TXD AS SELECTIVE DEPRESSANT OF FLUORITE AND CALCITE①

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ABSTRACT

The benefication flotation of fluorite with TXD as depressant was emphasized from theoretical and practical aspects. The results show that new depressant TXD can depress calcite strongly, activate fluorite to some extent. The mixture of pure fluorite and calcite can be separated successfully with TXD through two stage cleaners by the result of 73.8% recovery and fluorite grade 97.5%. In addition, the batch flotation tests have also been conducted on the fluorite ore of Shi Zhu yuan Mine containing a lot of quartz and garnet with amphetoric collector 6RO-12 and depressant TXD, a concentrate with fluorite grade 97.56%, fluorite recovery 72.82% was gained through six stage cleaners. The action mechanism of TXD was studied with zeta potential and X-ray photoelectron spectra. It shows that adsorption and chemical reaction of TXD on calcite surface result in depression of calcite.

Key words: flotation depressant fluorite calcite

1 INTRODUCTION

Flotation is the most important processing method to produce high grade fluorite, but it is rather difficult to get high grade fluorite, because calcite, garnet and apatite are frequently associated with fluorite in fluorite ores. Their floatabilities are very similiar since they all contain calcium cation. Under common conditon of flotation, these calcium minerals can easily float and contaminate the fluorite concentrate. The effective separation of fluorite from calcite and garnet is therefore a necessity. For decades, flotation theory and technology of fluorite have been widely investigated and a great deal of progress have been achieved[1-7].

In this paper, a new depressant, named TXD, was developed and used to separate fluorite from calcite in artificial mixture of pure minerals, and from garnet and quartz on fluorite ore of Shi Zhu Yuan Mine.

2 EXPERIMENTAL MATERIALS AND METHODS

The sample of pure fluorite and calcite were obtained from Shi Zhu Yuan Mine and the Mineral Powder Factory of Changsha, respectively. These samples were crushed to −1 mm in a laboratory jaw crusher and a laboratory roll crusher, then they were concentrated on a concentrating table and with a high-intensity magnetic separator several times to remove the magnetic minerals. The non-magnetic products were ground to −0.074 mm in a porcelain laboratory mill, and washed with distilled water, then they were dried at room temperature(25 ℃), and stored as starting samples on which the foltation tests and X-ray photoelectron spectra measurements were run. Zeta potential measurements used −0.005 mm samples which were obtained by setting analysis.

The purities of the samples of fluorite and cal-

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cite were 99.8% and 99.7%, respectively. The fluorite ore was obtained from 380 Concentration Plant of Shi Zhu Yuan Mine. It is the tailing of the scheelite flotation operation. The composition of the ores tested is given in Table 1. This fluorite ore has been ground to 90% −0.074 mm in 380 Concentration Plant.

Table 1 Composition of fluorite ore tested(%)

component	CaF_2	$CaCO_3$	SiO_2	Al_2O_3	Fe_2O_3	WO_3
content	27.68	0.43	40.85	8.05	10.11	0.11

The main reagents used in this paper are 6RO-12 and TXD[8-10]. 6RO-12 is a kind of amphetoric collector. Its constitutional formula is

R—C—NH$(CH_2)_5$COOH.

O

The new depressant TXD is an acid, containing P element. It dissolves easily in water. Other reagents, all of analytical grade, were used in the tests: H_2SO_4, Na_2CO_3, NaOH, Na_2SiO_3.

All the flotation tests of pure minerals and artifitial mixture minerals were carried out in an MC model laboratory flotation cell(30mL in volume, 1 600 r/min. The 2g mineral sample and 30mL distilled water and the inorganic regulators (H_2SO_4, Na_2CO_3 or NaOH) were given into the cell and then agitated for 1 min. The TXD was added into the pulp and then agitated for 2 min before the collector 6RO-12 was added and agitatied for 2 min. The flotation time was 1 min.

3 RESULTS AND DISCUSSION

3.1 *Flotation of Pure Minerals*

Amphetoric collector 6RO-12 can collect fluorite strongly, collect calcite satisfactorily as shown in Fig. 1, so an effective depressant is necessary to separate fluorite from calcite. Based on a wide range test work of both organic and inorganic depressants, we developed a new depressant named TXD, can depress calcite strongly, activate fluorite to some extent, as shown in Fig. 2.

3.2 *Flotation of Mineral Mixture*

In the following flotaion tests the composition of the mineral mixture is 66.7% fluorite and 33.3% calcite, and the concentration of 6RO-12 is 10 mg/L. Table 2 is the effect of the concentration of TXD on the rough concentrate. Table 3

Table 2 Effect of concentration of TXD on rough concentrate

TXD /mg·L^{-1}	Fluorite concentrate	
	grade(%)	recovery(%)
30	81.0	78.5
40	81.6	78.0
50	82.8	77.8
60	84.2	77.3

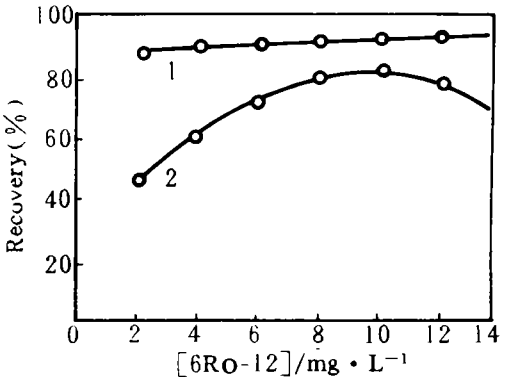

Fig. 1 Effect of concentration of 6RO-12 on minerals(pH=8.0)
1 fluorite; 2 calcite

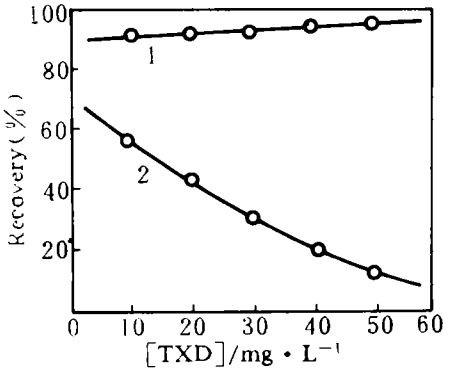

Fig. 2 Effect of concentration of TXD on minerals(6RO-12 10mg/L)
1 fluorite; 2 calcite

shows the results of flourite concentrate after one rougher and two cleaners.

Table 3 Result of fluorite concentrate after one rougher and two cleaners

No.	TXD/mg·L^{-1}			fluorite concentrate	
	rougher	cleaner 1	cleaner 2	grade(%)	recovery(%)
1	40	15	15	94.7	72.5
2	50	15	15	96.8	74.0
3	50	20	15	97.5	73.8

To compare TXD with commonly used depressants, a series flotation tests were carried out with water glass, acidic water glass and water glass with Al^{3+} as depreassants, respectively. The best results of each kind of depressants are listed in Table 4. From Table 4 we find that TXD has the best selective depression on calcite in the condition of this test.

Table 4 Relation of depressant and fluorite rough concentrate

Depressant	Fluorite rough concentrate	
	grade(%)	recovery(%)
TXD	84.2	77.3
water glass	66.9	65.1
acidic water glass	69.3	68.7
water glass with Al^{3+}	68.5	68.0

3.3 *Flotation of Natural Fluorite Ore*

The fluorite ore of Shi Zhu Yuan Mine is rather complex. It contains a large number of garnet and quartz, which is polluted by iron cation. In addition, before the flotation of fluorite, there are sulphide minerals and scheelite foltation operations, so the reagent composition in the pulp is very complicated, and this makes the foltation of fluorite more difficult.

According to a series of conditional experiments, the open-circuit test flowsheet was determined and the best result was obtained. The flowsheet is 1 rougher, 2 scavengers and 5 cleaners; the rougher pulp density is 24% and pulp pH is about 8.5 with Na_2CO_3 as modifier; and the reagent rate of TXD is 4.3 kg/t. The result is fluorite grade 97.04% and fluorite recovery 44.08% in the fluorite concentrate.

Then, on the basis of the open-circuit test, just adding one cleaner and other conditions unchanged, the locked cyclic batch test was carried out. A concentrate with fluorite grade 97.56% and fluorite recovery 72.82% was gained.

4 DISCUSSION

From the results of the flotation test we know that TXD can depress calcite as well as garnet and quartz. In order to illustrate the mechanism TXD acted on the minerals, zeta potential and X-ray photoelectron spectra were used in the research work. Fig. 3 is the effect of TXD on zeta potential of minerals. It is obvious that TXD can change the zeta potentials of both fluorite and calcite. When there is no TXD in the pulp, the zeta potential of fluorite is 28.0 mV and calcite 7.0 mV. In TXD solution, fluorite is still possitively charged, so TXD can not depress fluorite which surface to 6RO-12 can produce physical adsorption. With the increasing TXD density, the zeta potential of fluorite rises gradually, so the adsorption of 6RO-12 on fluorite surface increases. This is the reason why TXD can activate fluorite to some extent. But, the zeta potential of calcite decreases in TXD solution. When TXD density is over 50 mg/L in the solution, the surface charge of calcite changes to negative, which prevents the adsorption of 6RO-12 and

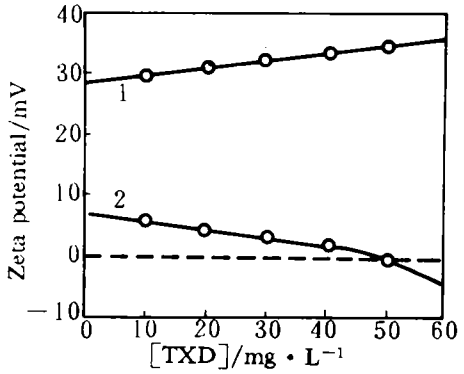

Fig. 3 Effect of TXD on zeta potential of minerals (pH = 8.0)

1 fluorite; 2—calcite

leads to depression of calcite.

Fig. 4 and Fig. 5 are the X-ray photoelectron spectra measurements of pure calcite and the calcite acted by TXD. From Fig. 5 we can see that the calcite acted by TXD has P_{2p} and P_{2s} waves at the points of about 140 and 195 binding enery, but, from Fig. 4, the pure calcite has no such waves. This shows that after calcite has been acted by TXD, its surface contains TXD, because the element P is provided by TXD. Therefore X-ray photoelectron spectra measurements comfirm that adsorption and chemical reaction of TXD on calcite surface result in depression of calcite.

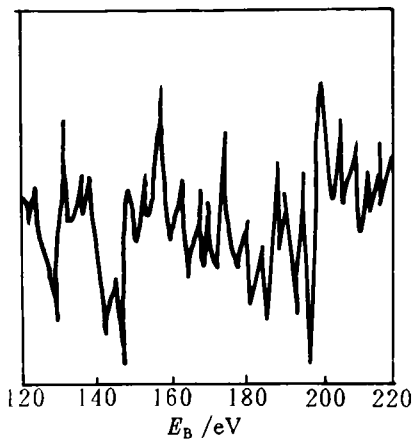

Fig. 4 The X-ray photoelectron spectra of pure calcite

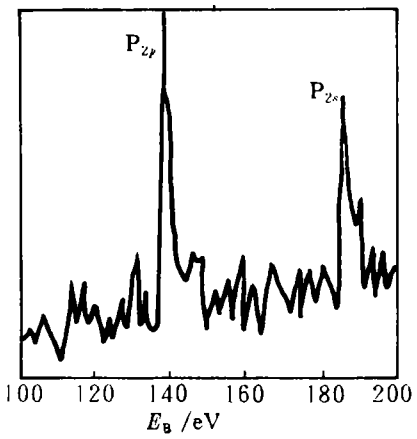

Fig. 5 The X-ray photoelectron spectra of calcite acted by TXD

5 CONCLUSIONS

The results of flotation tests of pure mineral, mineral mixture and natural fluorite ore have shown that new depressant TXD can effectively depress calcite as well as garnet and quartz. With TXD as depressant, fluorite can be separated successfully from calcite. The effective depresstion of TXD on calcite is due to the chemical adsorption and chemical reaction.

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