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EXPERIMENTAL STUDY ON REMOVAL OF TOXIC METALS FROM LEACHATE USING RICE HUSK AND FLY ASH

C. Vaishnavi[1], E. Vasumathi[2], P. Visva Barathy[3], M. Sathya[4], Y. Sathya[5]

[1,2,3,4]UG Student, Department of Civil Engineering, Valliammai Engineering College, Tamil Nadu, India
[5]Assistant Professor(O.G),Department of Civil Engineering, Tamil Nadu, India

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ABSTRACT - *Leachate is one of the major problems for Municipal Solid Waste (MSW) landfills and cause significant threat to surface water and ground water. It may contain large amount of organic matter, chlorinated organic and inorganic salts and heavy metals. Therefore in this study rice husk and fly ash are used for the removal of toxic metals from the leachate. Sorption takes place due to rice husk. This study purposes to investigate the ability of rice husk to remove Cr, Cu, Ni and other traces. Adsorption increases with increase in pH was studied. Results show that these low cost adsorbents can be used for removal of toxic metals.*

Keywords: **Leachate, toxic metals, Sorption, Adsorption, adsorbent.**

1. INTRODUCTION

Leachate generation is a major problem for MSW landfills and causes threat to surface water and ground water due to the presence of large amount of organic matter, heavy metals, chlorinated organic and inorganic salts. Leachate from landfill depends on age and type of waste it contains. These substances cause major hazards to the world and can last for many years.[1] The dump yard contains all types of Municipal E-waste, agricultural etc. Electronics waste like batteries and television are dumped in a landfill for many years. So the water that percolates through this waste contains toxic metals which eventually end up in our environment causing severe problem to human health. The heavy metals present in the Leachate may contain atomic density more than 5. Generally Landfill leachate contains Lead, Cobalt, Chromium, Nickel, Zinc, Iron that causes threat to the environment.

There are many conventional methods for removing toxic heavy metals from Landfill Leachate. Thus it is a challenge to find the proper treatment to remove the Toxic metals on Landfill Leachate.

Adsorption is an alternative method for economical treatment of Leachate. Compared to all other treatment method, the adsorption process seems to be appropriate techniques due to its wide applications such as economic feasibility, Ease of operation, simplicity in design etc.

Generally heavy metals are present in the Leachate at low concentrations and adsorption is suitable even when the metal ions are present at concentrations as low as 1 mg/L. One of the conventional adsorbent is activated carbon that has been used in many applications. But due to the high cost of activated carbon it is not much economical. Hence an alternative method of adsorption technique is choosing low cost adsorbents for the treatment of Leachate.

In this study Rice husk and Fly ash are used as adsorbents for Adsorption method. Due to the increased production of agricultural waste and waste generated from industries this kind of adsorbents are used. In this study the husk is converted into Granular Activated Carbon (GAC) for increasing the adsorption process. Rice husk involves in Sorption process and GAC undergoes Adsorption process.

The adsorption increases when the surface area increases due to the incineration method while treating Rice husk.

The Granular Activated Carbon has high carbon content that tends to increase the Adsorption. Fly ash is used for Absorption process. Rice husk is used in the adsorption of metals like Chromium (Cr), Nickel (Ni), Copper(Cu) and Lead(Pb). Fly ash is used for the removal of Lead (Pb). In this study, the maximum metal removal efficiency was attained at pH 6. The adsorption increases with increase in contact time and pH were also studied.

2. MATERIALS AND METHODS

2.1 MATERIALS

2.1.1 ADSORBENT MATERIAL

In this study the leachate is treated using low cost adsorbent such as rice husk and fly ash. The rice husk has been collected from the local rice mill. It was washed with distilled water for several times to remove the impurities and dirt particles. To remove the remove moisture, it was dried at 100°C for 4hours.The fly ash has been collected from the paper industry in Madurantakam.

2.1.2 REAGENTS

Potassium hydroxide (KOH) was used for activation of the adsorbent distilled water for raising the solubility and Hydrochloric acid (HCl) for adjustment of pH. Since the molecular weight of KOH is 56, the ions are more and hence adsorption increases.

2.1.3 EQUIPMENT

The following laboratory equipment were used in the study, Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) for metal analysis like copper, chromium and nickel, Scanning Electron Microscope(SEM) to determine the morphological aspect of GAC, Energy Dispersive X-Ray Spectroscopy(EDAX) for elemental analysis of GAC.

2.2 METHODS

2.2.1 PREPARATION OF ADSORBENT

The rice husk is washed and dried off to remove the dust and adhered particles. Potassium hydroxide pellets were used as an activating agent for preparing GAC. 8.2g of Potassium hydroxide pellets was weighed and soaked in 100ml of distilled water to form a solution. Add 2g of rice husk and let it soak into a solution. 7 parts of Potassium hydroxide, 2 parts of rice husk and 1 parts of distilled water is taken to form 1 molar concentration of solution. After 24 hours the husk is filtered and dried in Muffle furnace for about 3 hours at 600°C. Then the activated carbon is hydrolyzed and dried in oven for about 2 hours at 105°C and further dried in muffle furnace to convert into Granular Activated Carbon.

The Rice husk is converted to Granular Activated Carbon for increasing the adsorption process by the incineration method. So to increase the adsorption,

Potassium hydroxide is dissolved in the husk and is incinerated. Therefore surface area of the husk increases. When the surface area of the husk increases the metal uptake also increases.

Fig -1: Granular Activated Carbon from rice husk

3. RESULTS AND DISCUSSION

3.1 LANDFILL LEACHATE SAMPLE

Leachate generated at landfill is collected from nearby dump yard at Pallikaranai. The characteristics of leachate such as COD, BOD, Dissolved Oxygen, TDS, TSS, turbidity and hardness is analyzed and preserved in refrigerator at 2°C. In this study Cr, Cu and Ni was analyzed by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES).

Table -1 Characteristics of Leachate

PARAMETERS	CONCENTRATION	UNIT
pH	7.9	-
Turbidity	242	mg/L
BOD	90	mg/L
COD	235	mg/L
Hardness	541.05	mg/L
TDS	389	mg/L
TSS	400	mg/L
Dissolved Oxygen	7	mg/L
Cr	0.037	mg/L
Cu	0.458	mg/L
Ni	0.441	mg/L

3.1 CHARACTERISATION OF ADSORBENT

The adsorbent characteristics is determined by Scanning Electron Microscope (SEM) and Energy Dispersive X-Ray Spectroscopy (EDAX) analysis. From SEM analysis it is found that the surface of the GAC adsorbent is non uniform. So the adsorption increases. If the surface of the adsorbent is uniform the adsorption does not takes place.

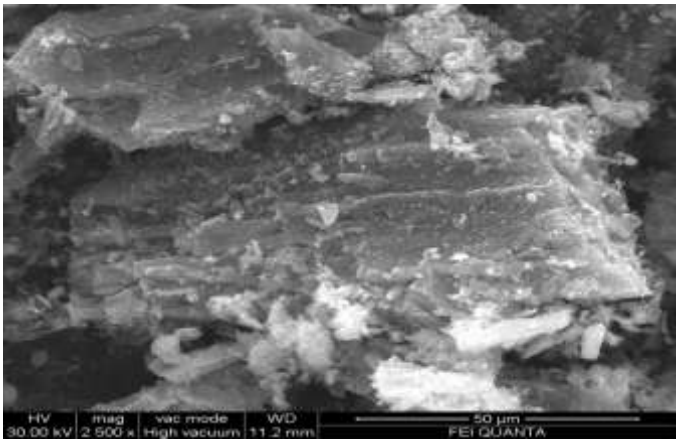

Fig-2 Surface of Granular Activated Carbon

The Energy Dispersive X-Ray Spectroscopy (EDAX) analysis is made for GAC and it is found that carbon is present in GAC. Due to increased mass percentage of carbon the adsorption is increased. So it is proved that the GAC has more adsorption than Rice husk due to its surface characteristics.

Table-2 Elements present in GAC

Element	At.no	Mass Norm	Atom	Abs. Error	Rel. Error
	%	%	%	%	%
C	6	49.77	55.85	13.25	26.6
O	8	34.97	24.96	13.06	37.3
N	7	15.26	14.68	10.84	71.0
S	16	0.00	0.00	0.00	1.69
		100	**100**		

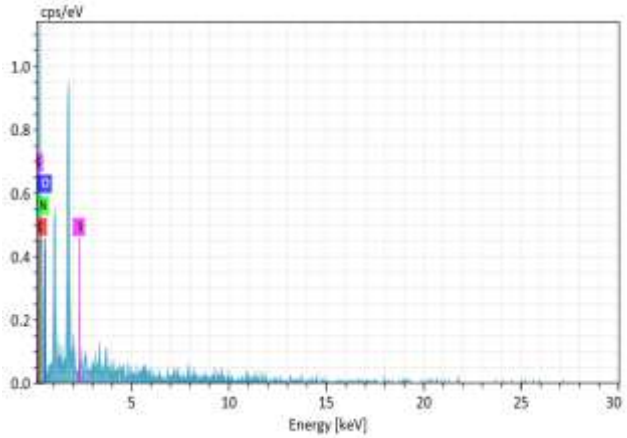

Fig-3 Elemental Analysis

3.2 ICP-OES ANALYSIS

Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) is a multi-element analytical technique used for the detection of chemical elements. In this study the metals present in the sample were analyzed by Perkin Elmer, Model: Optima 5300 DV ICP-OES.

Table-3 Percentage of metal removal for Cu

S.no	Name of the sample	Dilution Factor	% of removal (mg/L)
1	Raw Leachate	10	0.458
2	Rice Husk		0.215
3	GAC		0.091

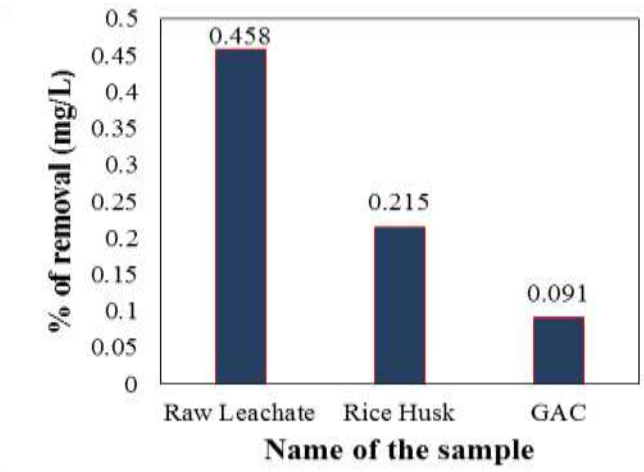

Chart-1 Percentage of metal removal for Cu

Table-4 Percentage of metal removal for Cr

S.no	Name of the sample	Dilution Factor	% of removal (mg/L)
1	Raw Leachate	10	0.037
2	Rice Husk		0.020
3	GAC		0.009

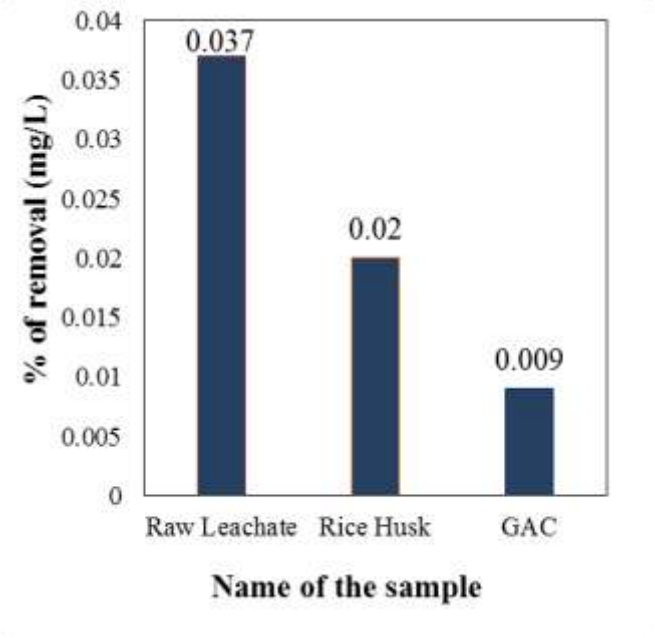

Chart -2 Percentage of metal removal for Cr

Table-5 Percentage of metal removal for Ni

S.no	Name of the sample	Dilution Factor	% of removal (mg/L)
1	Raw Leachate	10	0.441
2	Rice Husk		0.305
3	GAC		0.157

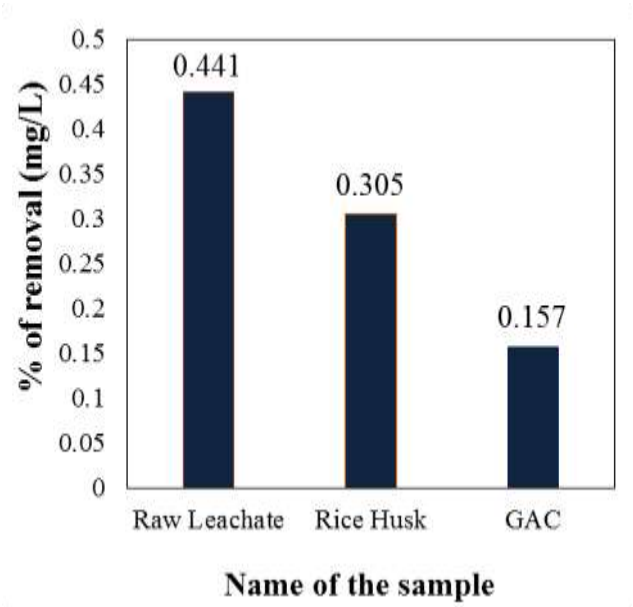

Chart-3 Percentage of metal removal for Ni

Table -6 Effect of pH

S.no	Metals Identified	Range of pH	Dilution Factor	% of removal (mg/L)
1	Cu	2	10	0.075
	Cr			0.027
	Ni			0.289
2	Cu	4		0.126
	Cr			0.035
	Ni			0.300
3	Cu	6		0.001
	Cr			0.013
	Ni			0.164

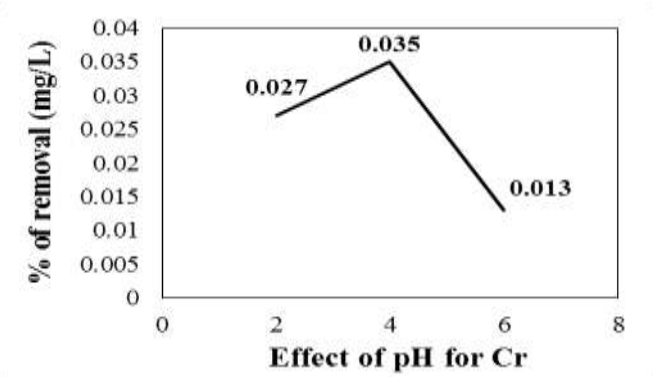

Chart-4 Effect of pH towards removal of Cr

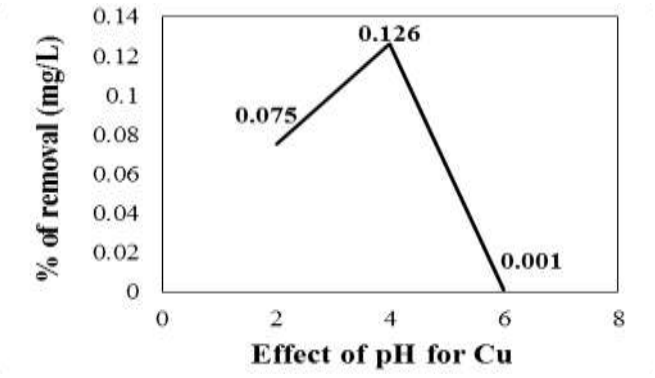

Chart-5 Effect of pH towards removal of Cu

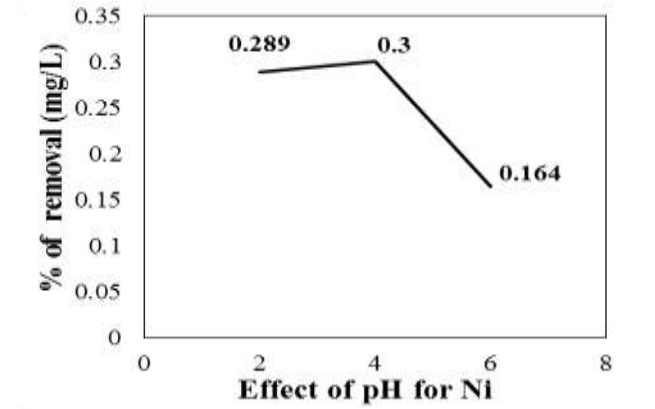

Chart-6 Effect of pH towards removal of Ni

4. CONCLUSION

A number of methods are used for the removal of toxic metals from Leachate water, but it has several disadvantages like high cost and input of chemicals. So in this study the rice husk and fly ash were used for the removal of toxic metals. The use of GAC prepared from Rice husk is proved to be the best and economic adsorbent for removing the toxicity from the Leachate water. From the above experimental procedure and test result it is proved that the maximum metal removing capacity is achieved at pH 6 at which heavy metals like Ni, Cu and Cr were removed from the Leachate by 100^{th} parts upto 80%. Odour and Color were removed by this treatment process. `

5. REFERENCES

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