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**Research Article**

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# Study on removal of chromium from aqueous solution using dry cow dung powder

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**ABSTRACT**

*The high toxicity levels and increased amount of chromium has severely caused various environment and public health problems, whose treatment is expensive. Thus, it is very important to find economical and conventional ways for treating these high levels of heavy metals like chromium. This was done by using dried cow dung powder and the uptake percentage was determined at different pH, time and initial concentration of chromium by using Atomic Absorption Spectroscopy (AAS). It was found that amount of chromium removed decreases from 73.884 % at pH 1 to 63.474 % at ph 11, thus suggesting that amount removed is inversely proportional to pH. The adsorption effect follows the Langmuir model of adsorption isotherm since adsorption is found to be directly proportional to time. Also, it was found that with increase in the initial concentration of chromium, amount of removal has been found to increase while the % removal remains constant at constant pH conditions.*

**Key words:** Chromium, equilibration time, adsorption, Cow dung, AAS, Langmuir model

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## INTRODUCTION

Industrial wastewaters are a common source for polluting the environment with toxic heavy metals and causing health problems among animals [1, 2, 3]. The discharge of toxic metal effluents by various industries leads to the major causes of land and water pollution and additionally, the destruction of mainly water flora and fauna due to intense toxicity [4]. The heavy metals enter in to the food chain through bioaccumulation from contaminated water, soil and air and pose a serious threat due to its toxicity and non degradable properties [5]. Concentration of metal beyond the tolerance level may be regarded as toxic if it impairs the growth or metabolism of cells [6]. The lethal toxicity mechanism of a high concentration of heavy metal during a short term exposure disrupts the respiratory surface while during a long term exposure, the metal gets accumulated in the internal organs [7]. The various advancements in the industrial activities have further increased the levels of discharge of these heavy metals. Some of these toxic pollutants like Pb, Cr, Cd get processed into food through various ways [8]. Chromium with its increasing industrial uses in plating, metal ceramics and as alloys in stainless steel has great economic importance, but is nevertheless a major metal pollutant for environment [9, 10, 11].

Chromium is lustrous, brittle and hard metal which exist in mainly zero, trivalent and hexavalent oxidation states [12]. Hexavalent form is the most toxic form as compared to other forms of chromium [13, 14]. Chemical and refractory processing, ore refining, cement-producing plants, catalytic converters for automobiles, automobile brake lining, leather tanneries, and chrome pigments are the factors contributing to the atmospheric burden of chromium. The primary target for the chromium toxicity is the respiratory tract following acute exposure, cardiovascular, gastrointestinal, liver and kidney. Nasal septal ulceration and perforation, respiratory irritation and inflammation, dyspnoea, cyanosis and gastrointestinal, hepatic, renal, haematological effects and lung cancer can be caused by occupational exposure to chromium (VI) [15]. Evidences have shown that chromium has carcinogenicity when exposed to the experimental animals [2].

Hence it becomes an utmost importance to reduce the presence of these toxic metals in environment. Some of the methods which have been employed till date are electrolytic deposition, electro dialysis, electrochemical, evaporation, precipitation, ion exchange, reduction, reverse osmosis. [17]. But most of these methods suffer a serious drawback of capital investment due to high instrumental and operational costs [18]. Thus, employing remediation biologically can be very cost effective and highly efficient. For this purpose, plants, microbes or biodegradable waste (e.g. dead leaves, vegetable peels) can be used. Cow dung is known to have many important properties which have been in use since ages. It is combined with soil bedding and urine which is being used as manure for agricultural. It is used in the production of biogas which is further used to generate electricity and heat. It can also be used to repel mosquitoes and as cheap thermal insulator. Cow dung is also an optional ingredient in the manufacture of adobe mud brick housing [9]. In our studies we are using cow dung to remediate the chromium toxicity.

## EXPERIMENTAL SECTION

(i) Preparation of the adsorbent:
Cow dung was collected from the nearby places in Vellore and was sun dried to remove the entire moisture content. Then, the dried cow dung was converted into powder form with the help of a mixer grinder.

(ii) Batch adsorption studies:
The batch adsorption studies were performed on an orbiteck electrical shaker using 250 ml conical flask having 100 ml of the stock solution (0.05mg/L) with 1 gm of adsorbent at a shaking speed of 120 rpm at room temperature. Different parameters like effect of pH, temperature and initial concentration of Cr were taken into consideration. Detection was done by using AAS (Atomic Absorption Spectroscopy).

## RESULTS AND DISCUSSION

(i) Effect of pH on Cr (VI) adsorption
The pH of a solution plays a significant role in the adsorption capacity of the adsorbent. The pH of the solutions was set in the range of 1-11 using concentrated sulphuric acid and sodium hydroxide with continuous testing by pH meter. The readings were taken after specific timings and the % removal of Cr was measured with the help of AAS, keeping concentration of the adsorbent as constant. The effect of pH on the adsorption of Cr is shown in table 1 and fig 1. It was found that the maximum adsorption of Cr occurs at pH of 1 and as the pH increases, the adsorption capacity of the adsorbent decreases.

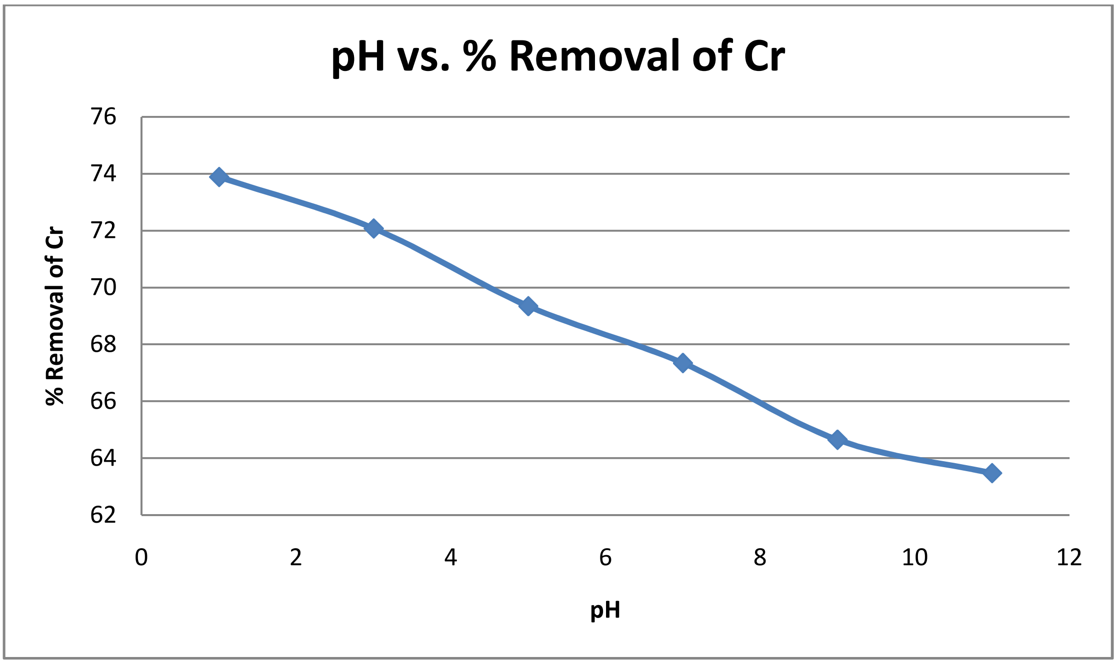


**Fig 1: pH vs. % Removal of Cr**

**Table 1: pH vs. % removal of Cr**

| pH | % Removal of Cr |
|---|---|
| 1 | 73.884 |
| 3 | 72.076 |
| 5 | 69.342 |
| 7 | 67.344 |
| 9 | 64.648 |
| 11 | 63.474 |

(ii) Effect of time on Cr (VI) adsorption

In order to understand the effect of time, pH and concentration were kept constant. The pH was kept constant at 1 since maximum adsorption was inferred at this pH. Thus the effect of time on the Cr adsorption is shown in table 2 and fig 2. It was observed that there was an increment in the adsorption from 52% to 74% as the time was increasing. Thus showing that time is directly proportional on the adsorption of Cr.

**Table 2: Time vs. % Removal of Cr**

| Time (in hrs) | % Removal of Cr |
|---|---|
| 0.5 | 51.698 |
| 1 | 64.10 |
| 2 | 69.282 |
| 3 | 71.108 |
| 4.5 | 72.73 |
| 6 | 73.884 |

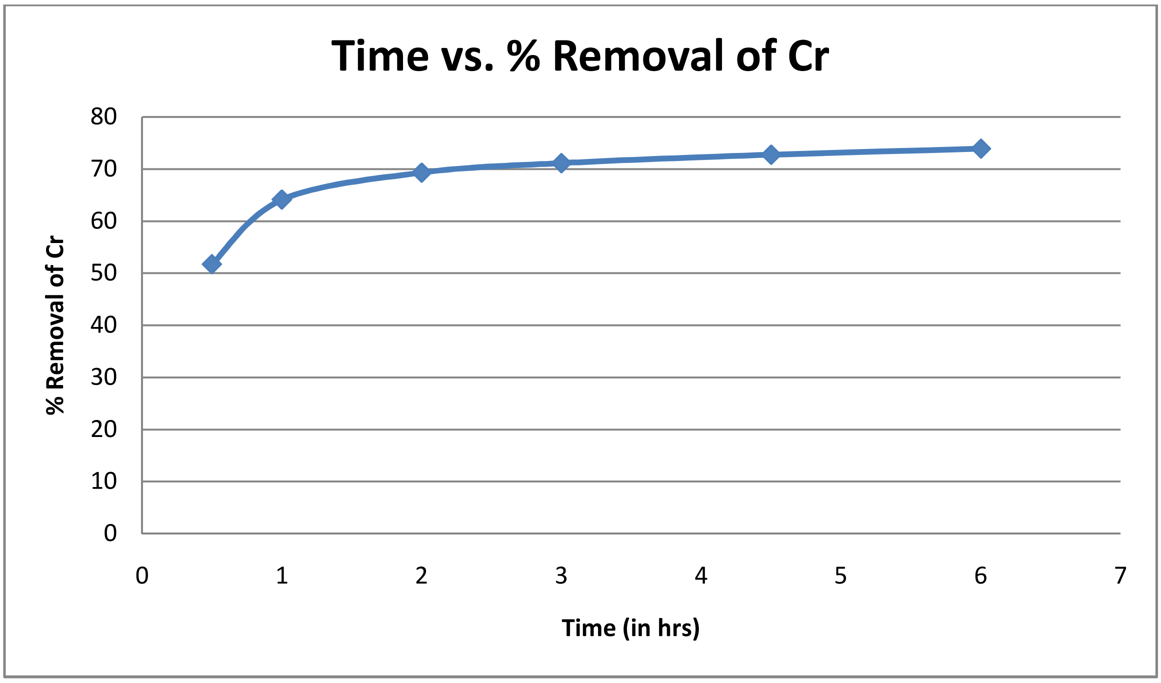


**Fig 2: Time vs. % Removal of Cr**

The effect of time vs. % removal of Cr follows the Langmuir adsorption isotherm process where adsorption and desorption are simultaneous processes occurring in the presence of each other.

$$\text{Adsorbate} + \text{Adsorbent} \underset{\text{desorption}}{\overset{\text{Adsorption}}{\rightleftharpoons}} \text{Adsorption}$$

$$A + B \rightleftharpoons AB$$

Langmuir model is followed among all 5 types of adsorption isotherm models. Fig 3 shows the Langmuir model.

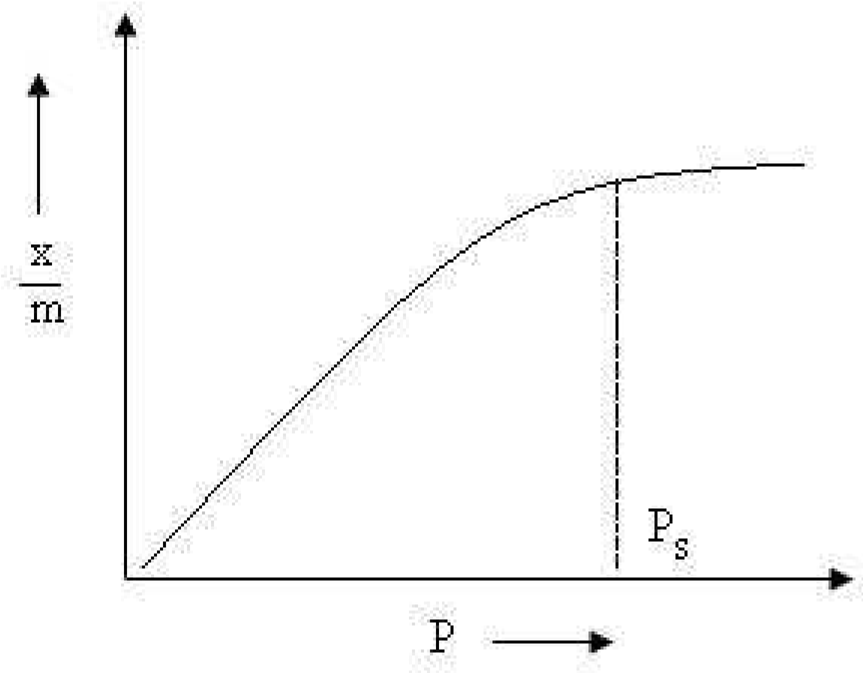


**Fig 3: % Removal of lead represented by the Langmuir model adsorption isotherm**

where $P_S$ is saturation pressure.

Thus giving us a mono layer adsorption graph [19].

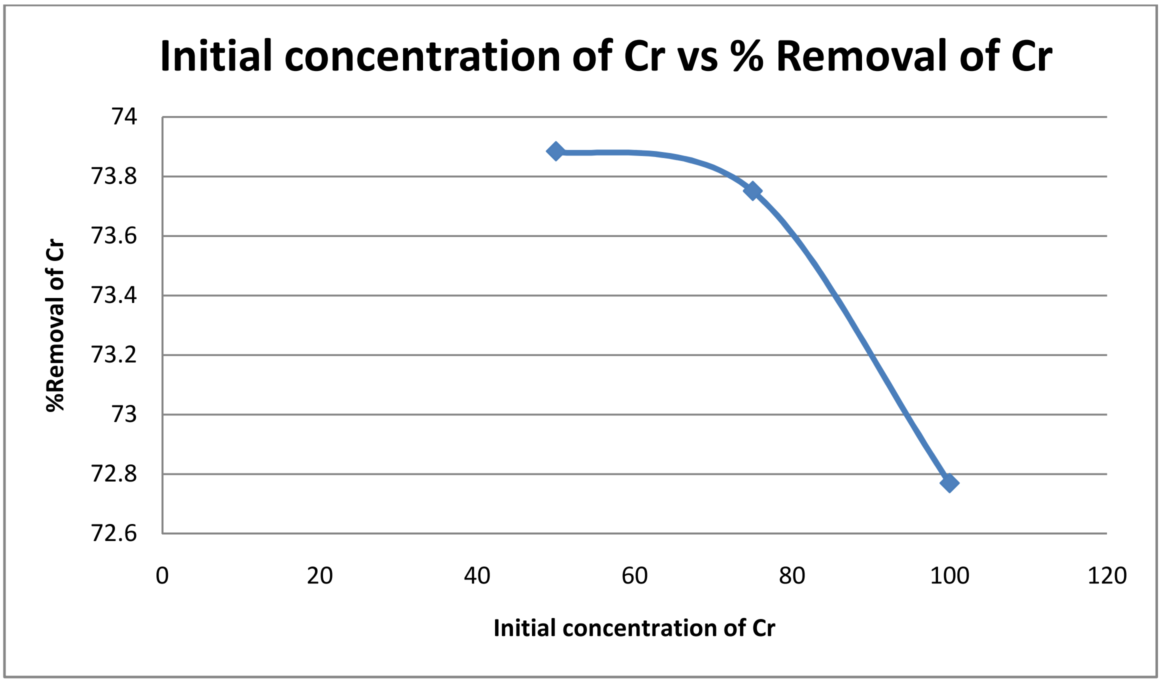


**Fig 4: Initial conc. of Cr vs. % Removal of Cr**

(iii) Effect of initial concentration of Cr on the Cr uptake
To know the effect of concentration of Cr, 3 test samples were taken in which the concentration of Cr were 50, 75 and 100 ppm respectively at a constant pH of 1 and temperature. Readings were taken after different intervals of time. The effect of initial concentration of Cr on its adsorption from the aqueous solution is given in table 3 and fig 4. On changing the initial concentration from 50 to 100 ppm, the amount increased from 36.942 to 72.770, thus

showing that with increase in the initial concentration of Cr, the amount of Cr removed increases while the % removal of Cr remains the same.

**Table 3: Initial conc. of Cr vs. % Removal of Cr**

| Initial conc. of Cr (ppm) | Removal of Cr | % removal of Cr |
|---|---|---|
| 50 | 36.942 | 73.884 |
| 75 | 55.313 | 73.751 |
| 100 | 72.770 | 72.770 |

## CONCLUSION

This study was conducted to investigate the adsorption capabilities of cow dung by using aqueous solution of chromium. The studies revealed that the adsorption highly depends on pH, time and initial concentration of Cr. It was found that the % adsorption or removal of Cr is maximum at pH 1. Thus concluding that cow dung shows maximum adsorption at an acidic pH.

Time has a significant role on the amount of Cr removed. It was observed that % removal of Cr is directly proportional to time. But the adsorption capacity seems to decrease after some time since the reaction tends to attain equilibrium after there is no much increase in the adsorption. It follows the basic adsorption isotherm process based on the Le-Chatelier principle and can be represented in the form of Type-1 adsorption isotherm graph out of all 5 types.

The initial concentration of Cr also plays an important role in the adsorption phenomena as it is having direct relation with amount removed, but the % removed is same in all the cases.

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