

Experimental study on removal of iron from potash feldspar

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Abstract. The potassium feldspar ore in a certain area of Chengde contains K_2O 9.82%, Na_2O 2.41%, which belongs to the high quality feldspar ore. It cannot be exploited and utilized because of the high iron content. An experimental research was carried out to remove iron from a feldspar ores in this area by the technique of high gradient magnetic separation respectively. The properties of potassium feldspar ore were analyzed, and the technology for iron removal from potash feldspar ore was expounded. The optimum parameters were determined. Finally, the content of Fe_2O_3 in the potash feldspar was reduced from the original 0.88% to 0.082%, significantly reduced the content of Fe_2O_3 . The effect of iron removal was ideal, and the products can meet the requirements of high-grade daily porcelain on feldspar raw materials.

1. Introduction

Feldspar minerals are rich in potassium, sodium and other alkali metals. Feldspar minerals have low melting temperature (1100~1200°C) and long-time interval, widely used in glass, ceramics and other industrial sectors [1]. The impurities of natural potassium feldspar are quartz or iron oxide, Sodium oxide and calcium oxide followed [2]. The iron in feldspar ore is mainly composed of biotite, iron mineral, pyrite, iron containing silicate (such as amphibole, garnet, etc.). The use of iron ore grinding process will also be brought into part of the mechanical iron, and these iron impurities can be removed by magnetic separation, flotation, washing and other technical means [3]-[4]. In the process of magnetic separation, most of the strong magnetic minerals can be sorted out. But for some ores with high weathering degree, the iron ore is easy to slime in the grinding process, and high intensity magnetic separation is difficult to remove this part of iron minerals. The flotation process is better for clay and fine grained iron minerals. But for the weathered ore, iron removal effect is not very well. Generally speaking, the glass industry on the feldspar requirements are $K_2O+Na_2O>10.0\%$, $Fe_2O_3<0.3\%$, ceramic industry for higher iron requirements (general ceramic $Fe_2O_3<0.2\%$, high-grade ceramic $Fe_2O_3<0.1\%$) [5].

2. Experimental sections

2.1. Ore properties

The samples were collected from a region of Hebei, Chengde. After the crushing of massive feldspar, it is overall gray by visual observation. A comprehensive study of the results of X-ray diffraction analysis showed that the main minerals are feldspar, quartz, followed by a small amount of biotite and pyroxene, and iron minerals are mainly magnetite, limonite and other trace minerals are olivine. Results of multi-element analysis of samples are shown in table 1, and results of iron chemistry are shown in table 2.



Table 1 Analysis of multi element chemical composition of ore

Component/%	SiO ₂	Al ₂ O ₃	K ₂ O	Na ₂ O	Fe ₂ O ₃	CaO	MgO	SO ₃	SrO	TiO ₂
Content/%	62.41	16.24	9.82	2.40	0.88	0.45	0.10	0.46	0.74	0.03

Table 2 Chemical phase analysis of iron in ores

Iron phase	Magnetite containing Fe	Limonite containing Fe	Silicate containing Fe	Total
Metal content /%	0.21	0.64	0.09	0.84
Distribution rate /%	21.61	64.54	13.85	100.00

As can be seen from table 1: the main ore elements are Si, Al, K, Na, and minor elements are Fe, Ti, Ca, Mg. The main components are SiO₂, Al₂O₃, K₂O, Na₂O, and as the content of Fe₂O₃ is as high as 0.88%, it cannot be directly used as raw material for ceramics and glass, so it should be excluded in the ore dressing. The content of K₂O in the ore is high, the content of K₂O and Na₂O is up to 12.23%, which can be used as the raw material of high quality ceramics, but the content of Fe₂O₃ in the mine is too high, resulting in low whiteness, which seriously affects its development and application.

As can be seen from table 2: iron mainly exists in the form of limonite, a small part of the existence of magnetite and other minerals. These iron minerals are either monomers or aggregates, highly dispersed in feldspar minerals, easy to remove; in the form of gangue minerals containing iron, such as biotite, fealties, hornblende, pyrite and so on.

2.2. Test flow

After the preliminary exploration test, we can determine the experimental process. Specific method: crushing raw ore, then grinding and screening, so that the feldspar ore 106μm through; Ore that is below the 106μm standard sieve has to remove the mud, taking the things that are on the top of sieve. The things that are on the top of sieve remove iron though superconducting high gradient magnetic separator, the optimum parameters were obtained by the contrast experiment. The iron removal test flow is shown in figure 1.

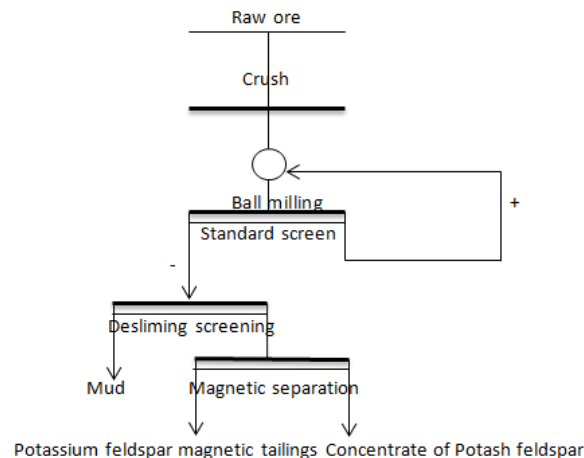


Figure 1 Iron removal test flow chart

3. Results and discussion

3.1. Test of grinding fineness

The test was carried out using a superconducting high gradient magnetic separator. Under the condition that the initial magnetic field intensity is 1.5T, the ore pulp flow rate is 500ml/min, the filling ratio of steel wool is 8%, and comparison results of different grinding fineness are shown in table 3.

Table 3 Test results of magnetic separation with different grinding fineness

Grinding fineness ($-106\mu\text{m}$) /%	Concentrate yield /%	Fe_2O_3 grade /%
50	32.32	0.42
60	43.55	0.39
70	56.12	0.27
80	64.63	0.22
90	68.25	0.32

It can be seen from the results of different grinding fineness magnetic separation tests: with the increase of grinding fineness, the productivity of concentrate increased gradually, and the content of Fe_2O_3 decreased firstly and then increased. When the content of the mineral that go through $106\mu\text{m}$ standard sieve is 80%, the content of Fe_2O_3 was the lowest. Considering the concentrate yield and Fe_2O_3 content, grinding fineness should be selected which the content of the mineral that go through $106\mu\text{m}$ standard sieve is 80%.

Table 4 Magnetic separation test results of magnetic induction intensity

Magnetic induction intensity /T	Concentrate yield /%	Fe_2O_3 grade /%
1.0	58.24	0.32
1.2	56.63	0.28
1.5	60.12	0.21
1.8	61.53	0.18
2.0	61.55	0.15
2.2	61.52	0.16
2.5	59.45	0.15

3.2. Test of magnetic induction intensity

Under the condition that the content of the particle size of -106 μ m is 80%, the ore pulp flow rate is 500ml/min, and the filling ratio of steel wool is 8%, the effect of different magnetic induction intensity on iron removal was investigated. Test results are shown in table 4.

It can be seen from the results of different magnetic intensity magnetic separation tests: with the increase of magnetic induction intensity, the content of Fe₂O₃ decreased firstly and then increased, and finally stabilized, the yield of mineral change little. Considering the concentrate yield and Fe₂O₃ content, and combined with the actual situation, the magnetic induction intensity should be selected 2.0T.

3.3. Test of ore pulp velocity

Under the condition that the magnetic induction intensity is 2.0T, the content of the particle size of -106 μ m is 80%, and the filling ratio of steel wool is 8%, the effect of removing iron from different slurry flow rate was investigated. Test results are shown in table 5.

Table 5 Test results of ore pulp velocity

Ore pulp velocity /(ml/min)	Concentrate yield /%	Fe ₂ O ₃ grade /%
300	56.14	0.13
500	60.23	0.15
700	60.42	0.18
1000	62.24	0.36
1200	64.15	0.37

It can be seen from the test results of ore pulp velocity: with the increase of pulp flow rate, little change in concentrate yield, and the content of Fe₂O₃ increased gradually. Considering the concentrate yield and Fe₂O₃ content, as well as the actual situation, the ore pulp velocity should be 500 ml/min.

Table 6 Test results of filling rate of steel wool

Filling ratio of steel wool /%	Concentrate yield /%	Fe ₂ O ₃ grade/%
8	62.36	0.15
10	61.52	0.14
12	61.34	0.11
15	57.35	0.16
18	50.45	0.23
20	45.34	0.28

3.4. Test of filling ratio of steel wool

Under the condition that the magnetic induction intensity is 2.0T, the content of the particle size of -106 μ m is 80%, and the ore pulp flow rate is 500ml/min, the effect of different steel wool filling rate on the iron removal index was investigated. Test results are shown in table 6.

It can be seen from the test results of filling rate of steel wool: with the increasing of the filling ratio of the separator, concentrate yield continued to decline, the content of Fe₂O₃ decreased firstly and then increased. Considering the concentrate yield and Fe₂O₃ content, combined with the actual situation, the filling ratio of the separator shall be 12%.

3.5 Multiple tests of superconducting high gradient magnetic separator

Under the experimental conditions of the optimum parameters of magnetic separation, the iron content of potash feldspar ore is 0.11%, which cannot reach the requirements of high-grade daily-use porcelain, so does magnetic separation test many times. Under the condition that the magnetic induction intensity is 2.0T, the content of the particle size of -106 μ m is 80%, the ore pulp flow rate is 500ml/min, and the filling ratio of steel wool is 8%, the results of multiple magnetic separation tests are shown in table 7.

Table 7 Test result of filling rate of steel wool

times of magnetic separation /times	Concentrate yield	Fe ₂ O ₃ grade/%
	/%	
Two times	61.35	0.094
Three times	62.23	0.082

It can be seen from the results of multiple magnetic separation tests: after two times, three times magnetic separation, the content of Fe₂O₃ in potash feldspar ore was obviously decreased, and the grade of concentrate is increased slightly. After three magnetic separation tests, the content of Fe₂O₃ reduced to 0.082%, which could meet the requirement of high grade domestic porcelain.

4. Conclusions

The results that an experimental study on removing iron from potash feldspar ore in a region of Hebei, Chengde, show:

- (1) Though magnetic separation test, the optimum parameters of magnetic separation were determined: magnetic induction intensity 2.0T, the grinding fineness is which the content of the particle size of -106 μ m is 80%, and ore pulp velocity 500 ml/min, Steel wool filling rate 12%.
- (2) The superconducting high gradient magnetic separator can effectively remove the iron of ore minerals. Raw ore is contained Fe₂O₃ 0.88%, after one time superconducting high gradient magnetic separator magnetic separation can obtain feldspar concentrate which is contained Fe₂O₃0.11%, and concentrate yield is 61.34%. After two times, three times magnetic separation, it can obtain feldspar concentrate that is contained Fe₂O₃ 0.082%, and concentrate yield was 62.23%.

5. References

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