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Removal of Cr (VI) from their aqueous solution by using brass industry waste (Slag) as an adsorbent

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ABSTRACT

The adsorption efficiency of the brass industry slag for removal of heavy metal Cr from its aqueous solution was studied as slag consist of calcium oxide, aluminum oxide, magnesium oxide etc. The research is a batch scale experimental type and analysis has performed by using different amount of adsorbent in solution with five different concentration of Cr metal. About 94% and 95% Cr removal achieved by using 1 and 1.5 g adsorbent for solution having concentration of 5 and 10 mg/L Cr. It was also found that adsorption efficiency depend on the amount of adsorbent as adsorption efficiency of Cr was increased from 70% to 100% in the same solution (5 mg/L).

Key words: Brass Industry Slag, Adsorption Efficiency, Heavy metals, Chromium Solution.

INTRODUCTION

The careless disposal of industrial effluents and other wastes in rivers & lacks continuously degraded the water quality [1-4]. Most of the rivers in the urban areas of the developing countries are the ends of effluents discharged from the industries. African countries and Asian countries experiencing rapid industrial growth and this are making environmental conservation a difficult task [5]. Although great efforts made to protect environment but still majority of industries of the world are constantly releasing toxic metals into the environment. They are dangerous environmental pollutants due to their toxicity and strong tendency to concentrate in environment [6-7] .The source of environmental pollution with heavy metals is mainly industry, i.e. metallurgical, electroplating, metal finishing industries, chemical manufacturing [8]. Several researches have been carried out over the last decade on the protection against plant and animal life degradation. Several big cities contribute to increase this problem, as they are sources of industrial effluents. In order to reduce the environmental pollution, a number of studies have been considered to minimize the problems caused by the commonly employed treatment of metal bearing effluents [9-10]
Removal of metals from wastewater achieved principally by the application of several processes such as adsorption [11], sedimentation [12], electrochemical processes [13-14], cementation [15], coagulation/flocculation [16], filtration and membrane processes [17]. .Adsorption is the one of the important procedure for the removal of heavy metals from the environment because of strong affinity and high loading capacity.

Moradabad is a B class city of Uttar Pradesh, India, famous for manufacturing brass items. The city has seen rapid industrialization during last few decades. The annual turn over of the city is nearly rupees 3000 million. All these industries are in unorganized sector and thus have unplanned growth leaving to high degree of air, water and soil pollution [18-19]. The most of the industries are dumping their effluents in Gagan and Ram Ganga River passes

from the heart of the city. A large number of small-scale manufacturing units of brass have been also situated in the heart of the city. During manufacturing process, high temperature coal based furnaces used to melt the metal. After the completion of the process, large amount of slag produced as a waste. This Slag consists of calcium oxide, magnesium oxide, and other metal oxides and can used as an adsorbent for the removal of heavy metals in the environmental field. Oxides containing in the slag are similar to those of Portland cement concrete, and the slag has been used such as raw material in road construction. For sorption properties of slag, several researchers reported the removal of heavy metals from wastewaters using slag [20-21] but no one uses brass industry slag as an adsorbent. In the present study brass industry slag is used as an adsorbent for the removal of toxic metal Cr from industrial wastewater.

MATERIALS AND METHODS

Adsorbent & Analysis

The brass industry slag collected from the bank of river Ram Ganga where local brass industries generally dump their waste. The raw slag crushed and sieved to less than 2mm size. The chemical composition of slag determined by ICP-AES presented in Table – 1.

Table-1: Chemical composition of Slag

Components	SiO_2	Al_2O_3	CaO	FeO	CuO	ZnO	MgO
Composition in %	16.13	1.82	54.3	1.12	9.13	3.5	3.15

Adsorbate Solution

The stock solution of Chromium (VI) (100 mg/l) was prepared by dissolving a weighed amount of $K_2Cr_2O_7$ in distilled water. From this stock solution 5,10, 20, 40, 100 ppm solutions were prepared by dissolving it accordingly.

Adsorption Studies

Solutions of Cr with different concentrations of 5,10, 20, 40, 100 ppm were prepared , the experiment were performed using three different amount of adsorbent 0.5, 1, 1.5 gm, in single solution. 0.5 gm adsorbent placed in a conical flask in which 100 ml of solution with known concentration of Cr added and the mixture shaken in shaker. The mixture was than filtered after 24 hours contact time and final concentration of metal ion was determined in filtrate by atomic adsorption spectrophotometer (GBC 902). All the Experiments carried out in triplet and mean concentration calculated by averaging them. The procedure repeated by varying the adsorbent dose and concentration of Cr solution and the results summarized in Table-2. Based on residual concentrations, the adsorption efficiency of slag is calculated and summarized in Table-3.

Table-2: Mean concentration of Residual Chromium after Adsorption by Slag (24 hour contact time)

S. No.	Quantity of Slag(gm)	Initial Concentration of Cr (mg/L)				
		5	10	20	40	100
1.	0.5	1.5	3	5.7	12.1	40.1
2.	1	0.3	0.9	2.5	4.3	20.1
3.	1.5	0	0.5	2	2.6	9

Table-3: Slag Adsorption Efficiency for Chromium at various Concentrations (24 hour contact time)

S. No.	Quantity of Slag(gm)	Initial Concentration of Cr (mg/L)				
		5	10	20	40	100
		Adsorption Efficiency (%)				
1.	0.5	70	70	71.5	69.75	59.9
2.	1	94	91	87.5	89	79.8
3.	1.5	100	95	90	93	91

RESULTS AND DISCUSSION

Table-2 shows the residual concentration of Cr in solution after 24 hours contact time and Fig (1-3) shows the adsorption efficiency for various concentrations of Cr by 0.5,1 & 1.5 g of slag. It is clear that slag is a good adsorbent for removal of Cr from wastewater. The adsorption efficiency is dependent on adsorbent amount and initial concentration of metal in synthetic solution. 70% removal of Cr from a 5 mg/L solution was possible by

applying 0.5 g slag. Where as the similar amount of adsorbent was not enough to treat 100mg/L Cr solution to above 70% but by increasing the amount of slag to 1.5 g it was possible to increase the efficiency of adsorption to about 91% for the same solution (100mg/L Cr). Table-2 also indicates that up to 100% of Cr removal is possible by increasing the amount of adsorbent. It shows that we would have better treatment by using excess slag. As this adsorbent is cheap and available in brass industry waste, there would be no problem to increase its consumption.

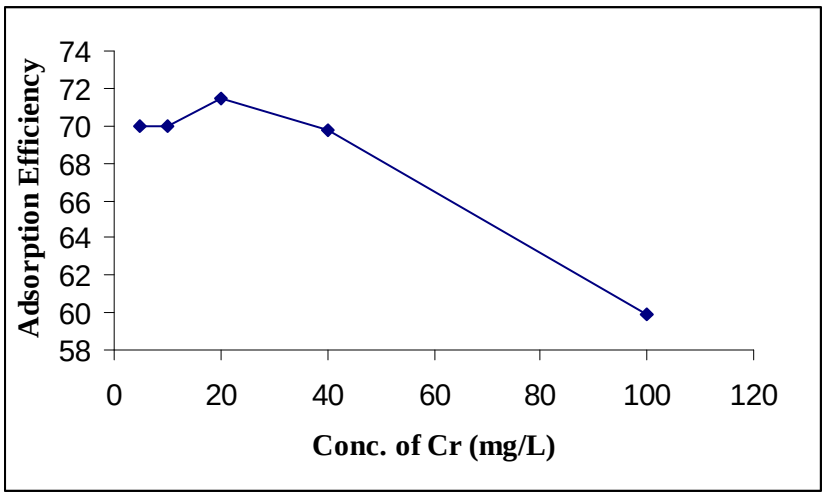

Figure 1: % Adsorption of Chromium by 0.5 g Slag

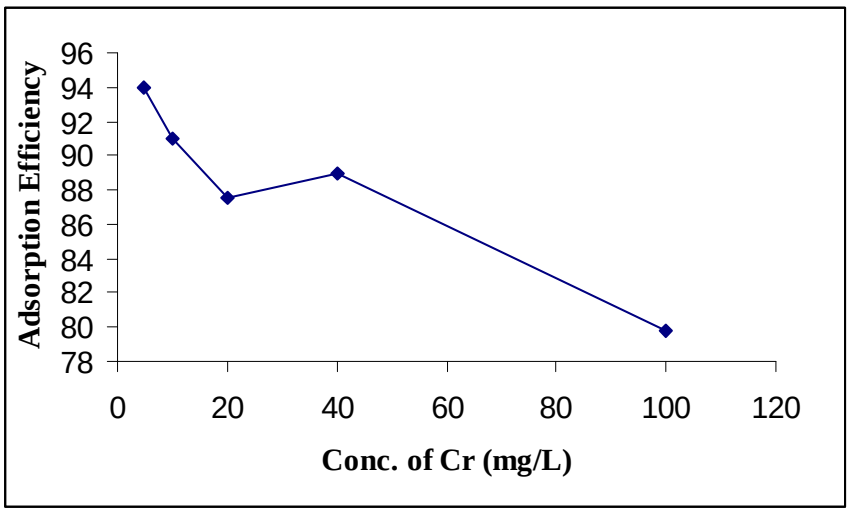

Figure 2: % Adsorption of Chromium by 1 g Slag

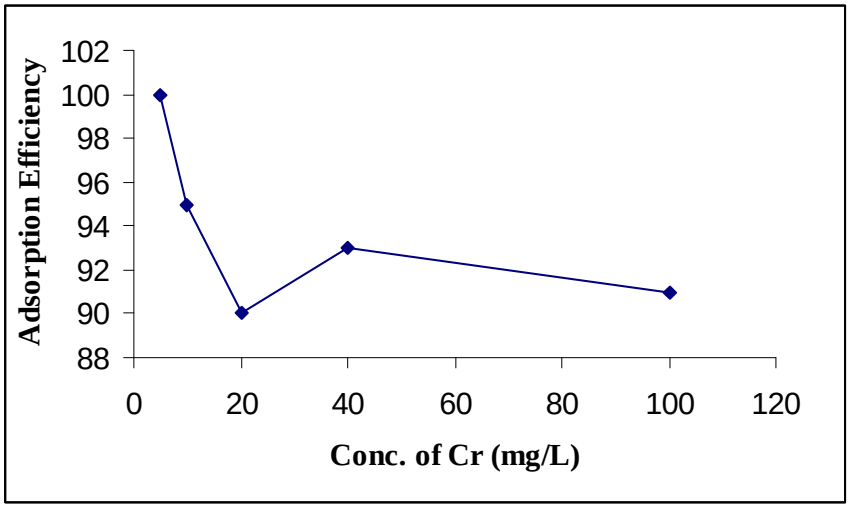

Figure 3: % Adsorption of Chromium by 1.5 g Slag

CONCLUSION

The above results show that brass industry slag has high adsorption capacity like the most other natural adsorbents and can use in the treatment process of heavy metals. The treatment efficiency may be as high as 100% by precise choosing of adsorbent amount. It also found that the concentration of heavy metal has an important effect on the result of this treatment. Slag is a waste material and conveniently used for the treatment of industrial wastewater, it is as the industrial waste is utilizing for the treatment of industrial wastewater. Further, it recommended that the industries should developed pretreatment process by using slag as an adsorbent before mixing the industrial wastewater into the river.

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