STUDY ON ADSORPTION CAPACITY OF LANDFILL LINER WITH BENTONITE AND ACTIVATED ALUMINA

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Abstract – Landfills are the most common method used for the disposal of solid wastes. But the problem associated with this is permeation of leachate through it. Different types of heavy metals are also deposited in landfills from the industries. Heavy metals are harmful to environment and human body. Therefore their removal is essential for the environment. Many technologies have been used for the removal of heavy metals such as adsorption, precipitation, membrane filtration, ion exchange etc. Among this adsorption is most commonly used technique. This paper studied about the bentonite and activated alumina as liner materials. Batch adsorption test, electrical conductivity tesi and pH test were conducted to study the feasibility of using these materials. The adsorption of Cu^{2+}, Zn^{2+}, Cr^{6+} and Fe^{3+} were studied.

***Key Words*: Bentonite, Activated alumina, Landfills, Electrical conductivity, Adsorption**

1. INTRODUCTION

Due to the development of many industries, discharge of heavy metals like Cu, Ni, Cd, Fe, Cr, Zn etc. into the soil or water increases [1]. Large amount of heavy metals may accumulate in the human body through food chain. Therefore accumulation of heavy metals should be prevented from reaching to the environment. To remove heavy metals from the environment different techniques are used, such as chemical precipitation, coagulation, ion exchange, evaporation, membrane methods, solvent extraction and filtration [2]. But now a days heavy metal adsorption using different types of adsorbents like activated charcoal, silica gel etc. are very common[4]. However the high cost of adsorbents like activated charcoal limits their use for adsorption.

Activated alumina is a cheapest porous material which can be used as an adsorbent for the heavy metals. This paper presents an overview on the adsorption capacity of landfill liner using bentonite and activated alumina.

2. LITERATURE REVIEW

Kovo et.al(2016) [1]They used acid treated montmorrilonite as adsorbent for the heavy metal removal on the basis of contact time, pH, particle size and adsorbent dose. The removal of metals from the solution is in the following order: Zn > Cu > Mn > Cd > Pb > Ni

Folasegun et.al (2015)[2]They utilize Nigerian bentonite as adsorbent for the heavy metals. Batch adsorption method was used in order to study effect of initial metal concentration, adsorption, pH, contact time etc.

Kayode et.al [2015][3]They investigate about the adsorption of Nickel and Manganese from waste water by batch adsorption. They also studied about the initial concentration, pH, temperature etc.

Mona et.al [2014][4] They studied about the heavy metal adsorption using activated carbon, silica and activated carbon – silica composites. For the removal of heavy metals Silica - activated carbon composite was more efficient than activated carbon and silica.

3. MATERIALS AND METHODS

3.1 MATERIALS

The soil sample is collected from a dump yard site near Alappuzha, Kerala which contain different types of wastes such as domestic waste, industrial waste etc. Bentonite is purchased from Kochi, Kerala and activated alumina from Tamil Nadu.


Fig – 1 Bentonite **Fig – 2 Activated alumina**

Table -1 Properties of soil and Bentonite

Properties	Local soil	Bentonite
% clay	8%	92%
% silt	8%	6%
% sand	82%	2%
% gravel	2%	0
Liquid limit	21%	393%
Plasticity index	10%	335%

Optimum moisture content	13%	52%
Dry density	1.764 g/cc	1.064g/cc
Permeability (cm/S)	1.14 x 10^{-3}	8.89 x 10^{-9}
pH	6.3	8.7

Table - 2 Properties of Activated alumina

Properties	Value
Color	Ivory/white
Specific surface area (m^2/g)	0.5 – 50
Molecular weight(g/cm^3)	0.83 – 1.01
pH	8.5
Specific gravity	3.4 – 4

3.2 METHODS

Six samples were selected by varying activated alumina, soil and bentonite content. Composition of each mix is shown in Table 3 Batch adsorption test and pH test are carried out on each sample to find highest percentage of adsorption.

Table-3 Sample composition

Sl.No	Sample	Composition
1	S_1	80% S+ 10% B + 10% A
2	S_2	80% S+ 15% B + 5% A
3	S_3	60% S+ 20% B + 20% A
4	S_4	60% S+ 25% B + 15% A
5	S_5	40% S+ 30% B + 30% A
6	S_6	40% S+ 35% B + 25% A

[S – soil , B- Bentonite, A – Activated alumina]

3.3 RESULTS AND DISCUSSION

3.3.1 Batch adsorption test results

Batch adsorption was carried out using multi parameter bench photometer as shown in Fig.3. 21 g of soil sample is mixed with 300 ml of the metal solution. 5 mg/L and 10 mg/L concentrated solutions were made in order to compare the effect of initial metal concentration. The variation of adsorption with metal concentration is shown in Figure 4 and Figure 5

Fig.3 Multi parameter bench photometer

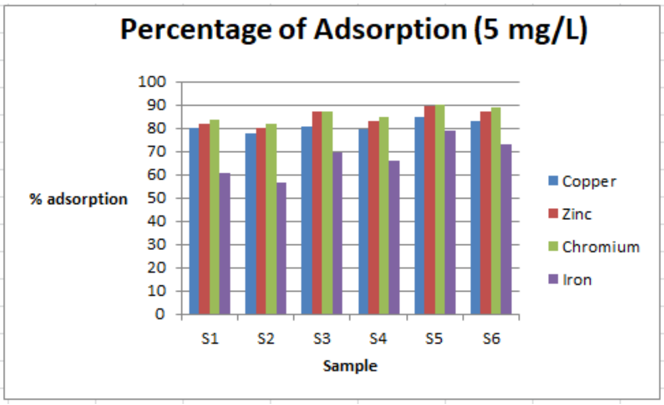

Chart – 1 Percentage of adsorption(5mg/L)

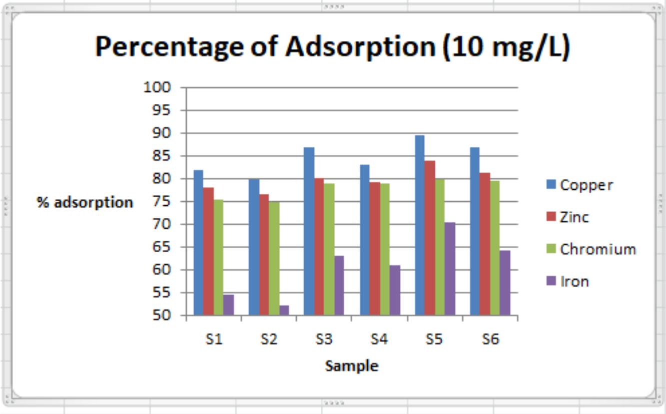

Chart – 2 Percentage of Adsorption (10 mg/L)

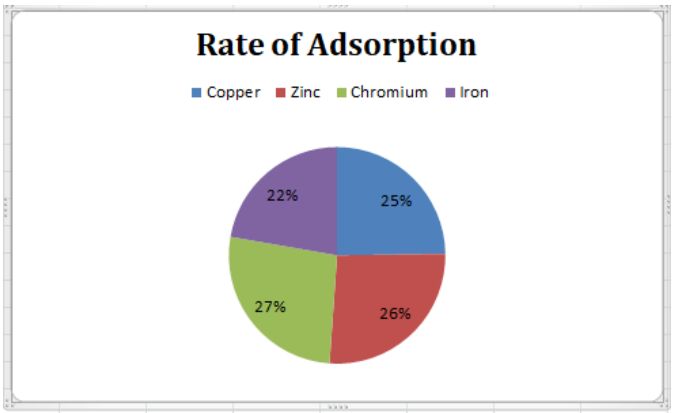

Chart- 3 Rate of Adsorption

3.3.2 Electrical conductivity

It is used to measure the soluble salts in the soil and measured with conductivity meter. Sand, clay and silts have low, high and medium conductivity respectively. It is generally expressed in milli Siemens per meter.

Fig.4 Electrical conductivity meter

Table 4 Electrical conductivity Test Results

Sample	5 mg/L				10 mg/L			
	Cu	Zn	Cr	Fe	Cu	Zn	Cr	Fe
S_1	1.2	1.3	2.1	2.7	2.0	1.6	3.3	3.6
S_2	1.4	1.6	2	3.0	2.1	1.8	3.0	3.8
S_3	1.0	1.2	1.9	2.0	1.6	1.5	2.8	2.8
S_4	0.9	1.9	1.8	2.2	1.8	1.6	2.7	3.2
S_5	0.9	1.2	1.6	1.9	1.2	1.3	2.4	2.3
S_6	0.9	1.2	1.4	1.6	1.5	1.5	2.3	2.7

3.3 pH

pH was measured using digital pH meter and it indicates the intensity of acidity and alkalinity of the soil. pH is the negative logarithm of hydrogen ions present in the soil.

Table 5 pH Test Results

Sample	5 mg/L				10 mg/L			
	Cu	Zn	Cr	Fe	Cu	Zn	Cr	Fe
S_1	7.50	7.32	7.9	6.85	6.91	7.16	7.28	6.7
S_2	7.6	7.45	7.93	6.96	7.02	7.21	7.81	6.7
S_3	8.0	7.66	7.99	7.13	7.11	7.22	7.91	6.8
S_4	8.26	7.96	8.0	7.29	7.64	7.33	8.13	6.9
S_5	8.29	8.33	8.3	7.42	7.84	7.58	8.22	7.0
S_6	8.42	8.29	8.33	7.58	8.23	7.92	8.33	7.2

3. CONCLUSIONS

i. Adsorption of heavy metals decreases with increase in metal concentration, i.e highest for 5mg/L

ii. Adsorption increases with increase in activated alumina content.

iii. Percentage of removal is in the order of $Cr^{6+}>Zn^{2+}>Cu^{2+}>Fe^{3+}$

iv. pH value increased with decrease in concentration.

v. Electrical conductivity increases with increase in concentration.

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