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Adsorption of Copper (II) ions from SyntheticWaste Water By Teak Leaves

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Abstract— **Studies on a batch adsorption system using Teak Leaves Powder as adsorbent were carried out to remove copper from waste water. The aim of the present investigation is to study the potential of teak leaves for copper removal and optimize the parameters like contact time, pH and the temperature. Optimum contact time found to be 60 minute as after that desorption also become dominant. As adsorbent dose increases, % removal increases as surface area increases for adsorption.The optimum dose was 2 g/l. Maximum % removal was at 55 ^{0}C. The equilibrium adsorption data were fitted to Langmuir and Freundlich adsorption isotherm models and model parameters were evaluated. We can say both models were suited to the experimental equilibrium data for teak leaves because value of R^2 was found to be 0.993 and 0.995 respectively. The results show that Teak Leaves Powder has scope for modification, to use it as low cost adsorbent for adsorption of Cu (II) from aqueous solution.**

Index Terms— **Adsorption, Cu (II), Teak Leaves, Adsorption Isotherm**

I. Introduction

The presence of heavy metals in the environment is of great concern because of their increased discharge, toxic nature and other adverse effects on receiving waters. Unlike organic pollutants, heavy metals are essentially non-biodegradable and hence are accumulated in living organisms. Some metals such as Cd, Hg, Ag and Pb can become extremely toxic to living beings, others such as Cu, Zn, Mn, Fe, Ni and Co though essential for plant and animals, when present in excess concentrations and above certain limits, can be very harmful to living organisms. Their concentrations have to be reduced before discharging them into the environment to meet ever increasing legislative standards. Copper is considered as micronutrient but is extremely toxic to living organisms at higher concentrations. The main sources of copper pollution are metal cleaning and plating baths, paints and pigments, a pulp, paper board mills, wood pulp production, and the fertilizer industry [1, 2]. Copper may also be found as a contaminant in food, especially shellfish, liver, mushrooms, nuts, and chocolate [3]. In advanced countries, removal of heavy metal ion in waste water is normally achieved by conventional methods include chemical precipitation, adsorption, oxidation or reduction, coagulation, filtration, ion exchange, application of membrane technology, solvent extraction and evaporation[4]. However, these processes have considerable disadvantages including incomplete metal removal, requirement of expensive equipment and monitoring systems, large reagent or energy requirements or generation of toxic sludge or other waste products that require disposal [4]. Among these adsorption, an alternative technology for conventional wastewater treatment, has received considerable attention for the development of an efficient, clean and cheap technology [5-8]. The World Health Organization (WHO) recommends a maximum acceptable concentration of Cu (II) as 1.5 mg.L−1 in drinking water. It has been reported that excessive intake of copper by humans leads to hepatic and renal damage, capillary damage, gastrointestinal irritation and central nervous system irritation. In recent years, attention has been focused on the removal of copper from aqueous solution using adsorbents derived from low-cost materials. Many researchers have investigated low-cost materials as a viable adsorbent for heavy metal removal, namely, rice husk [8], Sugarcane Bagasse [9], peanut shells [10], cashew nut shell [5], activated sludge [11], brewery biomass [12], ipomoea carnea [13], cassava [14], teak leaves [4,15], fly ash [16]. The need for a cost-effective process and a safe method for removing heavy metals from discharging effluents have resulted in the search for other unconventional materials such as organic or inorganic sorbents. Tumin et.al have carried studies on Adsorption Of Copper From Aqueous Solution By Elais Guineensis Kernel Activated Carbon with resonable succes.[17]. The adsorption of copper(II) ions on to dehydrated wheat bran (DWB):determination of the equilibrium and thermodynamic parameters was tried by Ozera et.al.[18]. The investigation on Adsorption of Copper and Cadmium lons by Activated Carbon From Rice Hulls was carried out by Teker et.al.[19]. Alyuz et. al have studied the Adsorption of copper and zinc from aqueous solutions by using natural clay[20].

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II. MATERIALS

A. *Adsorbents*

Mature teak leaves were collected from trees in University campus of North Maharashtra University, Jalgaon, west part of India and were washed repeatedly with water to remove dust and other soluble impurities and dried at room temperature in shade. These were crushed into fine powder in a mechanical grinder and sieved to a particle size of approximately 32 mesh.

B. Synthetic Wastewater

Analytical grades of CuSO4.5H2O were purchased from Merck, India. Stock solution of copper concentration 1000 mg/L was prepared by dissolving 3.93 g of 100% CuSO4·5H2Oin 1000mL of distilled water. The solution was prepared using standard flasks. The concentration of the metal solution of 20 mg/L prepared by diluting stock solution.

III. METHOD

For Adsorption studies, desired quantities of the chosen adsorbents Teak Leaves powder were mixed with 100 ml of Cu (II) solution in 250 ml conical flasks. The flasks were placed on a magnetic stirrer at 120 rpm and the samples were taken at regular time intervals. The experiments were carried out at different adsorbent dosage (5-25g/l), temperature (30-75°C). The samples were then filter. The Cu (II) content in the supernatant was determined according to the standard methods of analysis using Atomic Absorption Spectrometer at λ = 324.8 nm.

The amount of the metal adsorbed (mg) per unit mass of adsorbent was obtained by using the equation:

$$q = (Co - Ce) * \frac{V}{W}$$

Where,

q is amount of metal ion adsorbed per gram of biomass in $mg.g^{-1}$,

Co is the initial metal ion concentration in $mg.L^{-1}$,

Ce is the final metal ion concentration in $mg.L^{-1}$,

V is the volume of the reaction mixture in liter, and

W is the weight of biomass in the reaction mixture in mg.

The percentage adsorption of metal ion was calculated as follows:

$$\% \ Removal = \frac{(Co - Ce)}{Co} * 100$$

IV. RESULT AND DISCUSSION

The adsorption of copper (II) ions on the Teak Leaves was investigated as a function of the contact time, adsorbent dosage and temperature. The performance of Teak Leaves for the copper (II) removal using the experimental equilibrium data for Langmuir and Freundlich adsorption isotherms was tested.

C. Effect of Contact Time

Contact time is an important factor affecting removal; most of adsorption occurs in initial half an hour and increases very slowly later. Further increase in contact time tends to decrease adsorption due to desorption. Maximum adsorption occurs at 60 minutes. After that % removal decreases. This is due to, after equilibrium achieved, desorption becomes dominant over adsorption. So, we can optimise contact time as 60 minutes.

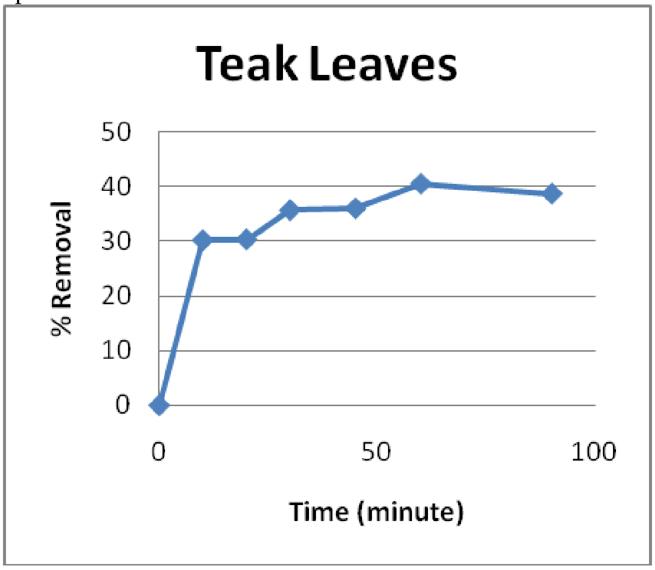

Figure 1: % Removal V/s Time at 20 $mg.l^{-1}$ (ppm) concentration for Teak Leaves Powder (Adsorbent dose: 1g/l, Temperature: Room Temp.)

B. Effect of Adsorbent Dosage

The sorption efficiency increased with an increase in adsorbent dosage. This is due to an increase in the surface area of the adsorbent which in turn increases the number of binding sites. But as we increase dose of teak leaves to system, another problems are arises like system becomes bulky, separation of adsorbent from solution becomes tedious. Teak leaves in larger quantity gives colour to aqueous solution with some odour. Taking into consideration all this fact, we optimise adsorbent dose as 2 g/l

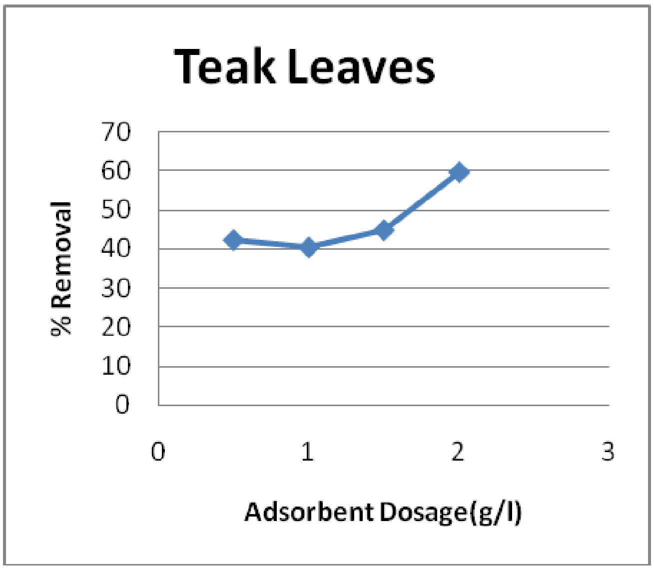

Figure 2: % Removal Vs Adsorbent Dosage for 20 mg/L (ppm) solution of copper for Teak Leaves powder (Contact time: 60 min, Temperature: Room Temp)

C. Effect of Temperature

In the case of adsorption by Teak Leaves Powder, it was found to be first increase upto 55°C and then decrease with increase in temperature.

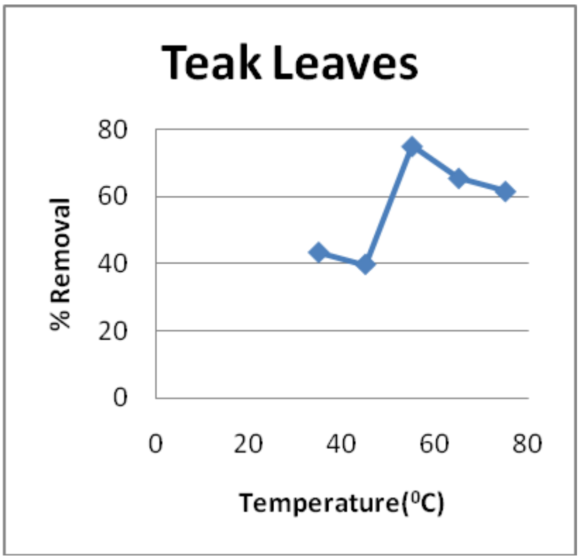

Figure 3: % Removal Vs Temperature for 20 mg/L (ppm) solution of copper for Teak Leaves powder & Fly Ash, respectively.(Contact time:60 min, Adsorbent Dose:2.5 g/l)

D. Adsorption Isotherm

The linearized Langmuir and Freundlich adsorption isotherms obtained at room temperature are shown in figure 4 and 5 and adsorption coefficients computed from these are given in table 1. All the curves had good linearity (correlation coefficient) indicating strong binding of copper (II) ions to the surface of particles.For Teak Leaves Powder from Langmuir isotherm, the adsorption affinity constant (*b*) and maximum capacity (q_{max}) of the ion copper(II) to form a complete monolayer on to the surface of the biomass was estimated as -0.195 and 0.023 g/g, respectively.

For Freundlich isotherm the constants related to the adsorption coefficients (K_f) and intensity (*m*) were 7.98 g/g and -1.85, respectively. The correlation coefficients obtained from the Langmuir model and Freundlich model were 0.993 and 0.995, respectively.

Table 1: Langmuir and Freundlich model parameters estimated from the fitting of experimental points of copper (II) adsorption

	Langmuir Isotherm			Freundlich Isotherm		
Adsorbent	q_{max}	R^2	B	K_f	R^2	M
Teak Leaves	0.023 g/g	0.993	-0.195	7.98	0.995	-1.85

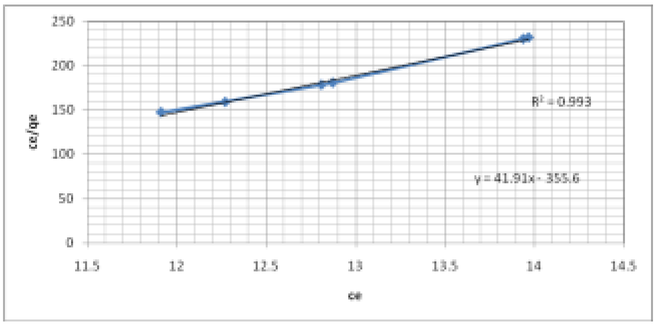

Figure 4: Langmuir adsorption isotherm for copper at 1g/100mLof biomass concentration of Teak Leaves Powder

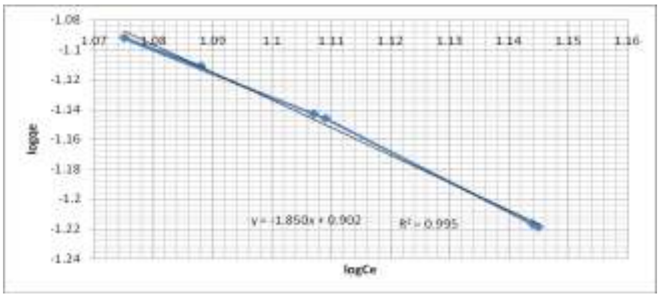

Figure 5: Freundlich adsorption isotherm for copper at 1g/100mL of biomass concentration of Teak Leaves Powder

V. CONCLUSION

In this study, the adsorption of copper by Teak Leaves powder was investigated and the following conclusions can be drawn.

The adsorption performance is strongly affected by parameters such as contact time, adsorbent dosage and temperature. As contact time increases % removal also increases but after some time desorption also become dominant and % removal decreases. From the results, we can optimise contact time to 60 minutes. Then, % adsorption of copper (II) increases with increasing adsorbent dosage. As adsorbent dose increases, copper get more surface area available to adsorb on adsorbent. The Langmuir and Fruendlich model were proved to be the best adjustment of the experimental data for teak leaves .The present work helped in identifying a new source of adsorbent for removal of metals from effluent wastes containing low concentrations of metals.

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