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A LOW COST MATERIAL, BANANA PEEL FOR THE REMOVAL OF LEAD (II) FROM AQUEOUS SOLUTIONS

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Abstract - *Environmental pollution by toxic heavy metal has become a challenging problem for maintaining the quality and hygiene of water. The discharges of industrial effluents into aquatic environment cause a threat for human health. Therefore a batch adsorption methodology is developed for the removal of toxic metals from aqueous solution. In the present work banana peel was used as adsorbent. The parameters used in the study were contact time, pH, concentration and adsorbent dosage. Adsorption of these metals was found to be pH dependent.*

Key Words:
Adsorption, banana peel, adsorbent, adsorbent dosage and batch studies etc.

1. INTRODUCTION

Lead is one of the heavy metals, often found in industrial wastewater and its discharge into the environment poses a serious threat due to its toxicity. It is the IV group element in the periodic table. It is naturally occur as element buried in the earth crust in insoluble form. Enhancement of industrialization such as manufacturing of storage batteries, television tube, printing, paints, pigments, photographic materials and gasoline additives increase the amount of lead in environment. Exposure to Lead is recognized as a major risk factor for human beings. Once it goes beyond the maximum permissible limit, it affect the haemoglobin synthesis and porphyrin metabolism (1-2).

A high amount is required to establish a waste water treatment plants. These are un-economical and consume lot of space. There are many techniques for water treatment such as electro coagulation, floatation, filtration, conventional oxidation methods by oxidizing agents, These technologies are having many disposal problems. Ion exchange and membrane technologies are also very costly. So there was a need of alternative method which can overcome these problems.

Bio-sorption is the ability of biological materials to accumulate heavy metals from wastewater through physical chemical pathways.

The main advantage of Bio-sorption is that it gives the significant amount of energy saving from a more efficient wastewater treatment system operating for fewer hours; it is economically attractive because waste biomass is inexpensive and widely available (3-4). In bio-adsorption, removal of metal ions helps in the effective usage of bio-waste as metals stick on to the surface of biological components.

2. MATERIAL AND METHOD

2.1 Adsorbent Preparation

Banana peels were selected and washed with water several times to remove ash and other contaminants. After sometime banana peels was washed with distilled water until dust is removed.

After sometime banana peels was dried in the oven at 80°C for 2 hours. Then crushed and sieved through 2.2 mm sieve (1). Powder was collected and washed with distilled water after this sample was used for batch adsorption studies.

Figure-1: Banana peel (A)
Banana peel powder (B)

2.2 Adsorbate solution

The Pd (II) ion solution was prepared from an AR grade [Pb $(NO_3)_2$]. Distilled water was used for the preparation of solutions and adsorption experiments. 1000 ppm stock solution prepared for lead metal.

Lead nitrate 1.6 grams was added in 100 ml of distilled water in 1000 ml volumetric flask. It was dissolved by shaking and the volume was made up to the mark. Concentration lead solution was 1000 mg/l.

3. PROCEDURE BATCH ADSORPTION METHOD

The known weight of adsorbent material (banana peel powder) was added to 100 ml of the metal ion solutions with initial concentration varying from 10 mg/l to 50 mg/l. into separate 250 ml conical flasks and shaken thoroughly using orbital shaker rotating with 250 rpm speed. Then

solution was filtered using Whatman filter paper No. 42 and metal ion concentration was measured by Atomic adsorption spectrophotometer (4, 6). pH of each solution was adjusted by drop-wise addition of 0.1 M NaOH and 0.1 M HCl.

Adsorption capacity and % removal efficiency were calculated using the following equations respectively.

$$qe = \frac{(Co - Ce) \times V}{m} \quad \ldots\ldots (1)$$

$$\textbf{Removal efficiency (\%)} = \frac{(C0 - Ce) \times 100}{C0} \quad \ldots\ldots (2)$$

Where:
qe (mg g−1) is the amount of Pd (II) ions adsorbed, Ci (mg L−1) is the initial concentration of Pd (II) ions, Ce (mg L−1) is the concentration of Pd (II) ions in solution at equilibrium, V (L) is the volume of of Pd (II) ions and m (g) is the mass of the adsorbent.

4. RESULTS AND DISCUSSION

4.1 Effect of pH:

The effect of pH on the amount of Pd (II) metal ions was analyzed on pH range from 1-8. In this experiment, 100 ml metal ions concentration of 100 mg L-1 was measured into 250 ml conical flask and 1.0 g of the adsorbent was added and agitated at 250 rpm. The solution was filtered using Whatman filter paper No. 42 and the residual metal ions concentration analyzed by atomic absorption spectrometer (4, 7). The effect of adsorption parameters, such as pH, concentrations, contact time and adsorbent dose on the adsorption were studied.

The amount of metal adsorption increases with pH. Metal adsorption depends on the nature of the surface of adsorbent and species solution. At lower pH, H+ competes with metals for the exchange sites in the adsorbent material. The heavy metals are released in more amount in acidic conditions. The amount of adsorption was minimum in case of pH 2 but it increase with increasing pH (1, 7). The maximum adsorption occurs at pH 7 for banana peels after this precipitate of lead hydroxide with increasing pH.

The minimum adsorption at low pH = 2 may be due to the high mobility and high concentration of H+. Due to this H^+ ions are adsorbed in more amount than the comparison of metal ions.

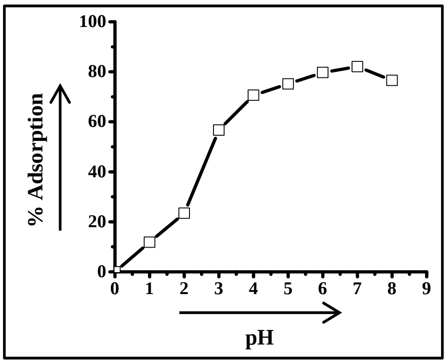

Figure - 2: Effect of pH on % adsorption of lead ion by banana peel, adsorbent dose = 0.5g, contact time =2 hr.

4.2 Effect of contact time:

Effect of contact time was observed on adsorption of Pb (II), banana peel is used as adsorbent. Percent adsorption increase up to 80 min. after this it starts decreases slowly up to 120 min. Therefore, 80 minutes could be considered for whole batch experiments (1, 8). The agitation speed was 250 r.p.m. It proves that the metal ions took 80 minutes to bind the banana peel.

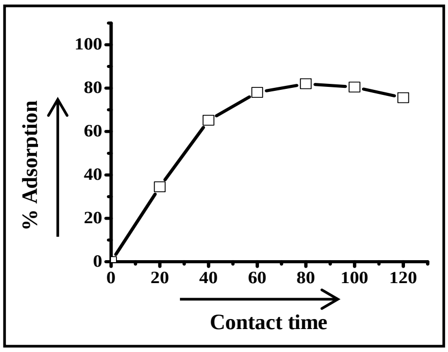

Figure - 3: Effect of contact time on % adsorption Pd (II) by banana peel, adsorbent dose= 0.5g, pH= 7.

4.3 Effect of metal ions concentrations

The removable efficiency decreases with increasing initial concentrations from 10-100 mg L^{-1}, shown in Figure 4. Maximum adsorption obtained at minimum concentration of metal ions. The different lead solutions with concentration ranging from 10mg/l to 100 mg/l were agitated at 250 rpm for 80 minutes with adsorbent dose of 0.5 gm,. The percentage adsorption of lead (II) decreases as the initial concentration of increased from 10 mg/l to 100 mg/l.

Maximum adsorption obtained at minimum concentration of metal ions. Such behavior can be because of the unchanging number of available active sites on the adsorbent here the amount of adsorbent was constant.

Therefor lead (II) ions are left unadsorbed in solution due to the saturation of binding sites on the available adsorbent (1,4,9).

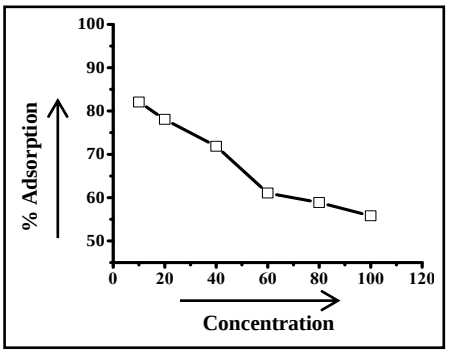

Figure - 4: Effect of concentration on % adsorption of Pd (II) by banana peel, adsorbent dose= 0.5g, pH= 7.

Effect of adsorbent dosage :

The effect of adsorbent dosage on percentage adsorption of Pd (II) is shown in Figure 5. The adsorbent doses vary from 0.1 to 1.0 gm. It was that percent adsorption increases with increasing the amount of adsorbent. The percentage adsorption increased up to 82 % with increase in adsorbent dosage from 0.1gm to 0.5 gm. After 0.5 gm % adsorption remains constant. This can be explained by a greater availability of exchangeable sites or surface area at higher amount of the adsorbent.

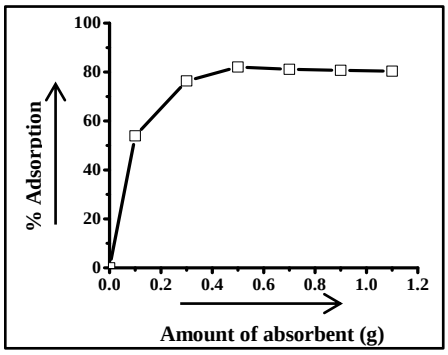

Figure - 5: Effect of adsorbent dosage on % adsorption of Pd (II) by banana peel, adsorbent dose= 0.5g, pH= 7.

4. CONCLUSIONS

Conclusions are drawn from the above results and discussion:

1. Banana peel is a cheap and effective adsorbent for the adsorption of Pb (II) ions from aqueous solution.

2. The maximum adsorption of Pb (II) by banana peel was observed at ph = 7, Contact time = 80 min., adsorbent dose 0.5 g/100ml and concentration = 10 ppm is 82%.

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