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A new collector for wolframite slime flotation①

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[Abstract] With aniline and salicylaldehyde as main materials, a new collector for wolframite slime was synthesized. In a pulp of natural pH value, this collector can collect wolframite effectively. Its selectivity is similar to that of benzyl arsenic acid and better than that of sodium oleate. With this collector, a wolframite rough concentrate with grade 30.12% WO_3 and recovery 91.50%, and a concentrate with grade 58.66% WO_3 and recovery 85.00% were obtained respectively from a wolframite ore containing 4.08% WO_3.

[Key words] collector; wolframite; flotation
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1 INTRODUCTION

Flotation is the most effective method for recovering wolframite from wolframite slime or tailings of gravity concentration, and collectors play an important role in obtaining a wolframite concentrate with satisfactory grade and recovery. Tolune arsonic acid, alkyl phosphonic acid, styrene phosphonic acid, 8-hydroxyl quinoline are commonly used as collectors in wolframite flotation[1]. Based on the "isomer principle", benzyl arsonic acid (an isomeride of p-toluene arsonic acid), alkyl imino bis-methylene phosphonic acid (an isomeride of α-amino alkylidene-1.1-diphosphonic acid) and monoalkyl phosphite (an isomeride of alkyl phosphonic acid) were synthesized by some researchers and flotation tests proved that these isomerides are effective collectors for wolframite[2,3].

The separation of wolframite from calcite, fluorite , garnet and tourmaline is not easy by common reagents and techniques. To solve this problem, a lot of effort has been taken and some progress has been made[4]. A study on solution chemistry and electrodynamic phenomena in wolframite flotation showed that the main potential-determining ions of wolframite are $MnOH^+$ and HWO_4^-, and the isoelectric points of MnO_4 and $FeWO_4$ are 2.8 and 2.0, respectively. The point of zero charge of wolframite is in the range of pH 6.0 to pH 9.5, in which the mineral floatability is the best[1]. Another study showed that wolframite is floated well in pH 11.0 by a special slowsheet[5~7]. Some researchers investigated the effects of chelating collectors, neutral oil and carrier on wolframite flotation[8,9]. Chelating reagents can be used to improve the selectivity and their combining use with neutral oil have been tested to be specific reagents. Carrier flotation is an effective process and coarse carrier and neutral oil are used to strengthen the flotation of wolframite slime.

2 EXPERIMENTAL

2.1 Samples

Pure minerals wolframite and calcite were ground to < 0.074 mm with a porcelain laboratory mill. The purity of wolframite is 75.30% WO_3 and that of calcite is 99.20% $CaCO_3$. Wolframite slime was obtained from a mine in Hunan Province, China. It is a centrifuger rough concentrate of a mixture of primary slime and secondary slime. The size distribution is that 3.59% WO_3 is bigger than 0.074 mm, 5.43% WO_3 is smaller than 0.01 mm and 92.8% WO_3 is in the range from 0.074 mm to 0.01 mm. The component of the sample is listed in Table 1.

Table 1 Components of sample

Component	WO_3	Cu	Bi	Mo	Pb
w/%	4.08	0.14	0.07	0.01	0.02
Component	Ca	Fe	SiO_2	S	
w/%	3.92	4.47	43.80	1.38	

2.2 Flotation tests and reagents

The new collector, named as BAW in this paper, was synthesized in a laboratory with salicylaldehyde and aniline as main materials. Other reagents are of chemical grade or industrial products.

Flotation tests of pure minerals and wolframite slime were carried out in FXG and FXD flotation cells, respectively.

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3 RESULTS AND DISCUSSION

3.1 Comparison of BAW with other collectors

Collector is the most important factor for determining wolframite floatability. In different pH values, collectors display different collecting capacities. Generally speaking, the best pH value of wolframite flotation is from 3 to 4 for benzyl arsonic acid and toluene arsonic acid, 6 to 8 for 8-hydroxyl quinoline styrene phosphonic acid, and 7 to 10 for sodium oleate. Comparative tests were carried out on the new collector BAW, benzyl arsonic acid and sodium oleate in pure minerals flotation. The effects of pH on floatability are shown in Fig. 1 and Fig. 2, and the effect of depressant water glass ($Na_2O \cdot 2.4SiO_2$) on floatability is shown in Fig. 3.

It can be seen from Fig. 3 that BAW collects wolframite effectively in a rather wide pH range, and collects calcite weak, especially in the presence of water glass. The selectivity of BAW between wolframite and calcite is better than that of sodium oleate. BAW

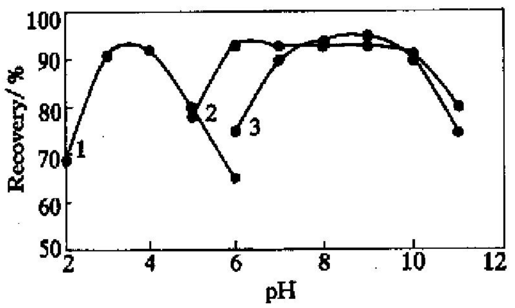

Fig. 1 Effect of pH on wolframite floatability (collector 250 mg/ L, regulator is H_2SO_4 or NaOH)
1 —Benzyl arsonic acid; 2 —BAW; 3 —Sodium oleate

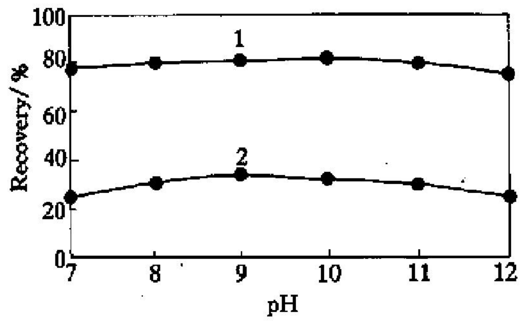

Fig. 2 Effect of pH on calcite floatability (collector 250 mg/ L, regulator is NaOH)
1 —Sodium oleate; 2 —BAW

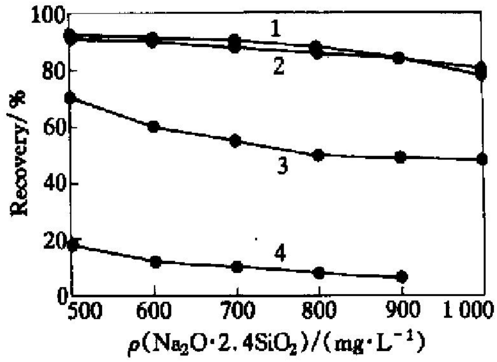

Fig. 3 Effect of water glass on minerals floatability (collector 250 mg/ L, NaOH 0 mg/ L)
1 —BAW/ wolframite; 2 —Sodium oleate/ wolframite; 3 —Sodium oleate/ calcite; 4 —BAW/ calcite

can float wolframite around pH 7.0. However, the pH should be 3 to 4 with benzyl arsonic acid as a collector. Therefore, the flotation performance of BAW is better than that of benzyl arsonic acid.

3.2 Flotation tests of wolframite slime

A series of flotation tests were made to compare the selectivity and collecting ability of BAW, with those of benzyl arsonic acid and sodium oleate. On the basis of conditional experiments, the optimum pH and optimum dosage of collector for rough flotation were determined, and results are listed in Table 2.

From the results, it is known that pH regulator (H_2SO_4 or NaOH) is necessary when benzyl arsonic acid or sodium oleate is used as a collector. Instead, BAW can float wolframite well at natural pH in the absence of any pH regulator. The selectivity and collecting ability of BAW on wolframite is nearly similar to that of benzyl arsonic acid, and the selectivity of BAW is better than that of sodium oleate.

On the basis of the wolframite rough concentrate, further test with four cleaners and BAW as a collector was carried out, and a wolframite concentrate with a grade of 58.66% WO_3 and a recovery of 85.00% WO_3 was gained.

3.3 Analysis of structural formula

BAW was synthesized with salicylaldehyde and aniline. Its structural formula is as following:

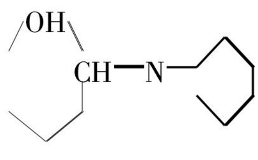

Table 2 Effect of collector on rough flotation

Collector	Dosage/ ($g \cdot t^{-1}$)	pH and regulator	WO_3 grade/ %	WO_3 recovery/ %
BAW	850	7.0	30.12	91.50
Benzyl arsonic acid	900	3.5(H_2SO_4)	30.80	90.24
Sodium oleate	750	8.5(Na_2CO_3)	26.54	92.36

Same as 8-hydroxyl quinoline, it contains an acidic polar group —OH and a basic polar group ═N —, so it can also be used as a chelating collector for wolframite.

3.4 Measurements of adsorption

The adsorption of BAW on minerals was measured with UV-3000 model ultraviolet spectrometer made in Japan, and the results are shown in Fig. 4. BAW can be adsorbed on wolframite in a wide pH range from about 6 to 10, and the adsorption is just a little on calcite. These results are consistent with the flotation test results.

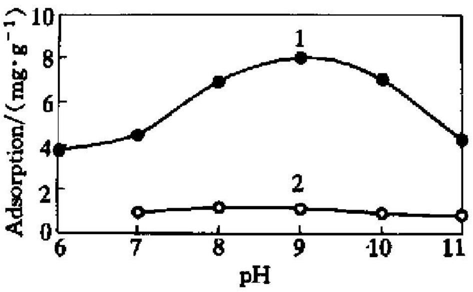

Fig. 4 Effect of pH on BAW adsorption
1 —Wolframite; 2 —Calcite

4 CONCLUSION

BAW is a new collector for wolframite slime. It can be used at natural pH value as well as at a wide pH range . Its selectivity for wolframite is similar to or better than that of some commonly used collectors such as benzyl arsenic acid and sodium oleate.

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