The Research on Desulphurization of an Iron Concentrate

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Abstract: Iron ore concentrate sales in a mineral processing plant appeared a trend of high sulfur, exceeding the sales requirement of 0.3% significantly. To this end, for the sulfide in iron concentrate mainly exists in the form of pyrrhotite, companies with iron minerals and has a high degree of oxidation, we can add flotation agent to the magnetic separation column, and at the same time fill gas for sorting test, in order to reduce the sulphur content in concentrate.

Keywords: magnetic separation column, flotation, desulfurization, pyrite

1. Introduction

With the rapidly development of economic, China's demand for steel also increased significantly. However, the excessive sulfur content in iron concentrate will seriously impact the after work iron and steel smelting. On the one hand, it will lead to excessive sulfur content of steel, thus affecting the quality of steel. On the other hand, if you do not desulfur in the iron concentrate timely, there may result in arbitrary emissions of sulfur oxides in smelting, polluting the environment. Therefore, depressing the sulfur content of iron concentrate is very important on the development of China's steel market.

The treatment of iron ore in this plant is not desulfurization thoroughly, the sulfur content in iron ore production is generally 0.4 to 0.5%, sometimes more than 0.7%, far more than the sales requirement of 0.3%. The selected plants for the need of future development, require the sulfur content of iron ore dropped to 0.1%, which is difficult to achieve only by magnetic separation. Therefore, this experiment use the overproof sulfur iron concentrate of this mineral processing plant to drop sulfur.

2. The Nature of Ore

2.1 Mineral composition of ore
The iron ore mineral is composed mainly by magnetite, while a small amount of pyrrhotite, pyrite, chalcopyrite, arsenopyrite, etc. Gangue minerals are quartz, hornblende, plagioclase, biotite and so on. Sulfur mineral usually exist in pyrrhotite, chalcopyrite, pyrite.

2.2 Incrustation characteristics of the main metallic minerals
2.2.1 Pyrrhotite
Light rose brown, it is mainly granular form, particle size of 0.3mm below, unequal particle, distributed in the magnetite particles or edge, with orientation, and coexist with magnetite, non-even obviously, piece of light and yellow gray, 5 ~ 10% of the content.
2.2.2 Chalcopyrite
Yellow copper, granular, distributed in the pyrrhotite particles, saw part occasionally, a weak non-even, its content is minimal, less than 1%.
2.2.3 Pyrite
Yellow-white, subhedral granular, granular 0.5mm below, the bulk granular pyrite closely associated with other sulfide minerals, but the contact interface is straight, easily dissociated into monomers. Sporadic shows significantly, surface is rough, homogeneity, content 1 to 2%.

3. Exploration of Experimental Study
3.1 Grinding conditions test
0.7% or more of the sulfur concentrate for sieve analysis and regrinding.
Concentrate sieve, to take more than 0.7% sulfur content in concentrate for sieve analysis, investigations of different particle sizes in the S content level, is to determine whether lacking of grinding fineness would affect the monomer dissociation degree to S enough or not.
Sieve analysis results in Table 1

<table>
<thead>
<tr>
<th>Sieve size range</th>
<th>Particle size (mm)</th>
<th>Yield (%)</th>
<th>Concentrate Grade (%)</th>
<th>Metal Distribution Ratio (TFe%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>TFe</td>
<td>MFe</td>
</tr>
<tr>
<td>+ 160</td>
<td>11.01</td>
<td>58.54</td>
<td>51.60</td>
<td>0.41</td>
</tr>
<tr>
<td>160~180</td>
<td>2.00</td>
<td>63.98</td>
<td>59.66</td>
<td>0.634</td>
</tr>
<tr>
<td>180~270</td>
<td>29.63</td>
<td>65.82</td>
<td>63.32</td>
<td>0.734</td>
</tr>
<tr>
<td>270~325</td>
<td>12.21</td>
<td>68.51</td>
<td>65.58</td>
<td>0.91</td>
</tr>
<tr>
<td>~ 325</td>
<td>45.15</td>
<td>69.75</td>
<td>66.90</td>
<td>0.89</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ore: TFe=66.38%  MFe=62.55%

Note: Samples taken from a mixed samples of vice-like iron ore shipments, specifically from greater than 0.7% of sulfur content.

As the fineness of the sample particle, S content has not decreased but increased. It said that desulfur should not depend on the concentrate’s regrinding. So the iron concentrate needn’t to regrind in this experiment.

3.2 Influence on the S in different grinding fineness of the magnetic
Concentrate were ground to 85% and 92% at 200 µm, then separating in the magnetic tube under the magnetic field strength which is 1000 GS, the results are given in Table 2.

<table>
<thead>
<tr>
<th>Head fineness -200 (%)</th>
<th>Production</th>
<th>Yield(%)</th>
<th>Grade(%)</th>
<th>Recovery(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>TFe</td>
<td>MFe</td>
</tr>
<tr>
<td>85</td>
<td>Concentrate</td>
<td>90.50</td>
<td>69.00</td>
<td>66.22</td>
</tr>
<tr>
<td></td>
<td>Tailings</td>
<td>9.50</td>
<td>41.64</td>
<td>27.59</td>
</tr>
<tr>
<td></td>
<td>Ore</td>
<td>100.00</td>
<td>66.38</td>
<td>62.55</td>
</tr>
<tr>
<td>92</td>
<td>Concentrate</td>
<td>88.00</td>
<td>70.61</td>
<td>69.30</td>
</tr>
<tr>
<td></td>
<td>Tailings</td>
<td>12.00</td>
<td>34.34</td>
<td>12.44</td>
</tr>
<tr>
<td></td>
<td>Ore</td>
<td>100.00</td>
<td>66.26</td>
<td>62.48</td>
</tr>
</tbody>
</table>

Note: Samples taken from a mixed samples of vice-like iron ore shipments, specifically from greater than 0.7% of sulfur content.

3.3 The Choice of Flotation Reagent
By the sample of iron ore geological report on the discussion of sulfur, we can understand that sulfur minerals usually exist in pyrrhotite, chalcopyrite, pyrite. For the main sulfur content mineral pyrrhotite,
its floatability is poor, should choose a suitable activator.
Experimental procedure as follows,

Weighing sample 200g
↓
Mixing sample in the flotation tank 20%
↓ Stirring 1min
Using lime to adjust pH
( not adjust if use partial acidic or neutral )
↓ Mixing 1min
Adding activator
( sodium sulfide, oxalic acid, ammonium chloride, ammonium sulfate, ammonium thiosulfate, copper sulfate. the dosage is about 500 g / t)
↓ Mixing 3min
Joining B xanthate
(the amount is about 450 g / t)
↓ Mixing 2min
Adding foaming reagent 2# oil
(the amount is about 6 drops)
↓ Mixing 2min
Inflating and blowing froth
(normally blow bubbles 6~8min)
↓ Drying and weighting each product, the next step is to assay

3.4 Application of Magnetic Separation Column
Magnetic separation column is a low-intensity magnetic field mineral processing equipment. The high-intensity magnetic particles are selected in the magnetic separation column many times by continuous magnetic polymer - dispersion - magnetic aggregation and the role of increased water flow, it can be effectively separated with the gangue. In this test the magnetic separation column and pneumatic equipment will be connected, mixing sample and reagent fully effect in the flotation tank, and then added to the magnetic separation column for magnetic separation. Hoping to be able to separate pyrrhotite from pyrite, and remove gangue mixed in the iron concentrate.
Experimental procedure as follows,

Weighing sample 300g
↓
Mixing sample in the flotation tank 30%
↓ Stirring 1min
Using lime to adjust pH
( not adjust if use partial acidic or neutral )
↓ Mixing 1min
Adding activator
( sodium sulfide, oxalic acid, ammonium chloride, ammonium sulfate, ammonium thiosulfate, copper sulfate. the dosage is about 500 g / t)
↓ Mixing 3min
Joining B xanthate
(the amount is about 450 g / t)
↓
Mixing 2min
Selecting in the magnetic separation column
↓
Drying and weighting each product, the next step is to assay

4. The Results of the Experiment

4.1 Flotation tank test
In this experiment, we chose six activator, sodium sulfide, oxalic acid, ammonium chloride, ammonium sulfate, copper sulfate and ammonium thiosulfate, were used on the experiment of pyrrhotite activation. The sulfur content of target product recorded in Table 3.

Table 3 The Results of Sulfur Grade Determination After Activation of Iron Ore Concentrate

<table>
<thead>
<tr>
<th>Activator</th>
<th>Ore Sodium Sulfide</th>
<th>Oxalic Acid</th>
<th>Ammonium Sulfate</th>
<th>Copper Sulfate</th>
<th>Ammonium Chloride</th>
<th>Ammonium Thiosulfate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur (%)</td>
<td>0.4197</td>
<td>0.4007</td>
<td>0.4201</td>
<td>0.3950</td>
<td>0.4009</td>
<td>0.3992</td>
</tr>
</tbody>
</table>

In the process of experiment it can be found that the activation effect of ammonium thiosulfate, oxalic acid and sodium sulfide are poor, producing bubbles with little ore, shaving foam is most the slurry, the sulfur content determination is the same as raw ore. With ammonium sulfate, ammonium chloride as the activator of flotation, the bubbles carry a small amount of mineral. The phenomenon of copper sulfate activation is obviously, but known from the Table 3, after flotation the sulfur content barely changed, indicating copper sulfate on the magnetite also has certain activation.

4.2 Application of magnetic separation column in iron ore desulfurization
4.2.1 Appropriate conditions of the magnetic separation column application
Early tests using sodium sulfide as the activating reagent, testing in the magnetic separation column to chose the optimum experimental conditions, the determination of sulfur minerals shows in Table 4

Table 4 Experimental results of magnetic separation column frequency debugging

<table>
<thead>
<tr>
<th>Frequency (S)</th>
<th>2.5</th>
<th>3.0</th>
<th>3.5</th>
<th>4.0</th>
<th>4.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur (%)</td>
<td>0.4713</td>
<td>0.5005</td>
<td>0.4988</td>
<td>0.4895</td>
<td>0.4265</td>
</tr>
</tbody>
</table>

We can know from the table 4, the sulfur content of iron ore increased after separating in the magnetic separation column. Mainly due to the ore in the mine was out of mud, but have not been to a decrease of sulfur minerals.

4.2.2 Inflatable Experimental Research and Analysis in Magnetic Separation Column
At a frequency of 4.5S experimental conditions, used three types of activator sodium sulfide, ammonium chloride and ammonium sulfate, on iron ore concentrate for sorting test, after sorting the purpose of mineral sulfur content results shows in Table 5

Table 5 Inflatable Experimental Results of Magnetic Separation Column

<table>
<thead>
<tr>
<th>Activator(500g/t)</th>
<th>Sodium sulfide</th>
<th>Ammonium chloride</th>
<th>Ammonium sulfate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose of mineral sulfur</td>
<td>0.4265</td>
<td>0.4185</td>
<td>0.4194</td>
</tr>
</tbody>
</table>
5. Conclusion

The experiment did not succeed in solving the problem of high sulfur content, analyze its causes: First, pyrrhotite belongs to strong magnetic minerals, and the magnetic separation column had a magnetic effect to pyrrhotite so that it can not flow smoothly on the leading role of rising flow and rising bubbles into the overflow. Second, the actual operation of a mine was uneven, flow size of water in magnetic separation column is difficult to control. Third, the choice of activator need for a further exploration, to find a activator which has a superior activation performance to pyrrhotite, and no activation to the magnetite.

Iron concentrate of this plant has a high mud content, which is the result of selection process of the sorting plant. In the sorting process of magnetic separation column, driven by the rising water to get rid of the slurry effectively, improving the taste of fine iron powder. It can say that is also a harvest in the process of this explore test.

References