Leaching of Valuable Metals from Boiler Slag

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Abstract: This paper is aimed at presenting a new way of recycling valuable metals in boiler slag derived from steel plants. In these testing, boiler slag was leached by sulfuric acid, elemental analysis of aqueous solutions was determined by EDTA titration. The Particle Size Distribution was derived by a standard screens. The components of the sample were examined by means of XRF. An aluminium extraction efficiency of 86.20% was achieved when the sintered pellets were leached using 4 mol·L^{-1} H_2SO_4 at solid liquid ratio of 1∶5 at 80 ℃ for 24 h. An iron extraction efficiency of 94.30% was achieved at the same conditions of the maximum extraction efficiency of Al.

Key words: boiler slag; Al extraction efficiency; Fe extraction efficiency; extraction
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The quantity of boiler slag produced in China is about 0.12~0.16 billion ton each year. This boiler slag causes many serious environmental problems[1]. The boiler slag comes from steel plants of China is typically contains 40%~60% SiO_2, 18%~38% Al_2O_3, 2%~7% Fe_2O_3 and 1%~4% CaO according literatures report[2]. The content of alumina is rich.

1 Experimental

1.1 Materials

The boiler slag using in this test came from Baotou Steel Plant, Inner Mongolia, China. The particle size distribution was shown in Fig.1. The XRF analysis shows the samples consist of 42.60% SiO_2, 32.60% Al_2O_3, 2.43% Fe_2O_3%, 2.16% CaO, 0.74% K_2O, 0.88% TiO_2 and some other trace elements.

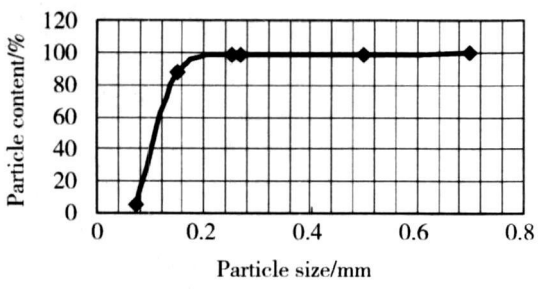

Fig.1 The PSD of boiler slag

1.2 Methods

The dried residue was analysed by XRF. Elemental analysis of aqueous solutions was determined by EDTA titration (GB 15892—1995)[3].

2 Results and Discussion

The leaching parameters such as temperature, strength of sulfuric acid, leaching time and solid liquid ratios are considered to find the optimal condition to extraction efficiencies of aluminium (Al) and iron (Fe). The pellets were placed into a silicon crucible and sintered at 1 000 ℃ for 2 h in all tests[4]. The results are presented in Table 1—Table 4.

The results in Table 1 show that the increase in temperature from 20~95 ℃ resulted in a improvement in the extraction efficiency. However, the extraction efficiency of Al and Fe remained low increase when the temperature exceeds 80 ℃.

Tab.1 Effect of temperatures

Temperature/℃	Al extraction efficiency/%	Fe extraction efficiency/%
20	41.70	67.20
40	60.20	73.10
60	72.10	80.50
80	75.80	83.00
95	76.00	83.10

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Tab. 2　Effect of acid strength

c/(mol·L^{-1})	Al extraction efficiency/%	Fe extraction efficiency/%
2	57.30	70.20
4	75.10	81.60
6	77.50	85.20

The results in Table 2 show that the extraction efficiencies of Al and Fe increase with an increase in both sulfuric acid strength and leaching time, particularly Al. However the extraction efficiencies of the Al and Fe remained low increase when the strength of H_2SO_4 increased from 4 mol·L^{-1} to 6 mol·L^{-1}.

Tab. 3　Effect of leaching time

Time/h	Al extraction efficiency/%	Fe extraction efficiency/%
2	63.10	79.50
4	75.30	80.90
8	83.00	84.70
12	85.60	89.70
24	86.20	94.30

From the results given in Table 3 it is clear that the extraction efficiency of Al and Fe increased significantly as the leaching time increased from 2 to 24 h at a solid liquid ratio of 1∶5 and 80 ℃. However, the extraction efficiency of Al remained constant as the leaching time increased from 12 ~ 24 h. But the extraction efficiency of Fe remained increased significantly as the leaching time increased from 12 ~ 24 h during the leaching process.

From the results presented in Table 4 it can be seen that at a solid liquid ratio of 1∶5 and to a solid liquid ratio of 1∶6 are almost same extraction efficiencies both Al and Fe. At solid liquid ratios below 1∶4 were yielded low levels of extraction efficiencies both Al and Fe.

Tab. 4　Effect of solid liquid ratios (m/V)

S∶L/(g·mL^{-1})	Al extraction efficiency/%	Fe extraction efficiency/%
1∶6	83.90	85.00
1∶5	83.10	84.90
1∶4	76.00	71.20
1∶3	53.10	55.60

3　Conclusions

The best conditions for the leaching of Al and Fe from boiler slag are as follows:

Leaching temperature range from 60 ~ 80 ℃;

Strength of H_2SO_4 range from 4 ~ 6 mol·L^{-1};

Leaching time range from 4 to 8 h;

Solid liquid ratio range from 1∶5 ~ 1∶6.

The maximum extraction efficiency of Al is 86.20% using 4 mol·L^{-1} H_2SO_4 at solid liquid ratio of 1∶5 and at 80 ℃ for 24 h. The maximum extraction efficiency of Fe is 94.30% at the same conditions of the maximum extraction efficiency of Al.

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从沸腾炉渣中浸取有价金属

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摘　要：研究了从钢厂炉渣中回收有用金属的一种新方法。实验中，炉渣用硫酸浸取，浸取液采用 EDTA络合滴定分析元素组成，颗粒粒径分布采用标准筛筛分，化学组成和微观结构分别采用 XRF。结果表明，铝的最大提取率为 86.20%，条件为：H_2SO_4 浓度 4 mol·L^{-1}、固液比 1∶5条件下在 80 ℃浸取 24 h。在同一条件下铁获得最大提取率为 94.3%。

关键词：沸腾炉渣；铝提取率；铁提取率；浸取

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