

# **Separation of Ni(II) and Hg(II) ions from synthetic waste water by adsorption on activated carbon derived from *Tridax procumbens***

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**ABSTRACT:** Adsorption of toxic heavy metals viz. Ni(II) and Hg(II) from synthetic waste water was studied on activated biocarbon derived from *Tridax procumbens*. Batch adsorption experiments were performed with activated biocarbon as a function of pH, contact time and amount of activated biocarbon. The most favourable pH required for maximum adsorption was found to be 2.1 and 5.0 for nickel and mercury respectively. The maximum contact time for the equilibrium condition was found to be 180 min. The maximum efficiencies of nickel and mercury removal by this biocarbon were 87.68% and 82.23% respectively.

**KEYWORDS:** Adsorption, biocarbon, *Tridax procumbens*.

## **I. INTRODUCTION**

The problems of the ecosystem are increasing with developing technology. The industrial revolution has resulted in an improving lifestyle, raising the standard of living of people, but it has also given rise to an indiscriminate exploitation of natural resources. Increased use of metals and chemicals in process industries has resulted in generation of large quantities of effluents that contain high level of toxic heavy metals and their presence poses environmental-disposal problems due to their non-degradable and persistence nature [1]. Heavy metal pollution is one of the main problems. Almost all the industrial and commercial activities generate effluents containing one or more heavy metals. The discharge of metallic ions in industrial effluents is of great concern because their presence and accumulation have a toxic effect on living species [2]. Until recent centuries, when the orientation towards industrialization and production brought about many technological advances, most of these pollutants were present in environment only in minute quantities. At present, these toxic metals have polluted our atmosphere, water, soil and have also entered into food chain. Therefore, the study of the existing effluent disposal methods, facilities and attitudes is essential in order to make a positive impact on the environmental hygiene [3].

Currently, water treatment technologies for the removal of heavy-metal ions include chemical precipitation, membrane filtration, ion exchange and electrochemical processes. However, these methods often incur high operational costs [4]. Most of the methods are not economically feasible for small-scale industries prevalent in developing economies due to huge capital investment [5].

Compared with other conventional techniques, adsorption appears to be an attractive process in view of its efficiency and simplicity of operation in the treatment of wastewaters containing heavy metals, as well as the availability of a wide range of adsorbents [6]. In developing countries like India, industries cannot afford to use conventional wastewater treatment chemicals like alum, ferric chloride, polymer flocculants and coal based activated carbon because they are not cost-effective. An inexpensive and more easily available adsorbent would make the removal of pollutants an economically viable alternative [7]. At present, adsorption is widely accepted in environmental treatment applications throughout the world. Adsorption on activated carbon is a very popular separation process for wastewater treatment as well as the purification of drinking water. Activated carbon is normally produced in the forms of granules, powder and fibers [8].

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Biosorption of heavy metals from aqueous solution is an efficient technology in industrial wastewater treatment. The major advantages of biosorption technology are (i) its effectiveness in reducing the concentration of heavy metal ions to very low levels and (ii) its usage of inexpensive biosorbent materials [9]. In the present communication, we report the studies on the removal of Ni(II) and Hg(II) from synthetic waste water using activated biocarbon derived from *Tridax procumbens*.

## II. RELATED WORK

*Tridax procumbens* has great percentage of carbon. Therefore it is responsible to form activated biocarbon used for adsorption. Activated biocarbon prepared from *Tridax procumbens* leaves are used to remove toxic heavy metals and dyes from industrial waste water [9]. Drinking water can contain natural fluoride or fluoride might be added as a protective agent for teeth by water companies. However, in some natural drinking water, fluoride levels may be above those considered safe by the World Health Organization. Singanan has suggested that this medicinal herb can be used as a biocarbon absorbent for fluoride [10]. The potential of *Tridax procumbens* for biosorbing copper metal ion in aqueous solutions has also been reported [11].

## III. EXPERIMENTAL

### 1. Preparation of activated carbon:

*Tridax procumbens* plant leaves were washed, dried, powdered and treated with concentrated sulphuric acid. The resulting carbon was kept in an air-free oven at temperature 150 °C for 5 hours followed by washing with distilled water until free of acid and then air dried.

### 2. Preparation of synthetic waste water:

A stock solution of nickel and mercury was prepared in distilled water with AR Grade (s. d. Fine Chem.) nickel(II) sulphate and mercury(II) chloride. For pH adjustment, throughout the experiment, hydrochloric acid and/ or sodium hydroxide solutions were used. All the pH measurements were done on Elico LI613 pH meter.

### 3. Adsorption experiment:

The experiments were carried out in batch mode for the measurement of adsorption capabilities. 20 ml synthetic waste water and 1.0 g of prepared activated carbon were taken in 100 ml beaker. The contents were stirred at 420 rpm for predetermined period at room temperature. The separation of the adsorbents and solutions was carried out by filtration and the filtrate was stored to carry out further analysis. Ni(II) and Hg(II) were estimated quantitatively by complexometric titrations.

## IV. RESULTS AND DISCUSSION

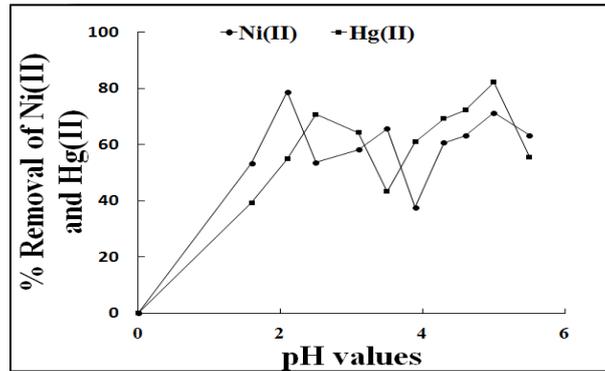
### Effect of pH:

The solution pH is one of the parameters with greatest influence on the adsorption of metal ions and organic compounds on activated carbon as the ionic activity plays the major role in metal uptake [12]. Maximum adsorption has been found to occur at a particular pH value. The most favourable pH values required for maximum adsorption of nickel and mercury were found to be 2.1 and 5.0 respectively as can be seen in Fig.1.

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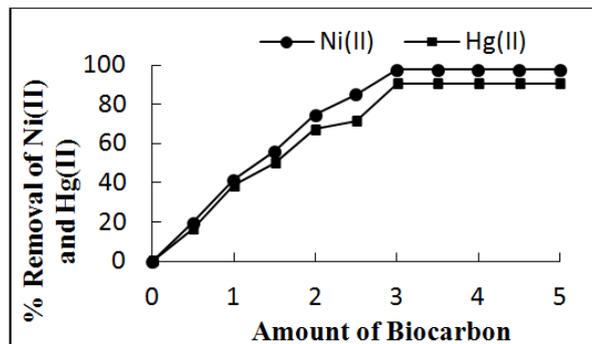
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**Fig1.** Effect of pH on the removal of Ni(II) and Hg(II) ions

Effect of amount of biocarbon:

It is important to fix the amount of the activated biocarbon to design the optimum treatment systems and for a quick response of the analysis [10]. When the amount of activated biocarbon increased, percentage removal of metal ion also increased upto 3.0g. Beyond this no appreciable change was observed in both the systems as can be seen in Fig.2.



**Fig2.** Effect of amount of biocarbon on the removal of Ni(II) and Hg(II) ions

Effect of contact time:

For the metal ions present in the synthetic wastewater, there was a progression in the percentage removal of metal ions present in the synthetic wastewater with time. From the result of adsorption experiment, it is found that Ni(II) and Hg(II) ions had the highest percent removal of 78.68% and 82.23% respectively at the end of 180 minutes.

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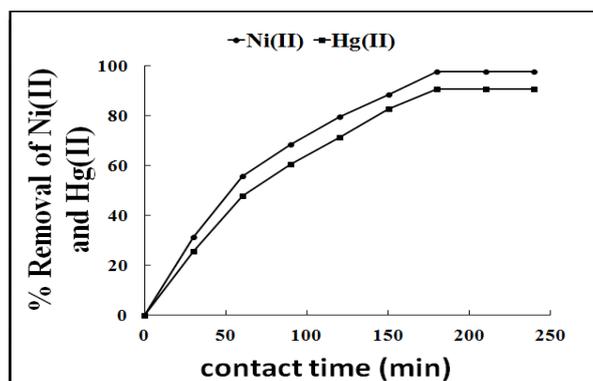


Fig.3. Effect of contact time on the removal of Ni(II) and Hg(II) ions

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