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Technical Note

Application of different collectors in the flotation concentration of feldspar, mica and quartz sand

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Abstract

The potential application of different cation collectors in the flotation concentration of mica, feldspar and quartz sand has been investigated. Raw materials (Bujanovac and Ub) from two localities in Serbia were used.

The results showed that for flotation of feldspars, Aero 3030C performed better than Flotigam DAT. Aero 3030C was more selective, and with its application a higher mass recovery of feldspar was obtained. In particular, the mass recovery of feldspar was 19.58% when Aero 3030C was applied and 7.58% when Flotigam DAT was used. However, the chemical compositions of the feldspar concentrates were not significantly different no matter which of these reagents was used.

For the flotation of impurities from quartz sand, Aero 3030C was better than a combination of R 825 and Armak C. When Aero 3030C was used, a higher quality of quartz sand concentrate was obtained than when a combination of these collectors was applied. The mass recovery of quartz sand was almost the same: 64.47% when Aero 3030C was used and 61.72% when a combination of Aero 825 and Armac C was used.

Keywords: Flotation reagents; Flotation collectors; Industrial minerals; Mineral processing

1. Introduction

The pegmatite ore of the white granite from Bujanovac contains K–Na feldspar (~60%), quartz (~25%), muscovite (~10%) and impurities. At "FELDSPAT", Bujanovac, concentrates of feldspar, mica and quartz sand have been produced from this raw material for industrial use. The deposit of quartz sand "Ub" contains quartz as the main mineral and feldspar, mica and heavy metal minerals as impurities (ITNMS, 1998). Many papers on the application of different collectors in the flotation of feldspar have been published in the past 80 years. In particular primary long-chain alkylammonium salts are the most commonly used flotation collectors for beneficiation of silicates (Shimoiizaka et al., 1976; El Salmawy et al., 1993). In this study, the results of application of different collectors in the flotation concentration of mica and feldspars from the white granite raw material from the "Bujanovac" deposit are presented. Also, the application of different collectors in the reverse flotation of quartz sand from the raw material from "Avala"-Ub deposit has been investigated.

2. Experimental

2.1. Materials

The sample of quartz sand stone was taken from the plant "Feldspar" Bujanovac at the beginning of the milling operation. The size range −0.6 to +0.063 mm was used for further investigations. The sample is denoted as "Bujanovac". The sample of quartz sand was taken from the "Kopovi"-Ub operation. The sample was wet sieved to obtain a −0.5 to +0.125 mm fraction. This grain size of quartz sand is required for the glass industry. The sample is denoted as "Ub". Chemical composition of used samples: "Bujanovac": 74.51% SiO_2; 14.17% Al_2O_3; 0.60% Fe_2O_3; 1.05% CaO; 0.22% MgO; 4.05% Na_2O; 4.22% K_2O; 0.84 % I.L. and "Ub": 92.53% SiO_2; 3.97% Al_2O_3; 0.33 % Fe_2O_3; 0.07% Na_2O; 1.16% K_2O; 1.25 % I.L.

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The chemical compositions of these samples suggest that concentration is required to obtain quartz sand, feldspar and mica of high quality.

2.2. Reagents

For flotation concentration of minerals cationic collectors were used. AERO 3030C was supplied by Cytec Industries Inc., (Cytec, 1999) Flotigam DAT was supplied by Clariant Co. (Clariant, 2000), while Armoflot 64, Armac C and Aero 825 were supplied from Akzo Nobel AB (Akzochemie, 1986).

3. Results and discussion

3.1. Flotation tests

Three flotation tests were performed on sample "Bujanovac" and two flotation tests on sample "Ub". Experimental conditions for flotation tests are given in Table 1.

Total balance of the products obtained in flotation tests on the sample "Bujanovac" is given in Table 2.

In all three experiments on sample "Bujanovac" (class −0.6 to +0.063 mm), in the first phase mica was floated, feldspar in the second. Quartz sand stayed in the underflow (Table 1). From Table 2 it can be seen that the chemical composition of the mica concentrate obtained in all three tests was almost the same (SiO_2 = 51.00%, 50.83%, and 50.79%, respectively; I.L. = 4.23%, 4.72% and 4.53%, respectively). Also, compared to the raw material, the mass recovery of the mica concentrate varied from 6.24% to 6.51%. From these results it can be concluded that for flotation concentration of mica, either collector Armoflot 64 or collector Aero 3030C should be used. In the first and second tests for the flotation of feldspar, Flotigam DAT was used and in the third test Aero 3030C. The amount of each collector was 300 g/t. The quality of feldspar concentrate (Table 2)

Table 1
Experimental conditions for flotation concentration

Sample "Bujanovac"				
Phase in the experiments	Content of solid phase (%)	Time (min)	H_2SO_4 to adjust pH	Depressing agent for quartz, NaF (g/t)
Constant conditions				
Conditioning for the flotation of mica	50	5	3–3.5	
Flotation of mica	28	6	3.5	
Washing underflow of mica	50	3	–	
Conditioning for the flotation of feldspar	50	5	2–2.5	600
Flotation of feldspar	27	6	2.5	
Experiment number	Type and amount of collector during the flotation of mica		Type and amount of collector during the flotation of feldspar	
	Armoflot 64 (g/t)	AERO 3030C (g/t)	Flotigam DAT (g/t)	AERO 3030C (g/t)
Changeable conditions				
1	300	–	300	–
2	–	300	300	–
3	–	300	–	300

Sample "Ub"				
Phase in the experiments	Content of solid phase (%)	Time (min)	H_2SO_4 to adjust pH	Depressing agent for quartz, NaF (g/t)
Constant conditions				
Conditioning for the flotation of impurities	50	10	2–3	1000
Flotation of the impurities	27	1	3	1000
Experiment number	Type and amount of collector during the flotation of impurities			
	Aero 825 (g/t)	Armac C (g/t)	AERO 3030C (g/t)	
Changeable conditions				
1	500	240	–	
2	–	–	400	

Table 2
Recovery and chemical composition of products of flotation concentration

Experiment no.	Product	Mass recovery (%)		Chemical composition (%)					
		On the raw material	On the input in flotation	SiO_2	Al_2O_3	Fe_2O_3	K_2O	Na_2O	LOS
Sample "Bujanovac"									
1	Concentrate of feldspar	6.18	7.58	65.81	19.84	0.39	6.69	5.60	0.78
2		6.34	7.77	65.25	20.32	0.39	7.05	5.13	1.07
3		19.58	24.01	65.35	20.79	0.39	6.26	5.80	0.55
1	Concentrate of mica	6.27	7.69	51.00	30.71	2.36	9.40	1.15	4.23
2		6.24	7.65	50.83	30.24	2.50	9.66	0.84	4.72
3		6.51	7.98	50.79	30.24	2.64	9.64	0.96	4.53
1	Concentrate of quartz sand	69.11	84.73	79.83	11.81	0.18	3.31	3.92	0.21
2		68.98	84.58	80.15	11.34	0.14	3.43	3.98	0.24
3		55.47	68.01	82.28	10.39	0.17	2.89	3.38	0.16
1 2 3	Tailing	18.44	–	70.15	17.01	1.53	4.10	4.39	1.77
–	Raw material	100.00	–	74.51	14.17	0.60	4.22	4.05	0.84
Sample "Ub"									
1	Concentrate of the quartz sand	62.47	91.19	99.03	0.34	0.054	0.06	0.011	0.17
	Impurities	6.03	8.81	78.94	11.80	0.35	7.89	0.454	0.51
2	Concentrate of the quartz sand	64.05	93.50	98.81	0.45	0.06	0.11	0.016	0.17
	Impurities	4.45	6.50	74.96	14.30	0.37	9.94	0.54	0.63

measured by the total $K_2O + Na_2O$ content was, in all three experiments, approximately the same (12.29%, 12.18% and 12.06% respectively). The content of Fe_2O_3 in the feldspar concentrate obtained under these conditions in the flotation tests was 0.39%. As also seen, compared to the raw material the mass recovery of feldspar concentrate varied with the conditions of flotation concentration. The lowest mass recovery (6.18%) was obtained when Flotigam DAT was used as collector (Test 1), while the highest mass recovery (19.58%) was obtained when collector Aero 3030C was applied (Test 3). These results clearly demonstrate that reagent Aero 3030C was a better collector for feldspar minerals.

Two reverse flotation experiments were performed on sample "Ub" (Table 1). In the first experiment, as a collector of impurities (heavy metals, mica and feldspar), Aero 825 was used in combination with Armac C and in the second experiment collector Aero 3030C was applied. Comparing the results obtained for mass recovery and chemical compositions of the products of flotation (Table 2) it can be concluded that a better quality of quartz sand concentrate (99.28%-SiO_2, 0.26%-Al_2O_3, 0.031%-Fe_2O_3 and 0.055%-$K_2O + Na_2O$) was obtained in Test 2, when AERO 3030C was applied as collector, than in Test 1 (99.03%-SiO_2, 0.34%-Al_2O_3, 0.054%-Fe_2O_3 and 0.06%-$K_2O + Na_2O$). Furthermore, the mass recovery of quartz sand concentrate was almost the same regardless of type of collector.

4. Conclusions

Comparing the results of laboratory research on the application of collector Flotigam DAT with results obtained with the application of Aero 3030C in the flotation concentration of feldspar and mica on sample "Bujanovac", it can be concluded:

- For flotation of mica from raw material "Bujanovac", collector Armoflot 64 or Aero 3030C may be used. The quality and recovery of mica in both cases are satisfactory.
- For flotation of feldspar better recoveries were obtained with the application of the collector Aero 3030C (19.58%) than with collector Flotigam DAT (6.18%). Furthermore, the quality of feldspar and quartz sand was satisfactory regardless of which reagent was used.

For flotation of impurities in the reverse flotation of quartz sand from raw material “Ub”, with collector Aero 3030C, better results were obtained than with a combination of collectors R 825 and Armac C. In particular, when a combination of Armac C and R 825 was applied the quartz sand concentrate had the following content: SiO_2-99.03%, Al_2O_3-0.34%, Fe_2O_3-0.054% and $K_2O + Na_2O$-0.06% and with the application of Aero3030C the quartz sand concentrate contained SiO_2-99.28%, Al_2O_3-0.26%, Fe_2O_3-0.031% and $K_2O + Na_2O$-0.055%.

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References

Akzochemie, 1986. Handbook, Mineral Processing, Product Datasheet Summary.

Clariant, 2000. Safety data sheet in accordance with 91/155/EEC.

Cytec, Safety data sheet, 1999.

El Salmawy, M.S., Nakahiro, Y., Wakamatsu, T., 1993. The role of alkaline earth cations in flotation separation of quartz from feldspar. Minerals Engineering 6 (12), 1231–1243.

ITNMS Monographs, 1998. Domestic nonmetalic mineral raw materials for industrial application, ITNMS, Belgrade, Yugoslavia.

Shimoiizaka, J., Nakatsuka, K., Katayanagi, T., 1976. Separation of feldspar from quartz by a new flotation process. In: Weiss, A. (Ed.), World Mining and Metals Technology. Port City Press, Baltimore, pp. 428–438.