Paper from Proceeding of the National Conference on Innovative Developments in Science, Technology & Management (NCIDSTM-2015) Organized by Ganga Technical Campus, Soldha, Bahadurgarh, Haryana (India) March 1st 2015 Published by International Journal of Engineering Sciences Paradigms and Researches (IJESPR) with ISSN (Online): 2319-6564, Impact Factor: 2.20 and Website: www.ijesonline.com

A Study on Feasibility of Low Cost Adsorbent to Reduce the Organic Load of Leachate

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Abstract

The present study is involved in finding the feasibility of easily available agro-waste materials like bagasse and rice husk to be used as adsorbent to remove many toxic pollutants from the leachate. The problem of leachate arises due to improper land filling and insanitary disposal of municipal solid waste which further percolates into the ground water to pollute it. The leachate which is never easy to collect in improper land filled site was prepared in laboratory in anaerobic conditions to obtain the similar range of parameters of actual leachate. Various adsorption experimental studies were performed in continuous flow manner by using both types of low cost adsorbent made up of bagasse and rice husk to get the optimized system. Further, using the optimized setup, experiments have been carried out to find out the better low cost adsorbent out of these two. The study concludes that adsorbent prepared by using rice husk is showing better adsorptive properties than the adsorbent prepared from bagasse. The reason of this performance is due to the high porosity of rice husk made adsorbent which provides more active sites for the adsorption of organic compounds present in the leachate, this result in bringing down the parameters of leachate those are necessary for its treatment. Although the study also confirms that the use of low cost adsorbent of rice husk in treatment process can not be the main process of treatment but it could be used as pretreatment or post treatment stage of treating the waste water like leachate.

Keywords: *leachate, Bagasse, adsorbent.*

1. Introduction

Leachate is a problem associated with the improper disposal of municipal solid waste. It may contain large amount organic compound [1] and inorganic chemicals [2]. It is usually a very high strength of waste water created as rainfall lands on a uncapped landfill and percolates through the waste. Leachate may also produce due to available of moisture in the solid wastes. The poorly maintained methods are causing ground water contamination because of leachate percolation [3]. The composition of leachate is given in Table 1 which shows it is high strength and organic matter rich waste water which is difficult to treat in a single step method. Although there has been many studies that involved in treating the waste water of different sources but the treatment of leachate had been not been studied in vast which have to be explored in detail. The present study is about finding the technique that could be better for the treatment of leachate and its ultimate disposal.

Table1 Typical Leachate's Composition

Parameter	Concentration (ppm)
pH	4-8
COD	1000-90000
BOD	1000-30000
TKN	2-600
Phosphate as P	0-5
Total Volatile Fatty Acid	5870
Total Sugar (g/L)	0.17
Total Dissolved Solids	5000-40000

(Source: Bull et. al. 1983)

Various methods to treat the leachate have been studied like physical methods including air stripping, adsorption and membrane filtration [2], chemical methods like coagulation, flocculation and electro-chemical oxidation [4] and biological methods like aerobic and anaerobic treatment may also be used to treat leachate [5].

But due to their high cost and low efficiency some other methods that are cheap and effective have been suggested. One of these methods is adsorption which can deal with this problem to some extent. There are many studies which have been done over the adsorption of pretreated landfill leachate. This type of research shows that removal efficiency of adsorbent is increased when the new leachate is pretreated [6,7,8]. In the present study various adsorption experimental studies were performed in continuous flow manner by using both types of low cost adsorbent made up of bagasse and rice husk to get the optimized system. Further, using the optimized setup experiments have been carried out to find out the better low cost adsorbent out of these two.

2. Methodology

The study has been divided into following parts to achieve the objectives of the present work:

2.1 Preparation of adsorbent

Two agro-industrial waste bagasse and Rice husk were used to make activated carbon. Both after collections were washed several times with tap water followed by rinsing with distilled water for 5 to 6 times to remove all dirt and unwanted materials. Then biomass was soaked in distilled water for 24 hrs to remove salt and metal ion present in these waste followed by air drying for 4-5 days. Then, these were dried in an oven at 60^{o}C for 12 hrs. These raw biomass were carbonized by using sulphuric acid, about 100gm of waste was burned by using 200ml of concentrated H_2SO_4. Carbonized biomass was then washed with distilled water to remove the extra acid and dried in oven at 60^{o}C for 12 hrs, then it was ground and sieved through standard sieve (Sonar, GSMS, Mumbai) to obtain particle of size up to 0.3 mm.

2.2 Characterization of Adsorbent

Various parameters were analyzed in laboratory to obtain the characteristics of an adsorbent.
In which pH, Conductivity, Bulk Density, Particle Density, Moisture content, Solubility in water, Solubility in acid, Porosity were determined.

2.3 Preparation of Leachate

Leachate was prepared by using vegetable waste collected from vegetable market. This was mixed with water (1:2) and placed in a plastic tank under anaerobic condition for about one month. Prepared leachate was filtered through muslin cloth and stored in incubator at 4^{o}C for experiments.

2.4 Continuous flow adsorption studies

All the adsorption experiments were carried out at room temperature (32^{o}C ± 2^{o}C) in continuous flow system. Continuous studies were carried out in column of different diameter and different bed height. Peristaltic pump (Masterflex) was used to down flow leachate through columns filled with different adsorbent. After desired interval, samples were collected and analyzed according to the standard methods [9]. In these studies, pH, column diameter, Bed height and flow rate were optimized by analyzing the residual COD concentration of flowing out leachate.

3 Result and discussion

The present study investigates the organic content removal from leachate with the help of the both kind of low cost adsorbents i.e. bagasse and rice husk having particle size up to 0.3 mm by continuous process.
Various experiments have been conducted to reach the conclusion of the study. The result of each and every experiment have been discussed and properly analyzed to reach at particular end. This includes:

- **Characterization of adsorbents:** The pH of both the adsorbents was slightly acidic. Conductivity of bagasse as was observed slightly higher (1.42 mmhocm^{-1}) then rice husk (1.20 mmhocm^{-1}). In case of rice husk both the bulk and particle density (i.e. 0.116 and 0.168 g/cm^3 respectively) is slightly higher than the bagasse (0.104 and 0.147 g/cm^3). Moisture content was found to be 0.92 for rice husk and 2.43% for bagasse. This shows that bagasse had higher moisture adsorption capacity then other. Solubility of bagasse in water as well as in acid was found higher in comparison to rice husk. Rice husk had more porosity (30.95%) than bagasse (28.76%).
- **Continuous flow studies:** The removal of COD from leachate was carried out at concentration of 3200 ppm. The study was conducted to investigate the effect of pH, Bed height, Flow rate and Diameter of column in continuous mode.
  - *Effect of pH***:** The pH of leachate was adjusted at different levels to conduct the experiments like at pH 3, 5, 7, 9 and 11. The diameter of column was selected as 2 cm where as the bed height was of 5 cm, the flow rate was set at 10 mlmin^{-1} and the samples were collected at time interval of 10 minutes for 1 hour. It has been observed that both the Bagasse and Rice husk adsorbents are showing maximum percentage removal at neutral pH i.e. around 60 %.
  - *Optimization of Bed Height:* The height of bed for both the adsorbent was selected in three ranges that is 5 cm, 7.5 cm and 10 cm. The pH of leachate was set at neutral where as the flow rate was remain same i.e. 10 mlmin^{-1}. The diameter of column was 2 cm. The result shows that after 50 min of operation, the percentage removal of COD is increased to 60 % with the increase in height but the variation is not significant among all three bed heights. So bed height of 5cm was taken as optimum for further experiments in case of rice husk adsorbent. But for bagasse adsorbent the same percentage removal was attained in the case of bed height of 7.5 cm.
  - *Optimization of Flow rate:* For optimization of further desired parameter the bed height was kept 5 cm in case of rice husk adsorbent and kept 7.5 cm in the case of bagasse adsorbent. The pH was adjusted at 7. Diameter of column was 2 cm. And the flow rate was tested at 2, 5 and 10 mlmin^{-1}. It has been found out that at 2 mlmin^{-1}, the percentage removal of COD was maximum i.e. 65 % for both the adsorbent after 50 min of operation. This may be due to larger contact time between the adsorbent and adsorbate.

o *Optimization of Diameter of column:* After standardization of all the conditions the diameter of column has been optimized. Three columns of diameters 1.5, 2.0 and 2.5 cm have been taken for experiments. The results showed that diameter of 2.0 and 2.5 cm are showing similar range of percentage removal i.e. 65%. So the column diameter of 2.0 cm has been selected.

- **Characterization of leachate***:* The leachate obtained was yellowish in colour and was slightly alkaline (pH 8.1). COD was 3200 mg/L.

- **Feasibility of adsorbent***:* The optimized conditions for both types of adsorbents were applied to check their feasibility to treat organic content of leachate. The adsorption of organic content that is marked by the percentage removal of chemical oxygen demand (COD) of filtrate given in Table II shows the increase in percentage removal and reduction in COD after some duration in both the case of adsorbent but after attaining the maximum percentage of removal it shows the sudden increase in the value of COD. The reason behind this trend was due to presence of more available active site on the surface of activated carbon in starting but as the experiment progresses the site present on carbon may filled by the adsorbate and the adsorption rate become slow, further more the saturation of site may achieved, desorption starts beginning [11]

Table 2 Concentration and Percentage removal of chemical oxygen demand, cod of leachate after adsorption using both adsorbent.

		Activated Bagasse Carbon		Activated Rice Husk Carbon	
S.No.	***Duration (min)***	***COD (ppm)***	***%age Removal***	***COD (ppm)***	***%age Removal***
1.	10	1560	51.25	1480	53.75
2.	20	1320	58.75	1350	57.8
3.	30	1320	58.75	1280	60.00
4.	40	1160	63.75	1160	63.75
5.	50	1120	65.00	1120	65.00
6.	60	1320	58.75	1280	60.00
7.	70	1360	57.5	1280	60.00
8.	80	1360	57.5	1320	57.8
9.	90	1360	57.5	1360	57.8

4 Conclusion & Recommendation

Out of these two adsorbent Rice husk carbon has maximum adsorption potential, this may be due higher porosity. Based on present study, it is recommended that both the adsorbent have potential to treat leachate. But Rick husk has higher potential than bagasse adsorbent. And as the leachate is high strength waste water so its treatment using adsorbent is not feasible. This technique can be taken as pretreatment or post treatment process. Not only organic load but other pollutants like heavy metals, colour, dye can also be removed by this method.

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