Recovery of chromium from ferrochrome slag

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ABSTRACT

Ferro chrome slag may contain chromium in +3 and +6 oxidation states. Separation and determination of chromium content of the slag samples collected from Jindal Ferro Alloys Corporation, (Kottha valasa, Visakhapatnam Dt.) has been carried out following extraction with benzene solutions of TOAO(0.01M). Maximum extraction efficiency was achieved at pH 2.5M in presence and absence of impurities associated with ferrochrome slag. The results obtained in the present study are compared with synthetic as well as slag samples (as per the specifications of manufacturers).

Key words: Ferrochrome slag, Jindal Ferro alloys, TOAO.

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INTRODUCTION

Ferro alloys such as Ferrochrome are generally produced by electronic arc from melting of mineral chromites[1-3]. These are the sources for the production of all types of steels with different alloying metals (nickel, molybdenum, vanadium etc.) making the steel more passive and increasing its stainless steel properties[4]. The slag consists of oxides of magnesium, iron and chromium of various oxidation states. Ferrochrome slag may contain chromium in +3 and +6 oxidation states along with elemental chromium[5].Earlier studies reported the extraction of chromium (VI) [6-8] as well as microbial activity of different metals[9]. The aim of the present investigation is to separate and estimate the chromium content (as chromium(VI) by oxidation) of the slag samples (Jindal Ferro Alloys Corpn., Kottha valasa, Vsp. Dt.).The %composition of the slag is Cr_2O_3 10-15 ; FeO 2-5 ; SiO_2 25 – 30 ;MgO 22-25 ; Al_2O_3 16-22 and CaO 3-5.

EXPERIMENTAL SECTION

About 0.5 gm of slag is dissolved in conc. HNO_3 and conc HCl or mixture of two acids which is subjected to prolonged boiling and evaporation on a water bath. It is then diluted and filtered into a 100 ml flask, washed with distilled water and finally diluted up to the mark. The filtrate is discarded. Chromium content of the sample is quantitatively oxidized to chromium (VI) by using 10% potassium persulphate as oxidant.

An aliquot (10ml) of the (hexavalent chromium so formed) solution has been equilibrated with an equal volume of TOAO (0.01 M) in benzene pre equilibrated with appropriate concentration of hydrochloric acid[10]. The chromium (VI) concentration in the aqueous phase before and after extraction was estimated using Atomic absorption spectrophotometer AAS SVL Spectronics – Model 205.

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RESULTS AND DISCUSSION

The distribution ratio of chromium (VI) in the slag sample solution was found to increase with increasing acidity up to 2.5 M (Maximum extraction) followed by decrease in extraction efficiency. Representative data is presented in Table–1. The decrease in the distribution ratio at higher acidities (>3.0M) can be explained as due to the greater extractability of the mineral acid over the chromium (VI) species.

Stripping of chromium (VI) was carried out using HCl, H_2SO_4, HNO_3, NaCl, $NaNO_3$ distilled water and NaOH as stripping agents. It was observed that HCl, H_2SO_4, NaOH, NaCl and $NaNO_3$ are extremely poor stripping agents for Chromium (VI). On the other hand 1.0M HNO_3 alone is a good stripping agent. However, in no case HNO_3 strips out all the Chromium (VI) in a single extraction. Thus stripping time between 3 to 5 minutes would be optimal to recover chromium (VI) by making contact three times with equal volumes of 1.0M nitric acid.

In order to test the applicability of the proposed method, it was applied to analyze synthetic samples containing chromium are compared with ferro chrome slag samples. Results are presented in Table- 2.

Table.1 Variation of pH with extraction efficiency

S. No	pH	% of Chromium extracted
1	1.0	99.86
2	1.5	99.80
3	2.0	99.80
4	2.5	99.94
5	3.0	99.75
6	3.5	99.74
7	4.0	99.73
8	4.5	99.71

Table 2. Recovery of Fe Cr alloy & Synthetic samples

Synthetic sample	Chromium(VI) present (g/l)	Chromium found by extraction (g/l) *	Recovery (%)
1	0.20	0.196	98.0
2	0.30	0.292	97.3
3	0.40	0.386	96.5
4	0.50	0.494	98.8
Metal	Certified (g/kg) [as given by the manufacturer]	Measured	Recovery (%)
Ca	----	307	----
Cr	680	662	97.35
Fe	249.8	230.6	92.31
Mg	----	221.8	----

(Average of three determinations)

CONCLUSION

The method was very selective and permits the separation and determination of chromium from slag and synthetic samples with accuracy.

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