REMOVAL OF NICKEL (NI) AND COPPER (CU) FROM AQUEOUS SOLUTION USING PUNGAN LEAVES (PONGAMIA PINNATA) AS A LOW COST ADSORBENT

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Abstract: To removal of toxic metals from aqueous solution is the primary substantial issue for many industries. Adsorption of Ni and Cu ions onto a non-conventional plant biosorbents, Pungan Leaf Powder was investigated in batch adsorption experiments. Process parameters which include pH, adsorbent dosages and contact time were varied in order to evaluate their influence on the adsorption process. The results obtained indicate that the adsorption of Cu on Pungan Leaf Powder is better than Ni. Besides that, the adsorption of Cu(II) on Pungan Leaf Powder was found to fit the Freundlich isotherm The effective removal of nickel and copper from textile wastewater is studied using Pungan Leaf Powder.

Keywords: Pungan leaves, **Nickel, Copper**, adsorption, Langmuir and Freundlich Isotherms

1. Introduction

In recent decades, treatment of wastewater has become popular to removal of toxic metals as a result of technological developments and industrials activates, the amount of heavy metals discharged into streams and rivers by industrial and municipal wastewater have been increasing pollution such as Copper (Cu) and Nickel (Ni). However, heavy metals such as chromium, iron, mercury, lead, cadmium are toxic to organisms. Increased use of metals and chemicals in method has resulted in generation of huge quantities of effluent that contains high level of toxic heavy metal and their presence poses environmental disposal problems so adsorption processes are generally used. Hence used alternative source of pungan leaves powder are a low-cost agriculture waste which could be used for adsorption of heavy metals in wastewater. Industrial Wastewater and Heavy Metals are commonly released in the wastewater from various industries These heavy metal ions are toxic to both human beings and animals. The toxic metals cause physical discomfort and generally life threatening sickness and irreversible injury to vital body system. The metals get bio-accumulated in the aquatic environment and tend to biomagnified along the food chain. All these activities are also responsible for polluting the water. Generally billions of gallons of wastewater from all these sources are thrown to freshwater bodies every day. The requirement for water is increasing while slowly all the water resources are becoming unfit for use due to improper waste disposalThe results of their removal performance are compared to that of pungan leaves powder and are presented in this study. “Biosorption” is that the term given to the passive natural process and/or complexation of metal ions by biomass [1]. The increase of metal bearing effluents into the aquatic setting has caused progressive developments in waste treatment. A typical wastewater treatment plant is divided into several areas and the removal of metallic pollutants is performed mainly in the tertiary stage. Current developed methods in this stage include filtration, ion exchange, membrane separation, nutrient stripping and adsorption [2]. The biosorption process involves several mechanisms that differ qualitatively and quantitatively, depending on the origin of the biomass, the species used and its processing [3]. These mechanisms are generally based on Physico-chemical interactions between metal ions and functional groups present on the cell surface, which include ion exchange, complexation, electrostatic attraction and micro precipitation [4].

2. Materials and Methods

Preparation

Fresh Pungan leaves were collected from local trees and washed thoroughly by using distilled water to clean them from dirt and impurities. After that, the leaves were sun dried for a day on a perforated tray until the leaves turned brownish in colour. After drying, the leaves were ground by a mechanical grinder to constant size of 300μm and the resulting Pungan Leaf Powder was kept in a glass bottle ready for further experiments.

Experimental Adsorption Analysis

The initial pH of the dye solutions was prepared in the range of pH 1 to 11 by adding few drops of 0.1M NaOH aqueous solutions. The glass conical flask with 250ml capacity were filled with 50mk of the dye wastewater and added pungan leaves powder at various of adsorption dosage such as 0.5, 1.0, 1.5, 2.0 and 2.5g at different prepared glass conical flask. The standard glass flask was shaken for a predetermined period at room temperature in an orbital shaker for several time duration as 1.0, 1.5, 2.0, 2.5, and 3.0 hours at 300 rpm. The residual ions concentrations were determined by using a Multiparameter photometer. Metal analysis enabled the calculation of the total amount of Ni ion adsorbed is evaluated by using the equations,

Equilibrium Adsorption Capacity

$$(qv) = \frac{V(1-F)}{W}$$

where Ac (mg/L) is the initial dye concentration,
Bc is the concentration at equilibrium time (t),
V (L) s the volume of dye solutions and W (g) is the weight of the adsorbent.

3. Equilibrium Studies

Equilibrium information, unremarkably called as adsorption isotherms, are basic necessities for the planning of adsorption systems. Classical adsorption models, Langmuir [5] and Freundlich [6], were used to describe the equilibrium between Ni and Cu ions on the Pungan Leaf Powder at constant temperature. The Langmuir equation is valid for a monolayer sorption on a homogenous surface with a finite number of identical sites and when there are no interactions between the sorbed species. The linear form of Langmuir equation is given in equation;

$$\{\frac{Ce}{qe}] = \{\frac{Ce}{qmax}\}+\{\frac{1}{qmax\ K}\}$$

where Ce (mg/L) is the equilibrium concentration of adsorbate, qe (mg/g) is the quantity of adsorbed material (mg/g) at equilibrium, KL is the Langmuir equilibrium constant related to the energy of sorption (L mg-1) and qm is the maximum amount of metal ions per unit weight of Pungan Leaf Powder to form a complete monolayer on the surface bound at high Ce. The empirical Freundlich equation applies to multilayer sorption on a heterogeneous surface and can only be employed in the low intermediate concentration ranges. The Freundlich equation is given in equation;

$$\log qe = \log K + (\frac{1}{n}) \log ce$$

where the Kf (mg g-1) and n (value between 0 and 1) are the Freundlich constant characteristic on the system. Kf and n are indicators for adsorption capacity and adsorption intensity, respectively

4. Results and Discussion

Effect of pH

The pH of the adsorbate solution is considered one of the primary important component capacities that were achieved by the biosorption of Ni and Cu on Pungan leaf powder in this study. A variation in pH on adsorption was considered at acidity (< pH 6), neutral (pH 7) and alkalinity (> pH 8). By using of mango leaves, the percentage removal was found to increase from 42 to 85% along with pH 1 to 7 and gradually reduced after pH 8 to 11 due to alkalinity increased. The maximum efficiency of nickel (Ni) and Copper (Cu) removal was attained at pH 7 is 83.05% and 85.62% respectively as shown in Fig.1. It was sustained that adsorption increased with the reduced in acidity.

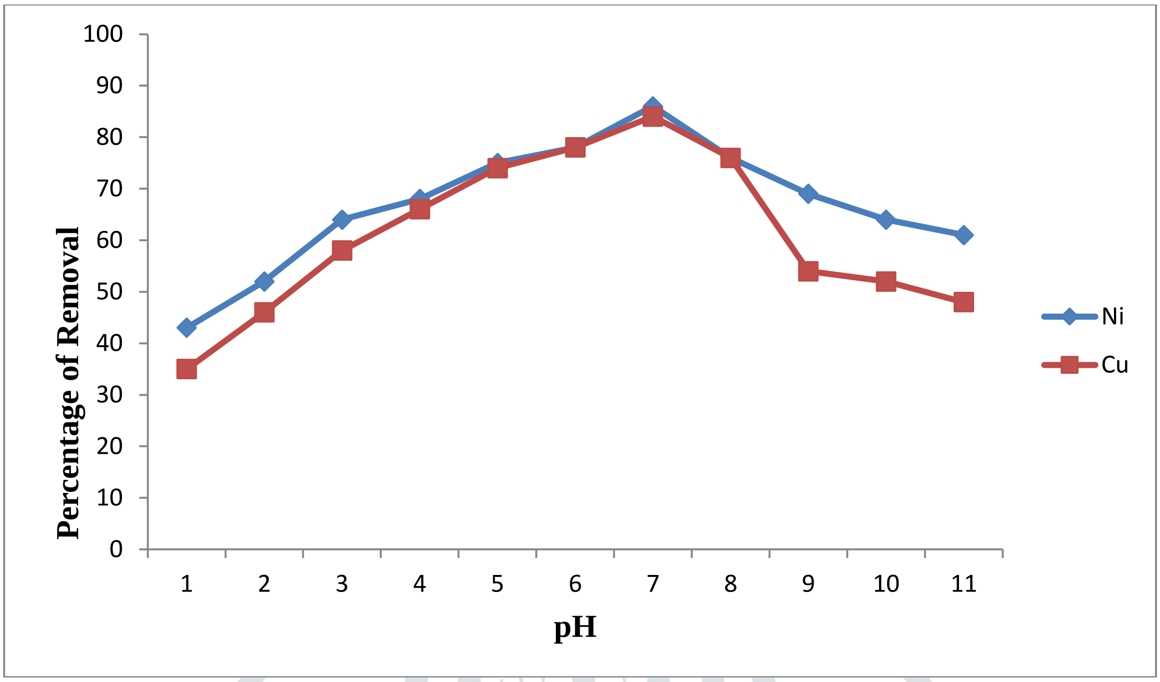

Fig 1 . Effect of pH

Effect of Adsorbent Dosage

The effect of adsorbent dosage on the removal of Ni and Cu was shown in Fig.2. The influence of the biosorbent dosage on the process was examined by using five different dosages at 0.5, 1.0, 1.5, 2.0 and 2.5 g/L. Fig. 2 shows the relationship of metal uptake with the biosorbent dosage at Ni and Cu concentration of 100 mg/L and time of 120 minutes. It can be observed that the increase in the biosorbent dosage causes increase in the percentage of metal removal. For the purpose of analyses the adsorbent mass that will bring about a better removal of nickel and copper polluted wastewater. The consequence proposes that after a certain dosage of adsorbent the attained optimal adsorption sets in and hence the amount of nickel ions remain constant even with further increase of the dosage of adsorbent. About **81.92%** and **84.19%** on 2gm of Ni and Cu respectively can be removed with Pungan leaves.

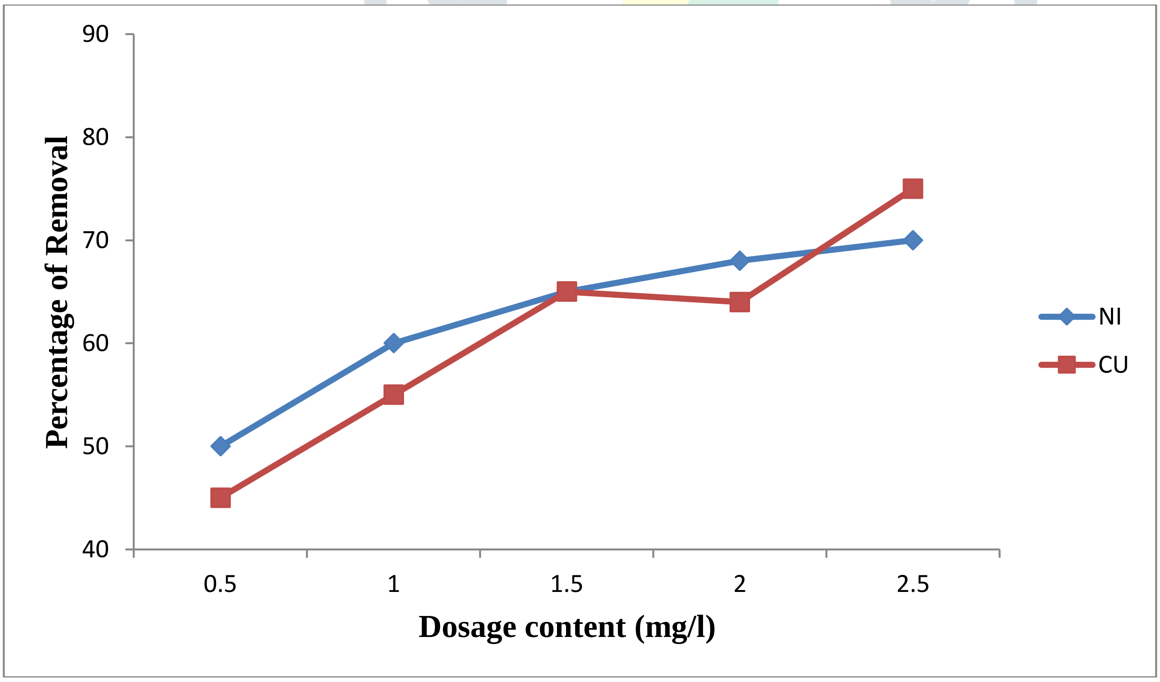

Fig 2. Effect of Dosage Content

Effect of Contact Time

The effect of contact time was studied at initial metal ion concentrations and Pungan Leaf Powder dosages. An increased of removal efficiency with an increase in contact time and this could be detailed discussed by chemical attraction of the adsorbents for Ni and Cu ions. It can be clearly observed that the percentage of adsorption generally increased until time reached 120 minutes. After this time, there was a drop in the adsorption percentage. This experimental method was carried out to evaluate the potential of the adsorbents for the commercial applications. The result was obtained an efficiency of nickel and copper removal is **85.88%** and **86.70%** respectively at 120 minutes.

Percentage Of Adsorption Removal

Percentage of removal from effect of dosage content on the adsorption result was obtained an efficiency of nickel and copper removal is 81.92% and 84.19% respectively on 280 minutes.

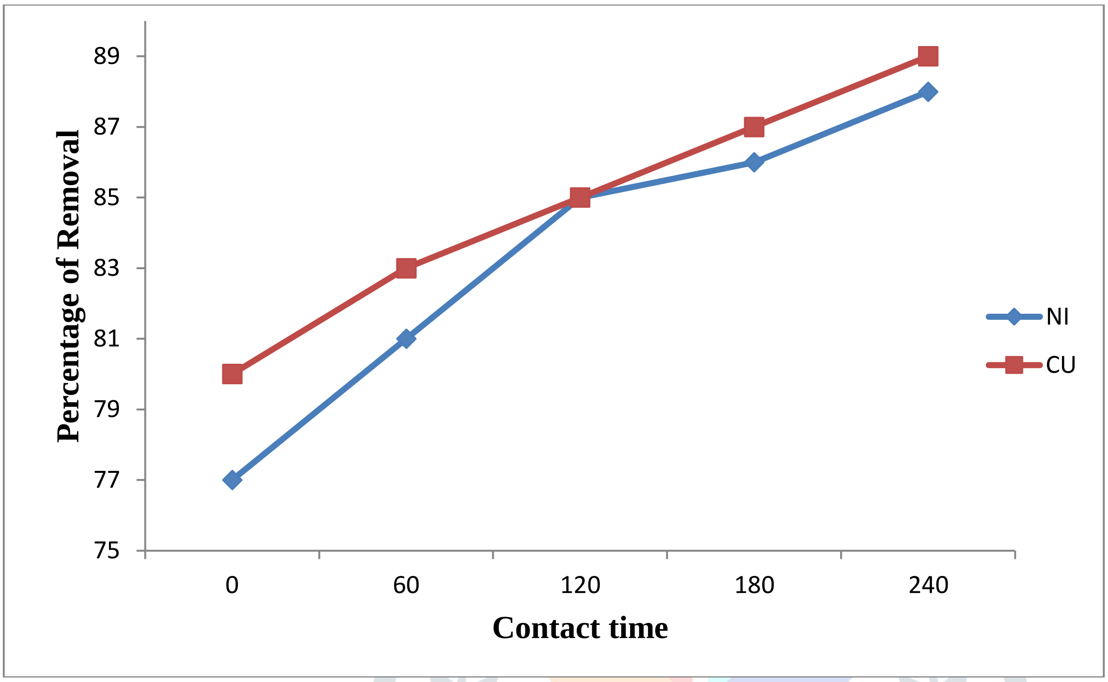

Fig.3. Effect of Contact Time

5. Adsorption Isotherms

Adsorption isotherms models have been proposed to explain adsorption equilibrium, but the most important factor is to have applicability over the entire range of process conditions. The most widely used isotherms for solid-liquid adsorption are the Langmuir and Freundlich isotherms (Bulut and Tez, 2007). Both of these isotherms relate the adsorption density, qe (metal uptake per unit weight of adsorbent) to equilibrium adsorbate concentration in the bulk fluid phase.

Langmuir isotherm model is valid for monolayer adsorption onto a surface containing a finite variety of identical sites. This isotherm is derived from the assumption that a maximum adsorption corresponds to a saturated monolayer of solute molecules on the adsorbent surface, with constant energy of adsorption, and no reincarnation of adsorbate within the plane of the surface . The correlation coefficient that was obtained from the Langmuir plot as shown in Fig. 4 is 0.884 and 0.910.

Percentage Of Adsorption Removal

Percentage of removal from effect of contact time on the result was obtained an efficiency of nickel and copper removal is 85.88% and 86.70% respectively at 120 minutes.

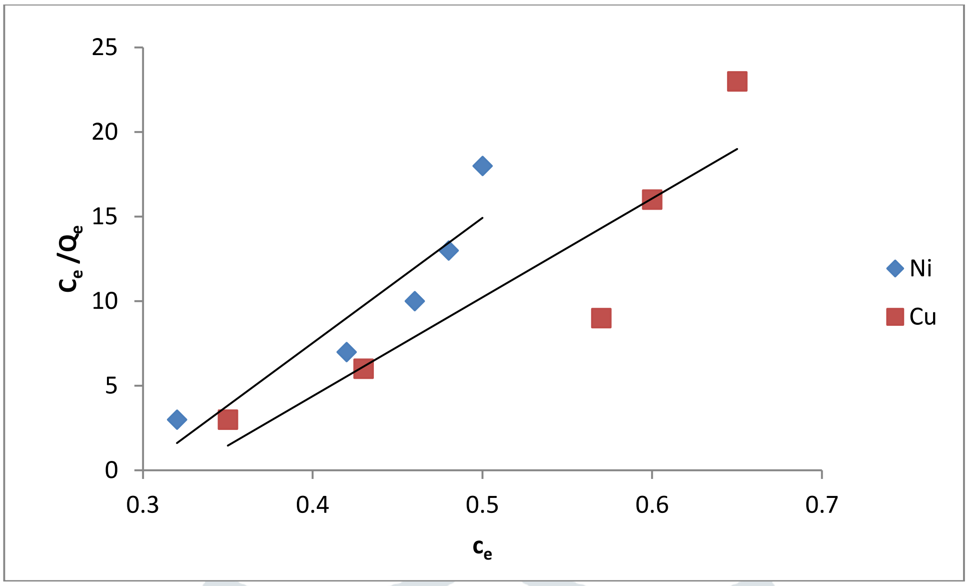

Fig.4. Langmuir Isotherm on the adsorption of Ni

Freundlich isotherm gives the relationship between the equilibrium liquid and solid phase capacity based on multilayer adsorption (heterogeneous surface). The Freundlich isotherm is based on the assumption that the adsorption sites are distributed exponentially with respect to the heat. Based on Fig. 5, the correlation coefficient that was found from the **Freundlich** plot is 0.907 and 0.812. In addition, the adsorption intensity, n, this was found to be 0.396 and 0.91 for Ni and Cu respectively. This is smaller than 1. Meanwhile, the Freundlich constant, KF was found to be 0.873 and 0.138.

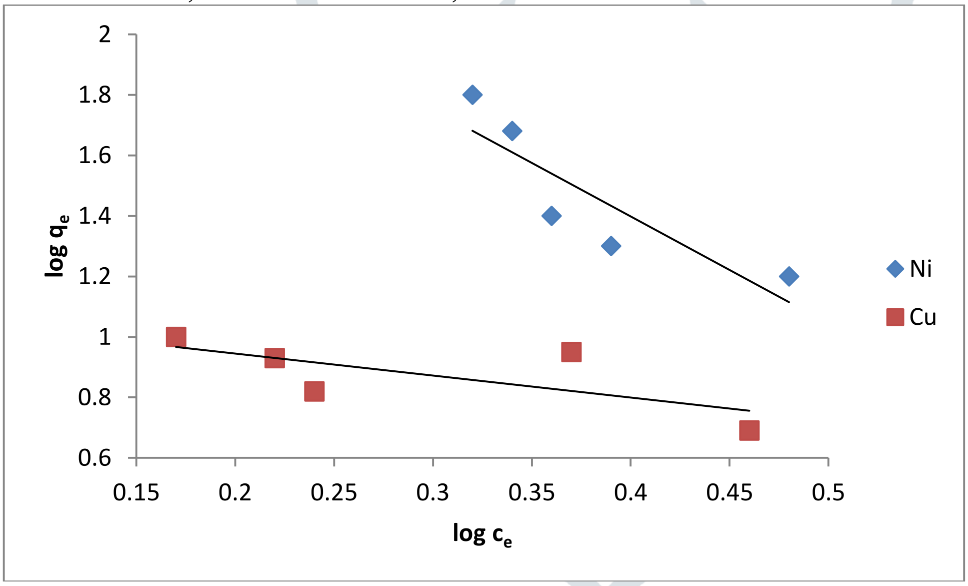

Fig.5. Freundlich Isotherm on the adsorption of Ni

6. Conclusion

The results of the study indicated that with increase in the contact time percent removal of nickel and copper increases. The adsorption was rapid during initial period of time & equilibrium was reached in 120 minutes. The results also showed that with increase in the adsorbent doses percent removal of copper increases than nickel. Thus it can be concluded that Pungan leaves can be considered as an alternative biomass for the removal of Cu ions since it is effective, low cost and abundant, it can be obtained locally. Thus reducing heavy metals from waste water environmental pollution can be lowered.

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