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Treatability Studies On Municipal Solid Waste Landfill Leachate Using Up-Flow Reactors

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Abstract - *The main objective of the present paper was to exploit the treatment of municipal solid waste Landfill Leachate. This paper present the experimental results obtained on the treatment of landfill by using waste adsorbent media. The present study mainly focused on the treatment of municipal solid waste landfill Leachate by using up-flow reactors with using waste laterite stones and waste brick bats. Finally comparison of treatment efficiency is done by using both adsorbent media. The present study investigated and concluded, in brick bats removal efficiency is less and laterite removal efficiency is very good. It can be concluded that the removal efficiency of treatment of landfill Leachate mainly depends on the surface area of the adsorbent media in the up-flow reactors.*

Key Words: **Treatment of landfill leachate, up-flow reactors, waste Laterite stones, Waste brick bats, Adsorbent media, Removal efficiency**.

1. INTRODUCTION

Urban cities are a link to connect for a future threat to the environment because of the production of increasing complexity and quantity of wastes. About 1.7-1.9 billion metric tons of municipal solid waste is generated worldwide. In many cases, municipalities cannot handle the produced wastes and municipal wastes are not well managed in developing countries, about 50% of collected waste is often disposed uncontrolled land filling and wastes collection is lower than 70% in low-income countries. About 15% is processed through un safe and informed cycling establishing and advanced improved facilities for collection recycling, treatment and disposal for municipal solid waste management will be very costly. For example establishment of building and operating sanitary landfill and incineration plants needs huge investments and huge maintenance and operation costs. Furthermore, it is difficult to find a suitable place or location for waste treatment facilities due to attitude among the countries therefore urban has to be encouraged to pursue the paths of reduce, reuse, and recycles instead of waste reduction, waste prevention and waste recycling due to solid waste creates nuisance, odour. It attracts mosquitoes, flies, street animals etc., which is a route to transmit various diseases.

Percolation of surface water and rainfall through the landfill and leaches out organic and inorganic constituents from the disposed solid waste is termed as Leachate. The production of Leachate states at early stages of landfill and it continuous to remain several decades even after the closure of landfill. Mainly landfill Leachate is generated when water is in filtered through the solid waste landfill and this facilitates for transfer of contaminants from solid phase to liquid phase. Characteristics of Leachate usually varies depending upon the amount of percolation and precipitation, the biological and chemical process, quality and quantity of solid waste and age of landfill . Leachate contains both suspended and dissolved materials. Usually landfill receives mixture of commercial, municipal and industrial waste but excludes the highly concentrated chemical waste. Landfill Leachate is a liquid which has four groups of contaminants such as xenobiotic organic, heavy metals, inorganic macro components, and dissolved organic matter. The physical appearance of Leachate is dark brownish red in colour and the smell is acidic and offensive.

Today solid waste generation and its proper management in a society is becoming a major problem and is, a burning issue on public health and surrounding environment, in both urban and rural areas. Improper management of municipal solid waste causes hazards to inhabitants. In-adequate knowledge and unscientific disposal methods into the open dumps creates severe problem. Proper collection, transportation, and safe disposal of solid waste is very important in Indian cities. It is the main responsibilities of municipal and governmental authorities. Indian cities generate on an average of 100-500 gms/capita/day of solid waste and of which only 60-80% of waste is collected on daily basis and rest of the waste is left unknowingly to decay on streets, roads, drains, which attracts flies, mosquitoes, street animals etc.., and causing odour nuisance, thereby transmitting of various diseases.

On the other hand the natural run-off and infiltration of rain water into the solid waste landfill area generates liquid waste called Leachate. This contains high dissolved organic and inorganic substances with reddish brown colour.

Since Leachate is a complex and toxic effluent, it should be handled properly in the process of collection, treatment, and safe disposal. Otherwise it creates a serious problem on

surrounding soil, ground water aquifers, and nearby surface water if any. Hence various studies reveals that, the Leachate generation and control has become a major problem and challenging to available technologies in urban areas. Also due to increase in population, increases urbanization and industrialization, there by increases the generation of solid waste. Now a day the availability of suitable land for the disposal of solid waste is very difficult task with economical consideration, for the disposal of solid waste as well as Leachate treatment process.

Leachate concentration may exceed permissible levels. So Leachate treatment and its management over a landfill is the most important issues. If Leachate is directly disposed into environment it creates serious problems on the surrounding soil, ground water aquifers and nearby surface water. Therefore great attention has been directed towards new techniques based on physio-chemical process. In this stage, experimental setup is made in the laboratory to treat landfill Leachate with low-cost waste adsorbents using up-flow reactors which are fabricated using PVC pipes.

2. Materials and Methodology

2.1 Materials used in treatment of Leachate

For experimental study following materials were obtained.

1. Reactor body: PVC pipe reactor is purchased from supplier.
2. Adsorbent material: Waste Laterite stones and waste brick bats.
3. Leachate is collected from Municipal solid waste disposal site at Turmurai, Belagavi.

2.2 Laterite

The experiment was carried out using the process of adsorption in which laterite material was used as a adsorbent media. Laterite is heavily weathered subsoil, rich in oxides of iron, aluminum or both ranging from reddish yellow to dark brownish red in colour. They are highly porous in nature and acts as a good adsorbent media.

2.3 Brick Bats

In this study waste brick bats are also used as a low cost adsorbent media in the treatment of municipal solid waste landfill Leachate. The two different types of brick bat granules of size 4.75mm-2.36mm and 12.5mm-10mm are prepared in the laboratory. The media prepared and are used in the treatment studies using up-flow Reactor.

2.4 Experimental setup in the treatment of Landfil Leachate

Experimental studies were carried out in the laboratory to find out the treatment feasibilities of landfill leachate using pre-fabricated reactors with low- cost waste adsorbents.

Lateritic Granules (Type-I) of size (4.75mm-2.36mm)and (12.5mm-10.0mm) and Brick Bat Granules(Type-II) of size(4.75mm-2.36mm)and (12.5mm-10.0mm) are used in the treatment of Leachate. The details of experimental studies carried out in the laboratory are shown in table 2.1.

Table 2.1 Details of experimental studies made in the treatment of Leachate with Low-Cost Adsorbent using Up-flow Reactors

Sl. No.	Up-flow Reactors	Media used in Reactors	Sizes
1.	Reactor 1 (R_1)	Laterite (L1)	4.75mm-2.36mm
		Brick Bats (B1)	
2.	Reactor 2 (R_2)	Laterite (L2)	12.5mm-10.0mm
		Brick Bats (B2)	

2.5 Reactor-1 (R_1)

This reactor is completely filled with coarse granular lateritic stone media and brick bats granules, to a height of 800 mm. This media is prepared using IS: 4.75mm - 2.36mm sieve. Then it is soaked with leachate and filtered before filling the reactor. Proper compaction is made, layer by layer while filling the media to maintain the wet density of 17.220 kg and 16.560 kg for Lateritic stones and Brick bats respectively. The effective liquid volume of the reactor was 6.5 litres after being filled with filter media.

2.6 Reactor-2 (R_2)

This reactor is completely filled with coarse granular lateritic stone media and brick bats granules, to a height of 800 mm. This media is prepared using IS: 12.5mm - 10.0mm sieve. Then it is soaked with leachate and filtered before filling the reactor. Proper compaction is made, layer by layer while filling the media to maintain the wet density of 20.02 kg and 17.01 kg for Lateritic stones and Brick bats respectively. The effective liquid volume of the reactor was 9.0 liters after being filled with filter media.

Two Up-flow reactors R_1 and R_2 are used for the study purpose, which were fabricated using sanitary PVC pipe of 6kg pressure, having 130 mm internal diameter and 900mm height. Each reactors are provided with 100mm free board at the top. The distance of 800mm is maintained between inlet and outlet ports which were kept constant in all two reactors and volume was found to be 11.94 litres. Separate Leachate storage tanks of 25 litres capacity are used shown in figure 3.1 The Leachate is passed to two reactors with the help of peristalatic pump. The flow rate or hydraulic retention time is 20ml/min is fixed.

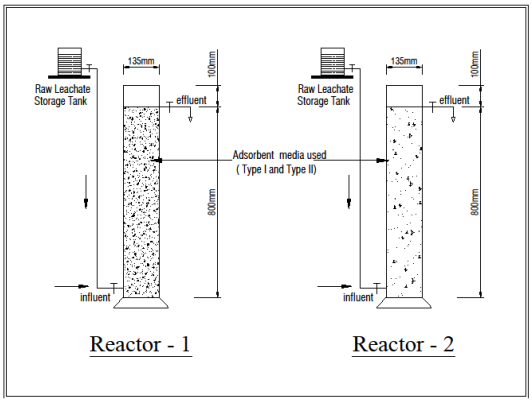

Fig 3.1: Line Diagram showing Cross sectional view of the Reactors

2.7 Charactarization of Landfill Leahate

The Leachate sample was collected from landfill site. The Leachate was analyzed for the study purpose in the laboratory. Initial characteristics of the landfill Leachate was analyzed have been present in table 2.2.

Table 2.2 Physico-chemical Characteristics of Raw Leachate collected from the field

Sl. No.	Parameters tested	Values in range
1.	Appearance	Reddish Brown
2.	Total Dissolved Solids (TDS)in mg/l	11570-15570
3.	Total solids in mg/l	17840-18480
4.	pH	8.5 - 8.6
5.	Total Alkalinity (as $CaCO_3$) in mg/l	570-590
6.	Total Hardness (as $CaCO_3$) in mg/l	545-565
7.	Calcium (as Ca) in mg/l	218-226
8.	Chloride (as Cl) in mg/l	410-430
9.	BOD_5 @ 20^0C (mg/l)	3410-3840
10.	COD (mg/l)	9540-9870

3. Results and Discussions

The results obtained after the treatment of leachate from the reactors are analyzed for various Physico-chemical characteristics like Total solids, Total dissolved Solids, pH, Total Alkalinity, Total Hardness, Calcium, Chlorides, BOD_5 @ 20^0 C, and COD, as per standard methods. The leachate loading rate of 20ml/min was maintained in the treatment studies for all media used. The flow rate of Leachate was maintained using peristalatic pump. The experimental studies were carried out in the laboratory to know the treatment feasibility using low cost waste adsorbents in the removal of pollutant parameters. Required quantity of samples of Leachate effluents were collected during the treatment process at an interval of 2 litres, 4 litres, 6 litres ,8 litres,10 litres, and 12 litres from all the four types of adsorbents used. The treated waste water was analyzed and the results are presented in graphical in figures 3.1, 3.2, 3.3, 3.4.

Bio-chemial oxygen demand (BOD) is the amount of oxygen required by the bacteria to stabilize/oxidize the organic matter present in water and waste water under aerobic condition. This experiment was carried out in the laboratory using BOD incubator maintained @ 20^0c for 5 days. The samples were collected after the treatment of Leachate from the Up-flow reactors with different sizes of low cost waste adsorbents, are analyzed for BOD_5 @ 20^0c. It is observed that the raw waste water BOD_5 @ 20^0 was ranging from 3400-3800 mg/l. the treated effluents obtained from different media are very much capable of removing BOD from R_1& R_2 using Laterite and Brick Bats. 75% of the BOD removal in the laterite (1) of size (12.5mm-10mm) ,80% of the pollutants are removal in the laterite media of size (4.75mm-2.36mm), 75% of the pollutants are removal in the Brick bat of adsorbent
media size (12.5mm-10mm), 95% of the pollutants are removal in the Brick bats of size (4.75mm-2.36mm) Results of analysis are given in The Laterite of size 4.75mm-2.36mm is showing better efficiency compared to other adsorbent media used. The details of results obtained are shown in figures 3.1, 3.2, 3.3, 3.4.

Chemical oxygen demand is the amount of oxygen is required for chemical oxidation of organics and inorganic impurities. The important advantage of COD test is the short time required for total oxygen is required for oxidation. The efficiency of the impurities as shown in the table the treated effluents obtained from different media are very much capable of removing COD from R_1& R_2 using Laterite and Brick Bats. The Laterite of size 4.75mm-2.36mm is showing better efficiency compared to other adsorbent media used. The details of results obtained are shown in figures 3.1, 3.2, 3.3, 3.4.

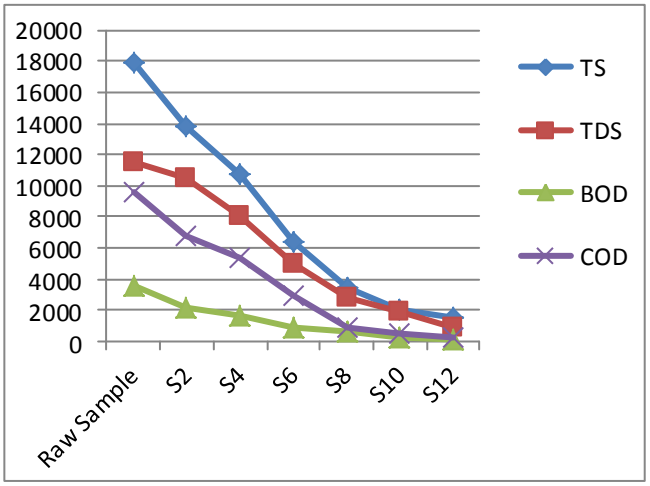

Fig. 3.1 Graphical representation of Treatment efficiency of Laterite (1) of size 12.5mm-10mm.

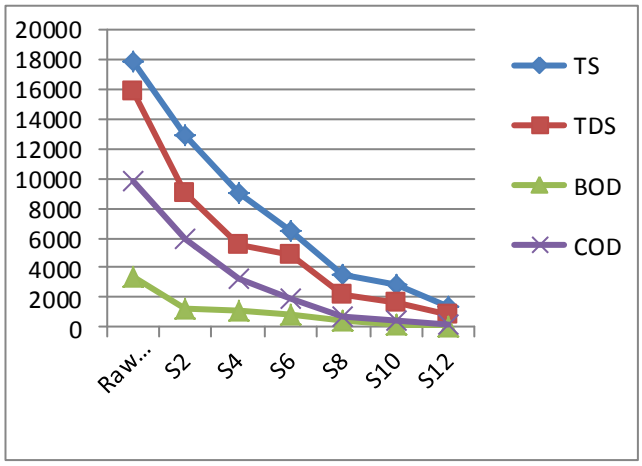

Fig. 3.2 Graphical representation of Treatment efficiency of Laterite (2) of size 4.75mm-2.36mm.

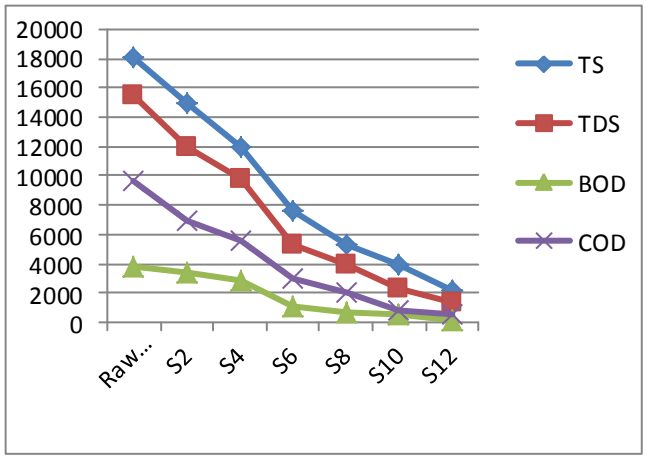

Fig. 3.3. Graphical representation of Treatment efficiency of Brick bats (1) of size 12.5mm-10mm.

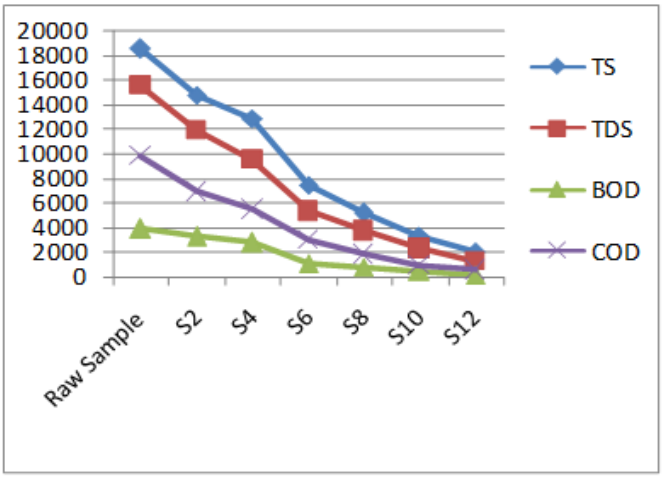

Fig. 3.4 Graphical representation of Treatment efficiency of Brick bats (2) of size 4.75mm-2.36mm.

4. Conclusions

The experimental studies has been carried out to know the treatment feasibilities on landfill leachate generated at municipal solid waste disposal site, using low- cost waste adsorbent materials of different sizes such as, (12.5mm-10mm) and (4.75mm-2.36mm) respectively, through Up-flow reactors. In this study, laboratory experiments were conducted in laboratory to know the raw and treated leachate effluents physico-chemical characteristics. Based on the experimental analysis and evaluation of results obtained from the study, made using Up-flow reactors, some of the following conclusions have been drawn.

- Using low-cost waste adsorbent materials in the treatment of Leachate, it seems to be highly economical process.
- The treatment of Leachate can be achieved without using any additional chemicals.
- The up-flow filters are more efficient in the treatment process than down flow treatment techniques. Since the entire flow is against to the gravity and can be achieved greater performance compared in various literatures.
- The hydraulic retention time can be controlled easily in up-flow treatment process.
- Use of lateritic granules as an adsorbent media (4.75mm – 2.36mm) is having more effective than brick bats.
- Smaller the media size, grater the efficiency since, getting more surface area.

4.1 Scope for Future Work

Based on the studies made in this project work, we have given some of the suggestions for future studies.

- The pollutant parameters particularly Nitrates and heavy metals like Iron, Lead, Chromium, Mercury, etc., can be analyzed using same reactors.
- Treatment efficiency can be studied by mixing of various adsorbent materials.
- The treated water can be tried to use for growing vegetation.
- Microbiological experiments can be carried out for treated effluents.
- Studies can be made using two reactors with same and different adsorbent media.
- By changing different hydraulic retention time values the treatment efficiency can be evaluated.

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