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PRESENCE OF HEAVY METALS IN SOLID WASTE LEACHATE AND ITS REMOVAL USING AGRICULTURAL WASTE

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Abstract

Municipal solid waste leachate contains many contaminations like organic pollutants and toxic metals which cause serious effect on human health and environment. In this study, removal efficiency of toxic metals including Pb, Cr, Cu and Co by using agriculture waste adsorbents i.e. rice husk and corn cub was observed. Under Batch sorption experiment the parameters including contact time, dosage of adsorbents and pH were studied. Concentration of metals was determined by using atomic adsorption spectroscopy and it was observed that various adsorbents exhibited differently at various pH levels, the adsorption efficiency is directly proportional to contact time and metals ion concentration is inversely proportional to the amount of adsorbents. Rice husk showed better adsorption (90 to 95 %) at pH range (2-5) and corn cub performed relatively better (90%) at neutral pH 7. It was found that Removal of heavy metals using locally available agriculture waste is cheaper and environmental friendly.

Key words:

Municipal solid waste leachate, Heavy Metals, Adsorption efficiency

Introduction

Landfill leachate is a complex wastewater generated when the moisture content of a landfilled solid waste is higher than its field capacity [1]. The organic carbon compounds (e.g. BOD, COD), nitrogenous compounds, and metal ions are generally main pollutants in landfill leachate [2, 3]. The quality and quantity of leachate varies from landfill to landfill, and over times, as a particular landfill ages, that is why the selection and design of leachate treatment system are not so simple.

Landfill leachate often contain various toxic metals such as Barium, Copper, Nickel, Calcium, Cadmium, Chromium, Mercury, Zinc and Cobalt [3]. Varieties of industrial activities become cause of these heavy metals origination and waste sources and some are well known toxic and carcinogenic. The environment is threated by residual metals on the one hand and on the other hand theses metals cause serious detrimental effects on aquatic ecosystems [4]. Sometimes landfill leachate permeates through landfill liners and becomes cause of contamination of the ground water. So we can say that the

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removal of heavy metals from landfill leachate is important matter that requires proper consideration.

Traditionally, conventional landfill leachate treatment processes have been similar to those that have been used for regular wastewater. The main approaches include: biological, physical and chemical treatment processes. Biological treatment processes primarily remove high concentrations of organic compounds. However, to date, there is no evidence indicating that biological leachate treatment processes can provide the adequate microbial transformations of heavy metals through the selection of suitable microorganism [5, 6]. Besides most chemical and physical treatment processes prove costly when removal of heavy metals considered [7,8]. It has been identified by several researchers that adsorption is the most appropriate process for heavy metals removal [9,10].

Activated carbon is used as the main adsorption medium in traditional adsorption processes, but it is not so cheap and particularly effective for heavy metals. Many investigations have shown that natural low cost materials as adsorbents for heavy metals removal from aqueous solution and waste water, are alternative to activated carbon. These include: chitin and chitosan [11], macroalgae [12], etc. In this study rice husk and corn cob were tested as potential natural adsorbents for the removal of heavy metals from leachate. In Pakistan, there are extensive unexplored agriculture wastes, which are following the hierarchy of waste management strategies. There wastes possess high efficiency of adsorption and can be utilized for the treatment of waste water.

MATERIALS AND METHODS

Material collection

The municipal solid waste leachate and low cast agricultural adsorbents were collected from different places. Leachate was collected from Losar Dumpsite (an official dumpsite of Rawalpindi city), Pakistan. Per day municipal solid waste is dumped in Losar is about 1,200 metric tons. Most of the waste which is dumped is organic. Low cost agricultural adsorbents includes Rice Husk and Corn Cob were collected from local market where these are readily available.

Leachate and Adsorbents Preparation

Leachate was filtered using filter paper of 0.1µ to remove suspensions for further experiment. The adsorbents were also washed in plastic tubs to clean them from dust using distilled water. Adsorbents were then oven dried at 105ºC for 24 hours [13]. Adsorbents were ground to make in powder form using laboratory mill, then sieved to 0.2mm. The material is quite ready for experimental analysis.

Experimental Setup

The batch experiment was used for adsorbent analysis. In batch experiment 50ml leachate sample with different dosage 1, 2, 3, and 4g of adsorbent add in 250ml flask and flask was kept on shaking using Shaker (Thermolyne Sybron, Big Bill SE Rotator/Shaker) at 150 round per minute in different 1, 2, 3, and 4hrs time intervals at constant temperature 18º C ± 2. The pH of leachate was changed by using 0.1M H_2SO_4

and 0.1N NaOH solutions. After shaking at different time intervals sample was then filtered using filter paper of 0.1µ and prepared for metals analysis using Atomic Absorption Spectroscopy (AAS).

Leachate analysis

The basic parameters of leachate, pH and Electrical Conductivity were analyzed using pH meter (WTW pH 526) and EC meter (inoLab pH/Cond 720). The analysis of chemical oxygen demand was conducted in PTFE vial which were heated in COD reactor (HACH) at 120oC for 2 hrs. X-Ray Fluorescence (XRF) Elemental Analyser JEOL JSX 3202 M Elemental Analysis (Na-U) was used to analyse metals present in leachate. The Atomic Absorption Spectroscopy (AAS) (AAnalyst 800) was used for quantitative analysis of metals present in leachate.

The amount of metal ion adsorbed was calculated by using equation 1;
% adsorption = (Co – Ce)/Ce X 100 (1)
Where;
Co = Initial concentration of metal ions
Ce = Final concentration of metal ions

RESULT AND DISCUSSION

Effect of Contact time

The effect of contact time of adsorption efficiency has been showed in figure 1 for rice husk and in figure 2 for corn cob. Our results showed that the adsorption efficiency is directly proportional to contact time. The adsorption increased with increased the contact time till the equilibrium attained. This is concurrent with previous studies [14]. The percent adsorption of different metals found different the Pb (89.5%), Cr (90.1%), Cu (86.1%), Co (78.9 %) for rice husk and Pb (80 %), Cr (77.6 %), Cu (75.6 %), Co (62.5 %) for corn cob were found. Maximum adsorption obtained at 4 hours contact time. There is no significant effect on adsorption by increasing further contact time, it may be due to the saturation of active sides of adsorbent and achievement of equilibrium at 4 hours.

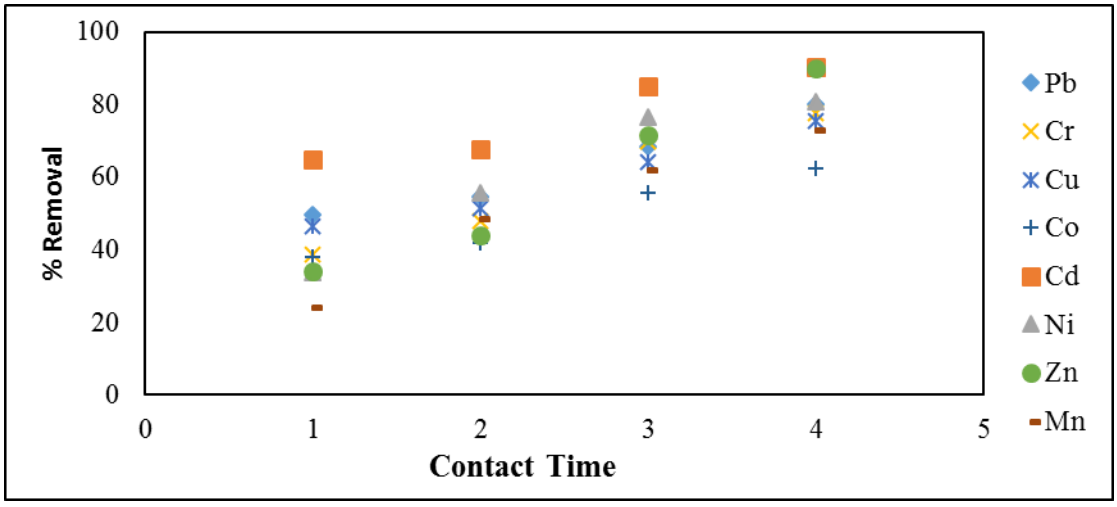


Figure 1: Effect of contact time using 4 g sorbent dose of rice husk

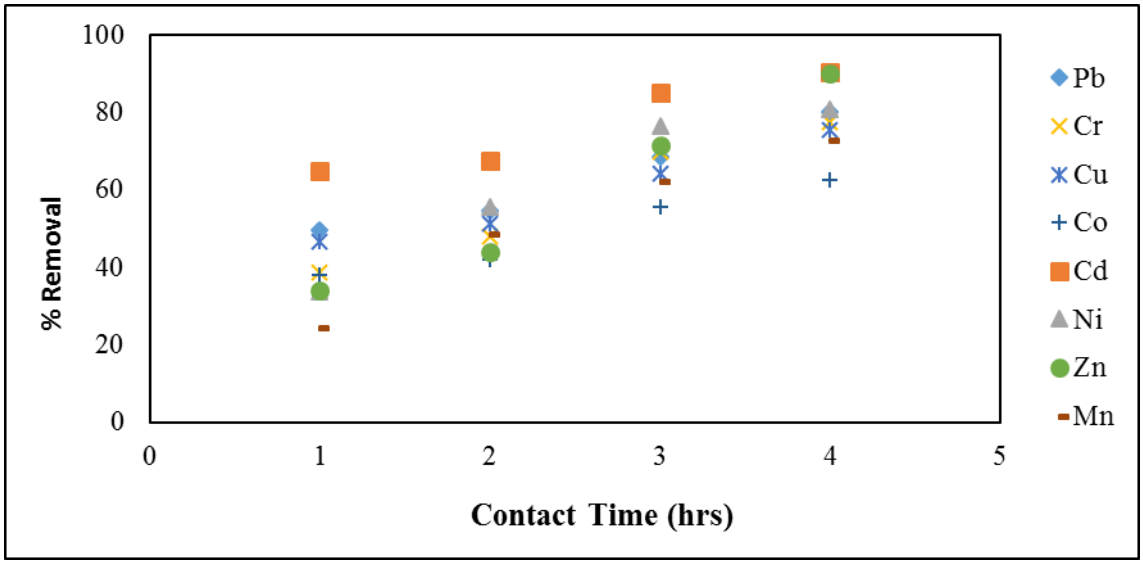


Figure 2: Effect of contact time using 4 g sorbent dose of corn cob

Effect of Dosage

The effect of dosage of adsorbents on the removal of heavy metals by rice husk is shown in figure 3 and by corn cob is shown in figure 4. The percent adsorption of different metals found different the Pb (89.5%), Cr (90.1%), Cu (86.1%), Co (78.9 %) for rice husk and Pb (80 %), Cr (77.6 %), Cu (75.6 %), Co (62.5 %) for corn cob were found. It is anticipated that metals ion concentration is inversely proportional to the amount of adsorbents, which means that heavy metals concentration in solution decreases with increasing the dose of adsorbents till the equilibrium is attained. This is concurrent of the previous studies [15].

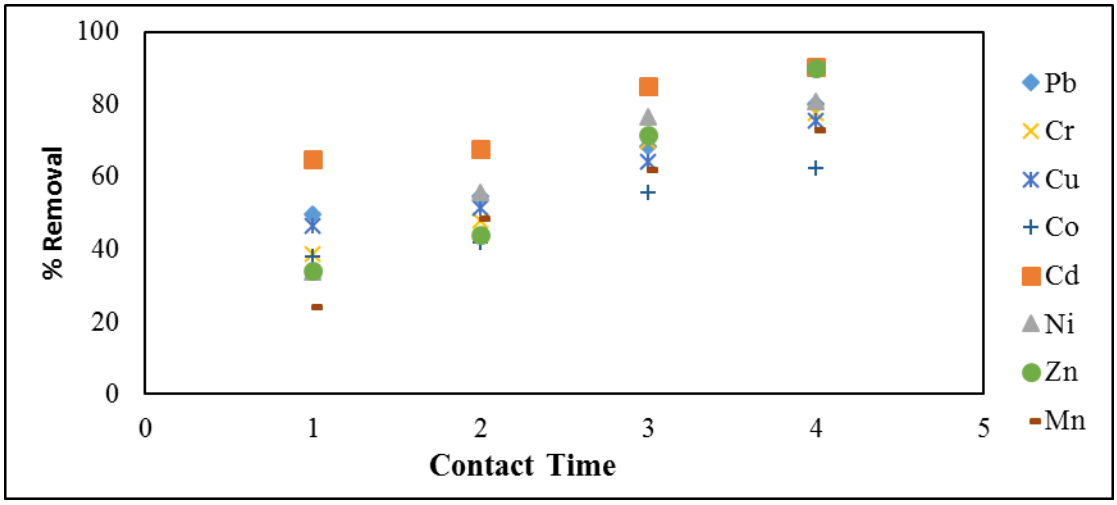


Figure 3 : Effect of sorbent dose of rice husk

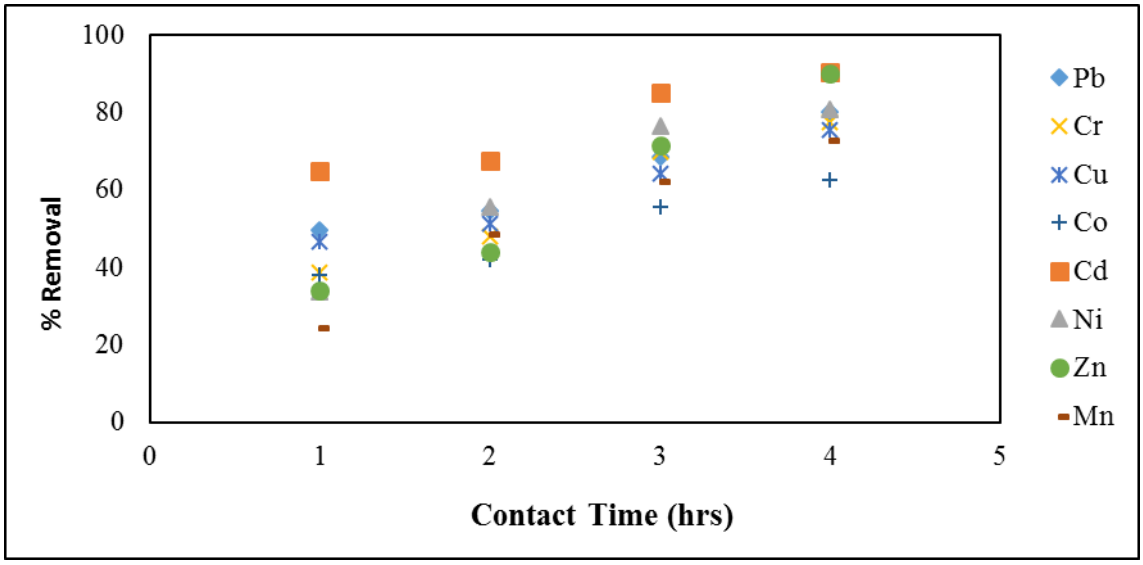


Figure 4: Effect of sorbent dose of conr cob

Effect of pH

When optimum contact time and dosage of adsorbent was identified then further to verify the pH effect as one of important factors on the heavy metals (Pb, Cd, Cr, and Co) removal using rice husk and corn cob, different experiments were performed by changing pH of leachate i.e. 2, 5, 9 and 11. It is also reported by several scientists that adsorption is pH dependent [16, 17]. Our results showed in figure 5 and figure 6, the maximum adsorption efficiency of rice husk obtained at pH 2 for Pb (95 %), Cr (93.7 %), Cu (93.3 %), Co (90.4 %) and for corn cob Pb (80 %), Cr (77.5 %), Cu (75.6 %), Co (62.5 %) at pH 7.5.

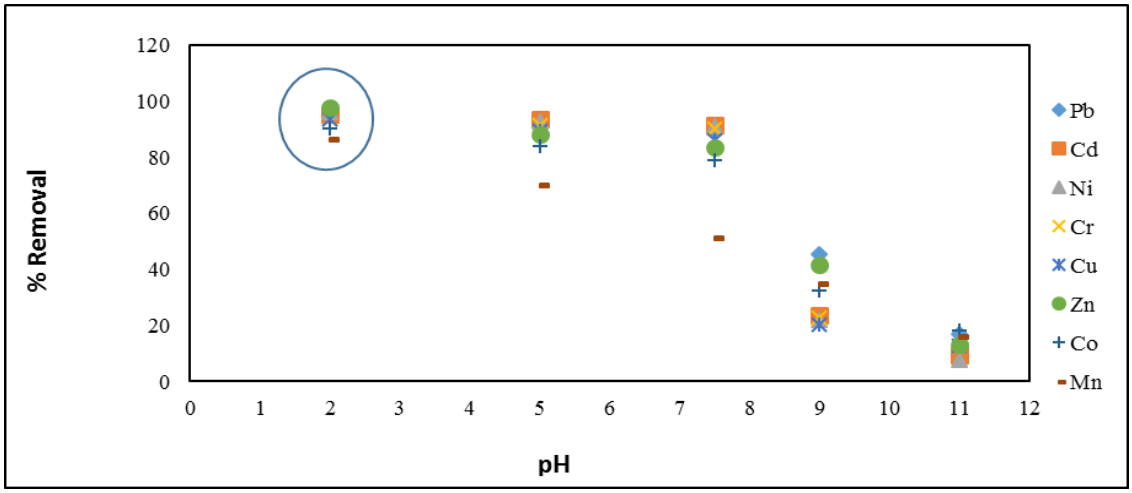


Figure 5: The removal of heavy metals in % studied at various pH using rice husk

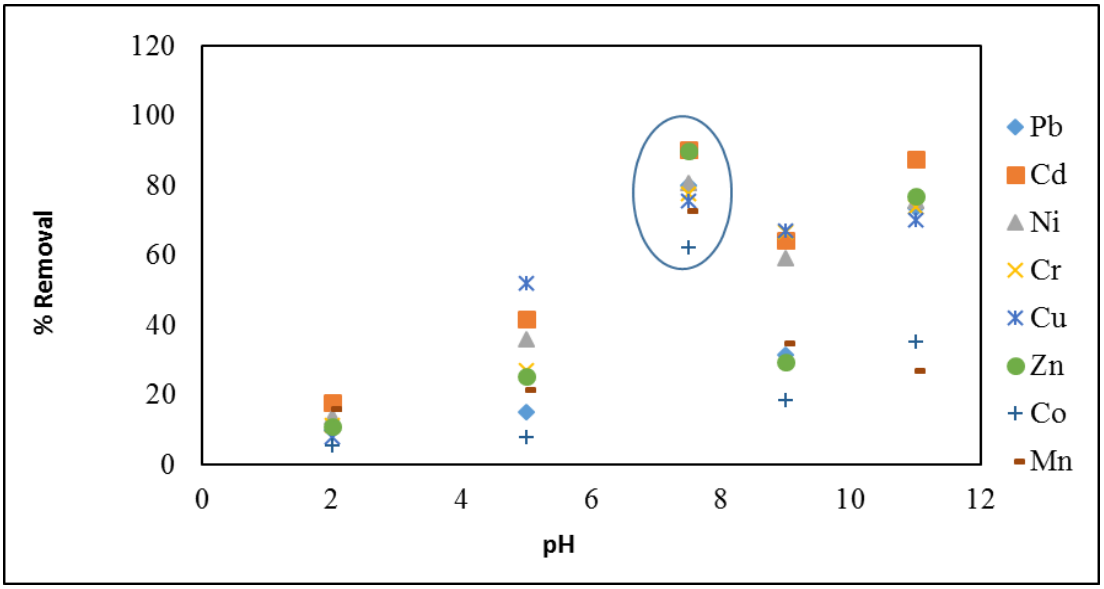


Figure 6: The removal of heavy metals in % studied at various pH using corn cob

Conclusion

The rice husk and corn cob are low cost easily available agricultural waste substances and are very effective adsorbents for heavy metals removal in leachates solution. The removal efficiency of rice husk (95 %) is significantly better at pH 2 as compare to the removal efficiency of corn cob (90%) which showed better efficiency at neutral pH. The rice husk and corn cob are very useful adsorbents for the removal of heavy metals in municipal solid waste leachate.

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