Study on the Influence Factors of the Adsorption of Cr³⁺ by Steel Slag

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Abstract. The paper selects 100 mesh steel slag as the adsorbent, to study the effect of temperature, adsorption time, pH value of the solution and steel slag dosage on the removal rate of Cr³⁺. The results show that for 50 ml, 100 mg/l Cr³⁺ simulated wastewater, the best adsorption condition of steel slag is that temperature is room temperature, adsorption time is 50 min, the dosage of steel slag is 25 g / L, pH value has less effect on adsorption of steel slag and in a wide pH range, Cr³⁺ has stable removal rate of more than 97%.

Introduction

With the rapid development of the iron and steel industry, steel slag production is gradually increasing, as a typical representative of the waste residue, if steel slag can't be utilized reasonably, it will seriously affect the development of the iron and steel industry and the growth of the national economy. Steel slag comprehensive utilization, to the environment, the economy has the long-term significance^[1-3]. Waste water containing chromium mainly contain large amount of Cr (VI) and Cr (III), the toxicity of Cr (VI) is about 100 times more than that of the Cr (III) and related research shows that the mass concentration of Cr (VI) which is greater than 200 mg / l can lead to the death of most of the aquatic animals and plants^[4]. Because of steel slag's characteristic, such as high mechanical strength, high alkalinity, porous structure, strong adsorption capacity and so on, it has a good application prospect in wastewater treatment^[5]. The paper investigated effect of the temperature, pH value of solution, adsorption time and the dosage of steel slag on the treatment efficiency of wastewater containing chromium by using 100 mesh steel slag to dispose simulated wastewater containing chromium, and the optimal wastewater treatment conditions were obtained, and provided scientific reference for intensive study of steel slag treating wastewater containing chromium.

Experimental

Materials. The steel slag powder used in the experiment is taken from the local Steel Corp, and its composition is shown in Table 1.

Table 1 Main Components of Steel Slag

Component	SiO ₂	Fe ₂ O ₃	Al ₂ O ₃	CaO	MgO	MnO	TiO ₂	Loss on ignition
content (%)	26.10	2.49	10.60	50.39	0.34	0.26	1.02	0.21

Methods. Added a volume of 10% sulfuric acid solution into a beaker with a certain amount of steel slag, stirred for 30 min, filtrated and washed three times with distilled water, dried the steel slag and for spare.

A certain concentration of simulated wastewater containing chromium was prepared with chromium chloride, and added a certain amount of steel slag to the simulated wastewater, then oscillated for a period of time with certain speed and temperature, filtered, reduced Cr (III) to Cr (VI) with potassium permanganate under acidic conditions, determined the concentration of Cr

(VI) using diphenyl carbazide photometric method and simulated the removal rate of Cr (III) in the wastewater.

Results and discussion

Effect of the amount of steel slag on the removal rate of Cr^{3+} At room temperature, weighed different quality of steel slag and added it to 50ml ,100mg / l of Cr^{3+} solution separately , stirred for 60 min, determinated ion concentration of upper clear liquid after stewing, results are shown in Table 2.

Table 2 Effect of the amount of steel slag on the removal rate of Cr^{3+}

Amount of steel slag [g]	Initial concentration [mg/L]	Equilibrium concentration [mg/L]	Removal rate [%]
0.5	100	25.4	74.6
0.75	100	14.8	85.2
1.0	100	8.5	91.5
1.25	100	1.6	98.4
1.5	100	1.3	98.7
1.75	100	1.2	98.8

According to the results of Table 2, the removal rate of Cr^{3+} increased rapidly with the increase of the amount of slag. when the dosage reached 1.25g, the change of removal rate tended to be gentle, all reached more than 98%. So the appropriate dosage of steel slag was 25 g/l.

Effect of adsorption time on the removal rate of Cr^{3+} At room temperature, weighed 1.25g steel slag adsorption and added it to 50ml, 100mg / l Cr^{3+} solution, stirred for different time, determinated ion concentration of upper clear liquid after stewing. The adsorption results are shown in Figure 1.

Fig.1 Effect of contact time on the adsorption efficiency of heavy metal

Figure 1 shows that the removal rate of Cr^{3+} increased with the increase of the adsorption time, when the adsorption time was 50min, the removal rate of Cr^{3+} tended to be stable, reaching 98.7%, so the best adsorption time was 50min.

Effect of pH value on the removal rate of Cr^{3+} At room temperature, weighed 1.25g steel slag, and added it to 50ml , 100mg/l Cr^{3+} solution, adjusted of the pH value of the solution ,oscillated 50min, static, determinated ion concentration of upper clear liquid after stewing. the results are shown in Figure 2.

Fig.2 Effect of solution's pH on the adsorption efficiency of heavy metal

Figure 2 shows that pH value had little effect on the adsorption of Cr^{3+} , and in the range of 2 to 12, the removal rate of Cr^{3+} are all above 97%. Therefore pH value can be adapted to a wide range in steel slag processing chromium containing wastewater.

Effect of adsorption temperature on the removal rate of Cr^{3+} Weighed 1.25g steel slag, and added it to 50ml, 100mg/l Cr^{3+} solution, stirred at different temperatures, determined ion concentration of upper clear liquid after stewing. The adsorption results are shown in Table 3.

Table 3 Effect of adsorption temperature on removal rate

Adsorption temperature [°C]	Removal rate [%]
20	97.6
30	97.9
40	98.2
50	98.3
60	98.4

Table 3 shows that the removal rate of Cr^{3+} increases slowly with the increase of temperature, so the temperature has little effect on the adsorption rate of steel slag, adsorption of chromium ion can be processed at room temperature.

Conclusions

The removal ability of Cr^{3+} in wastewater with steel slag is strong, and the adsorption rate is high. Using 100 mesh steel slag to process 50ml, 100mg/l simulated wastewater containing Cr^{3+} , the optimum conditions were: input quantity of steel slag is 25g/l, adsorption time is 50min, adsorption temperature is room temperature PH value does not affect the adsorption effect, the removal rate of Cr^{3+} by steel slag is more than 97%.

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