ISSN NO. 2320-5407

*Journal homepage: http://www.journalijar.com*

*INTERNATIONAL JOURNAL OF ADVANCED RESEARCH*

**RESEARCH ARTICLE**

# REMOVAL OF CHROMIUM (VI) USING ACTIVATED CARBON PREPARED FROM MARINE ALGAE ENTEROMORPHA SP.

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## *Manuscript Info*

***Manuscript History:***

Received: 15 August 2015
Final Accepted: 22 September 2015
Published Online: October 2015

***Key words:***

Adsorption, Chromium, *Enteromorpha sp* , Activated carbon.

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## *Abstract*

Heavy metal ions have become an ecotoxicological hazard of prime interest and increasing significance, because of their accumulation in living organisms. In this study, a series of batch laboratory experiments were conducted in order to investigate the feasibility of *Enteromorpha sp* activated carbon for the removal of chromium from aqueous solution by the adsorption process. Investigation was carried out by studying the influence of initial solution pH, adsorbent dosage, contact time and initial concentration of chromium. The activated carbon produced showed excellent efficiency in removing chromium with percentage removal up to 90 % at low adsorbent dosage of 400mg. The study also showed that the adsorption of chromium by the activated carbon is dependent on the contact time of the adsorbent and the initial metal concentration and pH. The use of *Enteromorpha sp* for activated carbon also helps in solving the problem of waste water treatment.



## INTRODUCTION

The awareness of increasing water pollution implies studies concerning water treatment. Removal of heavy metals from industrial wastewater is of primary importance. The presence of heavy metals in the environment is of major concern because of their toxicity to many life forms. Numerous industrial processes produce aqueous effluents that contain heavy metal contaminants. Since the majority of heavy metals do not degrade into harmless end products, their concentrations must be reduced to acceptable levels prior to discharge of industrial effluents. Otherwise, they could pose threats to public health and/or affect the aesthetic quality of potable water. According to the World Health Organization (WHO), the metals of most immediate concern are aluminum, chromium, manganese, iron, cobalt, nickel, copper, zinc, cadmium, mercury and lead. These toxic materials may be derived from mining operations, refining ores, sludge disposal, fly ash from incinerators, the processing of radioactive materials, metal plating, or the manufacture of electrical equipment, paints, alloys, batteries, pesticides or preservatives. The commonly used procedures for removing metal ions from effluents include chemical precipitation, lime coagulation, ion exchange, reverse osmosis and solvent extraction. These techniques apart from being economically expensive have disadvantages like incomplete metal removal, high reagent and energy requirements, and generation of toxic sludge or other waste products that require disposal. Efficient and environment friendly methods are thus required to be developed to reduce heavy metal content. Adsorption using activated carbon is an effective method for the treatment of industrial effluents contaminated with chromium (VI) and quite popular. Other commercial adsorbents are recently reported to have been used in industries, although their versatility and adsorption capacity are generally less than those of activated carbon. In the present study, adsorbent is prepared from *Enteromorpha sp* and studies are carried out for chromium (VI) removal. *Enteromorpha sp* were activated by giving heat treatment with the use of concentrated sulfuric acid. Batch experiments are carried out for the removal of chromium (VI) from aqueous solution using the activated *Enteromorpha sp* adsorbent. The effect of various parameters such as, initial chromium (VI) concentration, contact time, adsorbent dosage and pH has been studied.

## MATERIALS AND METHODS:

**Procedure for adsorbent preparation and activation**

*Enteromorpha sp* belonging to family Chlorophyceace, The algae was collected from kovalam beach at Chennai. Collected algae was washed with water to remove dust particles and dried in shade condition and further dried in a hot air oven at 50·C for 24 hours. The completely dried material was chipped, powdered well and stored in desiccators for further experiment.

Activated carbon of the material was prepared by treating with the concentrated Sulfuric acid in a weight ratio of 1:1 (material: acid). The resulting black product was kept in an air-free oven maintained at 160 ± 5·C for 24 hours followed by washing with distilled water until it becomes free of excess acid and dried at 90·C. The activated carbon obtained from biomaterial was ground and sieved with 80-mesh siever and was used for metal adsorption experiments.

**Experimental**

**Instrumentation**

UV- Double beam spectrophotometer was used for determining chromium concentrations. PH meter was used for pH measurements. Remi mechanical shaker was used for agitating the samples.

**Preparation of stock solution**

**(Synthetic wastewater)**

An aqueous stock solution (1000 mg/l) of Cr (VI) ions was prepared using K2Cr2O7 salt. pH of the solution was adjusted using 0.1 N HCl or NaOH. Fresh dilutions were used for each study.

**Adsorption dynamic experiments**

**Batch equilibration method**

The adsorption experiments were carried out in a batch process. The known weight of adsorbent material was added to 100 mL of the synthetic solutions of chromium with an initial concentration of 10 mg/L to 50 mg/L. The contents were shaken thoroughly using a mechanical shaker rotating with a speed of 120 rpm. The solution was then filtered at present time intervals and the residual Chromium concentration was measured. Cr was determined spectrophotometerically at 540 nm after complexation with 1, 5 diphenylcarbazide. Percentage removal of heavy metal from initial solution concentration calculated from the following equation. Percent removal were used to optimize the activation conditions:

$$\% \text{ Removal} = \frac{C_{\circ} - Ce}{C_{\circ}} \times 100$$

**Effect of variable parameters:**

**Initial concentration of chromium solutions:**

In order to determine the rate of adsorption, experiments were conducted with different initial concentrations of chromium solutions ranging from 10 to 50 mg/L. All other factors have kept constant.

**Dosage of adsorbents**

The various doses of the adsorbents are mixed with the chromium synthetic solutions and the mixture was agitated in a mechanical shaker. The adsorption capacities for different doses were determined at definite time intervals by keeping all other factors constant.

**Contact time**

The effect of period of contact on the removal of the chromium synthetic solution adsorbent in a single cycle was determined by keeping initial concentration, dosage, pH and concentration of other ions constant.

**pH**

Adsorption experiments were carried out at pH 1,2,3,4,5,6 and 7. The acidic and alkaline pH of the media was maintained by adding the required amounts of dilute hydrochloric acid and sodium hydroxide solutions. The parameters like particle size of the adsorbents, chromium concentration, dosage of the adsorbent and concentration of other ions have kept constant while carrying out the experiments. The pH of the samples was determined using pH meter.

## RESULTS AND DISCUSSION

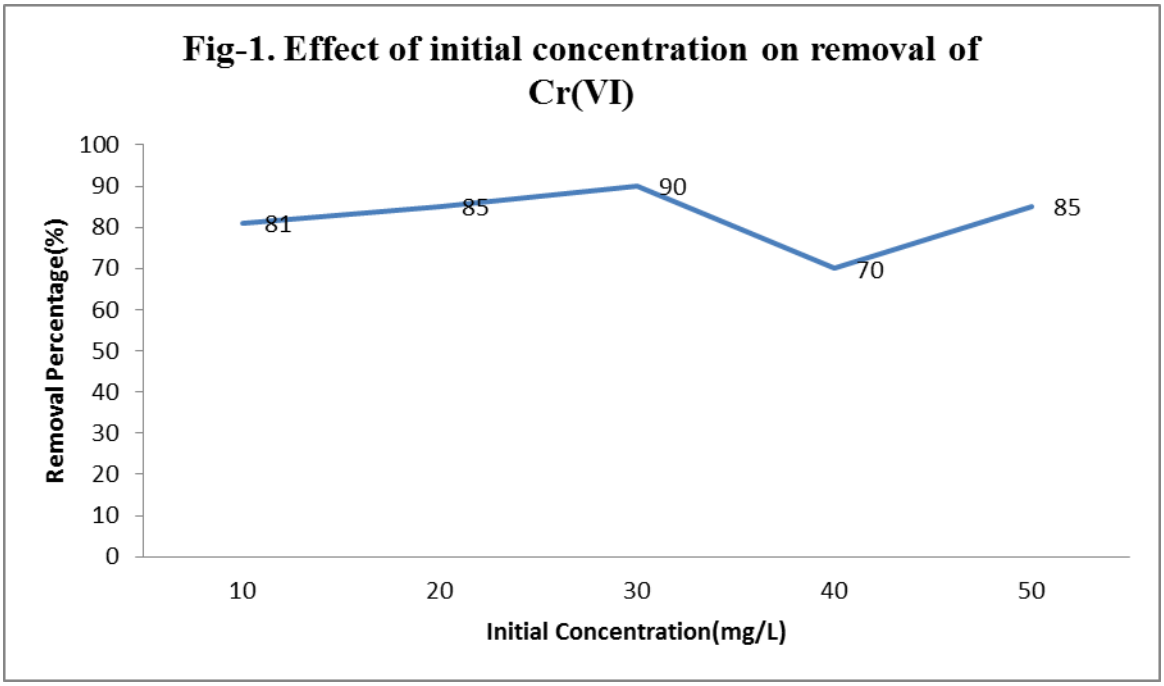
**Effect of initial chromium concentration**

The experimental results of adsorptions of at various concentrations (10,20,30,40 and 50 mg/L) percent adsorption decreased with increase in initial metal concentration, but the actual amount of chromium adsorbed per unit mass of carbon increased with increase in metal concentration. It means that the adsorption is highly dependent on initial concentration of metal. It is because of that at lower concentration, the ratio of the initial number of metals to the

available surface area is low subsequently the fractional adsorption becomes independent of initial concentration. However, at high concentration the available sites of adsorption becomes fewer and hence the percentage removal of metal is dependent upon initial concentrations.

**Table. 1. Effect of initial concentration on removal of Cr(VI)**

| S.No | Initial Concentration(mg/L) | Removal percentage(%) |
|---|---|---|
| 1 | 10 | 81 |
| 2 | 20 | 85 |
| 3 | 30 | 90 |
| 4 | 40 | 70 |
| 5 | 50 | 85 |



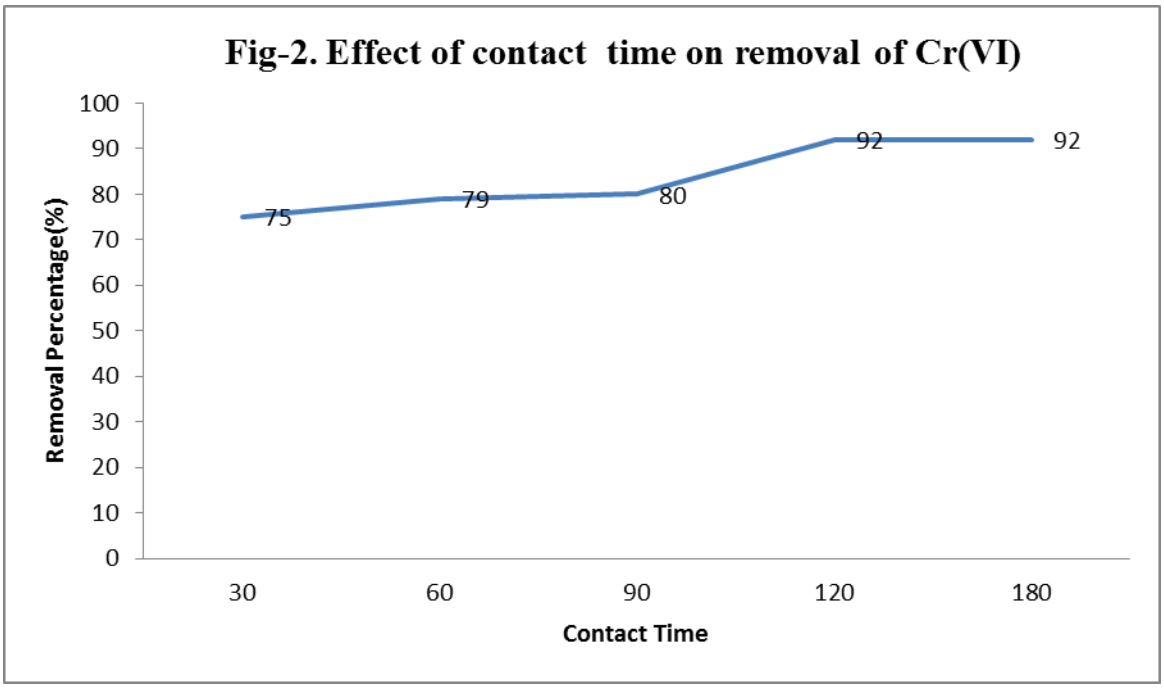

**Effect of contact time on Cr (Vl) removal**:

In adsorption system, the contact time play a vital role of the other experimental parameters. Table 2.depicts that there was an appreciable increase in percent removal of chromium up to 120 minutes and thereafter further increase in contact time the increase in removal was very small. Thus the effective contact time is taken as 120 minutes.

**Table. 2. Effect of contact time on removal of Cr(VI)**

| S.NO | Contact time | Removal percentage(%) |
|---|---|---|
| 1 | 30 | 75 |
| 2 | 60 | 79 |
| 3 | 90 | 80 |

| | | |
|---|---|---|
| 4 | 120 | 92 |
| 5 | 180 | 92 |

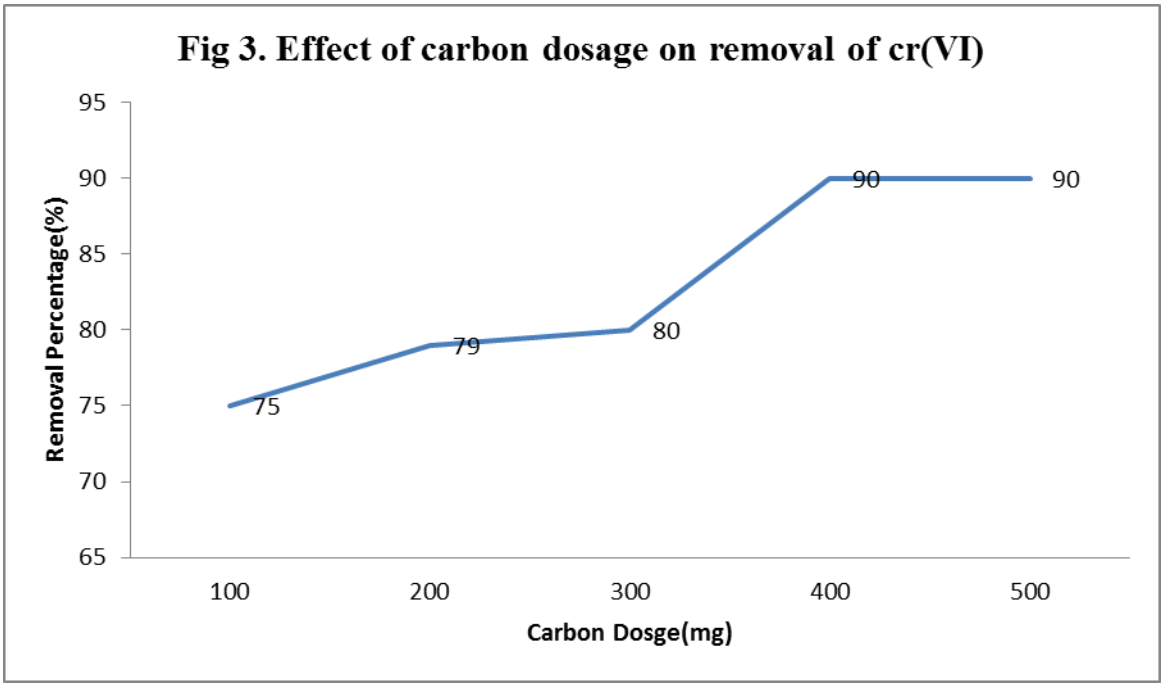



**Effect of adsorbent dose**

The results for adsorptive removal of Chromium (VI) with respect to adsorbent dose over the range of 100 – 500 mg. The percentage removal of metal is seen to increase with adsorbent dose from Table.3. It is observed that there is a sharp increase in percentage removal with adsorbent dose for *Enteromorpha sp.* It is apparent that the percentage removal of metal increases rapidly with increase in the dose of the adsorbents due to the greater availability of the exchangeable sites or surface area.

**Table. 3. Effect of carbon dosage on removal of Cr(VI)**

| S.NO | Carbon dosage (mg) | Removal percentage(%) |
|---|---|---|
| 1 | 100 | 75 |
| 2 | 200 | 79 |
| 3 | 300 | 80 |
| 4 | 400 | 90 |
| 5 | 500 | 90 |

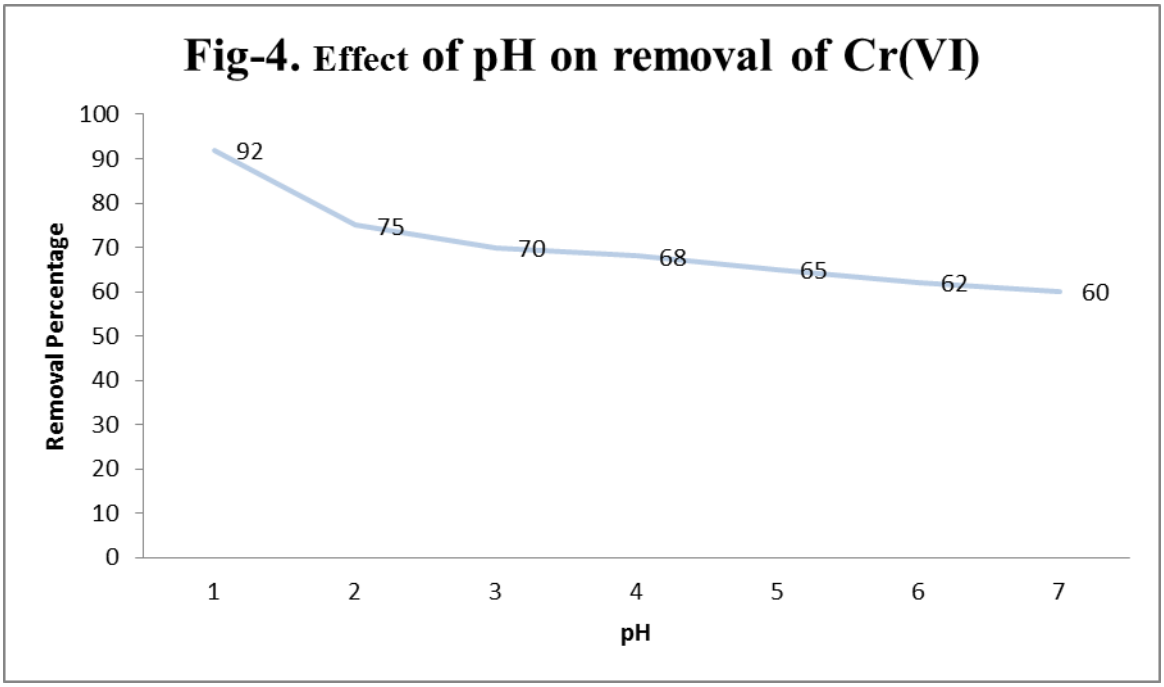



**Effect of pH**

The pH is one of the most important parameter controlling uptake of metal from waste water and aqueous solutions. Table.4 shows the effect of pH on metal removal efficiencies of Enteromorpha sp. The effect of pH on adsorption of metal on Enteromorpha sp. was studied at room temperature by varying the pH of solution from 1- 7. The results are shown in table 2. It can be observed that the removal of metal by Enteromorphasp was maximum at pH 1, other pH shows minimum adsorption.

**Table. 4. Effect of pH on removal of Cr(VI)**

| S.NO | pH | Removal percentage(%) |
|---|---|---|
| 1 | 1 | 92 |
| 2 | 2 | 75 |
| 3 | 3 | 70 |
| 4 | 4 | 68 |
| 5 | 5 | 65 |
| 6 | 6 | 62 |
| 7 | 7 | 60 |




## Conclusion:

Activated carbon prepared from *Enteromorpha sp* was studied to find out the adsorption efficiency of chromium. *Enteromorpha sp* powder used for adsorbent for the removal of chromium from waste water. In the batch mode studies, adsorption was dependent on initial concentration, contact time, carbon dosage and pH. The maximum level of adsorption of chromium (VI) was in the pH-1. The amount of metal ions adsorbed increased with increase in adsorbent dosage and contact time. Activated carbon from *Enteromorpha sp* used for waste water treatment to remove chromium and mainly pollution control in water. These methods are economical and eco-friendly because of its low cost and high capacity adsorption.

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