подготовки цеха каустической соды производства АО «Навоиазот» $CaCO_3$, Na_2SO_4, присутствуют $Mg(OH)_2$ и H_2O. В настоящее время ведутся научные исследования по получению новых видов продукции на основе шламов.

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POSSIBILITIES OF PROCESSING OF OXIDIZED COPPER ORE AT "ALMALYK MMC" JSC

The reduction of the base of mineral raw materials, the deterioration of the condition of quarries and mines, and the increasing requirements for environmental protection impose new requirements on the search and extraction of mineral resources. Improving existing technologies and increasing the share of hydrometallurgical processes in copper production are the main issues. Extraction of copper using hydrometallurgical processes is based on the treatment of oxidized copper ore with a solvent, followed by precipitation of the metal from the solution. Oxidized copper ores in the Kalmakyr mine of "Almaliq MMC" JSC can serve as a promising raw material for the development of copper metallurgy in Uzbekistan [1].

Involving oxidized ores in processing is one of the urgent problems for "Almalyk MMC" JSC. As of today, over the years, in 9 landfills, there are about 100 million tons of oxidized ore, in addition to the balance with a copper content of 0,455%, 10,4 million tons of ore with a balance of – 0,827% copper [2].

Flotation methods for copper oxide minerals mainly include direct flotation and sulfidation flotation. Direct flotation is performed by adding bulking and foaming reagents directly to the flotation process without the use of activators. Sulfidation flotation involves the addition of a sulfidizing reagent prior to the addition of a collecting reagent to modify the properties of mineral surfaces. Due to sulphidation, a highly active copper sulphide film is formed on the copper oxide mineral surface. Thus, xanthate scavengers with good selectivity are more likely to interact with the sulfided mineral surface. The main methods of direct flotation of copper oxides are chelate reagent flotation and fatty acid flotation. A chelate collector for copper oxide minerals usually has a strong collection capacity [3].

For mixed oxide-sulfide copper ores, the chelating collector can provide simultaneous flotation of copper oxide and copper sulfide minerals. However, the disadvantage of chelating collectors is their lack of selectivity, which can also affect their free rock. Compared to chelate collectors, fatty acids such as sodium oleate have several advantages as collectors.

Hydroxamic acid and its derivatives are used as collectors for direct flotation of copper oxide minerals. Hydroxamic acid directly covalently binds with metal cations on mineral surfaces through chemical adsorption and forms metal chelates. Metal cations on the mineral surface dissolve in the solution and form hydroxyl complexes, which are re-adsorbed on the mineral surface. Octyl hydroxamic acid and its derivatives are widely used in malachite flotation to increase the hydrophobicity of the mineral surface. Direct flotation is convenient for copper oxide ores with simple mineral composition and high quality. However, in actual production, the use of direct flotation for copper oxide ores with complex composition and low quality is ineffective. For this reason, it is appropriate to use sulfidation flotation for such ores [4].

The chemical composition of oxidized copper ore from the Kalmakyr mine No. 9 tailings dump of "Almalyk MMC" JSC was studied.

Table – Chemical composition of the oxidized ore sample from the No. 9 tailings dump

Minerals	SiO_2	A_2O_3	Fe_{total}	Fe_{oxide}	$Fe_{sulfide}$	K_2O	Na_2O	MgO	MnO	P_2O_5
Content, %	61,88	13,19	6,82	6,37	0,45	4,7	0,91	1,99	0,04	0,26
Minerals	S_{total}	SO_4	Pb	CaO	Zn	Ag, g/t	Au, g/t	Cu_{oxide}		$Cu_{sulfide}$
								free	bound	
Content, %	0,20	<0,25	0,0067	0,76	0,017	1,83	1,54	0,43	0,22	0,05

As can be seen from the table, the ore contains copper in both oxide and sulfide forms, with part of the oxidized copper existing in a free state and part bonded with other minerals. It was found that the ore contains copper in both oxide and sulfide forms. Based on the studies of the processing works performed and implemented in practice, a technological scheme for processing oxidized copper ores to recover valuable components was developed for "Almalyk MMC" JSC. According to the proposed technology, it is suggested to first process the oxidized copper ore hydrometallurgically, and then direct the remaining mass to flotation in order to separate copper in its sulfide form and extract rare metals.

The process was carried out in 3 stages using selective leaching and percolation. A sulfuric acid solution with a concentration of 70 g/l was used as the leaching agent. The copper recovery into the solution was 90-95%. The residual mass, after being washed, is crushed to -0.074 mm and sent to the flotation process. Effective flotation reagents are being studied to ensure the maximum flotation of copper minerals. The flotation concentrate obtained from the process is sent to control flotation, and the resulting concentrate is directed to the copper smelting plant, while the waste is returned to the process for re-flotation.

In conclusion, the structure of the minerals in the ore and the preparation processes for their treatment significantly impact the flotation process when processing oxidized copper ores. Selecting effective reagents in the flotation process is a key condition, as it is necessary to enhance the hydrophobic properties of the minerals and ensure their attachment to the air-water interface. Selective leaching in the heap is considered one of the most efficient methods for separating oxidized minerals, where various reagents can be used as solvents. After selective leaching, both free and bound copper oxides transition into the solution, resulting in the exposure of the surface of copper sulfide minerals, which ensures their easy flotation. The recovery of oxidized copper minerals reaches 90-95%. During the flotation process, gold and silver can also be separated along with the sulfide minerals.

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ИССЛЕДОВАНИЕ АНОЛИТА ПРИ ЭЛЕКТРОЛИЗЕ ХЛОРИДА КАЛИЯ В МЕМБРАННОМ ЭЛЕКТРОЛИЗЁРЕ

К существующей мембранной установке [1–5] присоединили лабораторный вакуумный насос так чтобы из анодной части электролизёра образующиеся газообразные продукты подсасывались. Такое изменение в установке дало б уменьшение содержание гипохлорита и хлоратов в составе анолита (солевой раствор обедненный хлоридом натрия), что позволяет использовать анолит в рабочем цикле многократно [6–7]. Эксперименты проводили при различной продолжительности до 80 минут и вакууме от 30 до 90 мм рт. ст. изменяя температуру от 60 до 90^{0}С. При этом после опыта определяли содержание гипохлорита и хлората в анолите. Полученные и рассчитанные экспериментальные данные приведены в таблицах 1–3.

Гипохлорит определяли методом ионометрии. Условия при анализе активного хлора в анолите: концентрация тиосульфата натрия 0,05 н; йодида калия – 5 см^3; 10%-ного раствора крахмала 1 см^3, 1 %-ного, объем пробы продукта 10 см^3. Расчет активного хлора производили по следующей формуле:

$$X_{г/л} = \frac{V_{TCH} \cdot 0{,}003545 \cdot 1000}{10 \cdot 2} = V \cdot 0{,}17725$$

Хлорат-ионы определяли титриметрическим методом, основано на их восстанавливая их сернокислым железом (II) в кислой среде при нагревании и последующем определении избытка восстановителя раствором перманганата калия. Химизм реакции восстановления хлорат-иона: $KClO_3 + 6FeSO_4 + 3H_2SO_4 \rightarrow KCl + 3Fe_2(SO_4)_3 + 3H_2O$. Определе-