International Journal of
Advances in Scientific Research and Engineering (ijasre)

E-ISSN : 2454-8006

DOI: http://dx.doi.org/10.7324/IJASRE.2017.32545

Vol.3 (11) December-2017

Diminution of Toxic Ions by using Mangifera Indica Foliages as Adsorption from Textile Effluent

Karthikeyan M[1], Asha B[2] and Selva Kumar D[3]

Research Scholar[1], Assistant Professor[2]

Department of Civil Engineering,

Annamalai University, Annamalai Nagar – 608 002.

Professor[3], Department of Civil Engineering,

Shanmuganathan Engineering College, Arasampatti, Pudukottai .

ABSTRACT

Mangifera indica leaf powder (MIFP) was used as a non-conventional plant biosorbent developed from mature leaves of mango, was investigated in batch adsorption experiments on textile wastewater. Process parameter which includes pH, adsorbent dosages and contact time were varied in order to evaluate their influence on the adsorption process. As the Mangifera indica foliages are locally available easily and are also cost-effective, so it can be used in little greater amounts to obtain complete removal of heavy metals. The percentage removal efficiency of Cu(II) was higher with increasing contact time and the equipoise time in nearly 240 minutes as 89.94 at pH 7 in the dosage content of 2.0g. The percentage removal efficiency of Cd(II) and Pb(II) were attained in contact time of 180 minutes such as 89.61 and 84.42, with the level of pH 6 respectively, and Zn (II) was 85.88 and Ni(II) was 89.94, at pH 7 severally. The results obtained indicated that the adsorption of Ni(II) on MIFP was better than other ions. Besides that, the adsorption of Ni on MIFP was found in the good fit with the Langmuir isotherm.

Keywords: *Mangifera indica, Cadmium, Lead, Nickel, Zinc, Copper, Adsorption, Textile Dye effluents, Langmuir and Freundlich Isotherms*

1. INTRODUCTION

Adsorption process offers the benefits of low costs, probability of heavy metal removal from the textile wastewater and regenerates the potential biosorbent, though research has been carried out for developing cost effective heavy metal removal techniques. The treatment of wastewater has become popular to the 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 has been increasing pollution, such as Cadmium(Cd(II)), Lead(Pb(II)), Nickel(Ni(II)), Zinc(Zn(II)) and Copper (Cu(II)). However, heavy metals such as chromium, iron, mercury, lead, cadmium are toxic to organisms. Increased use of metals and chemicals in process has resulted in the generation of large 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 mango leaf powder are a low-cost agricultural waste which could be used for adsorption of heavy metals in wastewater.

A lot of industries generate colored effluents containing various dyes and pigments and discharge the same to natural water bodies. Such effluents are characterized by fluctuating pH with large load of suspended solids and high oxygen demand [1]. The textile industry and the pulp and paper mills discharge highly coloured effluents, which retain their colour even after going through the conventional biological treatment process unless tertiary treatment measures [2-4] are taken to remove colour by adsorption on activated carbon etc. Lignin, a biopolymer recovered from pulp and paper industry was used for the uptake of Cd^{2+} ions [5] and sawdust of Red fir was used Hg2+ removal and it is seen that the sorption capacity increased with increasing temperature and pH [6]. Presently more than 9000 dyes are incorporated in colour index [7]. The textile industries alone account for two thirds of the total dye production and about 10-15% of dyes used are discharged into the effluents [8].

Industrial Wastewater and Heavy Metals are commonly released in the wastewater from various industries. Electroplating and surface treatment practices leads to creation of considerable quantities of wastewaters containing heavy metals such as Cadmium, Zinc, Lead, Chromium, Nickel, Copper, Vanadium, Platinum, Silver and Titanium. Apart from this wastewater from leather, tannery, textile, pigment and dyes, paint, wood processing, petroleum refining industries and photographic film production contains significant amount of heavy metals. These heavy metal ions are toxic to both human beings and animals. The toxic metals cause physical discomfort and sometimes life threatening illness and irreversible damage to vital body system. Adsorption is recognized as a superior technique in terms of initial cost, simplicity of design, ease of operation and insensitivity towards toxic substances [9] and granulated activated carbon (GAC) or powdered activated carbon (PAC) is a favorite method for the removal of persistent organics. However, adsorbent grade activated carbon is cost-prohibitive and regeneration of the used carbon s not straightforward [10]. Many novel materials have been used to test as adsorbents to replace activated carbon with cheaper alternatives and to utilize various waste products for the purpose [11]. In this paper, aqueous solutions of five toxic metals were taken as modal systems for testing the utility of MIFP as a biosorbent.

2. MATERIALS AND METHODS

2.1 Preparation

Mango leaves were collected from locally available trees and washed thoroughly by using distilled water to clean them from dirt and impurities. After that, the leaves were dried and until the leaves turned brownish in colour. After drying, the leaves were crunched by a mechanical grinder and were sieved to size of 80µm conserved in a glass bottle for utilize as an adsorbent.

2.2 Equilibrium studies

Equilibrium data, commonly known as adsorption isotherms, are basic requirements for the design of adsorption systems. Classical adsorption models, Langmuir [12] and Freundlich [13], were used to describe the equilibrium between heavy metals on the MIFP at constant temperature. The Langmuir equation is valid for a monolayer sorption on a homogenous surface with a finite number of identified sites and when there are no interactions between the sorbed species. The linear form of Langmuir equation is given in equation;

$$\left(\frac{Ce}{qe}\right) = \left(\frac{Ce}{qmax}\right) + \left(\frac{1}{qmax\ K}\right)$$

where Ce(mg/l) is the equilibrium concentration of adsorbate; qe(mg/g) is the quantity of adsorbed material (mg/g) at equilibrium, K is the Langmuir equilibrium constant related to the energy of sorption (mg/l) and q_m is the maximum amount of metal ions per unit weight of MIFP.

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;

$$logqe = \log K + \left(\frac{1}{n}\right) logCe$$

where the K (mg g-1) and n (value between 0 and 1) are the Freundlich constant characteristic on the system. K and n are indicators for adsorption capacity and adsorption intensity, respectively [14-22].

3. RESULTS AND DISCUSSION

3.1 Effect of pH

The pH is an important parameter in all the adsorption processes. For a typical experiment was carried out to removal of heavy metals from the aqueous solution. It was seen that there was no adsorption between pH 1.0 and 5.0, and the percentage removal efficiency of Cd(II) was maximum as 83.67 at pH 6.0, the adsorption process of Pb(II) was attained for maximum percentage removal efficiency as 79.72 at the level of pH 6. By further increasing of pH level from 6 to 7, the percentage removal of Ni(II) was obtained maximum and it was 83.05. Similar Zn(II) and Cu(II) was attained maximum and it was 79.60 and 85.27 respectively (Fig. 1). These interpretations of gradually rise in percent adsorption for the anionic dyes onto neem leaves were similar to that studied [23]. The pH values from acidic to alkaline medium causes both the degree of ionization of dye molecules and the surface attribute of the adsorbent to various, which in turn affect the biosorption rate of dyes. Another side, the presence of high concentration of ions on the adsorbents in the basic medium at pH of 8-11 complete effectively with the dye molecules have the effect of making happen to decreased percent adsorption for both dyes onto the surface of the adsorbent.

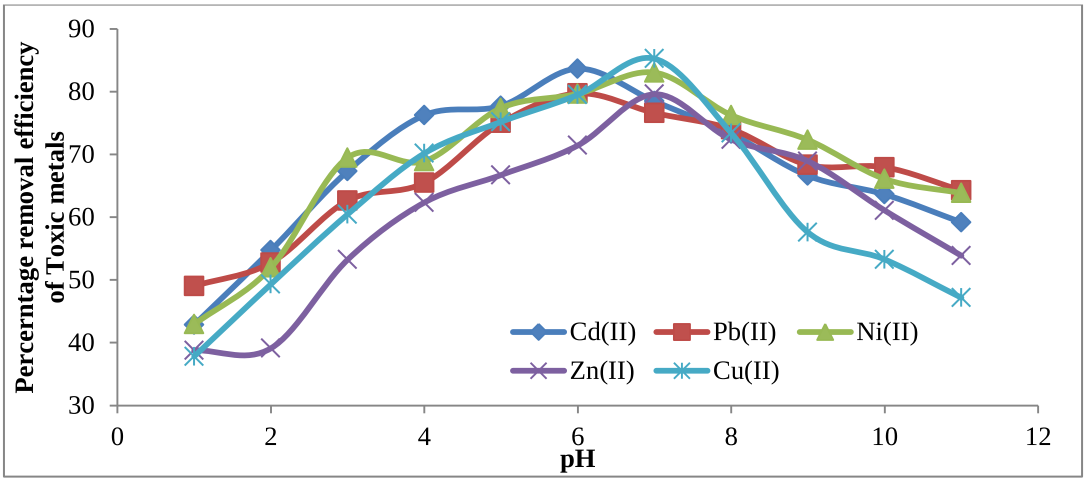

Fig.1. pH Vs Percentage removal efficiency of Toxic Metals

3.2 Effect of Adsorbent Dosage

The effect of adsorbent dosage from 0.5 to 2.5g in dye wastewater is shown in (Fig.2 and Fig.3). It can be observed that the increase in the biosorbents dosage causes an increase in the percentage of metal removal. The percent adsorption of metals onto the adsorbent varied for Cd the percentage removal efficiency of Cd(II) was maximum at 83.67% with the dosage content of MIFP (2.0g) as biosorbent and the adsorption process of Pb(II) was attained for maximum percentage removal efficiency as 79.72 with the dosage content of 2.0g (Fig. 2). After increased from the pH level 6 to 7, the percentage removal of Ni(II) was obtained maximum and it was 83.05. Similar Zn(II) and Cu(II) was attained maximum and it was 79.60 and 85.27 respectively at the dosage content of biosorbent as MIFP 2.0g (Fig. 3). As the amount of adsorbent increases, the number of active sites available for adsorption also increases, thus increasing the percent removal for the dyes. Initial stages of dosage content in 0.5g had started its removal efficiency, while at maximum dosage 2.0g; there was the greater availability of convertible places which ultimately led to the removal of maximum efficiency of ions.

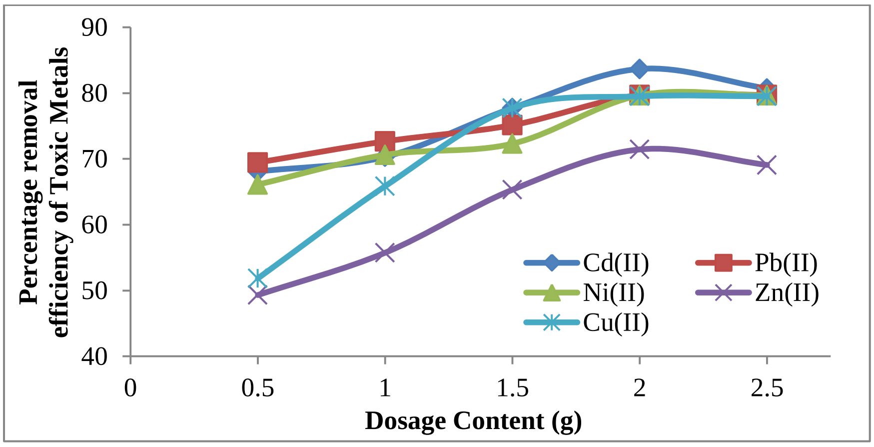

Fig.2. Dosage Content vs Percentage removal efficiency of Toxic metals

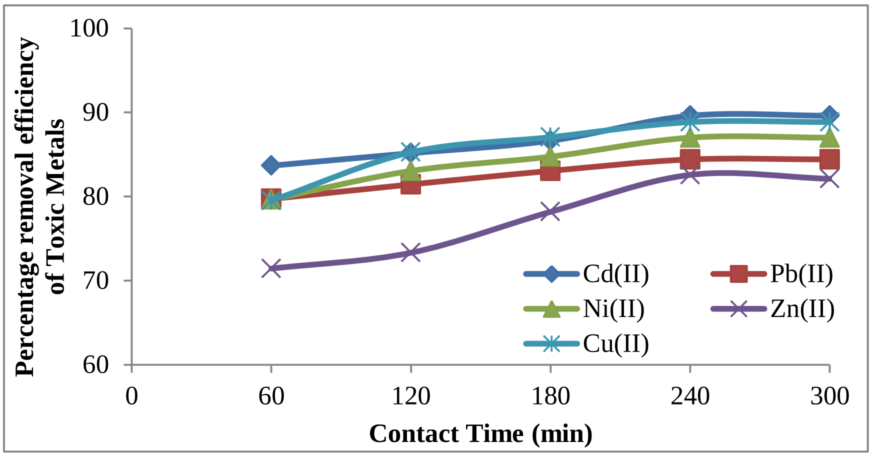

Fig.3. Dosage Content Vs Percentage removal efficiency of Toxic metals

3.3 Effect of Contact Time

Fig. 4 and Fig. 5, showed the percentage removal of the various heavy metals by the MIFP as biosorbent. For all the metal ions present in the textile wastewater, there was a progression in the percentage removal of metal ions present in the textile wastewater with contact time. An increased of removal efficiency with an increase in contact time and this could be detailed discussed by chemical attraction of the adsorbents for toxic ions. It can be clearly observed that the percentage of adsorption generally increased until time reached, the Cd(II) and Pb(II) had obtained the maximum percentage removal efficiency of metals 89.61 and 84.42 in 240 minutes respectively at pH 6 in the dosage content of 2.0g (Fig. 4). The maximum percentage removal efficiency of Ni(II) was obtained as 89.83 at pH 7 with contact time 180 minutes; meanwhile Zn(II) was 85.88 and Cu(II) was 89.94 had attained 240minutes at pH 7 (Fig.5). Afterwards the process becomes comparatively constant as it approaches equilibrium conditions until equilibrium was achieved at a respective time.

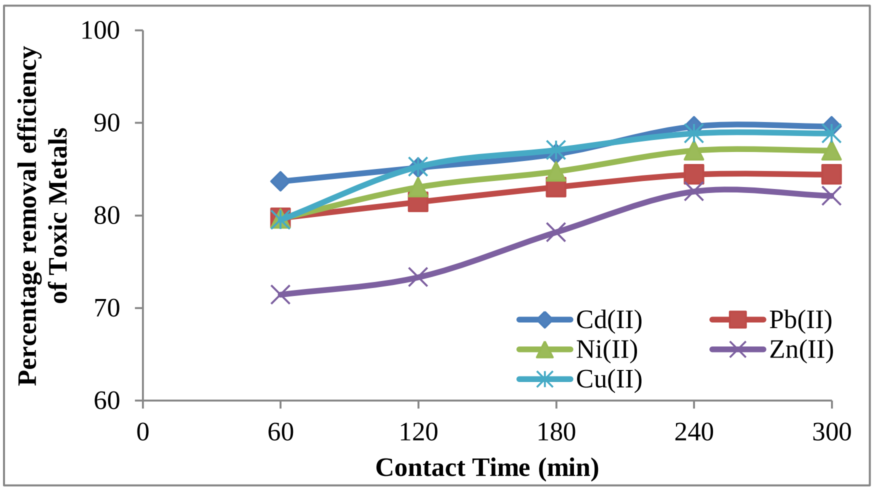

Fig.4. Contact Time vs Percentage removal efficiency of Toxic Metals

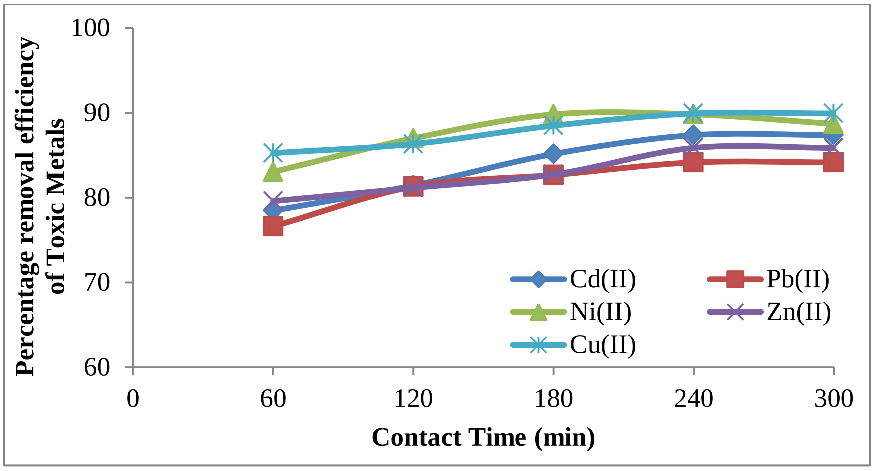

Fig.5. Contact Time vs Percentage removal efficiency of Toxic Metals

3.4 Adsorption Isotherms

The regression equation of MIFP through regression analysis for calculating the parameters of Langmuir isotherm, Freundlich isotherm, Temkin isotherm, Dubinin-Redushkevich isotherm, Harkin-Jura isotherm and Jovanovic isotherm were shown in the Table 1 and Figures 6 to 12. The essential characteristic of Langmuir isotherm can be shown in terms of RL (dimensionless separation parameter) which is indicative of isotherm shape and predicts whether an adsorption system is favorable. These results inferred that the equilibrium adsorption data of toxic metals were conformed well fitted to the isotherms; however, higher value of R^2 indicates Langmuir isotherm as the most favorable.

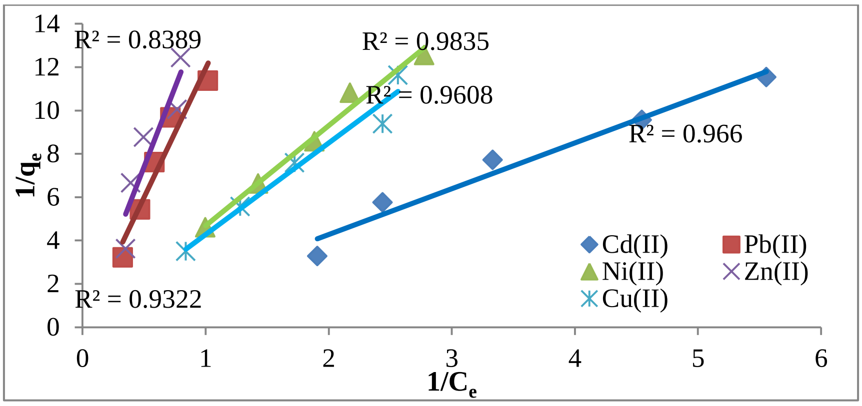

Fig.6. Langmuir Isotherm plot for toxic metals

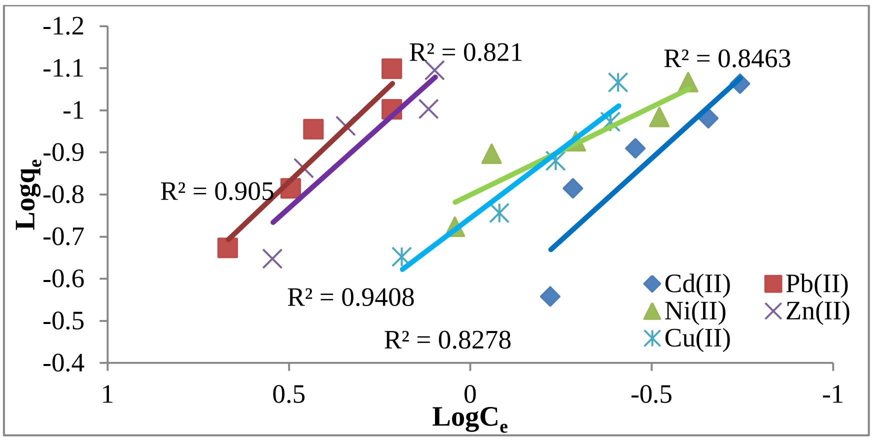

Fig.8. Freundlich Isotherm plot for toxic metals

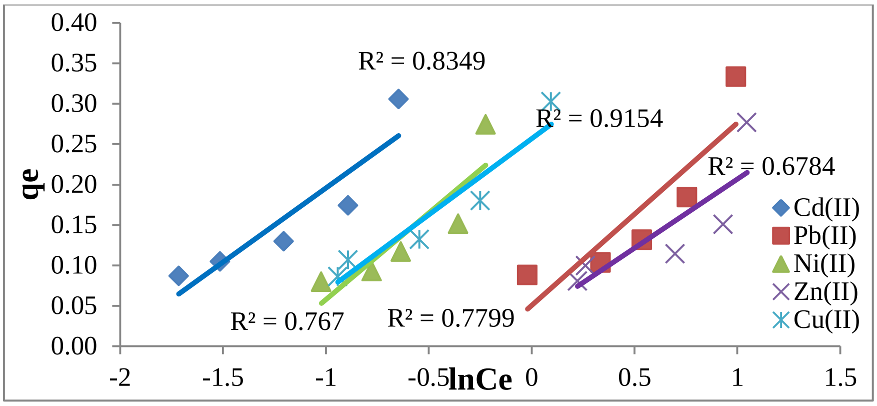

Fig. 9. Temkin Isotherm plot for toxic metals

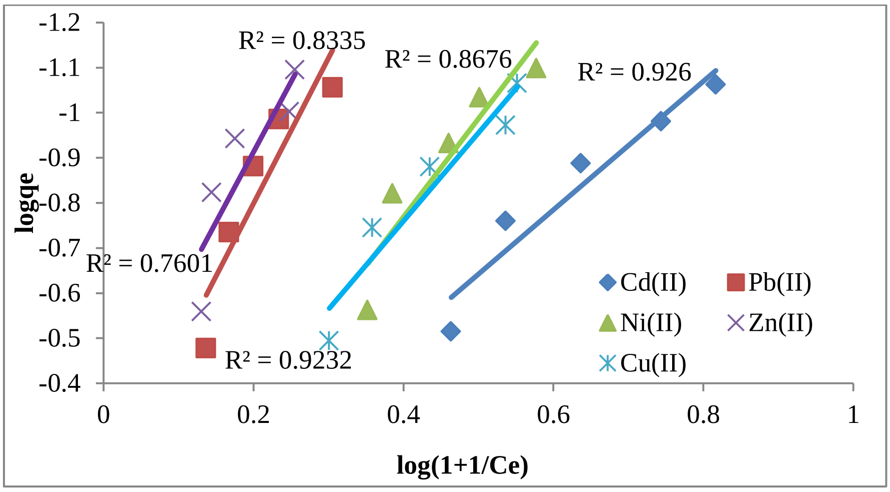

Fig. 10. Dubinin-Radushkevich Isotherm plot for toxic metals

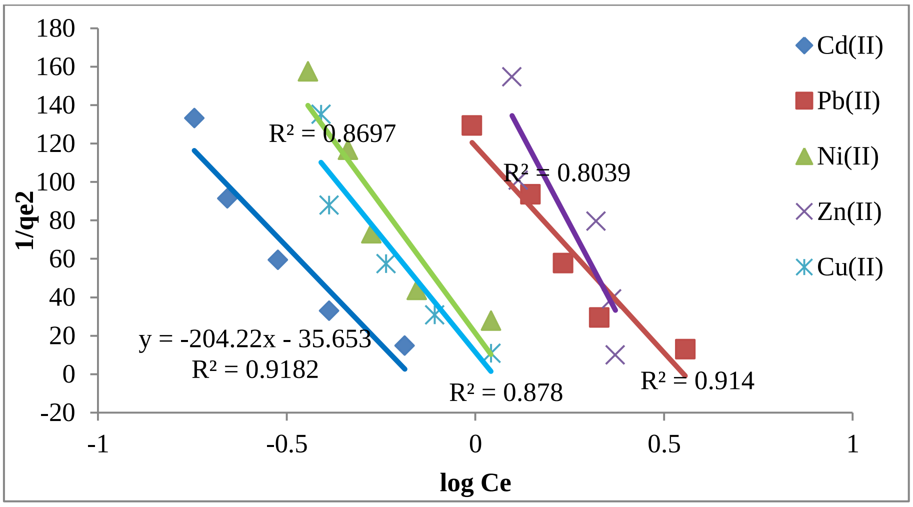

Fig. 11. Harkin-Jura Isotherm plot for toxic metals

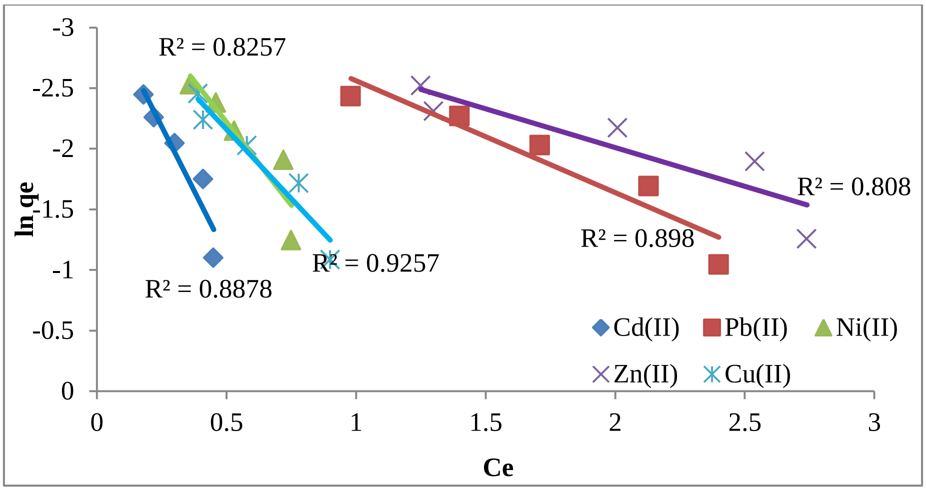

Fig. 12. Jovanovic Isotherm plot for toxic metals

Table 1 Isotherm Model Characteristics for MIFP

	Cd(II)	Pb(II)	Ni(II)	Zn(II)	Cu(II)
Langmuir Isotherms					
R^2	0.966	0.932	0.983	0.838	0.960
R_L	0.967	0.981	0.973	0966	0.960
q_{max} (mg/g)	18.51	35.71	14.08	12.65	15.87
b (l/mg)	0.025	0.002	0.015	0.005	0.014
Freundlich Isotherms					
R^2	0.827	0.905	0.846	0.821	0.940
n	1.290	1.219	2.392	1.298	1.536
K_F	0.320	0.058	0.160	0.070	0.180
Temkin Isotherms					
R2	0.834	0.779	0.767	0.678	0.915
B	0.183	0.225	0.213	0.170	0.188
KT (l/mg)	2.066	0.222	1.272	0.212	1.362
Dubinin-Radushkevick Isotherms					
R2	0.926	0.833	0.867	0.760	0.923
qD (mg/g)	1.424	3.221	2.179	3.115	1.956
B	0.069	0.154	0.102	0.290	0.022
Harkin-Jura Isotherms					
R2	0.918	0.914	0.869	0.803	0.878
A	5.730	1.811	12.52	2.170	2.110
B	1.552	2.074	1.330	2.230	1.060
Jovanovic Isotherms					
R2	0.887	0.898	0.825	0.808	0.925
qmax	0.308	0.287	0.280	0.304	0.303
KJ	0.764	0.264	0.763	0.195	0.691

4 CONCLUSION

The results of the MIFP studied can be used as a low cost adsorbent alternative for heavy metal removal from dye wastewater. It indicates a great capacity for adsorption and is highly efficient. The percentage removal of Cu(II) was higher with increasing contact time and the equipoise time is nearly 240 minutes as 89.94 at pH 7 in the dosage content of 2.0g. As the Mangifera indica foliages are locally available easily and are also cost effective, so it can be used in little greater amounts to obtain complete removal of heavy metals. Thus, it can be concluded that Mangifera indica foliages can be considered as an alternative biomass for the removal of Ni(II) ion, since it is effective, low cost and abundant, it can be obtained locally. Thus reducing heavy metals from wastewater, environmental pollution can be lowered. The results attained are best fitted with the Langmuir isotherms.

REFERENCES

[1] Sivraj R, Namasivayam C, Kadirvelu K, "Orange peel as an adsorbent in the removal of Acid violet 17(acid dye) from aqueous solution", Waste Management 2001, 21, 105-110.

[2] An H, Xiasheng Q, Y G, Tang WZ, "Biosorption treatment of dye wastewaters using an anaerobic-oxic system", Chemosphere, 1996, 33, 2533-2542.

[3] Liakou S, Pavlou S, Lyberatos G, "Ozanation of azo dyes", Water Sci Technol, 1997, 35, 279-286.

[4] Sarasa J, Roche MP, Ormad MP, Gimeno E, Puig A, Ovelleiro JL, "Treatment of a wastewater resulting from dyes manufacturing with ozone and chemical coagulation", Water Res., 1998, 32, 2721-2727.

[5] Verma, K.V.R., Swaminathan, T., Subramanian, P.V.R., "Heavy metal removal by lignin", J.Environ.Sci.Health 1990, A25, 243.

[6] Bryant, P.S., Peterson, J.N., Lee, J.M., Broun, T.M., "Sorption of heavy metals by untreated red fir saw dust", Appl.Biochem. Biotechnol. 1992, 777, 34-35.

[7] Garg V K, Gupta Renuka, Yadav Anu Bala & Kumar Rakesh, Bores Technol, 2003, 89, 121.

[8] Mohan S V, Rao N.C & J Karthikeyan, J.Hazard Mater, 2002, B90, 189.

[9] Meshko V, Markovska L, Mincheva M & Rodidigues A E., Water Res., 2001, 24, 307.

[10] Mckay G, J Chem Technol Biotechnol, 1982, 32,759.

[11] Pollard S J T, Fowler G.D., Sollars C J & Perry R, The Sci total Environ, 1992, 116, 3331.

[12] Langmuir, I., "The Adsorption of Gases on Plane Surfaces of Glass, Mica, and Platinum". J.Am.Chem. Soc., 1918; 40(9), 1361-1403.

[13] Freundlich, H., "Ueber die Adsorption in Loesungen", Z.Phys.chem., 1907; 57,387-470.

[14] Ajmal M., Rao R.A.K., Ahmad R. and Ahmad J., "Adsorption studies on Citrus reticulate (fruit peel of orange): removal and recovery of Ni(II) from electroplating wastewater", J. Haz. Mate. B, 2000; 79, 117-1131.

[15] Qin F., Wen B., Shan X. Q., Xie Y. N., Liu T., Zhang S. Z. and Khan S. U., "Mechanisms of competitive adsorption of Pb, Cu (pH = 4), and Cd on peat", Env. Poll., 2006; 144(1), 669–680.

[16] Nasernejada B., Zadehb T. E., Poura B. B., Bygia M. E. and Zamani A., "Comparison for biosorption modeling of Cr, Cu, Zn wastewater by carrot residues", Proc. Biochem., 2005; 40(2), 1319 –1322.

[17] Wong K. K., Lee C. K., Low K. S. and Haron M. J., "Removal of Cu and Pb by tartaric acid modified rice husk from aqueous solutions", Chemos., 2003; 50 (1), 23–28.

[18] Saeed A., Iqbal M. and Akhtar M. W., "Removal and recovery of lead (II) from single and multi-metal (Cd, Cu, Ni, Zn) solutions by crop milling waste (black gram husk)", J. Ha. Mate. B, 2005; 117(2), 65–73.

[19] Sun G. and Shi W., "Sunflower stalks as adsorbents for the removal of metal ions from wastewater", Ind. Eng. Chem. Res., 1998; 37(2), 1324–1328.

[20] Reddad Z., Gerente C., Andres Y. and LeCloirec P, "Adsorption of several metal ions onto a low cost adsorbent, kinetic and equilibrium studies", Environ. Sc.Tech., 2002; 36(1), 2067–2073.

[21] Keskinkan O., Goksu M. Z. L., Yuceer A., Basibuyuk M. and Forster, C.F., "Heavy metal adsorption characteristics of a submerged aquatic plant Myriophyllum spicatum", Proc. Biochem., 2003; 39(2), 179–183.

[22] Ozsoy H. D. and Kumbur H., "Adsorption of Cu(II) ions on cotton ball", J. Ha.Mate., 2006; 136(1), 911–916.

[23] Abdullah, N.M., Othaman, R., Abdullah, I., Jon, N. and Baharum, A. "Studies on the Adsorption of Phenol Red Dye using Silica-Filled enr/pvc Beads", Journal of Environmental Mangement, 2012; 71, 217-229.