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Utilization of Solid Waste for Treating Leachate

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ABSTRACT
The adsorption process is widely used for the removal of heavy metals from leachate because of its low cost, availability and eco-friendly nature. Both commercial adsorbents and bio-adsorbents are used for the removal of heavy metals from leachate, with high removal capacity. Hence in many of the landfills, adsorption is one of the very commonly used method. It is therefore very important that the adsorbents used are economical; considering the fact that these the leachate has no other use attached to it. Furthermore if the adsorbents are solid wastes or from such sources, it would be more effective and efficient considering the whole scenario.

Key words: Leachate, heavy metal, adsorption, removal rate

I. INTRODUCTION

Leachate is the liquid formed when waste breaks down in the landfill and water filters through that waste. This liquid is highly toxic and can pollute the land, groundwater and waterways.This problem could be worsened in the case of a landfill leachate, which is the liquid that exists as part of rainwater entering the landfill but is also due to the natural decomposition of organic material along with other liquids and chemicals that have been discarded. Rainwater passes through the waste in the landfill and if the landfill is not properly lined or the leachate is not properly managed, it is at great risk of mixing with the groundwater near the site or any water body, in the vicinity, especially in the lower gradient.

The pollutant composition of the leachate is important so that appropriate treatment systems could be installed for reducing or eliminating them. Leachates are composed of organic and inorganic substances. Organic substances consist of microorganisms, their metabolic products and materials from living organisms which are undergoing decay. Inorganic pollutants in the leachate consist of ammonium, phosphorous, sulphate and metals. Along with the substances mentioned above leachate contains many others that are undesirable because of their negative effect on the environment and human life.

Inorganic substances can have an impact on turbidity and deposits on pipes (Iron), increase the hardness of water (Calcium & Magnesium). Organic substances have an impact on colour, odour and taste of water. Nutrients such as ammonium and phosphorus contribute to the eutrophication of receiving waters which can lead to algae blooms.An important part of maintaining a landfill is the managing of the leachate to prevent pollution into surrounding ground and surface waters.

Since the discharge of the leachate into the ground and thus would find the way into ground water and nearby watersources such as lakes or rivers, if any change in altitude. The leachate would consist of wastes from industry and other sources containing organic and inorganic pollutants. Manyatimes the leachate consists of high levels of heavy metals which should be removed it so that it wouldn't affect the water sources by contamination. Often these heavy metals are toxic/or carcinogenicwhich are harmful to both humans and other living species.

Heavy metals pollution has raised serious environmental concerns worldwide because bio-accumulation of these elements beyond the tolerance thresholds of living organisms pose long term risk to the earth's ecosystem (Voegelinet al., 2003; Sparks, 2005). The main flows of heavy metals to the environment are from industrial and municipal wastes, both of which contained a variety of toxic heavy metals.

Heavy metals in leachate from landfills have been extensively studied and monitored (Yong, 2001; Selim and Sparks, 2001). The major part of the metals is retained in the landfill. As a consequence, it must be expected that leaching of heavy metals from the landfills will continue for a long time (Freeze and Cherry, 1979; Fetter, 2001;

Selim and Sparks, 2001; Yong, 2001). It can take years before groundwater pollution reveals itself and chemicals in the leachates often react synergistically and often in unanticipated ways to affect the ecosystem (Lee and Sheehan, 1996).

The heavy of most concern from industries include Lead(Pb), Zinc(Zn), Copper(Cu), Arsenic(As), Cadmium(Cd), Chromium(Cr), Nickel(Ni). They originate from sources such as metal complex dyes, pesticides, fertilizers, fixing agents etc.

Though there are many treatment technologies available for aiding in the heavy metal removal one very effect method most commonly used is adsorption.

II. OBJECTIVE

In this paper proper understanding of different solid wastes which could act as an potential adsorbent has been made. Out of the total potentialadsorbents based on the source they have been classified namely as natural adsorbents, agriculturalwaste, industrial solid waste and plastic waste.

And for all the above-mentionedpotential adsorbents, the assessment of heavy metal adsorption has been made referring to different factors which play a important role in the rate of adsorption and as well the quantity of adsorption. These factors include the influence of adsorbent dosage, effect of ph, effect of contact time etc.

And based on these factors the most suitable adsorbent and their optimum conditions have been identified.

III. MATERIALS AND METHODS

ADSORPTION

Adsorption relies on the physical and chemical interactions between heavy metal ions and adsorbents.

Usage of Solid Waste as Adsorbents

For the treatment of leachate adsorbents of high cost might not be suitable as because the main purpose is only stopthe leachate fromcontaminating the groundwater and nearby water sources if any. So, the usage of the Solid waste would be very useful and efficient solution.

Some of the solid waste for adsorption could be mainly split into different types based on their source namely natural adsorbents, industrial solid waste, inorganic solid wate, municipal waste, plastic waste.

The natural adsorbents include vegetable fibres, rice husk, straw, sawdust, peat, hay, kapok, certain kinds of wood etc.

The industrial solid waste include NHISW, red mud, activated carbon, alkali modified fly ash, food industry waste, granite and marble industry waste, class 4 bricks and brick powder, raw clay and broken clay-brick waste.

Inorganicsolid waste includes air-cooled blast furnace slag, water quenched blast furnace slag, steel furnace slag, coal fly ash, coal bottom ash. water treatment sludge, red mud.

The plastic wastes which could be used for adsorption include polypropylene waste, low density polyethylene (LDPE) waste, modified PET fiber, polyacrylic acid-polyvinylidene fluoride (PVDF) blende polymer adsorbent etc

IV. THE RESULTS

A. Soil Type

The adsorption results of the soils of different types and their ability to adsorb heavy metals

1) **For Copper** – The maximum adsorption occurs by using clay soil as an absorbent. Theminimum adsorption occurs by using silty soil as an absorbent.

2)**For Zinc**- The maximum adsorption occurs by using claysoil as an absorbent The minimum adsorption occurs by using silty soil as an absorbent.

3) **For Manganese** – The maximum adsorption occurs by using claysoil as an absorbent The maximum adsorption occurs by using clay soilas adsorbent.

4)**For Chromium** – The maximum adsorption occurs by using clayey soil as an absorbent The minimum adsorption occurs by using siltysoil as an absorbent.

Among all the soils, the maximum adsorption occurs in the clayey soil with zinc. The minimum adsorption occurs in the silty soil with copper.

B. Natural organicadsorbents

The below table shows a list of different types of natural adsorbents which could be use and their removal rate

Adsorbent	Heavy metals	Remarks	Source
Palm Kernel Shell	Chromium, Lead, Zinc and Cadmium	Highest contact time 120 min	Baby and Hussein, 2020
Palm Kernel Shell	Cadmium	Highest contact time 150 min, decreases at 180min	Faisal et al.,2019
Pomegranate Peel	Nickle	Sharply increased during the first 30min; gradually achieved the equilibrium in 150 min	Elsayed et al.,2020
Kenaf Fibre	Iron, Manganese, Zinc, Arsenic, Copper, Nickle	The contact time will eventually reach a maximum value at a certain point and remain constant	Saeed et al.,2020
Mango Leaf	Chromium and Iron	Adsorption takes place at 120min of interaction time	Duraisamy et al.,2020
Coffee Shell	Lead	In the first 30min until min. 90 the adsorption rate is slow; however from minute 90 until min. 150 ultimately the adsorption equilibrium occurs	Junair et al.,2019
Chestnut Shell	Chromium	An increase in adsorption was seen at initial 60-300 min thereafter remained constant	Singh et al.,2020
Jackfruit Peel	Lead and Chromium	Range of between 15minutes to 24hours. Adsorption was rapid during the	Ibrahim et al.,2020

		first 1 hour of contact but gradually decreases up to the point where equilibrium is achieved.	
Oil Palm Ash	Manganese	Within 80min the system reached equilibrium	Chowdhury et al.,2011

Table 1 – Credits Journal of Ecological Engineering 2021, 22(3), 249-265

The rate of adsorption depends on a number of factors namely the effect of ph, adsorbent dosage and contact time

Effect of Ph

For the set of natural adsorbents, the effect of pH on Heavy metal adsorption has also been specified

Adsorbent	Heavy metal	pH range	Optimum pH value	Adsorption capacity	Source
Pomegranate peel	Nickle	4 to 9	9	98%	Elsayed et al., 2020
Kenaf Fibre	Iron, Manganese, Zinc, Arsenic, Copper, Nickle	3 to 11	7	Between 5% to 30%	Saeed et al ., 2020
Mango Leaf	Chromium and Iron	2 to 10	8	99% to 99.5%	Duraisamy et al., 2020
Palm Kernel Shell	Chromium, Lead, Zinc and Cadmium	2 to 6	6	60% to 80%	Baby and Hussein , 2020
Chestnut Shell	Chromium	2 to 12	7	78%	Singh et al.,2020
Banana Peel	Copper, Nickle and Lead	0.6 to 7.4	5.7 to 7.4	40%, 51% and 54%	Thuan et al., 2017
Jackfruit Peel	Lead and Cadmium	4 to 9	7	50% to 90%	Ibrahim et al., 2020
Pistachio Hull	Nickle	2 to 10	6	60% to 90%	Beidokhti et al., 2019
Oil Palm Ash	Copper	2 to 8	8	50% to 94%	Chowdary et al., 2011
Oil Palm Shells	Nickle, Lead and Chromium	3 to 10	8	Up to 70%	Rahman et al., 2014

Table 2 – Credits Journal of Ecological Engineering 2021, 22(3), 249-265

Influence of Adsorbent Dosage

The influence of adsorbent dosage on the removal of heavy metal has been specified

Adsorbent	Adsorbent dose	Heavy metals	Removal capacity	Source
Mango Leaf	20 to 100mg/l	Chromium and Iron	Chromium: from 93.4% to 99.6% Iron: from 89.4% to 99.4%	Duraisamy et al.,2020

Chestnut Peels	0.2 to 1.0 g	Chromium	60% to 79%	Singh et al., 2020
Banana Peels	0.9 to 2.4 g/l	Copper, Nickle and Lead	Copper: 40%, Nickle: 51% and Lead: 54%	Thuan et al.,2017
Pistachio Hull	5 to 30 g/l	Nickle	66% to 76%	Beidokhti et al.,2019

Table 3 – Credits Journal of Ecological Engineering 2021, 22(3), 249-265

Effect of contact time

Variation of contact time for diverse adsorption systems

Adsorbent	**Metal ions**	**Conditions**	**Maximum adsorption capacity (mg/g)**
Sweet Potato Peels	Pb(II), Cd(II)	Contact time:0-60 min pH: 2-12 Adsorption dosage: 0.5g Temperature: 30-80 C Initial concentration: 10-80 mg/L	200.91 mg/g for Pb(II) 125 mg/g for Cd(II)
Musa paradisiaca peels	Pb(II), Cd(II)	Contact time:15-90 min pH: 5-8 Adsorption dosage: 0.1-0.7 g Temperature: 30-60 C Initial concentration: 50-200 mg/L	10 mg/g for both metal ions
Activated carbon from molasses	Cr(VI), Pb(II), Cu(II)	Contact time:0-300 min pH: 2-11 Initial concentration: 25 mg/L of Cu(II), 23.4 mg/L of Pb(II) and 24.3 mg/L of Cr(VI)	144.93 mg/g for Cr(VI) 303.03 mg/g for Pb(II) 526.32 mg/g for Cu(II)
Grounnut(Arachis hypogaen) shell	Pb(II), Cd(II), Zn(II)	Contact time:0-300 min pH: 1-6 Adsorption dosage: 0.1-2g Temperature: 20-45 C Initial concentration: 10-100 mg/L	94.07 mg/g for Pb(II) 104.71 mg/g for Cd(II) 86.13 mg/g for Zn(II)

Table 4 – Credits J Mater Res Technol, 2020, 9(5), 10235-10253

The adsorption values in the case of oil palm constituents and derivates along with their influence with change in pH, contact time, dosage has been specified

Optimum values of affecting factors for heavy metals adsorption using Oil Palm AC

Oil Palm AC	**Heavy metals**	**Factor affecting adsorptions (Optimum values)**			**Source**
		pH value	**Contact time**	**AC dose**	
Palm Kernel Shell	Lead	4	60 min	1.5 g	Baby and Hussein., 2019
	Chromium	6	60 min	1.5 g	
	Cadmium	6	90 min	2.0 g	
	Zinc	6	120 min	2.0 g	
Oil Palm	Manganese	7	60 min	N/A	Alothman et al.,

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Leaves	Lead	6	60 min		2019
	Cobalt	7	60 min		
Oil Palm Ash	Manganese	7	80 min	N/A	Chowdhury et al., 2011
Palm Kernel Shell	Chromium	6	120 min	0.25 g	Baby and Hussien, 2020
	Lead				
	Zinc				
	Cadmium				
Palm Fruit Fibre	Lead	5	120 min	N/A	Oola and Ong, 2019

Table 5 – Credits Journal of Ecological Engineering 2021, 22(3), 249-265

Adsorption of Copper
Maximum capacities for Adsorption of copper by different adsorbents

Capacity (mg/g)	Xm (mg/g)	Material	Reference
-	49.0	AnaerobicallyDigested Sludge	Gould and Genetelli (1978)
-	1.40	Kaolin Clay	Farrah et al. (1980)
-	2.54	Illite Clay	
-	23.3	Montmorillonite clay	
4.44	-	Treated bagasse	Kumar and Dara (1982)
3.46	-	Treated Acacia Bark	
3.08	-	Treated Laurel Bark	
3.69	-	Treated Techtona Bark	
1.53	-	Fly-ash	Panday et al. (1985)
3.58	-	Rice Hulls	Suemitsu et al. (1986)
7.88	-	Dyestuff-Treated (Red) Rice Hulls	
7.00	-	Dyestuff-Treated(Yellow) Rice Hulls	
27.3	-	Tea Leaves	Tan and Abd. Rahman (1988)
-	14.0	Amorphous Iron Hydroxide	Mustafa and Haq (1988)
-	9.22	Activated Carbon	Ferro-Gracia et al. (1988)
0.438	-	Chitin	Gonzalez-Davila and Millero (1990)
-	6.89	Aspergillus oryzae	Huang et al (1991)
-	6.06	Rhizopus oryzae	
13.8	-	Aspergillus oryzae	Huang et al (1991)
31.8	-	Treated Aspergillus oryzae	
35.7	-	Sludge Solid	Tien and Huang (1991)
42.9	-	Chlorella vulgarise	Aksu et al. (1992)
29.0	-	Zoogloearamigera	
1.89	-	Oil-Palm Fibres	Low et al. (1993)
-	15.9	Dye-Treated Oil-Palm Fibre	
-	1.98	Natural Oil-Palm Fibre	
-	28.5	G. lucidum	Nagendra et al. (1993)
-	64.5	Treated G. lucidum	
-	10.1	Treated A. niger	
-	16.3	Treated Sludge	
22.2	-	Yeast Biomass	Brady et al.(1994)
25.4	-	Yeast Cell Walls	Brady and Duncan (1994)
-	13.5	Banana Pith	Low et al (1995)

-	16.4	Sphagnum Moss Peat	

Table 6 – Credits Adsorption of Heavy Metals from Waste Streams by Peat by Yun-Shan Ho, The University of Birmingham

The optimum pH range for copper adsorption was pH 4.0 to 5.0. Since the surface of peat contains acidic functional groups, the optimum pH range is likely to be under weakly acidic conditions. At pH 2.0, there is minimal copper removal, which may be due to the proton exclusion effect, and there is competition of H for surface active sites which lead to minimum or negligible copper ion uptake at low pH, as the pH is increased from 2.0 to 5.0, the removal increases. However, increases above pH 4.0 produce less of an effect than was achieved among 2.0 and 4.0. This effect was most pronounced at low concentrations.

Adsorption of Nickel

Maximumcapacities for adsorption of nickel by different natural adsorbents

Capacity (mg/g)	**Xm (mg/g)**	**Material**	**Reference**
-	7.66	Anaerobically Digested Sludge	Gould and Genetelli (1978)
-	3.40	Delta-Manganese Dioxide	Gray and Malati(1979)
2.40	-	Peat (Rastunsuo)	Tummavuori and Aha (1980)
7.45	-	Treated Bagasse	Kumar and Dara (1982)
3.4	-	Treated Acacia Bark	
4.2	-	Treated Laurel Bark	
3.5	-	Treated Techtona Bark	
11.2	-	Eutrophnic Peat	Gosset et al. (1986)
11.7	-	Oligotropic Peat	
5.58	-	Rice Hulls	Suemitsu et al. (1986)
6.16	-	Dyestuff-Treated (Red) Rice Hulls	
6.08	-	Dyestuff-Treated (Yellow) Rice Hulls	
23.0	-	Sphagnum Moss Peat	McLellan and Rock (1988)
-	6.75	Amorphous Iron Hydroxide	Mustafa and Haq (1988)
5.22	-	Aspergillus oryzae	Huang et al (1991)
12.4	-	Treated Aspergillus oryzae	
40.8	-	Sludge Solid	Tien and Huang (1991)
-	3.46	China Clay	Sharma et al. (1991)
0.672	-	Sphagnum Peat	Viraraghavan and Dronamraju (1993)
0.5	-	Oil-Palm Fibres	Low et al. (1993)
6.46	-	Yeast Biomass	Brady et al. (1994)
-	9.18	Sphagnum Moss Peat	

Table 7 – Credits Adsorption of heavy metals from waste streams by Peat by Yun-Shan Ho, The University of Birmingham

Comparison of maximum adsorption capacities for lead of various metals with those of peat

Capacity (mg/g)	**Xm (mg/g)**	**Material**	**Reference**
-	3.93	Kaolin Clay	Farrah et al. (1980)
-	14.1	Illite Clay	
-	71.8	Montmorillonite Clay	
10.2	-	Treated Bagasse	Kumar and Dara (1982)

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10.4	-	Treated Acacia Bark	
10.9	-	Treated Laurel Bark	
10.8	-	TeatedTechtona Bark	
0.269	-	Waste Type Rubber	Rowley et al. (1984)
8.90	-	Rice Hulls	Suemitsu et al. (1986)
12.0	-	Dyestuff-Treated (Red) Rice Hulls	
12.0	-	Dyestuff-Treated (Yellow) Rice Hulls	
-	49.9	Moss (CalymperesdelessertiiBesch)	Low and Lee (1987)
-	78.7	Tea Leaves	Tan and Abd. Rahman (1988)
-	0.368	Fly-ash	Yadava et al. (1989)
-	1380	Waste Slurry	Srivastava et al. (1989)
19.0	-	Aspergillus oryzae	Huang et al. (1991)
114	-	Treated Aspergillus o	
90.9	-	Sludge Solid	Tien and Huang (1991)
-	0.415	China Clay	Yadava et al. (1991)
-	0.308	Wollastonite	
-	61.8	Sphagnum Peat Moss	Allen et al. (1992)
0.08	-	Oil-Palm Fibres	Low et al. (1993)
-	116	Pencillium Biomass	Niu et al. (1993)
149	-	Titanmium(IV) Oxide	Suzuki et al. (1994)
41.4	-	Yeast Biomass	Brady et al. (1994)
1860	-	Lignin	Srivastava et al. (1994)
-	251	Algae	Ozer et al. (1994)
20.0	-	Peat (Rastunsuo)	Tummavuori and Aho (1980)
40.0	-	Sphagnum Moss Peat	McLellan and Rock (1988)
-	30.7	Sphagnum Moss Peat	

Table 8 – Credits adsorption of heavy metals from waste streams by peat by Yun-Shan Ho, The University of Birmingham

Comparison of adsorption capacities of various adsorbents

Capacity, (mg/g)			**Material**	**Reference**
Cu	**Ni**	**Pb**		
5.10	2.40	20.0	Peat (Rastunsuo)	Tummavuori and Aho (1980)
4.44	7.45	10.2	Treated bagasse	Kumar and Dara (1982)
3.46	3.4	10.4	Treated Acacia Bark	
3.08	4.2	10.9	Treated Laurel Bark	
3.69	3.5	10.8	Treated Techtona Bark	
3.58	5.58	8.90	Rice Hulls	Suemitsu et al., (1986)
7.88	6.16	12.0	Dye stuff-Treated (Red) Rice Hulls	
7.0	6.08	12.0	Dye stuff-Treated (Yellow) Rice Hulls	
23.0	-	40.0	Sphagnum Moss Peat	McLellan and Rock, (1988)

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14.0	6.75	-	Iron Hydroxide	Mustafa and Haq., (1988)
27.3	-	79.7	Tea Leaves	Tan and Abd. Rahman., (1988)
13.8	5.22	19.0	Aspergillus oryzae	Huang et al., (1991)
31.8	12.4	114	Treated Aspergillus Oryzae	
35.7	40.8	90.9	Sludge Solid	Tien and Huang (1991)
18.5	0.672	-	Sphagnum Peat	Viraraghavan and Dronamraju, (1993)
1.89	0.50	0.08	Oil-Palm Fibres	Low et al. (1993)
22.2	6.46	41.4	Yeast Biomass	Brady et al.(1994)
13.0	9.26	30.2	Sphagnum Moss Peat	

Table 9 – Credits Adsorption of heavy metals from waste streams by Peat by Yun-Shan Ho, The University of Birmingham

C. Agricultural wastes

Adsorption capacity of biosorbents obtained from agricultural wastes on the removal of different metal elements

Adsorbents	Metal element	Q (mg/g) or removal percentage (%)	Sources
Coffee Pulp	Chromium (Cr)	13.48 mg/g	Aguilar et al., 2019
White yam	Cadmium (Cd)	22.4 mg/g	Asuquo et al., 2018
Brassica Campestris waste stem	Nickle (Ni)	1.1 mg/g	Shaikh et al., 2018
	Chromium (Cr)	95 mg/g	
Canola Seeds	Lead (Pb)	44.25 mg/g	Affonso et al., 2019
	Cadmium (Cd)	52.36 mg/g	
Rice Husk	Zinc (Zn)	94.33 %	El Nadi and Abd Alla, 2019
	Chromium (Cr)	89.20 %	El Nadi and Abd Alla , 2019
Banana Peel	Copper (Cu)	14.3 mg/g	Thuan et al., 2017
	Nickle (Ni)	27.4 mg/g	
	Lead (Pb)	34.5 mg/g	
Rice Husk	Chromium (Cr)	97.12 %	Kumar et al, 2017
Jackfruit Peels	Lead (Pb)	10.1 mg/g	Ibrahim et al.,2020
	Copper (Cu)	17.5 mg/g	
	Cadmium (Cd)	20.0 mg/g	
	Manganese (Mn)	76.9 mg/g	
	Iron (Fe)	4.40 mg/g	
Pistachio Hull Waste	Nickle (Ni)	14 mg/g	Beidokhti et al., 2019
Ground Nut Shell	Cadmium (Cd)	70.64 %	Vinaykumar et al., 2019
Pongamia Pinnata		79.9 %	
Onion Skin		75.45 %	

Table 10 – Credits Journal of Ecological Engineering 2021, 22(3), 249-265

D. A study on heavy metal removal rate: rice husk and fly ash

Fe removal by different weights of absorbents

The effect of the amount of adsorbent on the removal of Fe ions by rice husk is depicted in Table 3 for varied adsorbent doses of 20, 30, 40, 50 and 60 mg/l. Fe removal using rice husk increased from 68.59% to 99.25% i.e. with the increase of the amount of absorbent concentration , while Fe removal using fly ash varied from 46.18% to 86.757%.

Heavy metal	Adsorbent dose	In- Fe mg/l	Rice husk	Flyash		
			Outlet Fe mg/l	Removal ratio %	Outlet Fe mg/l	Removal ratio %
Fe	20	11.78	3.7	68.59	6.34	46.18
	30	11.78	2.1	82.17	82.17	58.4
	40	11.78	1.2	89.81	89.81	65.2
	50	11.78	0.09	99.236	99.236	74.788
	60	11.78	0.088	99.253	99.253	86.757

Table 11 - Fe removal efficiency for different absorbent doses

Pb removal by different weights of absorbents

The effect of the amount of adsorbent on the removal of Pb ions by rice husk is depicted in Table 4 for varied adsorbent doses of 20, 30, 40, 50 and 60 mg/l. Pb removal with rice husk increased from 22.22% to 87.17% i.e. with the increase of the amount of absorbent concentration, while the Pb removal using fly ash varied from 21.79% to 76.06%.

Heavy metal	Adsorbent dose	In- Pb mg/l	Rice husk	Flyash		
			Outlet Pb mg/l	Removal ratio %	Outlet Pb mg/l	Removal ratio %
Pb	20	1.17	0.91	22.22	0.92	21.79
	30	1.17	0.66	43.59	0.7	40.17
	40	1.17	0.38	67.52	0.46	60.68
	50	1.17	0.28	76.068	0.33	71.795
	60	1.17	0.15	87.179	0.28	76.068

Table 12 - Pb removal efficiency for different absorbent doses

Cd removal by different weights of absorbents

The effect of the amount of adsorbent on the removal of Cd ions by rice husk is depicted in Table 5 for varied adsorbent doses of 20, 30, 40, 50 and 60 mg/l. Cd removal using rice husk increased from 26.04% to 67.917% i.e. with the increase of the amount of absorbent concentration, while the Cd removal using fly ash varied from 25.21% to 73.54%.

Heavy metal	Adsorbent dose	In- Cd mg/l	Rice husk	Flyash		
			Outlet Cd mg/l	Removal ratio %	Outlet Cd mg/l	Removal ratio %
Cd	20	0.48	0.36	26.04	0.36	25.21
	30	0.48	0.31	35.42	0.30	37.50
	40	0.48	0.24	50.00	0.23	52.08
	50	0.48	0.19	60.417	0.180	62.500
	60	0.48	0.154	67.917	0.127	73.542

Table 13 - Cd removal efficiency for different absorbent doses.

Cu removal by different weights of absorbents

The effect of the amount of adsorbent on the removal of Cu ions by rice husk is depicted in Table 5 for varied adsorbent doses of 20, 30, 40, 50 and 60 mg/l. Cu removal using rice husk increased from 24.49% to 98.177% i.e. with the increase of the amount of absorbent concentration , while Cu removal using fly ash varied from 37.38% to 98.545%.

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Heavy metal	Adsorbent dose	In- Cu mg/l	Rice husk		Flyash	
			Outlet Cu mg/l	Removal ratio %	Outlet Cu mg/l	Removal ratio %
Cu	20	5.43	4.10	24.49	3.40	37.38
	30	5.43	2.84	47.70	1.81	66.67
	40	5.43	1.83	66.30	1.01	81.40
	50	5.43	1.210	77.716	0.089	98.361
	60	5.43	0.099	98.177	0.079	98.545

Table 14 - Cu removal efficiency for different absorbent doses.

Niremoval efficiency for different absorbent doses

Heavy metal	Adsorbent dose	In- Ni mg/l	Rice husk		Flyash	
			Outlet Ni mg/l	Removal ratio %	Outlet Ni mg/l	Removal ratio %
Ni	20	1.74	0.089	94.885	0.095	95.540
	30	1.74	0.071	95.920	0.085	95.115
	40	1.74	0.065	96.264	0.076	95.632
	50	1.74	0.058	96.667	0.070	95.977
	60	1.74	0.053	96.964	0.069	96.034

Table 15 - Niremoval efficiency for different absorbent doses

E. Industrial solid waste

In the case of calcined brick powder

Initial concentration Ci (mg/l)	Equilibrium concentration Ce (mg/l)	qe (mg/g)	Ce/qe() g/l
10	1.863	2.03	0.917
20	4.986	3.75	1.329
30	9.358	5.16	1.810

Table 16 – Initial pH 2.0

Initial concentration Ci (mg/l)	Equilibrium concentration Ce (mg/l)	qe (mg/g)	Ce/qe() g/l
50	12.23	25.13	0.486
75	28.23	31.18	0.905
100	48.24	34.50	1.398

Table 17 – Ni(II), pH 4.0

Adsorbent used is a solid waste calcined brick powder which is available in large quantities and can be used as an alternative to existing commercial adsorbents for removal of Cr (VI) and Ni (II).The removal of these carcinogenic toxicants was found to depend on dosage, pH, initial concentrations of Cr (VI) and Ni (II) ions and also contact time. The adsorption capacity of CBP adsorbent for Chromium (VI) is more than Nickel (II). Contact time for the maximum adsorption required is 60 min at pH 2.0 for Cr (VI) and 105 min at pH 4.0 for Ni (II). The equilibrium sorption data are satisfactorily fitted with Freundlich and Langmuir equations. The calculated values of the dimensionless separation factor from the Langmuir constant also confirm favourable sorption of Cr (VI) and Ni (II) onto calcined brick powder. Heavy metal removal with aforesaid CBP adsorbent appears to be technically feasible and eco-friendly too. Also, it helps in reduction of waste generation.

F. Plastic waste

In the recent times, much research has gone through for identifying the uses of plastic waste as an adsorbent. Additionally, plentiful plastic wastes as adsorbent have been developed and used in numerous environmental amputations

The advantages of the above specified Plastic wastes as adsorbent have been discussed

Polypropylene waste(PP)

i. Cost effective for waste water treatment processes
ii. Can successfully remove copper from waste streams
iii. Improved oil sorption performance of virgin PP fiber
iv. Most effective method
v. Have potential in wastewater treatment

Low-Density Polyethylene (LDPE) Waste
Reduce production cost of the hydrogel and new method for converting wastes into valuable products

Polyethylene Terephthalate (PET) waste

i. Effective adsorbent for removing MB and AB25 from aqueous solutions
ii. Low cost
iii. Have potentiality of utilized "waste treat waste"
iv. An effective adsorbent for removal of cadmium ions from aqueous
v. Low-cost adsorbent
vi. Good adsorbent to adsorb heavy metal pollutants
vii. Show better adsorptive properties than activated carbon

V. FINDINGS AND DISCUSSION

In the comparison of rice husk and flyash

Results showed that low-cost adsorbents can be fruitfully used for the removal of heavy metals with a concentration range of 20–60 mg/l. The results of using real wastewater showed that rice husk was effective in the simultaneous removal of Fe, Pb and Ni, whereas fly ash was effective in the removal of Cd and Cu.It was found that the percentage removal of heavy metals was dependent on the dose of low-cost adsorbent and adsorbent concentration.The contact time necessary for maximum adsorption was found to be two hours.The optimum pH range for heavy metal adsorption was 6–7.0.

VI. CONCLUSION

As it has been understood that the location of the landfill places a important role in the Leachate ability to contaminate the groundwater. It has to be understood that the landfill with proper implementation of the codalprovisions and suggestions. An appropriate location away from the human living along with proper distance from the waterbodies would be an ideal location.

And while selecting the location other very important parameters such as ground water level, type of soil as well play important role to understand the ability of leachate to percolate though the soil. And in such cases clayey soil would play its role in adsorbing most of the heavy metals compared to other soil types. But however clayey soil could also lead to stagnation in few cases which should be looked into.

Implementing the usage of solid wastes would be a very effective and efficient solution in most of the cases. And some natural adsorbents such as rice husk and milkweed would be effective. And it also be noted that not only a single adsorbent in the site but a combination of two or three adsorbents would be advantageous because a single adsorbent would not be able to adsorb all the different types of heavy metals which would be present in the leachate. In such cases a combination would work not only from effectiveness perspective but also availability point of view, which doesn't require huge quantities of adsorbent at a single point of time in practical scenarios.

And other alternatives are the industrial wastes which could be used as the adsorbent, such as Class IV brick powder, fly ash, blast furnace slag red mud etc which have a very high adsorption rate compared to naturally available adsorbents and could be more viable considering them as industrial wastes.

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