Recovery of toxic lead using mixed adsorbent

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Abstract:

The aim of this work was to evaluate the recovery of Pb(II) on tea waste and bitter orange peel as a cheap materials. In this experimental study, treated waste tea leaves and bitter orange peel were used as adsorbents for the removal of Pb (II) from aqueous solutions. Adsorption experiments were carried out as batch studies at different contact time, pH, amount of adsorbent and initial metal concentration.

.Introduction

Heavy metal pollution of aqueous streams is an important environmental problem in the world. Beyond any doubt, it is often established that dissolved substances, particularly heavy metals getting away into the environment, pose serious health hazards. To follow the fate of metallic species, once they enter into ecosystem, becomes very difficult and they start to inflict the damages as they move through, from one ecological tropic layer into another.[1]

Lead in the natural environment comes up from both natural and anthropogenic sources, all lead compounds are considered cumulative poisons. Lately, increasing interest has been focused on removing Pb(II) ions from drinking water due to its supreme toxicity to our health. Water to drink contaminated with Pb(II) ions for long term, even if in a very low concentration,

could lead to a wide spectrum of health problems, such as nausea, convulsions, coma, renal failure, cancer and subtle effects on metabolism and intelligence [2].

Tea is very readily available in much of the world and has been proven to exhibit a high removal efficiency and sorption capacity for Pb^{+2}. The surface of tea leaves contains many polar, aliphatic and aromatic function groups [3].

Lead is one of the most poison materials in environment pollutants. Its substance is used in paints and ceramics. It is also used for the production of antiknock compounds like tetraethyl lead for addition to petrol. One of the major sources of the environmental contamination by lead is the exhaust gases generated from vehicles which mainly contain oxides, halides and alkyl compounds of lead. It causes kidney, liver and mental retardation in children. Gastrointestinal damage. [4]

The performance of tea waste was compared to that attained with a similar biomass residue, coffee grounds and two commonly used adsorbents, activated carbon and Fuller's earth. [5]

Burned palm tree leaves powder could be used as efficient solid materials for removal of toxic Cd^{+2} from aqueous solutions [6].

Palm tree leaves were used as bio sorbents for the treatment of metals contaminated wastewater to remove the toxicity of these materials from aqueous solution have been established by several researchers in this field, copper was removed from aqueous waste using burned palm leaves [7].

Experimental section

Instruments:-

pH meter WTW, Shaker (Heidolph-unimax) , Furnce, Atomic bsorption (AAs aurrora) spectroscopy, Balance, Mill, deionize water system, Sieve (180 micron), Filtration device.

Reagents and Materials:-

Hydrochloric acid (HCl).

Sodium hydroxide NaOH.

Double-distilled water was used in all experiments.

Stock solution 1000 ppm of Pb(II) was prepared by dissolving 1.63 gm $Pb(NO_3)_2$ in double-distilled water The solutions of differentinitial concentrations were prepared by diluting the stock solution in appropriate proportions.

Preparation of adsorbents:-

Tea waste and bitter orange peel leaves were prepared from black tea and bitter orange peel as follow

the tea waste and bitter orange peel were washed and then rinsed with double-distilled water. After drying at 90°C, both substances were grounded and sieved at mesh size180µm. In order to minimize contact with humidity, they were kept in plastic stopper bottle containers, and, all these bottles were preserved in desiccators before the time of use.

General procedure method

All experiments were carried out in rotary shaker at 300 rpm using conical flasks containing 25 ml of Pb^{+2} as a feed solution at room temp (all these parameters have been fixed in this study) mixed with known amount of biosorbent. pH, biosorbent dosage, shaking time and Pb concentration were variable parameters. After each run, the solutions were filtered and the filtrates were analyzed to calculate the percentage of metal ion with atomic absorption.

Calculations :

metal removal percent and metal capacity has been calculated as following:

Removal (%) = (Co – Ce)/ Co * 100 .

q (mg/g) = [(Co-Ce)*V] / m .

where q is the amount of copper ion adsorbate capacity in (mg/g) . Ce the equilibrium concentration of ions after adsorption in (mg/l). Co initial concentration of ions in (mg/l) V is the initial volume of copper solution (L) m is the amount of dry added adsorbent in (g).

Results and discussion:

1-Effect of contact time

The effect of contact time on the batch removal of Pb^{+2} was studied at five period of shaking time (30,60, 90,120,180 min), with initial metal concentration of 91.25 ppm Pb^{+2} (25ml) at pH=5 and the adsorbents was 0.1gm tea waste and 0.1gm bitter orange peel.

As shown in table -1, the equilibrium of the reaction was eventually established after 30 min. and be stable.

Table-1:Effect of contact time on Pb^{+2} recovery

	Time (min)	Pb^{+2} recovery %
1	30	65.75
2	60	68.5
3	90	71.7
4	120	65.20
5	180	67.1

2- Effect of pH

A pH range of (3,5,7,9) were studied to investigate the influence of this factor on Pb^{+2} recovery, the run carried out at 120 min, 0.1:0.1 gm weight of both adsorbents was used in 91.25ppm lead concentration. The results observed in table-2 show that the best pH for completely lead recovery was pH=3.

Table-2: Effect of pH on Pb^{+2} recovery

	pH	Pb^{+2} recovery %
1	3	100
2	5	99.15
3	7	89.94
4	9	76.93

3-Effect of the weight on Pb recovery

Although Pb removal was found hundered percent at acidic medium at pH=3, different ratios of adsorbents were shaked with 91.25 ppm solution of lead ion for 120 min at basic medium pH=9.,The results seen in table-3 show that the perfect recovery obtained in the same ratio of adsorbents (0.1: 0.1) which reaches 91.49%

Table-3 : effect of the weight of adsorbent on Pb^{+2} recovery

	bitter orange peel (gm)	Tea waste (gm)	Pb^{+2} recovery %
1	0.1	0.1	91.49
2	0.05	0.15	89.24
3	0.15	0.05	87.98
4	0.2	0	84.75
5	0	0.2	86.84

Effect of the concentration:-

Five different concentration of Pb^{+2} solutions were treated with 0.1: 0.1 ratio of adsorbents at pH= 9 for 120 min. The results obtained in table-4 reflects the highly recovery of lead among 20 ppm as Pb^{+2} conc.

Table-4: effect of concentration of solution on Pb recovery

	Conc. (ppm)	Pb^{+2} recovery %
1	20	95.68
2	40	94.71
3	60	92.23
4	80	93.08
5	100	91.25

Conclusion

To evaluate the activity of the mixed adsorbents used in this work and from the obtained results , it can be concluded the importance of this mixture in the treatment of toxic liquid waste contaminated with heavy metal (lead) especially the outlet of refractory of batteries. The optimum condition for this process is as follow: pH 3 and 9, weight ratio 1:1 , time : 30 min, lead solution concentration 20 ppm.

Capacity (q) = 11.16 mg/gm

References

1- P. Goyal, S. Sharma, M. Srivastava, M. Srivastava and S. Indica. leaf powder for decontamination of Pb: removal, recovery, adsorbent characterization and equilibrium modeling, *Int. J. Environ. Sci. Tech*., 5 (1), pp:27-34, 2008.

2-M.Cheraghi,S., Sobhana R. Zandipak; B. Lorestani; and H. Merrikhpour , Removal of Pb (II) from Aqueous Solutions Using Waste Tea Leaves, *Iranian Journal of Toxicology*, 9(28), pp:1247-1253, 2015.

3-S. Yeo, S. Choi, V. Dien, Y. Sow, G. Qi and T. Hatton, Using agnetically Responsive Tea Waste to Remove Lead in Waters under Environmentally

Relevant Conditions, 8(6), pp:1-7, 2013.
4- B. Shrestha, J. Kour, Puspa Lal Homagai, M. Raj and K. Nath, Surface Modification of the Biowaste for Purification of Wastewater Contaminated with Toxic Heavy Metals Lead and Cadmium, *Advances in Chemical Engineering and Science*, 3, pp:178-184, 2013.
5- A. Zuorro and R. Lavecchia, Adsorption of Pb(II) on Spent Leaves of Green and Black Tea, *American Journal of Applied Sciences* 7 (2): pp:153-159, 2010.
6-S. Jassim, F. Ali, T. Mussa and A. Abdulla, REMOVAL OF DIVALENT CADMIUM FROM AQUEOUS SOLUTION BY BURNED PALM TREE LEAVES POWDER, *International Journal of Current Research* 6(08), pp.7812-7815, 2014.
7-S. Jassim, R. Gimaa, N. Khames and A. Farhan, Removal efficiency of copper (II) from aqueous solutions using Iraqi palm tree leaves, *Diyala journal for pure sciences*, 10(3) pp(68-72), 2013.