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THE EFFECT OF THE CHARACTERISTICS OF THE CATIONIC COLLECTOR AND APOLYAR SOLVENT MIXTURE IN DETERMINING THE ACCEPTABLE CONDITIONS OF THE FLOTATION PROCESS

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Abstract

The literature focused on the study of flotation processes was analyzed and it was found that the use of fatty amines in a mixture with hydrocarbons as a collector has a positive effect on the flotation enrichment of sylvinite ores. The composition of liquid paraffins obtained from imported and domestic secondary products was determined and compared by chromatographic analysis. Liquid paraffin derived from domestic secondary products has been shown to improve the flotation process, increase the separation of KCl into the concentrate, and reduce the consumption of valuable amine, thereby reducing the cost.

Keywords: *flotation, flotation reagents, collectors, izvlechenie, Selvinite ore, potassium chloride, liquid secondary raw materials, chromatographic analysis, liquid paraffins, residual hydrocarbons*

It is known that flotation is carried out due to the adsorption of air molecules on the mineral particles of the components under the influence of substances called "flotation reagents". The progress of the flotation enrichment process and its result are mainly determined by the reactive mode of flotation, i.e. assortment, type and method of their application. This regime is mainly determined by the physico-chemical properties of the mineral, its degree of dispersion, as well as conditions for finished products (Bobrakova A. A., 2013; Yunash A. A., 2004; Mergenbaatar N., 2005; Effective reagents for flotation of high-ash coals 2020).

In the flotation process, for the best enrichment result, several flotation reagents are usually used, their actions are interconnected and depend on the concentration of each of them. Therefore, excessive consumption of one reagent requires an increase in the consumption of other reagents, and an increase (or decrease) in their concentration can lead to deterioration of the technological performance of the entire process. Experiments have shown that the lowest possible consumption of reagents provides lower costs for the processing of mineral raw materials and better results of the enrichment process. Despite the accumulated theoretical and practical experience, the required amount of reagents is always determined for each mineral raw material using laboratory flotation experiments shown in industrial conditions (The concept of flotation examples of flotation reagents. 2009; Algebraistova, N. K. 2009; Garkovenko E. E., Nazimko E. I., Samoilov A. I., Papushin Yu. L., 2002).

The intended purpose of flotation reagents predetermines their suitability for one of three major classes: collectors, foam formers, and regulators.

Collectors are organic in nature and are mainly fixed on the surface of a solid liquid. Foam formers are mainly surfactant organic substances adsorbed at the liquid-gas interface. Regulators are used as additives to thickeners and foamers to increase flotation selectivity or mineral recovery. Representatives of this class are both inorganic and organic substances (Seyed, Hamid & Hosseini, Hamid & Hosseini. 2008; Shengo, Michel & Gaydardzhiev, Stoyan & Ngoy, Pierre. 2014).

The main purpose of the collectors is to hydrophobize the mineral surface, to increase the speed and stability of particles sticking to the air bubbles (Grigoriev A. A. 2001; Shubov L.Ya., Ivankov S. I., Scheglova N. K., 1990).

Liquid paraffins are the solvents that ensure the activity of the collecting reagents in Sylvin flotation.

As liquid paraffins today, '-dichlorodiethyl ether mixed with methyl ethyl or methyl isobutyl ketone in a mass ratio of 1:1 is used, treatment with urea is carried out by adding a solvent of 180–260 weight to the raw material. washing of the material and the complex is carried out in the first step with the specified solvent and in the second step with methyl ethyl – or methyl isobutyl ketone (Rodina, T. A., 2015).

The authors of (Mineral processing Design and Operations. 2020; Ukushkin V. V., 1999; Kukushkin V. V., Petukhov V. N., Osina NLO, 2003) suggested the use of kerosene, gasoil, etc. as a collecting reagent. Depending on the raw materials and processing conditions, they have different compositions and are in the form of a complex mixture of organic substances. The diversity of their composition makes it difficult to study the effect of kerosene and kerosene during flotation. However, it is difficult to determine which components of kerosene and gas oil are the most flotation active, and what to consider when choosing reagents for these conditions is complicated.

As aprotic solvents (Petukhov V. N., Osipa N.Yu., Kukushkin V. V. et al., 2003; Khan G. A., Gabrielova L. I., Vlasova N. S., 1986; Ya L. Shubov, Ivankov S. I., Shcheglova N. K. 1990; Ya. L. Shubov, Ivankov S. I., 1992), some aprotic reagents, such as clarified, tractor and oxidized kerosene, household stove fuel, apolar aromatic reagents AAP-1 and AAP-2, activated flotation reagent AF-2 and thermogasoyl are listed. Clarified kerosene is widely used in the early stages of flotation and is still widely used in a small number of factories. The predominance of saturated compounds in kerosene has a more selective effect on coal flotation than aromatized kerosene, but the flotation rate is slightly lower. The advantages of clarifying kerosene are the absence of a specific smell, ease of use, smooth process, and low cost. Kerosene does not foam, and at high consumption it exhibits anti-foaming properties. For coal flotation, clarified kerosene is used only in combination with a heteropolar reagent. Its consumption is 1–3 kg/t.

It is known from industrial practice that the yield of the concentrate and its purity in most cases are related to the mass fraction of soluble and insoluble salts in the saturated solution of sylvinite, which changes with temperature changes, and thus the efficiency of the reagents entering the flotation suspension system, the reaction of the reagents with the aqueous medium and the surface of the phase separation. also changes. As a result of these changes, the total technological process indicators can also change in a positive or negative direction.

There are many sources that have studied indicators related to temperature increase in the range of 30–35 C from saturated salt solutions to the processes of flotation beneficiation of potassium ore (Da Li, Pingmei Duan, Zhiping Du, Fangqin Cheng, Yunshan Guan. 2015).

In the natural conditions of our republic, the air temperature is high (35–45 C) in the months of July and September, which affects the flotation process and the passage of waste reagents, which are valuable as enrichment residues, is observed. It is urgent to determine the composition of reagents that allow high technological efficiency of potassium chloride enrichment of sylvinite ore at low and, especially for us, high temperatures.

Separation of potassium chloride from the mineral resources of our country – sylvinite ore by flotation enrichment, and the production of potassium fertilizers based on it is carried out according to the technology of OAZ "VNII Galurgii" of the Russian Federation, and operates at the expense of raw material crushed to 1 mm from the Tubegatan mines.

Therefore, in the course of our research, we considered it necessary to study the optimal technological parameters of flotation beneficiation of Tyubegatan ore silvin in the presence of synthesized collecting reagents.

In the technological process of JSC "Dekhkhanabad Potash Plant", mechanical or flotation cleaning is carried out with the help of SFM to slurry potassium chloride from natural sylvinite in a flotation enrichment system, then a mixture of alkylamines with apolar additives and depressants is used as a collector.

Saturated matochnium solution of JSC "Dekhkanabad Potash Plant" was chosen as the object of research. The density of this saturated matrix solution is 1244 kg/m^3, the amount of the main component is 18–35% by mass. and T_1, T_2 and T_3 contents were selected. The original ore also contains clay inclusions with a large specific surface in the amount of 4–15%, and the rest of the ore mass consists of sodium chloride (NaCl) and other soluble salts, which adversely affect the flotation beneficiation process of other sylvin (KCl).

The temperature of the climatic chamber is below 10 °C and not above 40 °C. All experiments to determine the effectiveness of the new reagents, with varying amounts of potassium chloride and insoluble residues, were carried out on samples with ore sizes no larger than 1 mm. Preparation of ore for flotation was carried out by cleaning it from the initial slurry.

When the temperature of the matochny solution is increased from room temperature to 40 C, the total amount of salts in the saturated saline solution increases from 30.8 to 33.1%, mainly due to potassium chloride, because at such temperatures the solubility of potassium chloride KCl increases compared to sodium chloride NaCl.

The results of laboratory studies on determining the flotation activity of cationic and apolar collectors against potassium chloride under different conditions made it possible to choose the effective working concentrations of the obtained reagents and determine the optimal conditions for use in beneficiation of natural ore.

For the experiments, domestic liquid paraffins extracted on the basis of secondary hexane were selected and compared with foreign analogues. As flotation components, reagents used in the technological system of "Dekhkanabad potash plant" JSC were selected.

The sylvinite ore smaller than 1 mm in size was first thoroughly cleaned in slurry and flotation process was carried out at a transfer rate of 15–40 g/t. It was found that in the composition of winter brand QA-2 amine containing 2% S20 < 24 fraction, local liquid paraffins exhibit a concentrate content of 71.24%, at consumption of 30 g/t (melting temperature 35 ± 1 C).

In the presence of summer YoA-1 with 22% S20 < 24 fraction in the local liquid paraffin collector, it was observed that potassium chloride separation reaches 90%. At the same time, the separation of potassium chloride from T-3 base solution using this composition made it possible to increase from 28.2 to 32.1%, while the separation of potassium chloride from ore with T-1 and T-2 composition was 35 C when 25 g/t was used. will have maximum efficiency.

Local liquid paraffin collector consumption of 30 g/t transfer winter and summer amine content S20 < 24 5, 10 and 15% by mass. It was found that the yield of concentrate increases by 0.8, 0.96 and 1.2%, and the level of potassium chloride separation increases by 1.0, 2.1 and 4.2%.

The results of the experiments show that at relatively low temperatures Amine: Liquid Paraffin (LP): Vacuum Gasoline (VGO) in the ratio of 35: 8: 2 had effective indicators. In the temperature range from 2 to 30 C, the same composition shows results close to the indicators of "base" industrial reagents

Table 1. *Results of flotation of sylvin in various samples with the presence of "Base" industrial and recommended reagents*

Results	A composition of collectors					
	SA-1 + SA-2: PEG: FA (40: 4: 8)			AmInes: DLP: VG (40:10:2)		
	T-1	T-2	T-3	T-1	T-2	T-3
Yield, %:						
concentrate	16,0	24,7	35,2	15,1	23,3	35,4
residual	84,0	75,3	64,8	84,9	75,7	64,6
Mass fraction of KCl, %:						
concentrate	67,3	86,8	83,1	68,2	86,9	83,9
residual	2,4	5,8	8,9	3,8	7,3	8,3
Separated KCl, %:						
concentrate	79,76	83,1	83,4	76,3	78,5	84,6
residual	20,24	16,9	16,6	23,7	21,5	15,4

When conducting laboratory experiments with the introduction of vacuum gas oil into an aqueous solution of amine, it was observed that the amine surface was covered with a film due to the formation of a difficult emulsion. At the same time, the resulting film can be removed by preliminary mixing of liquid paraffin and vacuum gas oil. As a result, a stable emulsion of amine and modifier is formed. Increasing the amount of amine to 40 g/t and the amount of apolar solvent to 15 g/t causes a sharp increase in the efficiency of the flotation process. At the same time, it is seen that flotation studies are higher than the indicators of the "base" regimes when reagents emulsified in the amine solution of vacuum gas oil are used. The separation of potassium chloride in the initial concentrate is 89.8%, compared to the "base" mode, it is 86.8%. Thus, the use of the reagent component in the same order is maintained at a high level even at temperatures of 35 C and above.

During the research, it was also observed that the flotation process of silvin can be controlled by changing the consumption of collectors. Taking this into account, the dependence of the proportions of the components of the aggregate composition on the indicators of sylvinite flotation was studied.

The sylvinite flotation was studied in conditions where the temperature of the matochny solution was higher than 40 C in the following proportions of the components of the collecting composition: Amine: summer amine (SA-1), winter amine (WA-2), foreign paraffin analogue (PA), domestic liquid paraffins (DLP), polyethylene glycol (PEG), vacuum gas oil (VGO), pine oil. Modified compositions were prepared by mixing components: 1) Amin+SA-2; 2) The ratio of SA-1+SA-2 is 59:41. Aggregate ratio to amine is unchanged at 35 g/t transfer. Amine: The dosage of apolar collecting reagents is strictly controlled. As a result of research, it was found that reducing the amount of amine in the mixture from 70 to 55% by mass improves the indicators of flotation beneficiation of sylvinite ore: the yield of the initial concentrate from the T-3 base is from 35.2 to 36.9%, and the degree of separation of KCl is from 83.4 to 84.0 increases to %. In the course of research, if the flotation process is carried out at high temperatures with a modified composition consisting of winter amine SA-2 and local liquid paraffins, it will be possible to completely replace foreign analogues. It should be noted that when using the SA-2+DLP+VGO flotation composition, the yield of the concentrate reaches 37.6%, and the separation of potassium chloride reaches 83.7%. Thus, with an increase in the percentage of collecting components added to the amine composition, its efficiency and potassium chloride flotation indicators increase. shows that it can be recommended for flotation beneficiation.

The material selected for enrichment has a large amount of water-insoluble additives, which during processing are transferred to a fine, difficult-to-filter soil slurry. The amount of soil sludge in the composition is within the limit of 3–12%. The component that needs to be separated is sylvin – potassium chloride, which is present within wide limits in the composition and makes up 18–35% of the total amount. The composition also contains sodium chloride, which has little effect on the flotation process. Flotation is carried out in solutions enriched with salts. The solution is characterized by strong foam formation, high viscosity and surface tension. Using liquid paraffin obtained in laboratory conditions, natural sylvinite was used in the process of separation of potassium chloride in flotation devices. in parallel, experiments were conducted with standard imported liquid paraffins (Table 2).

Table 2. *Comparative results of standard industrial and experimental liquid paraffin composition in flotation beneficiation of sylvinite ores*

№	Indicators	Standard liquid paraffins		Obtained liquid paraffins		Standard on MTX
		amount	KCl, %	Amount	KCl, %	
1.	Raw material	408	31.53	408	31.53	
2.	Potassium chloride obtained	130.5	89	132.31	89.2	≥ 83
3.	Residue	277.5	3.5	275.69	3.5	≤ 3,8

The obtained results show that the secondary product of "Uz-KorGasChemical" JSC – liquid paraffins obtained on the basis of used hexane, can replace the imported standard product in all its characteristics.

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