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RESEARCH ARTICLE

Metals adsorption from aqueous solution by coconut husk

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SUMMARY : The presence of heavy metals in the wastewaters is a major concern due to the toxicity to many life forms. Heavy metals will not degrade into harmless end product, unlike organic pollutants. Thus, treatment of wastewaters containing heavy metals requires secured disposal. This paper throws light on results of batch experimentations carried out to evaluate the potential of coconut husk in adsorbing zinc and copper ions from aqueous solutions. The influence of flow rate (contact time), pH of the solution and initial concentration of metal ions (Co) were investigated. Adsorption of metal ions were found to be pH dependent and results indicated the optimum pH of 7 for the removal of copper and zinc ions. The better removal efficiencies were recorded at flow rates of 40 ml/min and initial concentration of metals being 20 mg/l. Removal efficiency increased with increase in pH upto contain pH value and further decreased with increase in pH value. Also decrease in removal efficiency with increase in metal concentration was recorded. The coconut husk exhibited 80 % and 75 % removal of zinc and copper, respectively from aqueous solutions.

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Due to industrial activities and technology development, the amount of heavy metal ions released to the environment has been increasing significantly. Various industries such as mining, electroplating pulp and paper board mills, battery manufacture etc., were found to contain heavy metal ions in their wastewaters. The concentrations of metals must be reduced to acceptable levels before discharging them into receiving bodies, in particular, water bodies. Otherwise, these could pose threat to public health and / or affects the aesthetic quality of water bodies.

The conventional methods which are commonly used for the removal of metals from the industrial effluent includes chemical oxidation or reduction, chemical precipitation, filtration, ion exchange, membrane technologies etc. These processes may be ineffective or expensive, especially when the heavy metal ions in the wastewaters are high. Further, the operational problem and the high cost of treatment warranted the research for some techno-economically feasible method. In this regard, the researchers showed that the metals removal by adsorption was found to be more efficient, easy to operate, highly selective and hence cost effective. Many low cost adsorbent have been tried by various researchers in recent years for heavy metals removal. Low cost adsorbents such as peanut husk (Brown *et al.,* 2000), rice husk (Bishnoi *et al.,* 2004), coconut husk (Oyedeji and Basiru, 2010), rice husk (Dos Santos *et al.,* 2006), activated alumina (Mazumder *et al.,* 2011) saw dust and sugarcane leaves (Khan *et al.*, 2004, Nigam and Rama, 2003), maize leaf (Adesola Babarinde *et al.,* 2008) have been tried. Even though many adsorbents have been tried by the researchers, the need of the day is to evaluate/suggest the low cost adsorbent for removal of metal ions from wastewater which requires analysis of local conditions and needs together with the application of scientific knowledge, engineering judgement based on the past experience. An attempt has been made in this paper to document the results of batch studies and their by inferences

drawn in removing copper and zinc ions from aqueous solutions by adsorption with coconut husk.

EXPERIMENTAL METHODOLOGY

Preparation of adsorbent :

The adsorbent was prepared as documented by Oyedeji and Basiru (2010). The coconut husk procured from local coir factory was cut into small pices and blended, extracted with hot water several times until the supernatant was colourless. It was then dried at 70°C. Further, the biomaterial was sieved to obtain particle size of 0.5 mm and this was stored in clean air tight containers.

Adsorbents :

Stock solutions of copper and zinc were prepared by dissolving stachiometrically calculated quantities of analytical grade copper sulphate pentahydrate and zinc chloride in doubly distilled water. These stock solutions so prepared based on stachiometric calculations were further re-checked for absolute concentration by employing the procedure as given in APHA (2006). Further, samples of required concentration were prepared by suitably diluting the stock solution using doubly distilled water which are used for experimentation. The pH of solution was adjusted by adding NaOH in solution form.

Variables considered :

Effect of pH : 3, 5, 7, 9 and 10, initial metal concentration, 10, 20, 30, 40 and 50 mg/l and flow rates of 40, 60 and 80 ml/min were studied. The samples were analysed for metal concentrations using Atomic Adsorption Spectrophotometer and adopting the procedure as given in instruments suppliers manual.

Experimental set-up :

Up flow column (cylindrical jar) was used for experimentation. The hole was drilled at the bottom of the column and it was covered with a fine mesh to take care of adsorbent washout. A small plastic tube was attached to the hole at the bottom. Column was filled with adsorbent upto predetermined depth. The aqueous solution was fed at varied flow rates by adjusting the speed of peristaltic pump. Samples from the over flow pipe fixed to the column at the top were collected and analysed. The average values of samples collected (triplicate) were tabulated.

EXPERIMENTAL FINDINGS AND DISCUSSION

The findings of experimentation are shown in Fig. 1 and presented in Table 1. Based on the results and their analysis, the following inferences have been drawn :

pH was found to have good bearing on removal

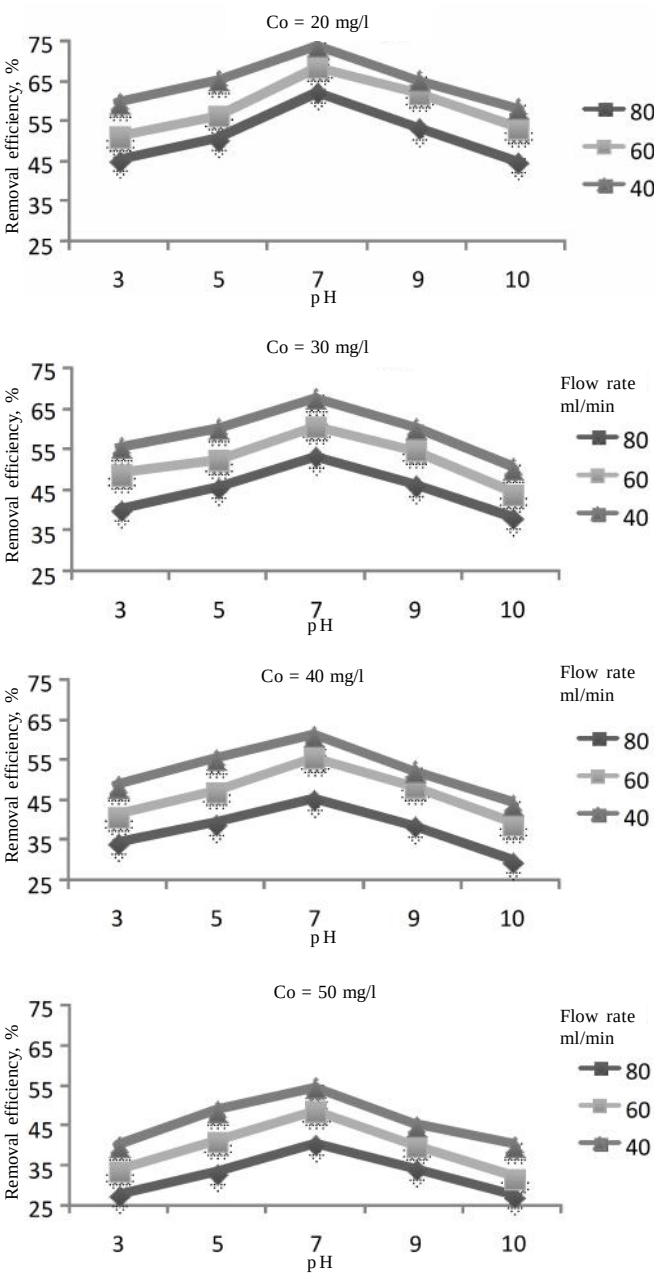

Fig. 1 : Effect of pH on removal efficiency of copper

efficiency. Increase in removal efficiency with increase in pH upto certain pH value and further decrease in removal efficiency with increase in pH was observed. The inverse relationship between the removal efficiency and flow rate and also initial concentration of metal was recorded. For both the metal ions studied, maximum removal efficiency was recorded for pH of 7, flow rate of 40 ml/min and initial metal concentration of 20 mg/l.

For all initial zinc concentrations and pH values considered for study, the removal efficiency varied from 82.3

Table 1 : Effect of experimental variables on adsorption of zinc

Flow rate ml/min	Initial Zn conc. mg/l	Removal efficiency at stated pH values				
		3	5	7	9	10
40	20	65.5	75.3	82.3	75.6	65.3
	30	61.8	67.5	75.2	65.4	60.3
	40	60.3	65.3	71.8	62.3	54.6
	50	51.7	57.5	64.3	60.6	49.5
60	20	60.3	68.8	76.7	70.3	60.1
	30	55.7	61.5	71.3	60.3	53.8
	40	53.4	59.5	65.3	55.4	48.9
	50	44.3	50.6	56.3	49.6	42.3
80	20	50.6	61.1	71.3	62.1	50.3
	30	46.3	55.6	64.7	54.7	45.5
	40	45.3	52.5	58.1	50.8	41.1
	50	36.1	30.1	47.4	40.6	34.1

to 49.5 %, 76.7 to 42.3 % and 71.3 to 34.1 %, respectively for flow rates of 40, 60 and 80 ml/min. Thus, using coconut husk, adopting pH of 7.0, initial concentration of zinc being 20 mg/l, 82.3 % removal of zinc can be achieved at flow rate of 40 ml/min.

Coconut husk was found to remove maximum of 73.8 % of copper from aqueous solution at pH 7.0, Co 20 m/l and flow rate of 40 ml/min. For all flow rates and initial concentration of metal (copper) studied. The removal efficiency varying from 59.6 to 27.8 %, 65.3 to 33.4 %, 73.8 to 40.6 %, 65.3 to 34.4 % and 58.3 to 27.6 % at solution pH of 3, 5, 7, 9 and 10, respectively were recorded (Fig. 1).

Comparison of removal efficiencies of copper and zinc by coconut husk clearly indicated that, coconut husk has higher potential in adsorbing zinc (82.3%) compared to copper (73.8%).

Conclusion :

On optimizing all the experimental variables studied in the present work, it was concluded that zinc from the aqueous solution can be best treated compared to copper. Solution pH of 7 was found to be more effective than other pH values studied. It was observed that the removal efficiency of both the metals decreased with increase in flow rate, and initial concentration of metal ions. Optimum removal efficiencies can be achieved at flow rate of 40 ml/min and metals initial concentration of 20 mg/l.

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