patent of the Azerbaijan Republic I 2001 0142 of October 02. – 2001.
10. Taghiyev E.I. Patent of the Azerbaijan Republic I 2003 0210 of October 30. – 2003.
11. Taghiyev E.I. Babayev I.S., Radjabli S., Khoudiyev A.T., Aliyev T. / USSR author certificate 8724560, June 15. – 1981.
12. Taghiyev E.I. Technology of an integrated waste-free processing of alunite ore. – Baku: Elm, 2006. – 504 p.
13. Alizadeh Shahab. Alunite processing method selection using the AHP and TOPSIS approaches under fuzzy environment International. // Journal of Mining Science and Technology – 2016, 26. – Pp.1017-1023.
14. Piga L., Pochetti F. Cipriani P. Beneficiation of alunite by piro- and hydrometallurgical treatment of alunite – K_2CO_3 mixtures. // Miner Metall Process. – 1999, 16 (2). – Pp. 20-4.
15. Taghiyev E.I., Agajeva L.G., Tagijev E. Patent of Czech Republic 307974 of January 30. – 2018.
16. Nemets G.Z. Conversion of mixture of potassium and sodium sulfates with potassium chloride. / USSR author certificate 784156 of June 14, 1979. – VAMI, published on November 10. – 1995.
17. Taghiyev E.I., Tagijev E.E., Agajeva L.G. Cost Effective Technology of Alunite Ore Processing. // International Journal of Chemistry. The Canadian Center of Science and Education (CCSE). – 2019. – Vol.11, №1. – Pp.36-44.

Xülasə

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Alunit filizlərinin emalında yeni ekoloji təmiz texnologiyalar

1965-ci ildə Gəncə gil-torpaq zavodu alunit filizinin sənaye miqyasında emal edilməsi üçün bərpa-qələvi texnologiyasının tətbiqinə başlayıb. Texnologiyanın dezavantajları konstruktor səhvləri ilə birlikdə istehsalın qeyri-rentabelliyyəinə gətirib çıxardı. Zavodun işə salınmasından bu yana bərpa-qələvi texnologiyası və avadanlığın konstruksiyası çatışmazlıqlarının aradan qaldırılması üzrə tədqiqatlar aparılmışdır. Bərpa edilmiş alunitin natrium sulfatların konversiyası ilə hidrokimyəvi emalının " əks " sxemi işlənib hazırlanmışdır. Bərpa-qələvi texnologiyanın bir sıra nöqsanlarının aradan qaldırılmasına baxmayaraq, aşağıdakı səhvlər aradan qaldırılmamışdır: 1) "CS" qovurma və bərpa sobasından qaz və tozun əhəmiyyətli dərəcədə çıxarılması; 2) alunit tozunun kifayət qədər olmaması, bu da prosesin texnoloji və iqtisadi göstəricilərini mürəkkəbləşdirir və pisləşdirir; 3) yandırılma və bərpa proseslərində gil-torpağın passivləşməsi; 4) gil-torpağın əmtəə məhsuluna aşağı çıxışla daxil edilməsi ($\leq 75\%$); 5) bərk tullantıların böyük miqdarı – 1 ton Al_2O_3 -yə 4-5 ton tullantı və s. Nəticədə, alunit filizinin emalı xətti 1992-ci ildə fəaliyyətini dayandırılıb və indiyədək

işləmir. Bu məqalə yeni texnologiyaların işlənilib hazırlanması, yeni kalium-qələvi üsulunun və alunit filizlərinin emalında yeni soda-qələvi texnologiyasının təkmilləşdirilməsinə həsr olunub. İlk qələviləşdirmədən sonra KCl ilə natrium sulfat konversiya üsulu ilə K_2SO_4 və NaCl ilə əvəz edilmişdir. Hər iki texnologiyanın müqayisəli texniki-iqtisadi hesabı, eyni şəraitlərdə hər birinin ildə 150 min ton Al_2O_3 istehsalını təsdiq etmişdir: a) potaş-qələvi texnologiyasının illik səmərəliliyi – 159-571 mln. USD; b) soda-qələvi texnologiyasının illik məhsuldarlığı isə 200-902 mln. USD. "CS" sobanın yerinə yeni yandırma sobası seçilmişdir.

Açar sözlər: əks sxem, gil-torpaq, koagulyant, kalium sulfat, kvarts qumu, xörək duzu, konversiya, kalium xlorid, soda, potaş.

Резюме

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Новые экологически чистые технологии переработки алунитовых руд

В 1965 году впервые в международной практике на Гянджинском глиноземном комбинате (ГГК) (Азербайджан) в промышленном масштабе была внедрена восстановительно – щелочная технология переработки алунитовых руд. Технология имела существенные недостатки и вместе с проектными ошибками привела к убыточности производства. С начала пуска комбината велись исследования по устранению недостатков восстановительно-щелочной технологии и аппаратурного оформления. Была разработана т.н. “обращенная” схема гидрохимической переработки восстановленного алунита с конверсией щелочных сульфатов раствором КОН. Несмотря на устранение ряда недостатков восстановительно-щелочной технологии, не были устранены: 1) значительный вынос газа и пыли из печей “КС” обжига и восстановления; 2) недостаточно время пребывания алунитовой пыли в процессе восстановления, что осложняет и ухудшает технико-экономические показатели процесса; 3) пассивация глинозема в процессах обжига и восстановления; 4) низкий выход глинозема в товарный продукт ($\leq 75\%$); 5) значительное количество твердых отходов – 4-5 т красного шлама на 1 т Al_2O_3 и другие недостатки. Из-за ряда технологических и проектных недостатков с 1992 года линия переработки алунитовых руд была остановлена и до настоящего времени не работает. Разработке новых технологий посвящена эта статья. Недостатком разработанной поташно-щелочной технологии является использование в качестве вспомогательного сырья дефицитного поташа (карбоната калия). Предложена новая сода-щелочная технология переработки алунитовых руд, в которой поташ заменяют на соду (карбонат натрия). Полученный после 1-го выщелачивания раствор сульфата натрия методом конверсии с KCl меняем на K_2SO_4 и NaCl. В сода-щелочной – дополнительным продуктом является пищевая поваренная соль. Сравнительные технико-экономические расчеты обеих технологий, в одинаковых условиях, при производительности каждой 150 тыс.т. Al_2O_3 в год показали: а) годовую эффективность поташно-щелочной технологии 159.571 млн USD; в) годовую эффективность сода-щелочной технологии 200.902 млн USD. Сделан выбор новой печи обжига, вместо печи “КС”.

Ключевые слова: «обращенная» схема, глинозем, коагулянт, сульфат калия, кварцевый песок, поваренная соль, конверсия, хлорид калия, сода, поташ.