Dry Magnetic Separation Recovery Iron from Steel Slag Powder

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Abstract. There are a lot of iron particles in the steel slag powder that can be recycled. In this work, the technological parameters of dry magnetic separation were optimized and the screening processwas used to replace the traditional magnetic separation process by low-intensity magnetic field.Somore than 80 wt. % concentrate of the iron was obtained, which improved the efficient recovery and rational utilization of steel slag powder.

Introduction

Steel slag is a by-product in the production of iron and steel, its main compositions are dicalcium silicate, tricalcium silicate, metallic iron, ferric oxide, etc[1]. At present, the ratio of utilization of the steel slag is only 50~60 wt. % [2].

Usually, the wet magnetic separation method is used for retrieving the metallic iron particles in the steel slag powder. But with this method, the concentrate of the by-product could not be exceeding to 60~65 wt. % and waste of water resources[3-4].

In order to improve the concentrate of the by-product, in this work,the technological parameters of dry magnetic separation were optimized and the screening processwas used to replace the traditional magnetic separation process by low-intensity magnetic field.

Experimental

The roller steel slag was supplied by MCC Baogang Steel Technology Services Co., Ltd;its particle size was 0~2.0 mm. The chemical composition analysis results are shown in Table 1.

Table 1. the chemical composition analysis results of the steel slag

Element	TFe	SiO_2	CaO	Al_2O_3	MgO	S	P_2O_5
Content (wt. %)	28.49	14.16	45.23	2.56	2.94	0.20	1.03

Phase composition of the steel slag was investigated by means of X-ray diffraction analysiswith a Rigaku X-ray Diffract (XRD) meter model D/MAX-3C with Cu *Kα* radiation.The recycling process including the dry magnetic separation process and fine grinding + low intensity magnetic separation + screening process, the two processes are shown in the Fig. 1 and Fig. 2. The equipment was asmall band type magnetic separator with 0~2000 Gauss. The minerals block in the tailings was investigated by a polarizing microscope.

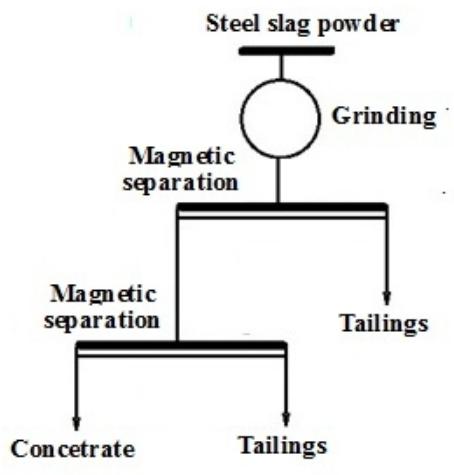

Fig. 1 Dry magnetic separation process

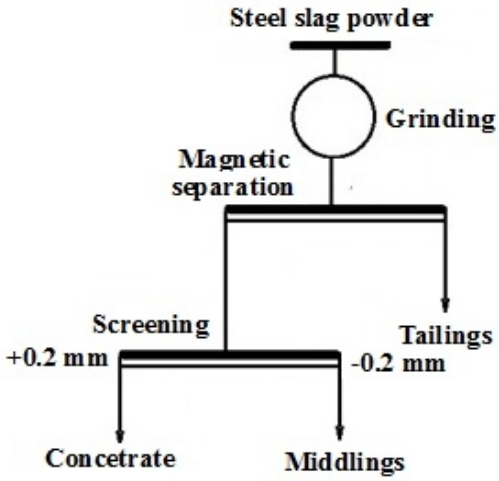

Fig.2 Fine grinding + low intensity magnetic separation + screening process

Results and Discussion

Phase composition. The phase composition of thesteel slag was tested by XRD, and the resulted were shown in Fig. 1. From Fig. 1, the main phases in the slag were tricalcium silicate (C_3S), dicalcium silicate (C_2S).The slag also contained a certain amount of pure Fe, hematite (Fe_2O_3), magnetite (Fe_3O_4) and calcium hydroxide ($Ca(OH)_2$).

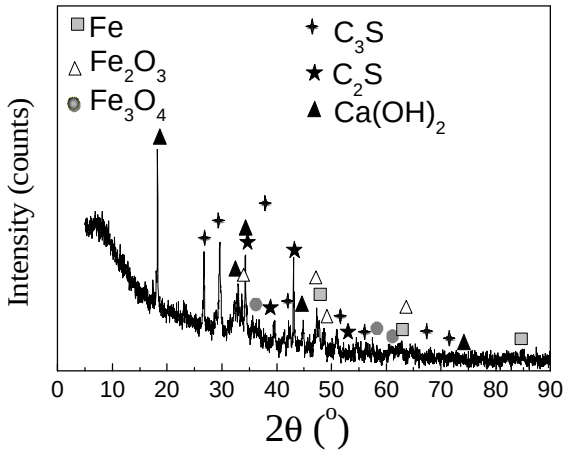

Fig. 3 the XRD results of the steel slag

Screening effect. The effects of the screening on the productivity and grade were listed in Table 2. From Table 2, with the grain size decreasing, the grade of iron elementin each size fraction was decreased too. Furthermore, the total grade of iron element in each size fraction was continually decreased. It can be seen that thehigher iron element grade products can be obtained by the screening process. Therefore, the iron element can be concentrated further through adding several screening processes.

In order to obtain the appropriate screening parameters,the effects of the grinding fineness on the screening effect of magnetic separation products was further researched. The product with -0.12mm grinding fineness and content of 70 wt. % through 70mT magnetic induction intensity was obtained and the results were shown in Table 3. From Table 3, with the grinding fineness increasing, the content of iron element was improved to 86.50 wt. %.

Table 2. the analysis results of concentrate products after screening

Size fraction (Mesh)	Productivity (%)	Grade (%)	Total grade (%)	Productivity of each size (%)
+40	43.14%	73.16	73.16	46.20
-40~+80	26.96%	68.31	71.29	26.96
-80~+120	18.71%	63.98	69.75	17.52
-120~+160	4.99%	59.11	69.19	4.32
-160~+200	3.66%	55.95	68.69	3.00
-200	2.54%	53.72	68.31	2.00
Total	100.00%	68.31		100.00

Table 3.the analysis results of products after screening with 70 wt. % fineness of grinding

Size fraction (Mesh)	Productivity (%)	Grade (%)	Total grade (%)	Productivity of each size (%)
+40	23.52	86.50	86.50	28.83
-40~+80	22.80	81.57	84.07	26.36
-80~+120	34.77	65.77	76.22	32.41
-120~+160	7.78	50.63	73.98	5.59
-160~+200	6.39	45.70	72.09	4.14
-200	4.74	40.04	70.57	2.69
Total	100.00	70.57		100.00

Recovery effect. The effect of grinding fineness on the recovery of steel slag and the experimental conditions were 60 mT magnetic induction intensity and variable grinding fineness. The effect of magnetic induction intensity on the recovery of steel slag and the experimental conditions were grinding fineness was -0.12mm and variable magnetic induction intensity. The results were listed in Fig. 4.

From Fig. 4(a), with the content of -0.12mm particles increasing, the recovery of iron in concentration was decreased and the iron grade was improved. From Fig.4(b), on the contrary, with the magnetic induction intensity increasing, the recovery of iron in concentration was improved and the iron grade was decreased.

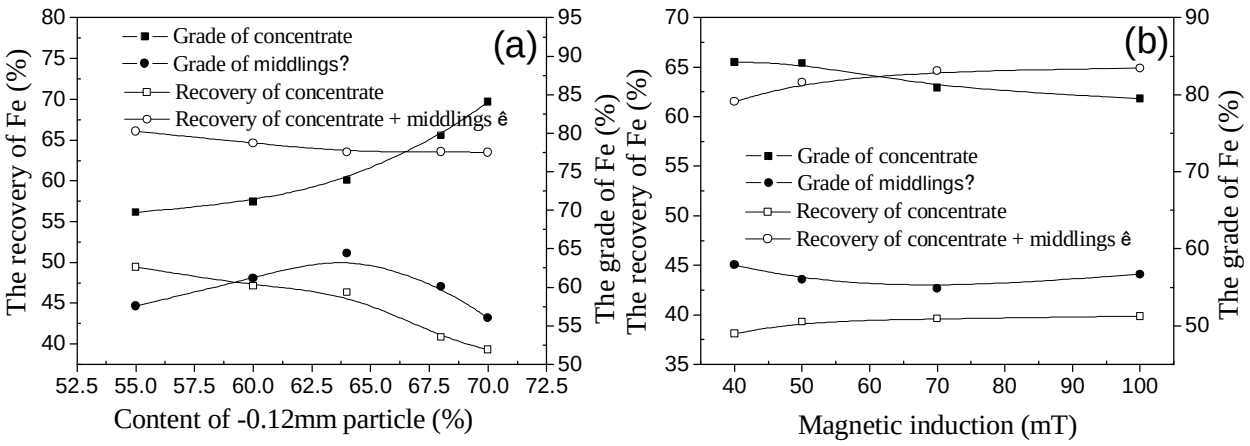

Fig. 4 Recovery effects affected by grinding fineness (a) and magnetic flux density (b)

Minerals block in the tailings. The tailingsphotoes of the steel slag after the strong magnetic separation (a), (b) and weakly magnetic separation (c), (d) were listed in Fig. 5. From Fig. 5(a) and (b), the existing states of the iron element wasvery smalliron particles and existed in magnetic，

Fig.5(c) and (d) showed that the iron element existed in perlimonite, which could not be recovery easily.

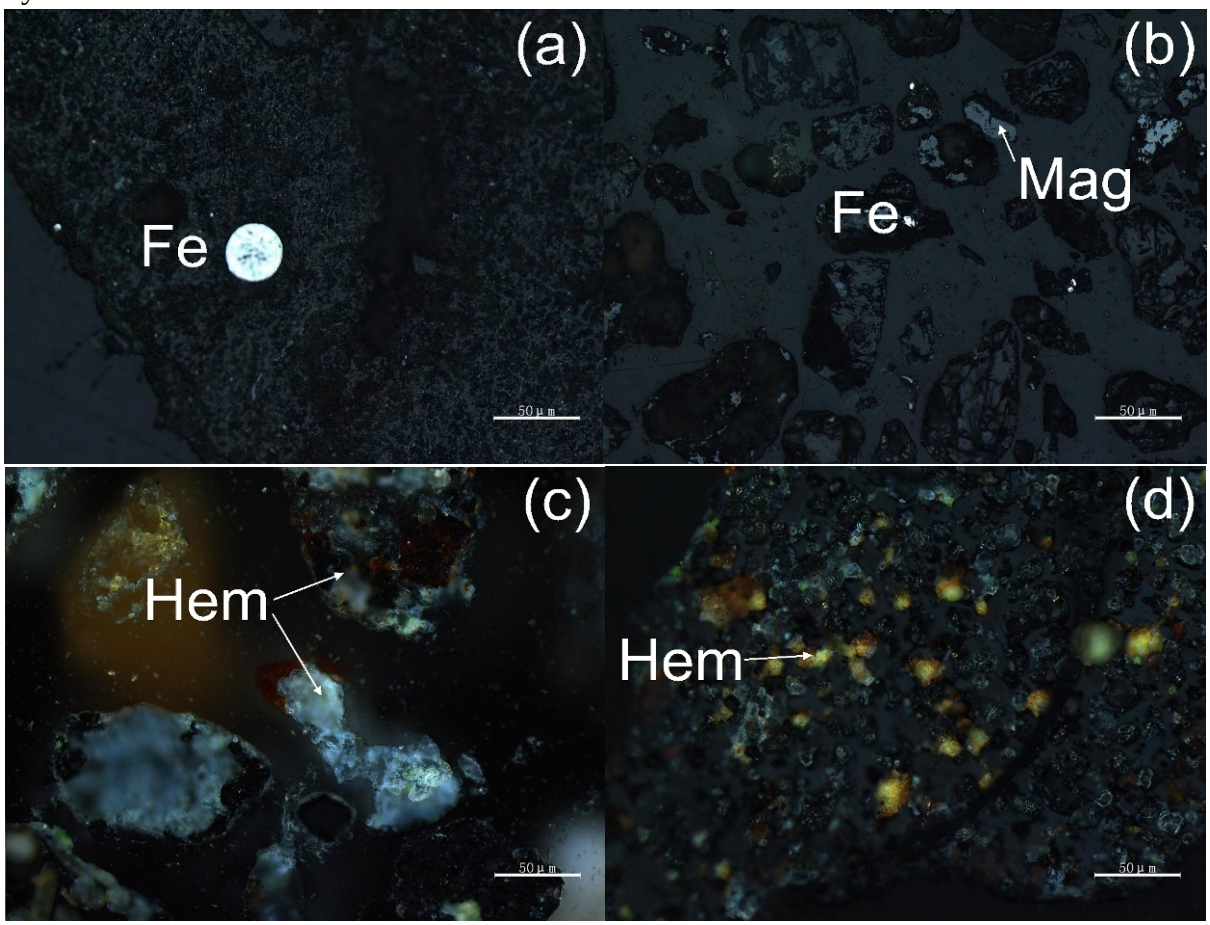

Fig. 5 Strong magnetic (a), (b) and weakly magnetic (c), (d) minerals block in the tailings

Mag-Magnetic; Hem-Perlimonite

Conclusion

The phases in the steel slag were tricalcium silicate (C_3S), dicalcium silicate (C_2S), iron, hematite (Fe_2O_3), magnetite (Fe_3O_4), etc.The technological parameters of dry magnetic separation wereresearched and the screening processwas used to recovery the iron element. Finally,more than 80 wt. % concentrate of the iron was obtained, which improved the efficient recovery.

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