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Removal of heavy metals from wastewater using low cost adsorbents

A. Zahir Hussain and K. M. Mohamed Sheriff

PG and Research Department of Chemistry, Jamal Mohamed College, (Affiliated to Bharathidasan University), Tiruchirapalli, Tamil Nadu, India

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ABSTRACT

This study reveals that the potential of papaya seed, egg shell and coconut leafpowder were used as adsorbent for the removal of heavy metals such as lead, cadmium and chromium from known concentration of waste water was investigated. Hence the present study reveals that the low cost adsorbent of Chicken egg Shell is used for removing 85, 82 and 86 % of chromium, lead and cadmium respectively. Coconut leaf powder used for removing 87, 90 and 85 % of chromium, Lead and Cadmium respectively. Papaya seed powder is used for removing 80, 85 and 79 % Chromium, Lead and Cadmium respectively from wastewater from the initial metal ion concentration of 100 ppm solution. Batch adsorption studies demonstrated that the adsorbents had significant capacity to adsorb the chromium, Lead and Cadmium from aqueous solution. It was found that the adsorption increased with increase in contact time.

Key words: Heavy metals, Adsorbents, Effect of Contact time and Agricultural waste.

INTRODUCTION

The presence of toxic heavy metals such as chromium, copper and lead contaminants in aqueous streams, arising from the discharge of untreated metal containing effluents into water bodies, is one of the most important environmental problems. Environmental pollution is currently one of the most important issues facing humanity. It was increased exponentially in the past few years and reached alarming levels in terms of its effects on living creatures. Toxic heavy metals are considered one of the pollutants that have direct effect on man and animals [1]. Inputs of these trace metals into ecosystem are largely as a result of mining operations, refining ores, sludge disposal, fly ash from incinerators, processing of radioactive materials, metal plating, or manufacture of electrical equipment, paints, alloys, batteries, pesticides and preservatives [2]. The discharge of metallic ions in industrial effluent is of great concern because their presence and accumulation have a toxic effect on living species [3].

MATERIALS AND METHODS

Preparation of coconut leaf and papaya seed as an Adsorbent

The coconut leaf and papaya seeds were taken as adsorbent for this experimental work. The collected coconut leaf and papaya seed were grinded into fine particles and sieved into 0.5 mm particles and were used as adsorbent for overall studies. The coconut leaf and papaya seed powders were stored in an air-tight container. No other chemical modification was taken place. All reagents used were of analytical grade (Merck) without further purification [4].

Preparation of Chicken Egg shell as an Adsorbent

The chicken eggshell were collected and washed with distilled water several times to remove dirt particles and dried for three hours in an oven at 150 ºC and then allowed to cool at room temperature, subsequently it were crushed and then finally sieved into particle size of 0.5 mm. The chicken eggshell powder comprises of 94% $CaCO_3$ with small amount of $MgCO_3$ calcium phosphate and other organic matter including protein. The sieved adsorbent was stored in an air-tight container. No other chemical modification was taken place [4].

Batch adsorption studies

The metal solutions used in this study were prepared as the stock solutions containing 1000mg/L of each metal. 100ml of adsorbate solution of known concentration was taken in the 250 ml conical flask and 1g of each adsorbent was added separately and then reactant was stirred by magnetic stirrer without any pH modification at room temperature. For a wide range contact time 30-180 mins. After that the solution was filtered by whatmann 42 filter paper and concentration of the filtered solution was determined by atomic absorption spectrophotometer (Perkin Elmer, model 2380) [4]. The percentage removal was determined by the following expression.

The amount of adsorption efficiency was calculated by,

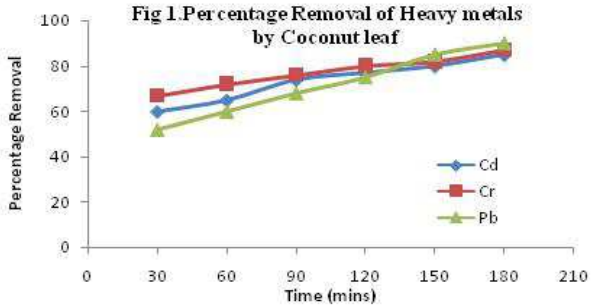
$$\text{Adsorption percentage} = \frac{(Co - Ce)}{Co} \times 100$$

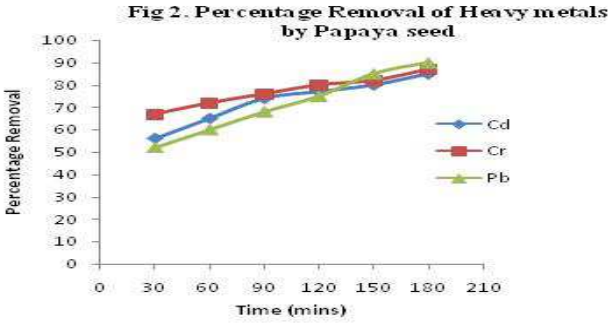
Where, Co = initial concentration of metal ion in the solution (mg/lit) Ce = final concentration of metal ion in the solution (mg/lit)

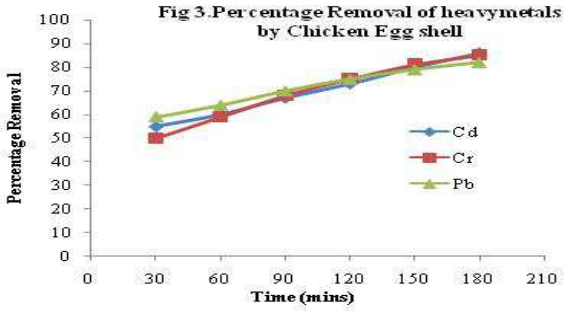
Effect of Contact Time on Adsorption of Heavy Metals

The percentage reduction of adsorption is found to increase continually with time till the equilibrium is attained with saturation at 180 mins. The percentage reduction of cadmium is 55-86, 60-85 and 56-79 for chicken egg Shell, coconut leaf powder and papaya seeds respectively. This may be due to utilization of active sites is larger surface area [2]. Then percentage reduction of chromium is 50-85, 67-87 and 60-80 for chicken egg Shell, coconut leaf and papaya seeds respectively. The decreased adsorption efficiency is due to less adequate availability of active sites on the adsorbents [5]. Then percentage reduction of Lead is 59-82, 52-90 and 65-85 for chicken egg shell, coconut leaf and papaya seeds respectively. They are shown in the figure 1-3.

The high percentage reduction of chromium, lead and cadmium is found to be 85, 82 and 86 for chicken egg shell powder is rapidly increased. It has been observed that the percentage of cadmium adsorption increased with increasing agitation speed due to the proper contact between the metal ions in solution and the adsorbents binding sites that promotes effective transfer of cadmium ions to the adsorbents sites [6]. The high percentage reduction of chromium, lead and cadmium is found to be 87, 90 and 85 for coconut leaf powder is rapidly increased. This increase maybe due to the activation of adsorption site takes place leading to increased adsorption probably through surface exchange mechanism [7]. The high percentage reduction of chromium, lead and cadmium is found to be 80, 85 and 79 respectively in papaya seed powder. This may be due to the smaller size of adsorbent in the metal solution provided a greater availability of the metal ions to penetrate to the internal pore structure of the adsorbent. The lower metal uptake with larger adsorbent particles was due to the high diffusion resistance to mass transport [8].







CONCLUSION

In the present study heavy metals such as chromium, lead and cadmium was selected for removal from aqueous solutions using adsorption technique. A particle size of 0.5 mm was observed to be highly efficient for the lead, cadmium and chromium. A decrease in the size of the particle increased the adsorption, as a decrease in size of the particle increased the availability of the number of active sites. Hence these adsorbents appear to be technically feasible, user-friendly, eco-friendly, economical process and with high efficacy. This work showed that the various adsorbents could be used as a good adsorbent material for Lead, Cadmium and Chromium for wastewater treatment. The present adsorbents can be used as an industrial scale to remove the chromium, Lead and Cadmium respectively. Hence, it is necessary to remove these metals from industrial effluents before discharging waste water into the environment.

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