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Recovery of Chromium from Ferrochrome Slag

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ABSTRACT: Ferrochrome slag generated from alumino-thermi method piles up in large quantities poses many problems to the environment and contaminates ground water on long run, needs to be addressed very urgently. It principally contains chromium, alumina, Iron, magnesium, calcium in small quantities. This paper deals with extraction of chromium and renders the slag harmless. In this paper industrial waste was collected from GTS industries and used in the subsequent experimentation. Ferrochrome slag is treated with lime to conduct slag-lime solid-solid reaction. Chromium present in the slag reacts with lime to form mixed chromates. The reaction is conducted at 973K, soluble chromium ion was extracted with water and is subsequently separated by adsorbing fly ash based zeolite which can be recovered. The recovery of chromium metal in the slag is 64%. The method is viable for the commercial recovery of chromium from slag.

KEY WORDS: Chromium, recovery, ferrochrome slag, adsorption, zeolite.

I. INTRODUCTION

Slag is a solid waste laden with heavy metal carrying chromium compounds imparts many problems to the environment. The waste disposal of chromium in air will eventually settle and end up in waters and soils. The ingestion of Chromium in ground water and surface water caused adverse effects on health. It's inclusion in blood can cause blood poisoning, inhaling chromium from air can cause respiratory problems, skin diseases, allergic reactions, weakens immune system etc., The main reason for its adverse effects is due to the non-biodegradability and its unfavourable tendency to accumulate into living organisms. Its removal, recovery and identification of alternative product design or processed to the safe environment and sustainable development of industry. Common methods for determining the chromium concentration in waste are volumetric analysis, precipitation as lead chromate followed by absorption spectroscopy, colorimetric method, UV-visible spectrophotometry, ion chromatography. Most common methods to remove ionic chromium from these wastes are the chemical precipitation and the adsorption on different materials, whose physical and chemical properties are adjusted to yield higher outputs. Numerous technologies relying on: precipitation of chromium and heavy metals as hydroxides, carbonates, phosphates, adsorption on coal, activated charcoal and absorption on zeolite are common. This paper deals with the recovery of chromium from ferrochrome slag generated out of aluminothermy method. Chromium recovered by solid-solid reaction of ferrochrome slag and lime.

II. LITERATURE REVIEW ON EXTRACTION OF CHROMIUM

R.S. Karale etal (2007) conducted experiments Removal and recovery of hexavalent chromium from industrial waste water by precipitation. Experiments were conducted to study the effect of Reduction time on the Reduction of Chromium against various doses of reducing agents viz.; Ferrous Sulphate and Sodium meta bisulphite and % Reduction was only 56.32. C.P. Mane etal (2012) worked on Hexavalent chromium recovery by liquid–liquid

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extraction with 2-octylaminopyridine from acidic chloride media and its sequential separation from other heavy toxic metal ions. He observed that 2-OAP extracts chromium(VI) in xylene from hydrochloric acid media by anion exchange mechanism in which a complex of stoichiometric formula [2-OAPH$^+$ CrO3Cl_](org) is formed. BOJANOWSKA I etal (2001) worked on Recovery of Chromium from Sludge Formed after Neutralisation of Chromic Wastewater. The method includes precipitation of the chromium(III) hydroxide and its dissolution, oxidation of chromium(III) to chromium(VI), solvent extraction and reextraction of chromium(VI). The chromium recovery yield of each procedure stage was in the range of 92 to 99%. Overall chromium recovery yield was about 90%. Binder et al., also worked on chromium recovery from industrial waste water. It was found that crystallisation is possible only after transformation of the initial sulfate containing chromium(III)-complex (green solution) to the chromium(III)-aquocomplex (violet or purple solution). Abass Esmaeili etal (2005) worked on Chromium (III) Removal and Recovery from Tannery Wastewater by Precipitation Process. Removal and recovery of chromium were carried out by using precipitation process using three precipitating agents calcium hydroxide, sodium hydroxide and magnesium oxide . The effects of pH, stirring time, settling rate and sludge volume were studied in batch experiments. Results show that the optimum pH is 8-9

III. ZEOLITE PREPARATION

Fly ash due to its composition(approximately 50 to 30%wt. of silicon oxide and aluminum),it can be used as raw materials for the synthesis of zeolites[5]. Different studies have used the ash from burned coal as a source of silicon and aluminum for the synthesis of pure phase zeolites or mixtures of materials. The synthesis of NaP1 zeolites by the hydrothermal treatment of ashes have shown good results for the adsorption of heavy metals. The synthesis of Na-X has used hydrothermal treatments and are associated with alkaline ash fusion[6]. synthesized material, Na-X by alkaline fusion with sodium carbonate, desilification and a hydrothermal process.

Fly ash and sodium carbonate are fused by mixing 85 and 15 grams of respective amounts of the compounds, was burned in the oven at a temperature of 873K for one hour, then desilification was done for 2 or 3 times, then the residue was burned again in the oven at 973K for 2 hours.

IV. PROCEDURE

Ferro chrome slag contains 7% chromium is considerably large quantity is being stock piled as solid waste. The chromium present in the slag can be recovered by the proposed method.

The method contains the following steps:

1. Treatment of slag with lime to convert chromium present in the slag into chemical compound soluble in water like CaCr2O7, Na2Cr2O7 etc
2. Extraction of chromium ion into water.
3. Water extract of chromium can be separated by adsorption onto Flyash based zeolite.
4. Recovery of chromium from zeolite.
5.

V. EXPERIMENTAL

Lime has affinity to chromium, hence it is proposed to conduct solid phase reaction of lime with slag 1:1,1:2, 1:3 of slag to lime ratio's are maintained and exposed to temperature of 973K in a muffle furnace about 4 hr. Solid - solid reaction takes place. After high temperature treatment the reaction mass is reserved for further investigation. 10grms of the reaction mass is taken and treated with 500ml of water for 2hrs. Chromium was recovered into water and the recoveries were reported. The chromium in the aliquot was estimated by volumetric analysis.

Chromium from the aliquot is adsorbed onto fly ash based zeolite which has exchange capacity of 3000 mmol/gm. Thus recovered chromium can be desorbed and can be recovered in water followed be crystallization to obtain pure form of calcium chromate.

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VI. RESULTS AND DISCUSSION

Chromium was recovered into water. The recovery of chromium is maximum and maintained at 64% for the sample of 1:1 of lime to slag ratio maintained during the solid phase reaction. Higher recoveries are possible with 1:2 slags to lime ratio. Thus, recovered chromium solution was treated with fly ash based zeolite. The concentration of chromium in the aliquot is monitored with time. A graph is drawn as % recovery versus time and shown as figure 1. The recovery increases with time and reaches maximum at 4 minutes which is an equilibrium concentration of chromium on zeolite. Further experimentation was carried out at a time of 7 minute.

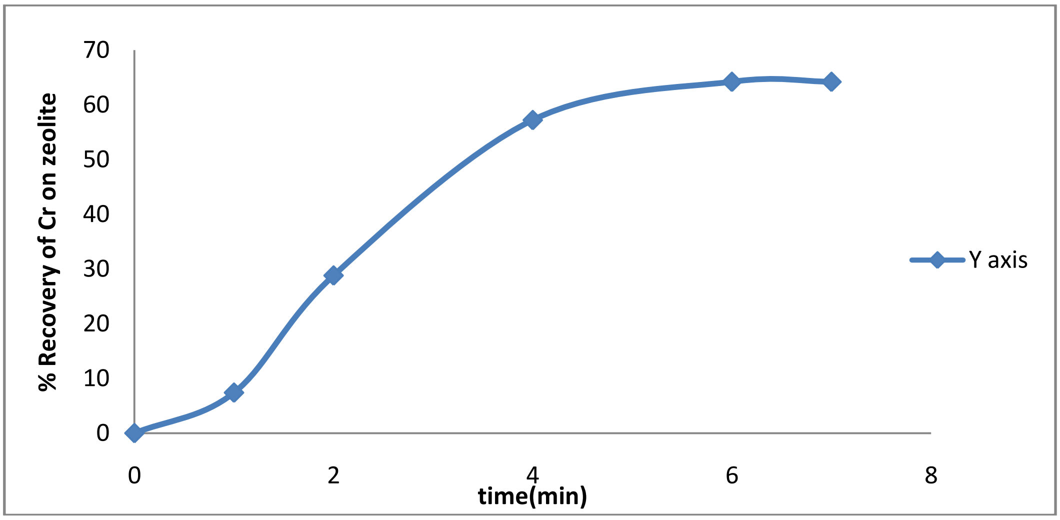

Fig 1 : **Graph showing the % recovery of chromium on zeolite with time**

A graph is drawn as % recovery versus slag to lime ratio and shown as figure 2. The recovery is increases to a peak followed by decease. Maximum recovery for the slag to lime ratio of 0.5 is obtained as 44.5% which can be observed from the figure.

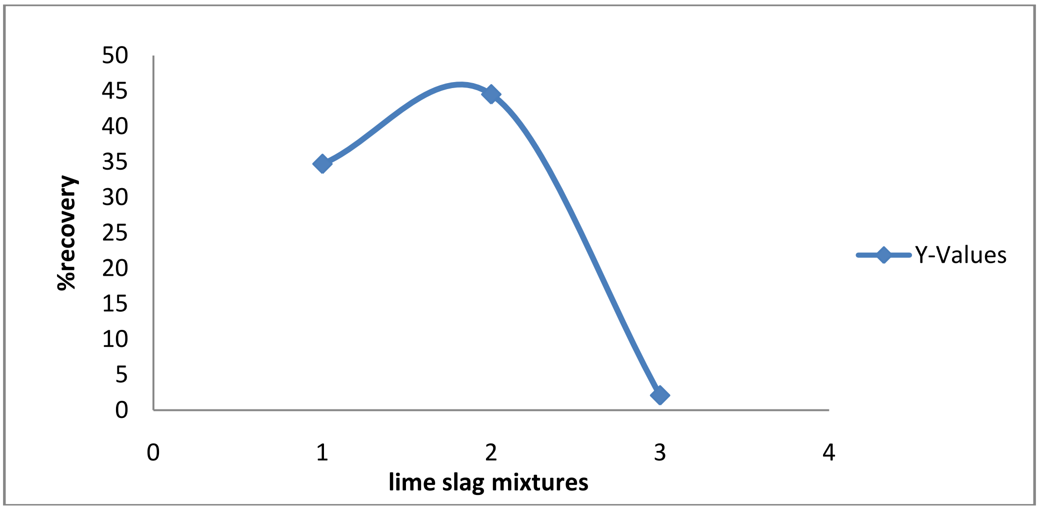

Fig 2 : **Graph showing variation of % recovery of chromium with different lime slag mixtures**

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VII.CONCLUSIONS

- Recovery of chromium from ferrochrome slag is 64% by treatment of slag with lime at 973K in solid phase.
- The soluble chromium ion was extracted with water.
- The chromium from liquid extract is separated with fly ash based zeolite which has 3000 mmol/gram and it can be regenerated to recover chromium.

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