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Effect of Residual Titano-Magnetite on Floating Ilmenite from Vanadium Titano-Magnetite

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Abstract: China is rich in the vanadium titano-magnetite resources. The main utilization mode of vanadium titano-magnetite in Panzhihua district is firstly separating titano-magnetite by low intensity magnetic separation, and then concentrating ilmenite from magnetic separation tailings. Magnetic separation tailings mainly contain ilmenite, but there is still a small quantity of titano-magnetite. It is found that titano-magnetite presents more optimal floatability than ilmenite. Magnetic agglomeration of titano-magnetite occurs because of the existence of remanence and pre-floatation grinding. Therefore some gangues wrapped by titano-magnetite go into the floatation concentrate. In a word, titano-magnetite has adverse effect on ilmenite floatation by decreasing the grade and recovery of concentrate and increasing the reagent consumption. The pre-removal of residual titano-magnetite by low intensity magnetic separation before floating ilmenite from vanadium titano-magnetite is suggested.

Key words: titanium; Vanadium titano-magnetite; floatability; magnetic agglomeration

钒钛磁铁矿浮钛时残余钛磁铁矿的影响

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摘要: 我国钒钛磁铁矿资源丰富, 最具代表性的攀枝花地区钒钛磁铁矿的选矿多是经弱磁选铁后, 磁选尾矿再选钛. 用于选钛的矿石中主要含钛矿物是钛铁矿, 但仍有少量残余的钛磁铁矿. 在磁选尾矿的浮选中, 钛磁铁矿具有比钛铁矿更好的可浮性, 同时由于残余磁铁矿的剩磁较大, 加之磨矿加剧了磁团聚, 部分脉石会随钛磁铁矿一起进去精矿, 从而影响品位和回收率, 也造成药剂的浪费. 钒钛磁铁矿浮钛时残余钛磁铁矿有十分不利的影响, 应在浮选前采取多次弱磁处理, 尽量把钛磁铁矿去除干净.

关键词: 钛; 钒钛磁铁矿; 可浮性; 磁团聚
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0 Introduction

The vanadium titano-magnetite is a kind of important titanium resource in China. The most important titanium resource of China is the vanadium titano-magnetite in Panzhihua region Shichuan Province, which accounts for about 97% of the native titanium reserves of China[1]. The main utilization mode of primary vanadium titano-magnetite is firstly separating titano-magnetite by low intensity magnetic separation, then concentrating ilmenite from magnetic separation tailings. Magnetic separation tailings mainly contains ilmenite, but there is still a small quantity of titano-magnetite. The titano-magnetite is a mineral with ferromagnetism. Some people have

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studied the magnetic agglomeration in the course of magnetite separation. Zhitao Yuan[2] considered that the magnetic minerals such as magnetite had residual magnetism after they leaving the magnetic field. Magnetic particles formed magnetic chains and magnetic conglomerations by the magnetic agglomeration. They had adverse effects on separation, classification and filtration. The mechanical entrainment caused by the magnetic agglomeration is one of the reasons for the low concentrate grade in the low intensity magnetic separation. Xuanxing Yang[3] also mentioned that magnetite would has residual magnetism after they leaving the magnetic field when he studied the magnetic separation of Miaogou iron mine. Chao Lin and Chuanyao Sun[4] especially analyzed the reasons and effects of magnetic agglomeration in detail in the article "Effect of Magnetic Property and Agglomeration on Mineral Processing of Magnetite". But there have no reports about the effect of magnetic agglomeration on ilmenite floatation. The magnetic separation tailings is the feeding mineral of many mineral processing plants to obtaint the ilmenite. The main separation ways of these mineral processing plants are high intensity magnetic separation and floatation[5~8].

But there are so many problems in the floatation stage such as the high reagents consumption and concentrate grade instability. One of the reasons for this phenomenon is most likely the conglomerations formed by the residual titano-magnetite having adverse effects on ilmenite floatation. In order to verify the above theoretical analysis, we conducted two comparison floatation tests with magnetic tailings of a vanadium titano-magnetite in Panzhihua Area. We conducted direct floatation in the first test and removed residual titano-magnetite by low intensity magnetic separation before floatation in the second test. It was verified that the TiO_2 grade of final floatation concentrate increased from 44.00% to 47.49%, and the recovery increased from 44.37% to 52.64%. It is important that the second test saved collector of 240g/t with the same floatation flowsheet and other reagents additions.

In order to confirm the adverse effect of titano-magnetite on ilmenite floatation and explore the scientific truth, we did detailed monominerals floatation tests and carried out detailed analysis and discussion. Finally we found out the true reason for the effect of titano-magnetite on ilmenite floatation.

1 Experimental

1.1 Mineral and Reagent

The test ore was obtained from a magnetic separation tailings in Panzhihua region. The main Ti-containing mineral is ilmenite, but there are a small amount of titano-magnetite and hematite. The gangue mainly contains Ti-augite, plagioclase and chlorite. The chemical analysis and mineral analysis of the ore used are shown in the Tab.1 and Tab.2. There are three types of minerals in the tests: ilmenite, titano-magnetite and the gangue. The titano-magnetite was obtained from the final concentrate of many times of low intensity magnetic separations after grinding. Then we separated ilmenite from the magnetic separation tailings by many times of cleanings with shaking table. The tailings of the shaking table was as gangue. The three types of test minerals were soaked with 5% dilute hydrochloric acid for 0.5 hour, then were rinsed with distilled water to neutral and dried. By chemical analysis, the purity of the ilmenite and titano-magnetite used were both above 95%. And TiO_2 grade of the gangue was below 2%. The floatation collector in the tests was SYB, depressant was carboxymethyl cellulose (CMC), and pH value regulator was H_2SO_4.

Tab.1 Chemical analysis of the ore used (mass percentage)

TiO_2	CaO	MgO	SiO_2	Al_2O_3	TFe	S	Co	Ni	P
11.81	10.71	11.68	31.99	9.86	15.10	1.01	0.02	0.01	0.03

Tab.2 Mineral analysis of the ore used (mass percentage)

Ilmenite	Titano-magnetite	Hematite	Ti-augite	Plagioclase	Chlorite	Sulfid
15	2.8	1.5	31.4	30.5	16.9	1.9

1. 2 Experimental Method

The floatation machine in the tests was the XFG type self aeration mechanical agitation floatation machine with the capacity of 150mL produced by Changchun Prospecting Machinery Factory. Each test mineral sample was 30 gram. We added regulator, depressant and collector in turn with stirring 1, 3, 3 minute respectively in each test. The floatation time lasted 1 minute. Finally we calculated the recoveries of the floatation concentrate and tailings by dried weight.

2 Results and Discussion

The average TiO_2 grade of titano-magnetite is between 6% ~ 15%[9], so the titano-magnetite in the final floatation concentrate will lower the TiO_2 grade. We studied the floatability of titano-magnetite in the first place.

The results of "effect of collector on floatation of ilmenite and titano-magnetite" and "result of the floatation velocity tests of ilmenite and titano-magnetite" tests are illustrated in Figure 1 and Figure 2 respectively. We can see from Figure 1 that the curve of the titano-magnetite recovery is above the curve of the ilmenite recovery. The curve of the titano-magnetite recovery is on the rise dramatically in trend, but the the ilmenite recovery is near zero. We can find titano-magnetite presents better floatability than ilmenite with the same floatation conditions. On the other hand, the floatation velocity of titano-magnetite was higher than that of ilmenite with the same conditions.

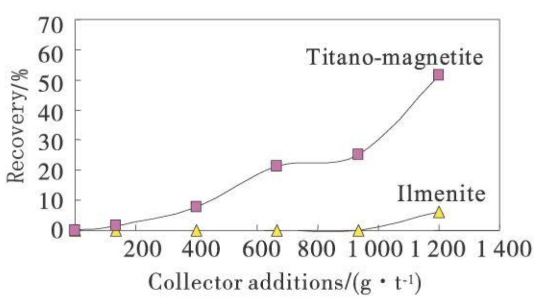

Fig.1　Variation curve of collector additions
(CMC additions: 33g/t ;　pH=5)

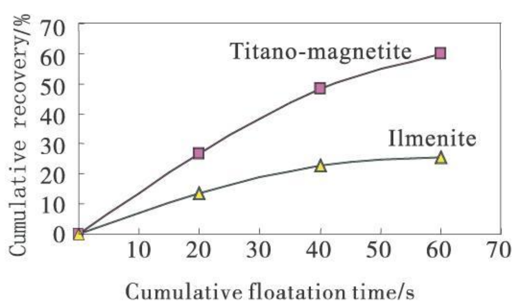

Fig.2　Variation curve of the floatation velocity
(Reagents additions: CMC 33 g/t　SYB 2 000g/t;　pH=5)

In order to further confirm that the floatability of titano-magnetite is better than that of ilmenite, we carried out "effect of pH value on floatation" and "effect of depressant (CMC) additions on floatation" tests. The results are illustrated in Figure 3 and Figure 4 respectively.

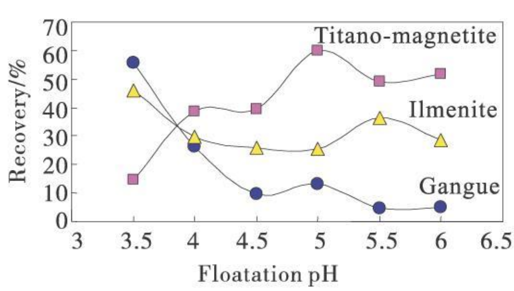

Fig.3　Variation curve of pH value
(Floatation reagents additions: CMC 33 g/t　SYB 2 000g/t)

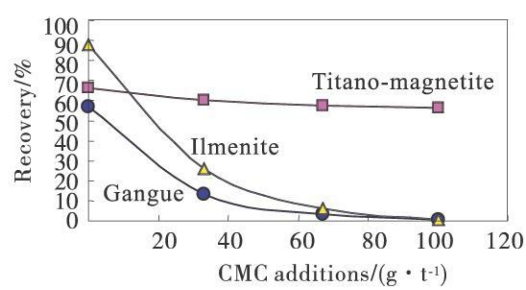

Fig.4　Variation curve of CMC additions
(SYB additions: 2 000g/t ;　pH=5)

Figure 3 illustrates that ilmenite only presents better floatability than titano-magnetite in strong acidic condition, but in this range gangue can float heavily. When the pH value is exceed 4, titano-magnetite presents better floatability than ilmenite, and ilmenite and gangue can be separated primely. Figure 4 illustrates that carboxymethyl cellulose can depress ilmenite and gangue strongly, but has little effect on the titano-magnetite. We can see that the curve of the titano- magnetite recovery in Figure 4 is almost flat So it is impossible to eliminate the adverse effect of titanium magnetite by increasing the depressant additions We can draw two conclusions for the ilmenite flotation is always carried out in the weak acidic environment One is that titano- magnetite presents better floatability than ilmenite; the other is that titano- magnetite can be removed by floatation only in strong acidic condition. Taking into account the acid causticity and the cost of production, we think the best measure of removing titano- magnetite is low intensity magnetic separation

Titano- magnetite has adverse effect on ilmenite floatation There are two points One is the problem of floatability, the other is magnetic agglomeration The feeding mineral of ilmenite separation is mostly taken from the magnetic separation tailings The residual titano- magnetite has remanence after magnetic separation though the amount of titano- magnetite is small So titano- magnetite and gangue or other minerals will form magnetic conglomerations that can not be broken easily. The gangue mixed with titano- magnetite is hard to be removed [4]. The mechanical entrainment is an important problem that we must think much of In addition, because the magnetic separation tailings always consists of coarse particles, grinding is required before floatation Although grinding is beneficial to flotation, it will also intensify magnetic agglomeration The fine particle has greater remanence coercivity than coarse particle The ferrimagnetic mineral has a magnetic domain structure The movement of magnetic domain wall is in the position of domination when the ferrimagnetic mineral is magnetized But the magnetic domain rotation increases gradually with decreasing particle size The required energy for the magnetic domain rotation is higher than that for the movement of magnetic domain wall, so the coercivity increases with decreasing particle size, and even increases dramatically [4]. As we discussed before, the floatability of titano- magnetite is better than that of ilmenite If the conglomerations consist of titano- magnetite and gangue caused by the magnetic agglomeration are not removed before the ilmenite floatation, they will go into the floatation concentrate and decrease the TiO_2 grade and the recovery of ilmenite

In order to confirm the existences of magnetic agglomeration and mechanical entrainment on ilmenite floatation, we mixed titano- magnetite and gangue according to the ratio of 1∶5 and conducted floatation tests A comparison test was conducted as the separate gangue floatation test with the same conditions The results of these tests are shown in Figure 5 Then we mixed gangue and titano- magnetite that had been demagnetized according to the ratio of 1∶5 and conducted floatation tests A comparison test was conducted as the separate gangue floatation test with the same conditions The results of these tests are shown in Figure 6

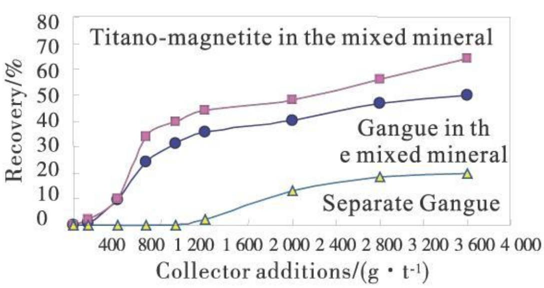

Fig.5 Variation curve of collector additions
(CMC additions: 33g/t; pH=5)

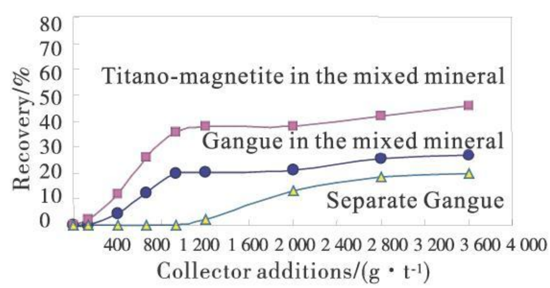

Fig.6 Variation curve of collector additions
(Titano-magnetite in the mixed mineral was demagnetized)
(CMC additions: 33g/t; pH=5)

Figure 5 and Figure 6 all illustrate that the recovery of gangue in the mixed mineral was higher than that of separate gangue with the same conditions A lot of gangue in the mixed mineral floated at low collector additions because of the existence of small amount of titano- magnetite One can find that the recovery curve shape of gangue in the mixed mineral is very similar to that of titano- magnetite in the mixed mineral The recovery of gangue increased with the increase of the recovery of titano- magnetite in the mixed mineral It is fully showed that the magnetic agglomeration and mechanical entraimment are very obvious. This is just one aspect of the problem, the more important aspect is the question of magnetic agglomeration caused by titano- magnetite.

Figure 6 illustrated that the mechanical entrainment was greatly reduced. We found in the floatation tests that the titano- magnetite had been demagnetized was more dispersed than titano- magnetite that had not been demagnetized and the froth layer was obviously thinner than before. Titano- magnetite is a ferromagnetic mineral, we can only reduce the magnetism of it and can not remove the magnetism completely. Thereby we consider that the magnetic agglomeration caused by the titano- magnetite is the other important reason for mechanical entrainment.

3 Conclusion

The residual titano- magnetite after concentrating magnetite from vanadium titano- magnetite will have considerable adverse effects on the follow- up ilmenite floatation. The adverse effects include the decline of concentrate TiO_2 grade and recovery and the increase of reagents consumption. The reason consists of two points. Firstly, the floatability of titano- magnetite is better than that of ilmenite, titano- magnetite with low TiO_2 grade will go into the final floatation concentrate. Secondly, a large number of conglomerations consist of titano- magnetite and gangue caused by the magnetic agglomeration will also go into the floatation concentrate. The ilmenite floatation is always carried out in the weak acidic enviromment, but titano- magnetite can be removed by floatation only in strong acidic condition. So it is the most economically feasible measure to avoid the adverse effect that removing titano- magnetite by low intensity magnetic separation.

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