

Biosorption of Nickel from Battery Waste Water using *Bauhinia purpurea*

Bejawada Surendra¹, Dr.Meena Vangalapati²

Research Scholar, Dept. of Chemical Engg, AUCE (A), Andhra University, Visakhapatnam, AP, India¹

Professor, Dept. of Chemical Engg, AUCE (A), Andhra University, Visakhapatnam, AP, India²

ABSTRACT: In the present days the contamination of water sources with heavy metals from industries is a major pollution problem in the current scenario. Biosorption seems to be an effective method for the removal of nickel from the battery wastewater. In this study, the removal of Nickel(II) ions was done by biosorption method using *Bauhinia purpurea* as biosorbent from industrial wastewater. The Biosorption efficiency of nickel on *Bauhinia purpurea* was evaluated as a function of Contact time, pH, sorbent dosage, Initial metal ion concentration and temperature. The Nickel(II) uptake was dependent on initial pH with pH 4 being the optimum value. For 100 mg/L initial Nickel(II) concentration, sorption equilibrium was attained at a contact time of 120 min. The sorbent dosage affected the biosorption efficiency, maximum removal of 74 % was obtained at a dosage of 0.75g/100mL and at the temperature of 30°C, the maximum biosorption efficiency 78% was obtained. From the performance studies, the biosorbent *Bauhinia purpurea* is found to be a valuable material for the removal of Nickel from battery wastewater and a better substitute for the conventional adsorbents.

KEYWORDS: Nickel , Biosorption, *Bauhinia purpurea* , Optimization and AAS (Atomic Absorption Spectrophotometer) .

I. INTRODUCTION

Nickel pollution is one of the most critical issue in the present scenario which is usually caused by several battery processes such as tableware electroplating , connector , battery manufacturing, metal finishing , from the released fertilizers, pigments, mining and metallurgical, nickel-cadmium batteries[1].The concentration of Ni(II) in wastewater has been reported up to 130 mg L-1.And the major toxic pollutants can approach 2-900 mg L-1 in plating rinse[2]. The increased concentration of Ni(II) in absorbed water may lead to severe damage of lungs, kidneys, gas trointestinal distress. Examples include nausea, vomiting, diarrhea, pulmonary fibrosis, renal edema, and skin dermatitis. In some cases it can also lead to cancer and hence nickel is also a known carcinogen[3].Due to these health effects it is really necessary to remove or recover nickel by developing effective and inexpensive methods. There are many such conventional methods for the removal of nickel from waste waters, those include Chemical precipitation, electro-dialysis, activated carbon adsorption, biosorption, ion-exchange, flocculation, chemical reduction, filtration, evaporation, solvent extraction, reverse osmosis, membrane separation processes, etc. Among these the chemical precipitation is the most cost-effective treatment technology but it usually produces large quantities of chemical sludge which needs to be treated further in order to complete the process[4].

The Bio-sorbent *Bauhinia purpurea* used in the work is from the family Caesalpiniaceae. It is a Purple Orchid Tree and an exotic tropical tree that blooms over a long period of time. It is a native tree of India with the beautiful & fragrant, classic.The leaves are generally used as bio-sorbent in the present experiment where a maximum adsorption has taken place[5].

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II. MATERIALS AND METHODS

Chemicals and reagents:

Alkaline Potassium permanganate, Nickel chloride, Sulphuric acid, Sodium hydroxide

Equipments :

1. AAS : Atomic Absorption Spectrophotometer was used to analyze the initial and final nickel concentration after each experiment. Flame method was used for the analysis of nickel and the flame used was air-acetylene flame. The instrument was adjusted to appropriate wavelength for estimating the heavy metal concentration [6].
2. pH meter
3. Orbital Shaker



a) waste water containing Nickel



b) Orbital Shaker



c) AAS

Collection of the plant material:

The *Bauhinia purpurea* leaves are collected from local market at Visakhapatnam, Andhra Pradesh, India.

Processing of the plant material:

The leaves are cleaned, dried under shade for 1 week and powdered. The powder is then screened in 300 micron mesh size and the obtained fine powder is stored in an air-tight container.

Determination of Nickel : A stock solution of Ni(II) was prepared (1000 mg/L) by dissolving 1 g of nickel chloride in 1 L of de-ionized water. The stock solution was diluted with de ionized water to obtain the desired concentration range of Ni(II) solutions. The concentration in the test solution was determined using AAS at a wavelength corresponding to the maximum absorbance 393 nm for Ni(II). pH of the solutions was adjusted using 0.1 M HCl or NaOH using Orion 420A pH meter. All the used chemicals were of Analytical grade [7].

III. EXPERIMENTAL RESULTS AND DISCUSSIONS

Optimization for sorption studies of process parameters:

Parameters like Contact time, Biosorbent Dosage, pH, Initial metal ion concentration and temperature were studied here in order to study the optimized highest Removal percentage of Nickel by *Bauhinia purpurea*, from battery wastewater

A. EFFECT OF CONTACT TIME:

The effect of contact time was analyzed by treating 100 mL of battery waste water sample containing Nickel(II) metal ion with initial concentration of 100mg/L at native pH (5.05) with known dosage of biosorbent in Erlenmeyer flask of 250 mL capacity and agitated in an incubator shaker at 150 rpm for different contact times (30, 60, 90, 120 and 150 min). Figure 1 shows the effect of contact time on sorption of nickel. It was observed that, 120 min was the best contact time for the removal of nickel with 72%.

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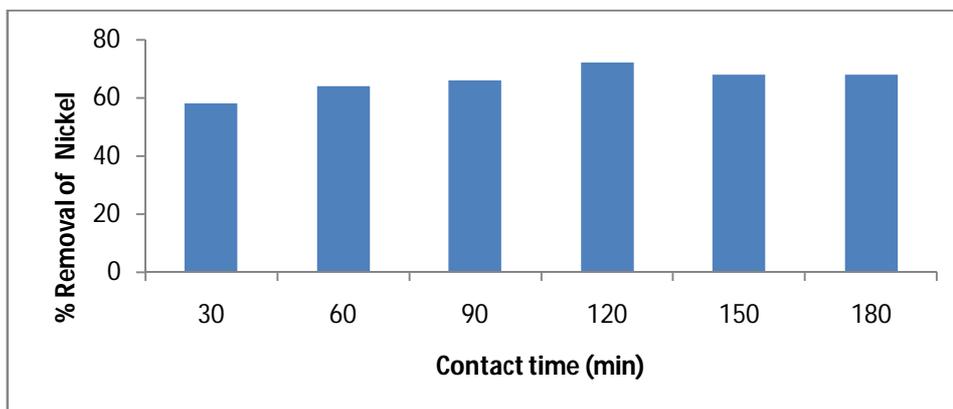


Fig 1: Effect of Contact time for the removal of Nickel(II) by *Bauhinia purpurea*

The biosorption has got slowed down in later stages, because the vacant sites may be decreased from the remaining time as they may be exhausted due to repulsive forces between the solute molecule of solid and bulk phase[8].

B. EFFECT OF BIOSORBENT DOSAGE:

100 mL of battery waste sample containing Nickel(II) metal ions at their native pH with initial concentration of 100 mg/L were treated with varying dosages (0.25, 0.50, 0.75, 1.0, 1.5 and 2 g/100 mL) of biosorbent. These samples were taken in Erlenmeyer flasks of 250 mL and agitated in incubator shaker and the samples were analyzed for Nickel(II) metal ion concentration by AAS. Figure 2 shows the effect of biosorbent dosage on metal removal[9].

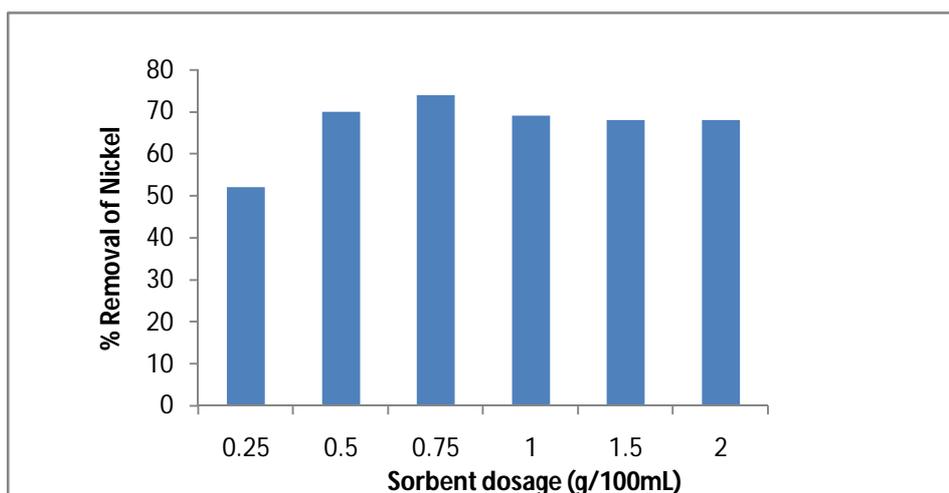


Fig 2: Effect of Sorbent dosage for the removal of Nickel(II) by *Bauhinia purpurea*

From the above graph, it was observed that the percentage of biosorption increased up to certain dosage and then decreased; the dosage at which equilibrium is attained is referred to as optimum biosorbent dosage. The optimum dosage was found to be 0.75 g/100mL with 74% removal of Nickel with *Bauhinia purpurea*[10].

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C. EFFECT OF pH :

Biosorption of Nickel depends on the pH of solution as it affects biosorbent surface charge, degree of ionization, and the species of biosorbent. The effect of pH on biosorption capacity was determined by adjusting the pH value of wastewater samples. The fixed volume of the solution (100 mL) with various pH values ranging from 3 to 7 was treated with constant dosage of biosorbent for optimum contact time and the residual Nickel(II) metal ion concentrations were measured[11]. The effect of pH on Nickel removal is shown below in Fig 3.

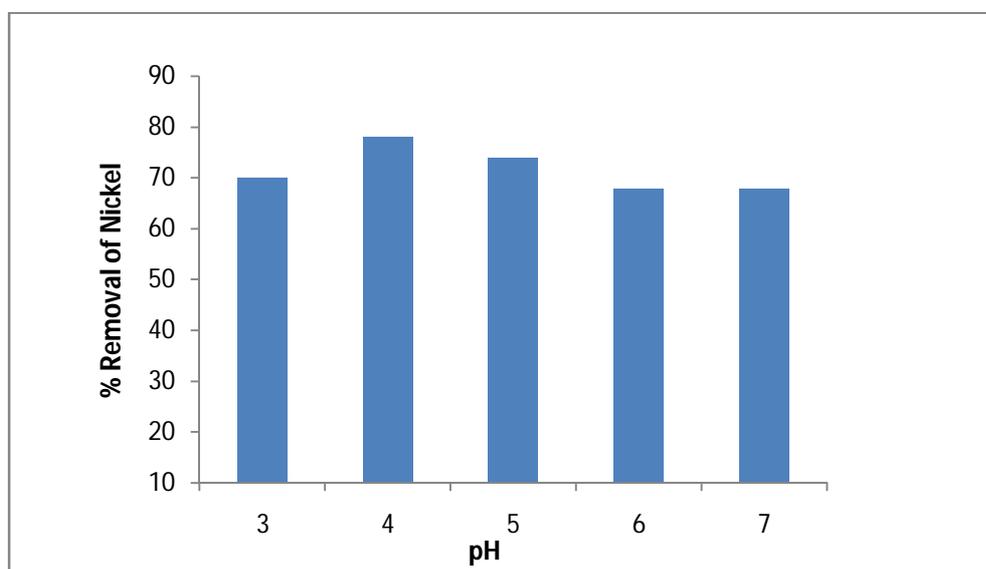


Fig 3: Effect of pH for the removal of Nickel(II) by *Bauhinia purpurea*

From the graph, it is inferred that at pH 4, 78 % of Nickel metal ion was removed from battery waste water containing 100 mg/L of Nickel. Since the waste sample is in acidic pH, optimization was carried out only for acidic range and pH 4 proved to be efficient. Due to increase in pH overall surface charge on the cell wall becomes negative and hence the biosorption decreases gradually thereafter[12].

D. EFFECT OF INITIAL NICKEL ION CONCENTRATION:

Initial metal ion concentration was varied by diluting wastewater of optimum pH with distilled water to different concentrations such as 50, 100, 150, 200, 250 and 300 mg/ L. Optimum dosage of the biosorbent was determined and agitated with Nickel(II) present wastewater for optimum contact time and the residual concentration in each sample were analyzed. It was observed that biosorption of Nickel has decreased with increase in metal ion concentration from 10 to 50 mg/L.

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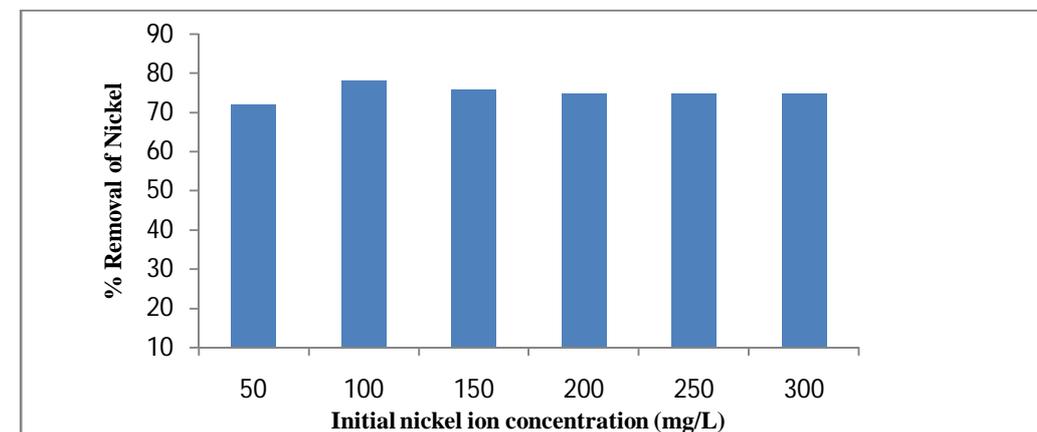


Fig 4: Effect of Initial nickel ion concentration for the removal of Nickel(II) by *Bauhinia purpurea*

From the above graph it was observed that initial metal ion concentration was maximum at 100mg/L. This was due to the increase in number of metal ions competing for available binding sites and also due to lack of binding sites for complexation of higher concentration levels.

E. EFFECT OF TEMPERATURE :

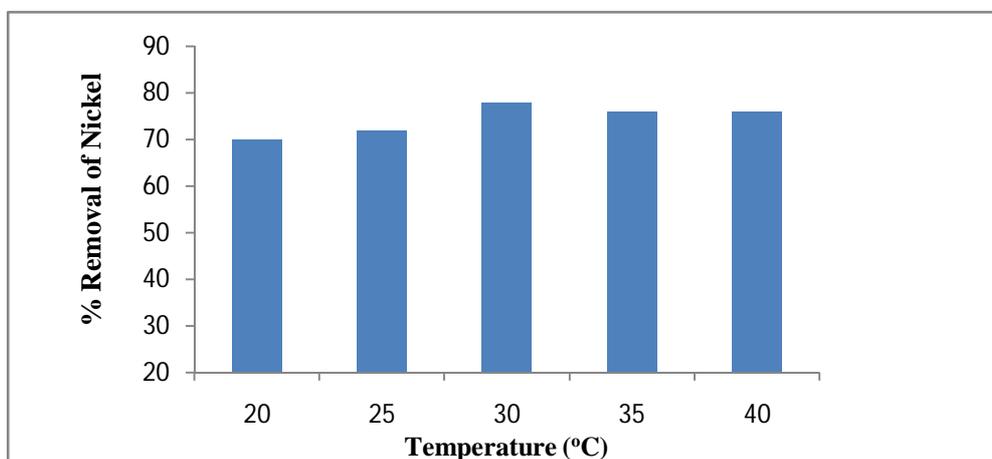


Fig 5: Effect of temperature for the removal of Nickel(II) by *Bauhinia purpurea*

The effect of temperature plays a key role in every process. 100 mL of battery waste water sample containing Nickel(II) metal ion with the initial concentration of 100mg/L with the optimized parameters ie. Contact time 120 min; pH 4; Biosorbent dosage 0.75g/100mL in Erlenmeyer flask of 250 mL capacity and agitated in an incubator shaker at 150 rpm. The below Figure shows the effect of temperature on biosorption of Nickel. It was observed that, 30°C was the best temperature for the removal of Nickel with 78%.

IV. CONCLUSION

In the present study, the biosorption of Nickel(II) on *Bauhinia purpurea* has been investigated. The data obtained through this work supports that the biosorbent is an effective plant material with low cost for the removal of nickel

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from wastewater. Based on the results, the following conclusions can be drawn. The Biosorbent *Bauhinia purpurea* was found to be an efficient biomaterial for removal of Nickel from battery wastewater. 78 % removal was observed at optimal conditions of pH 4 ;Initial metal ion concentration of 100mg/L ; contact time 120 min ; dosage of 0.75g/100mL and temperature of 30°C.Hence this biosorbent *Bauhinia purpurea* is considered to be one of the effective and promising adsorbent for the removal of nickel from battery waste water..

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