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PERFORMANCE EVALUATION OF CLAY LINER FOR THE REMOVAL OF HEAVY METAL FROM THE LANDFILL

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Abstract : Solid waste management is one of the most significant problems the Indian government is trying to deal with. In the last two decades, India has witnessed tremendous growth in social and economic sectors. An intensive study has been made to see the performance of the bentonite on the removal efficiency of Heavy Metal from the landfill. A stock solution of 100 mg/litre of lead was prepared by dissolving 1.6 g Pb(NO3) in 1 L deionized water. Metal solution of required lower concentration was prepared by diluting the of stock solution. The volume of sample was determined to be1 litre. pH adjustment for this study was carried out using 0.1 N HCl and 0.l N NaOH.The amount of clay is taken in the range of 5 g to 15 g. The mixture of clay and metal solution was stirred for 2 hours at 200 pm on magnetic stirrer. Centrifuge was used to separate the clay from the solution. The concentration of lead remains in solution afteradsorption was analysed in the Spectrophotometer. In this study, the effect of parameters like pH value, metal concentration, amount of clay, agitation time and speedwere examined. The optimal experimental conditions for maximum lead removal was achieved at 0.9 g/L of bentonite clay and solution pH of 10.5. An increase in concentration more than 20 mg/l shows the decrease in percentage of adsorption. It hasbeen observed that maximum adsorption occurs in within 30 minutes. Therefore, it can be said that adsorption is a spontaneous phenomenon. The experimental work proved that the Bentonite clay will be the best option for the removal of heavy metal from thelandfill.

Index Words: Land fill, Liner, Bentonite, adsorption

I. INTRODUCTION

Solid waste management is one of the most significant problems the Indian government is trying to deal with. In the last two decades, India has witnessed tremendous growth in social and economic sectors. In parallel, the Indian population has grown exponentially too, from 1.028 billion in 2001 to 1.252 billion in 2013. This population growth has seen an increasingly larger population concentration in urban areas due to the availability of more employment sources. With the globalization of the economy and technology development, cities like Mumbai, Bengaluru, Hyderabad, to name a few, have become megacities with larger populations than most small towns and rural areas of India. This growing population has resulted in the massive production of solid waste. Despite considerable developments in social economic sectors, solid waste management (SWM) systems in India have not kept up with the challenge and remain relatively rudimentary. As a result, around 90 percent of waste is currently dumped rather than adequately landfilled. Production of solid waste reflects the living standards, eating habits and seasonal changes and in the last few years, India has seen a tremendous transformation in each of these aspects. Economic classes have a significant impact on waste production as higher income groups are more likely to use packaged products, resulting in a substantial quantity of waste generated in the form of packaging bags, glass, metals and textiles along with compostable materials like left-overs of vegetables and fruits. Waste produced in urban areas also contain hazardous waste products such as medicines, batteries, colouring products and pesticides. On an average, the municipal solid waste generated in cities is 41 percent organic, around 40 percent inert, with 20 percent potentially recyclable products like plastic, glass and metal objects. Solid waste management (SWM) has emerged as one of the most massive development challenges in urban India. Numerous studies indicate that the unsafe disposal of waste generates dangerous gases and leachates, due to microbial decomposition, climate conditions, refuse characteristics and land-filling operations. During rainfall, the dumped solid wastes receivers water and the by-products of its decomposition move into the water through the waste deposition. The liquid containing innumerable organic and inorganic compounds is called 'leachate'. This leachate accumulates at the bottom of the landfill and percolates through the soil and reaches the groundwater. Areas near landfills have a greater possibility of groundwater contamination because of the potential pollution source of leachate originating from the nearby dumping site. Such contamination of groundwater results in a substantial risk to local groundwater resource user and to the natural environment. The impact of landfill leachate on the surface and groundwater has given rise to a number of studies in recent years and gained major importance due to drastic increase in population. There are many approaches that can be used to assess the groundwaterand surface water contamination. Rajkumar et al.,2010 evaluated the contamination in groundwater due to Municipal solid waste disposal in Erode, Tamil Nadu. This

research revolves around the improperdisposal of solid wastes as landfills at three distinct sites namely Vendipalayam, Vairapalayam, and Semur. with Geographical Information System (GIS), about 43 groundwater and seven surface water samples were analyzed for their physical, chemical and electrical properties were tested. The outcomes indicated that the qualityparameters of water exceeded the permissible limits of drinking at many locations leading the water unstable for drinking. M.Majone et al.,1992 experimented with clay liner and identified Langmuir/Frendulich Isotherms. Nurdan Gamze Turan et al experimented the Industrial leachate and removal of Cu(II) and Zn(II) were carried out with the differentcombinations of liner materials 60% of natural zeolite + 40% of bentonite . It was found that the optimum with high removal efficiencies of 95% for Cu(II) and 89.19% for Zn(II). RM Aghav, et al, 2011 studied the application of artificial neural network(ANN) for prediction of performances in competitive adsorption of phenol and resorcinol from aqueous solution by conventional and low cost carbonaceous adsorbentmaterials, such as activated carbon (AC), wood charcoal (WC) and rice husk ash (RHA). Hence, the present experimental work was focused to determine the efficiency of Bentonite clay for the adsorption of Heavy metal concentration and to evaluate the percentage of adsorption of heavy metal.

II.METHODOLOGY

Figure 1. Lab scale Batch Reactor

Batch reactors are used to study the behaviour of fluids with materials under various conditions of temperature and pressure. The reactants are initially charged into a container, are well mixed, and are left to react for a certain period. The resultant mixture is then discharged. A batch reactor has neither inflow nor outflow of reactants or products while the reaction is being came out. This is an unsteady-state operation where composition changes with time The Lab scale batch reactor used for the study is of about 2 litres capacity. The reactor is made of BOROSIL glass. The reactor is fitted with paddle stirrer in order to have the homogeneous mixing. The stirrer rotates about 200rpm.

STOCK SOLUTION PREPARATION

- Bentonite clay was used for this experiment.
- Take 5 g of bentonite clay.
- Take 1.6 g of lead solution.
- Take 1 litre of distilled water.
- Dilute the lead solution.
- Let mix the bentonite clay and lead solution with distilled water.
- Take the volume of stock solution 50 ml and do the experiment.
- First take 5 g of bentonite clay and take 1.6 g of lead solution.

Adsorption of lead was carried out in a batch reactor. A stock solution of 100 mg/litre of lead was prepared by dissolving 1.6 g Pb(NO;3)2 in 1 L deionized water. Metal solution of required lower concentration was prepared by diluting the of stock solution. The volume of sample was determined to be 1 litre. pH adjustment for this study was carried out using 0.1 N HCl and 0.l N NaOH. The amount of clay is taken in the range of 5 g to 15 g. The mixture of clay and metal solution was stirred for 2 hours at 200 pm on magnetic stirrer. Centrifuge was used to separate the clay from the solution. The concentration of lead remains in solution after adsorption was analyzed in the Spectrophotometer. In this study, the effect of parameters like pH value, metal concentration, amount of clay, agitation time and speed were examined.

EXPERIMENTAL WORK

- First take 5 g of bentonite clay and take 1.6 g of lead solution.
- And take 1 litre of distilled water.
- Next mix the clay and lead solution with water.
- Take 50 ml of sample solution.
- Stirring that solution for 24 hours.
- Again stirring that solution with 2 hours gap.
- Take the sample on syringe and centrifuge it.
- Analyse the sample solution in UV spectrometer.
- Next analyse the pH and concentration of sample solution.
- Analyse the solution and find the % of lead in sample solution.
- Analyse the effect of pH and effect of clay dosage and effect of initial concentration.

- Take the readings and find the calculation.
- Find the result.

III RESULTS AND DISCUSSION

EFFECT OF pH

To study the effect of pH on lead adsorption with bentonite, metal solution 500 ml in volume and 50 mg/L in concentration were used at pH ranging from 2 to 10. The massof clay is taken as 5g, 10g and 15g. Agitation speed and contact time is fixed as 200 rpm and 2 hours respectively. Figure 2 shows that adsorption increases with increasein pH value and at high pH value of 10.5, the percentage of adsorption is of 95.6%.

Table 1 showing the percentage of Adsorption for the given pH

SAMPLES	pH	% OF ADSORPTION
SAMPLE 1	2.5	60.5
SAMPLE 2	5.8	82.3
SAMPLE 3	10.5	95.6

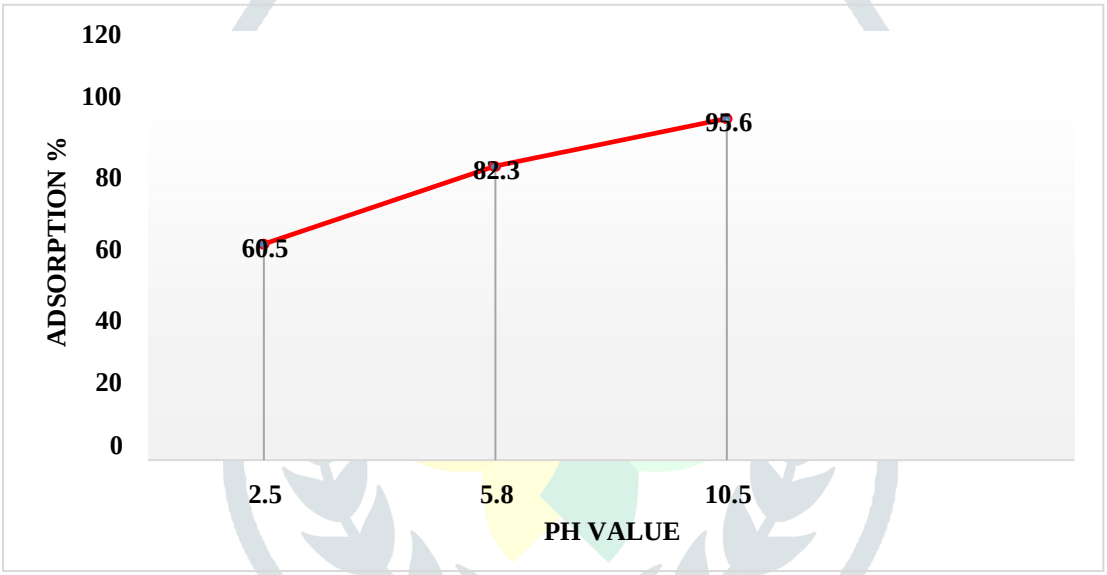

Figure 2 Effect of pH on adsorption

EFFECT OF CLAY DOSAGE

This experimental study is carried out in order to determine the optimum amount of clay. At optimum pH of 10.5 initial metal concentration of 50 mg/L by varying the clayamount 5 g to 15 g. The maximum adsorption was observed as 98.6%.

Table 2 showing the percentage of Adsorption for the given samples for theeffect of clay dosage

SAMPLES	% OF ADSORPTION
SAMPLE 1	60%
SAMPLE 2	72%
SAMPLE 3	98.6%

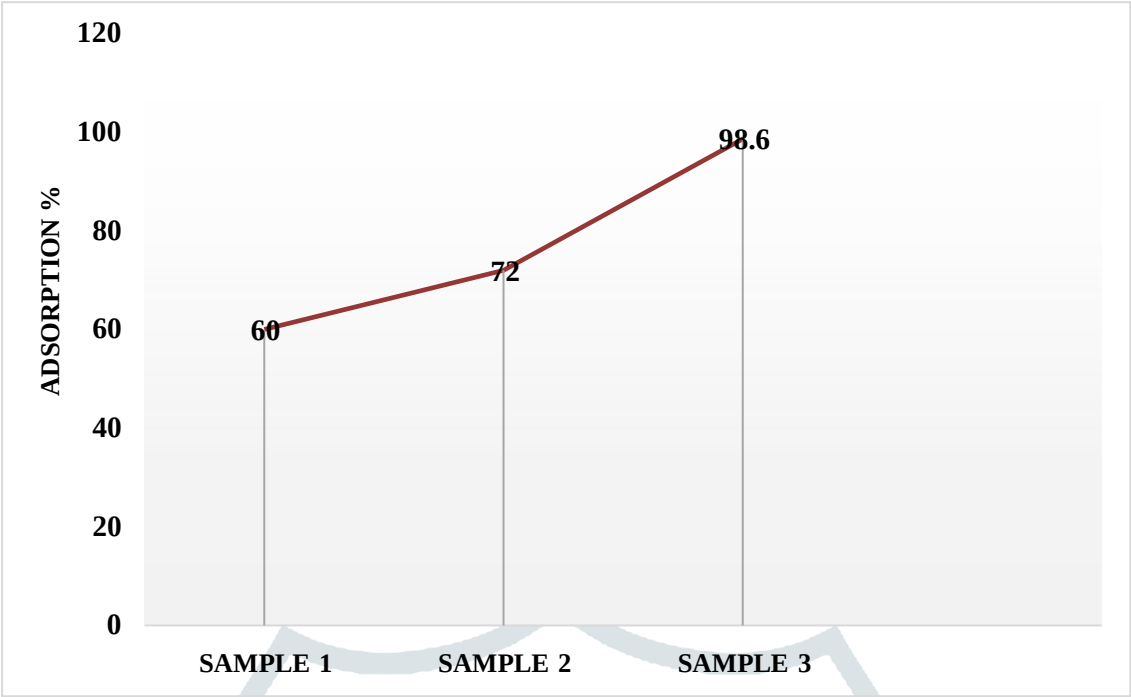

Figure 3 Effect of dose of clay on adsorption

It is seen from the Figure 3 that as the clay dose increases the adsorption efficiency increases and this is due to increase of surface area of the adsorbent.

EFFECT OF INITIAL CONCENTRATION

The optimization of metal concentration is determined by varying the lead concentrations from 5 mg/L to 40 mg/L. 5 g of bentonite clay added in 1 litre solutionand it was stirred for 2 hours at 200 rpm. Figure 4 shows that lead removal efficiencyincreases due to adsorption effect to some extent. The lead removal efficiency slightlydecreases from 35 mg/L. After attaining the saturation level, adsorption decreases as no more ions can be adsorbed.

Table 3 showing the Initial Concentration and percentage of adsorption

LEAD INITIAL CONCENTRATION	% OF ADSORPTION
5 mg / l	98.5
10 mg / l	98.5
15 mg / l	90.5
20 mg /l	90.5
25 mg / l	85.6
30 mg / l	80.2
35 mg / l	62.8
40 mg /l	60.5

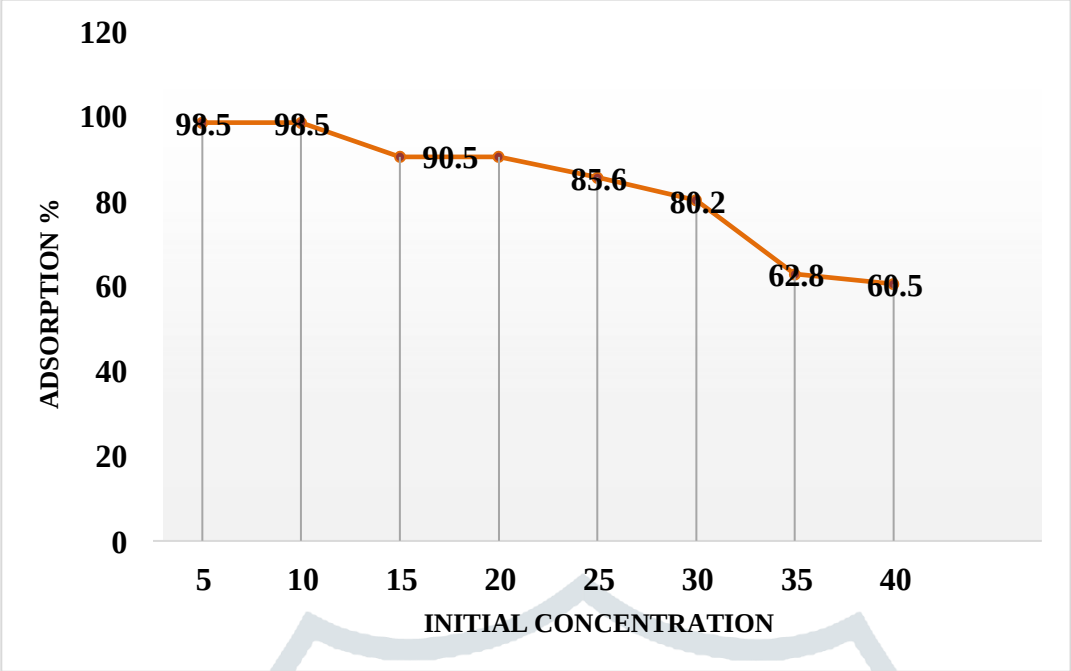

Figure 4 Effect of initial concentration on adsorption

III CONCLUSION

The optimal experimental conditions for maximum lead removal was achieved at 0.9 g/L of bentonite clay and solution pH of 10.5. An increase in concentration more than 20 mg/l shows the decrease in percentage of adsorption. It has been observed that maximum adsorption occurs in within 30 minutes. Therefore, it can be said that adsorption is a spontaneous phenomenon. The experimental work proved that the Bentonite clay will be the best option for the removal of heavy metal from the landfill.

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