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6. E. P. Randviir, D. a. C. Brownson and C. E. Banks, A decade of graphene research: production, applications and outlook, Mater. Today, 2014, 17, p.426 -432.

7. D. R. Cooper, B. D'Anjou, N. Ghattamaneni, B. Harack, M. Hilke and A. Horth, et al., Experimental review of graphene, ISRN Condens. Matter Phys., 2012, P. 56.

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INFLUENCE OF HYDRODYNAMIC REGIME OF FLOTATION CHARACTERISTICS ON TITANIUM-CONTAINING ORE

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Flotation, as a mineral processing method, is used to separate and concentrate ores by altering the surfaces of minerals to a hydrophobic or hydrophilic condition. That is, the surface is either repelled or attracted towards water. The flotation process was developed commercially early in the 20th century in order to remove very fine mineral particles which had previously gone to waste in gravity separation plants. Flotation has now become the most commonly used process for extracting various minerals from their ore sources. Many studies have suggested selective collectors for flotation, with sodium oleate being one of the more reliable candidates due to its ease of availability and lower cost when compared to other anionic fatty acid collectors.

Ilmenite, the primary titanium source vital for various industries, undergoes crucial processing through flotation. This review aims to systematize technological advancements in ilmenite upgrading. Understanding the fundamental properties of ilmenite and its metallogenic mechanisms is pivotal in selecting beneficiation strategies. Over time, flotation has become indispensable in ilmenite upgrading, with numerous collector types developed for different pH ranges. Surface modification methods have emerged as a prominent research area. Future endeavors should focus on enhancing the floatability of fine ilmenite and effectively recycling historic ilmenite-containing tailings.[6]

The experimental part. To enrich the source ore, a laboratory chamber-type flotation machine with mechanical stirring is used. Ilmenite ore was collected from the Satpayev deposit in the East Kazakhstan region of the Republic of Kazakhstan from 2020 to 2021.

Reagents: sodium oleate, sulfuric acid, foaming agent T-92.

Methodology. The prepared bulk of the enriched ore is placed in the mixing compartment of the flotation chamber and water is poured with a measuring cylinder, fixing the volume. The level of the resulting pulp should be slightly higher than the dividing wall of the chamber.

Then the appropriate reagents are added in the following sequence: pH regulators, collectors, foaming agents. When adding reagents, the agitator and the air supply are switched on each time. After processing the pulp with flotation reagents, the foam pen is turned on using the handle. It is taken to an upright position and at the same time the time of the beginning of flotation is fixed by a stopwatch.

Foam with concentrate is collected by a foam pad into a glass mounted on a table. Foam is removed every 3 minutes into separate glasses so that the progress of the process can be analyzed over time. The duration of the flotation is 9 minutes. The resulting concentrate fractions are filtered under vacuum on a Buchner funnel, dried at a temperature of 100-105 ° C and weighed on a technical scale.

At the end of the work, the foam and mixing are turned off, and the flotation chamber is freed from the “tails”. To do this, move the table to the side by turning the locking screw in one turn, and lower the camera down the guides. The mass of the “tails” is determined by the difference between the mass of the ore and the mass of the resulting concentrate.

The bulk ore weighing 100 g is crushed for 20 minutes. The resulting pulp from the mill is transferred to the chamber of the flotation machine. After mixing the pulp (without air supply) for 1 minute, in accordance with the accepted costs, flotation reagents are loaded into it in the following sequence: sulfuric acid, sodium oleate. With reagents, the pulp is agitated without air supply for 1 minute. Then the collector is loaded with a foaming agent and the air supply to the flotation machine begins. Next, the main and control flotation is carried out, separating the rough titanium concentrate in the form of a foam product.

Results and discussions. Studies have been carried out on the influence of airflow (20-40 l/h), impeller rotation frequency (25-40 Hz), flotation time (10-20 min) and consumption of a mixture of collectors (sodium oleate) (350 -550 g/t) on the degree of enrichment of ilmenite ore.

Based on the data obtained, the balance of flotation enrichment was calculated, presented in Table 1.

Table 1 Balance of flotation products

No. p/n	mass concentrate, g.	Tails, g.	α	β, %	extraction (concentrate) Ec, %	extraction (tails) Etale, %
			0			

The optimal parameters for flotation enrichment of copper ore were determined: air supply speed 20 l/h, impeller rotation frequency 25 Hz, flotation time 20 min, and collector mixture flow rate 350 g/t. On the other hand, the air supply rate determines the value of the redox potential of the pulp through the number of moles of oxygen retained by the pulp, and the consumption of sulfuric acid determines the pH value of the environment (Table 2).

Table 2 The results of recalculation of variable factors to physicochemical parameters of the medium

n (O_2), 10^3 mol	τ, s	pH	c, mg/l
5,74	10	7	7
5,74	8,57	7	9
5,74	7,5	6.5	11
11,49	10	6.5	9
11,49	8,57	7	11
11,49	7,5	7	7
17,23	10	5.5	11
17,23	8,57	5.5	7
17,23	7,5	6	9

When forming a model of the enrichment process, simultaneous consideration of the amount of oxygen retained by the pulp, the pH of the medium and the concentration of the collector (mixture) makes it possible to calculate the redox potential of the pulp. Introducing a time parameter into the generalized equation will make it possible to carry out kinetic monitoring of the system, which is directly related to the ore washability. The construction of surfaces in the coordinates of the speed constant - air flow, flotation reagent flow, and impeller rotation frequency (contact time τ, s) will make it possible to predict the stability of the bubble-particle complex in a wide range of the redox potential of the medium and hydrodynamic conditions.

Calculation of the flotation process. Based on a generalized equation that takes into account the influence of all factors, namely the impeller rotation speed, flotation time, air volume, and photo reagent consumption, changes in the extraction of the valuable component into the concentrate were calculated when these factors changed (Figures 1-4).

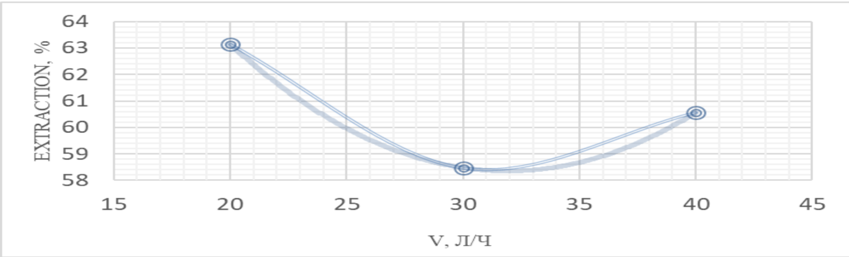

Figure 1 Dependence of extraction on the volume of air

It is shown that for samples of titanium-containing ore, the degree of extraction of titanium into a concentrate is closely interconnected with air consumption and the degree of dispersion of bubbles. These factors directly affect the redox balance in the pulp, namely, increase the likelihood of leakage of reaction reactions of hydroxy complexes, thiosulfates, and metal sulfates on the surface of oxide and sulfide minerals. The data presented show that in the flotation of titanium-containing minerals, which, according to X-ray-phase analysis, are represented by routine (TIO2), the optimal value of airflow is 20 l/h. The T.I. content in the concentrate under these conditions equals the total extraction of titanium by 43%.

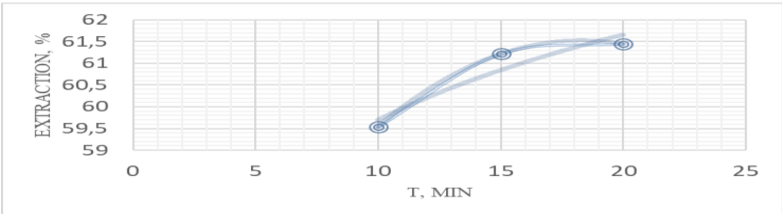

Figure 2 Dependence of extraction on the speed of rotation

The predominant influence on the quality of the concentrate and the degree of extraction of metal in the impeller rotation concentrate are shown. Under these conditions, the part of the particle's contact with a bubble of air is reduced. Therefore, the number of valuable minerals transferred to the foamy layer decreases. Varying the consumption of the regulator of the sulfuric acid and collector (mixture), with the constancy of hydrodynamic conditions, made it possible to establish that with an increase in the consumption of the mixture of the flotation reagents (sodium oleate) from 350 to 450 g/t, the extraction of. T.I., located in the form of rutile (TIO2) of a certain radio phasis and I.R. spectroscopic analysis, in a collective concentrate, is reduced, due to a decrease in the solubility of oleate and the formation of more strong complexes of sodium with iron ions, which subsequently exfoliated from the surface and pass into the solution (Figure 4).

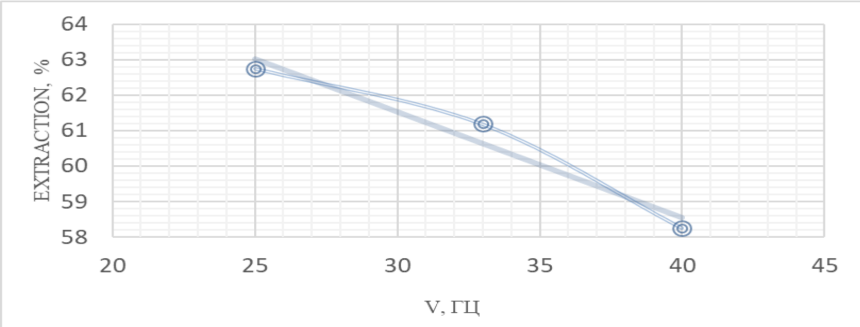

Figure 3 Dependence of extraction on time

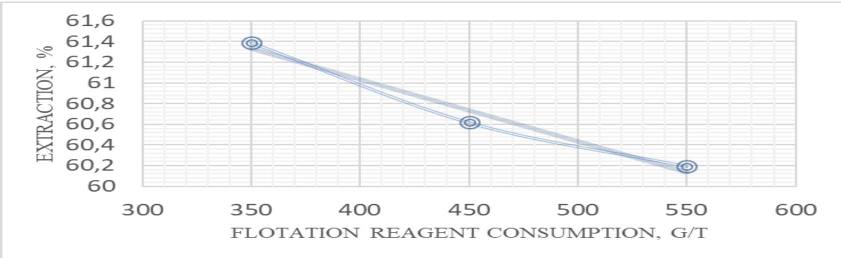

Figure 4 Dependence of extraction on the consumption of the felt-tip pen

It has been shown that increasing the air supply rate from 20 l/h to 40 l/h does not lead to significant changes in the fractional composition of the pulp. Consequently, under these conditions, the gradient of the flotation rate constant between complex and moderately floated fractions increases with increasing oxygen content in the pulp, which is due to oxidation to titanium and iron oxides, followed by depression of sulfuric acid and the formation of strong metal hydroxides, which are replaced by collector anions. It has been established that the share of the difficult-to-float fraction decreases, the share of the medium-floatable fraction remains almost constant, and the easily-floated fraction increases with high pulp aeration. An analysis of the flotation rate constants under the influence of air volume and flotation reagent flow rate showed that the indicated conditions are characterized by the presence of only two fractions with medium and easy flotation and the use of a mixture of sodium oleate and sodium benzene sulfonate makes it possible to extract difficult-to-float and medium-floatable fractions, which may include intergrowths with oxides titanium. However, the low flotation rate with aeration of 30 l/h does not allow the separation of medium and lightly floated fractions, which indicates the low selectivity of the reagent under these conditions due to the insufficient degree of oxidation of minerals and, accordingly, the proportion of the surface occupied by hydrophobic collector molecules.

Conclusion. Sequential flotation enrichment of titanium ores examined impeller speed, air supply, collector flow, and flotation time. Impeller speed had the most significant impact. Collective-secret flotation used a collector mixture, optimizing parameters like air supply, impeller speed, flotation time, and collector consumption. High mineral extraction in collective concentrate was achieved, with modest enrichment. Thermodynamic parameters of mineral dissolution considered hydrodynamic regime and entropy change. Impeller speed affected Gibbs energy during metal complex formation, correlating with extraction rates.

References

1. Chernet, T. Mineralogical and textural constraints on mineral processing of the Koivusaarenneva ilmenite ore, Kälviä, western Finland. Int. J. Miner. Process. 57, 1999. - P.153–165.
2. Chen, P., Zhai, J., Sun, W., Hu, Y., Yin, Z. The activation mechanism of lead ions in the flotation of ilmenite using sodium oleate as a collector. Miner. Eng. 111, China, 2017. P. 100–107.
3. Chen, Q., Kasomo, RM; Li, H.Q., Jiao, XK.; Zheng, HF.; Weng, XQ.; Mutua, NM.; Song, SX.; He, DS.; Luo, HH. Froth flotation of rutile - An overview. Miner. Eng. 163. Wuhan, China. 2021. – P - 106797.
4. Cheng, HW.; Liu, CM.; Guo, ZX.; Feng, AS.; Wei, M.; Lv, ZH.; Wu, DY.; Zhao, DK. Electrokinetic and flotation behavior of rutile in the presence of lead ions and aluminium ions, Physiochemical problems of mineral processing, 55, 2, 2019. China. P. 458-466.
5. Li, HQ.; Zheng, HF.; Chen, Q.; Kasomo, RM; Leng, JH.; Weng, XQ.; Song, S.X.; Xiao, LB.; Tian, CT. Flotation separation of rutile from almandine using octadecyl amine polyoxyethylene ether as collector, Physiochemical problems of mineral processing, 56, 4, 2020. China. P. 653-664.
6. Sun W., Li W.-J., Liu J.-D. Application of a new selective collector for rutile flotation. Mining and metallurgical engineering; Volume 30, Issue 2. C. 35-39
7. Hydrochemical benefication on of off-grade titanium slag: 16th International multidisciplinary scientific geoconference, SGEM: Science and technologies in geology6 exploration and mining, vol II. Albena, Bulgaria, jun 30-jul 06, 2016./Naimanbayev, M.; Lokhova, N.; Baltabekova, Z; Abisheva, A.; Maldybaev, G. – 2016. Albena, Bulgaria. – P. 1105-1112.
8. Xiao, W., Jiao F., Zhao H.,ID , Qin W., Qiu G., Wang J. Adsorption Structure and Mechanism of Styryl Phosphoric Acid at the Rutile–Water Interface. China. 2018. P. 1 – 8.
9. Bertini V., Pocci M., Marabini A., Barbaro M., De Munno A., Picci N. 3,4-(Methylenedioxy)benzyl acrylate/acrylic acid copolymers as selective pH-controlled flocculants for finely divided titanium minerals // Colloids and Surfuces. - 1991. –T.60. – P. 413-421.
10. Bulatovic, S., Wyslouzil, D. Process development for treatment of complex perovskite, ilmenite and rutile ores. Miner. Eng. 12, 1999 C. 1407–1417.
11. Cao M., Gao Y., Bu H., Qiu X. Study on the mechanism and application of rutile flotation with benzohydroxamic acid // Minerals Engineering. – 2019. – 134. – P. 275-280.
12. Flotation of colored impurities from feldspar ores M.S. Celik, B. Pehlivanoglu, A. Aslanbas and R. Asmatulu. 2001. – P. 101-105.
13. Detrimental effects of slimes on the flotation of rutile from eclogite ore Qian Chena, Bo Xub, Yangge Zhuc, Hongqiang Lid, Peng Chena, Yunliang Zhaob,e, Hongchao Lif, Shaoxian Songb. China. 2018, P. 250-255.
14. Qian Chen, Maomao Tian, Huifang Zheng, Huihua Luo, Hongqiang Li, Shaoxian Song, Dongsheng He, Xinhua Jiang Flotation of rutile from almandine using sodium fluorosilicate as the depressant China. 2020. P. 180-192.