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Study on Leachate Management and Design of Experimental Setup for Treatment of Leachate using Bio-absorbent

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Abstract: *The management of leachate, a complex and environmentally hazardous effluent generated from solid waste landfill sites, poses significant challenges to environmental engineers and policymakers worldwide. In this study, we present a comprehensive investigation into leachate management strategies with a focus on the design and implementation of an experimental setup for its treatment by using the method of Treatment unit Initially, we conducted a thorough review of existing literature to understand the composition, characteristics, and environmental impact of leachate. This literature review informed the development of effective treatment strategies targeting key contaminants such as heavy metals, organic pollutants, and pathogens present in leachate. Subsequently, we designed and constructed an experimental treatment setup tailored to address the specific challenges associated with leachate treatment. The experimental setup integrates various treatment processes including physical, chemical, and biological methods to achieve comprehensive removal of contaminants.*

To evaluate the efficacy of the experimental setup, we conducted a series of laboratory-scale experiments using synthetic leachate samples. The sample treated by MSV LABORATORY such Parameters are turbidity, biological oxygen demand (BOD), NPK, heavy metal concentrations throughout the treatment process.

Preliminary results indicate promising outcomes in terms of contaminant removal and it is found that promising results are seen with peanut shell as the bio-absorbent, with significant reductions observed in BOD 2050 mg/l (from 7301mg/l), and heavy metal (Lead as Pb 0.11 mg/l), (Cadmium as Cd 0.2mg/l), Turbidity (49 mg/l) is concentrations. Additionally, microbial analysis revealed a substantial reduction in pathogenic microorganisms following treatment. In conclusion, this study contributes to the advancement of leachate management practices by offering insights into effective treatment strategies and the design of experimental setups for practical implementation. The sample treated to yield the best results in peanut shell bio absorbent is now being utilized in irrigation fields and gardening applications.

Keywords: leachate

I. INTRODUCTION

When the unwanted solid material is discarded in the environment by human beings it is called solid waste. The municipal solid wastes include the waste generated from domestic, industrial and commercial sources. Domestic waste includes kitchen waste, food waste, etc., commercial waste includes containers, plastic bags, etc. and industrial waste includes metal, paper, fibres etc.

Landfill are the physical facilities used for the disposal of residual solid waste in the surface soil ofearth. Where land is available, landfill is usually the most economical method of solid waste disposal. Landfills are built to concentrate the waste in compacted layers to reduce the volume and monitored for the control of liquid and gaseous effluent in order to protect the environment and human health. Besidesmunicipal solid waste, faecal sludge can also be discharged into landfills. Leachate is defined as anycontaminated liquid that is generated from water percolating through a solid waste disposal site,accumulating contaminants, and moving into subsurface areas. The leachate

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from Municipal Solidwaste landfills is a highly concentrated "chemical soup", so concentrated that small amounts of leachatecan pollute large amounts of groundwater, leaving it unsuitable for domestic water use.
There are methods to treat landfill leachate,

Biological process

Which is often the most important and most commonly used method to treat leachate for ammonia andorganic matter. However, it is not effective in removing inorganic salts. The treatment is predominantlyperformed by aerobic bacterial degradation of organic matter and nitrification of ammoniac nitrogen tonitrite and nitrate. The cheapest and most robust biological process is aeration in lagoons, although lagoons often demand large areas. Activated sludge and rotating biological contractors may also be applied, although these are more sophisticated and entail much higher costs.

Physical/chemical treatment

Which primarily includes the addition of simple chemicals followed by mixing, flocculation, coagulation, and settlement before or after other treatment. The physical/chemical treatment primarily reduces suspended solids; precipitates iron, manganese, calcium carbonate, and heavy metals removesturbidity and color and removes some of the organic matter. Air stripping can be used to remove ammonia by increasing the alkalinity (pH > 10) and aerating the leachate.

Membrane process

Landfill leachate is a kind of heavily polluted toxic organic wastewater, which poses a serious threat tothe ecological environment. Due to the complexity of the composition of landfill leachate, according todifferent treatment purposes, four types of membranes: microfiltration membrane (MF), ultrafiltration membranes (UF), nano filtration membranes (NF) and reverse osmosis membranes (RO) have all beenused in landfill leachate treatment. MF and UF are generally used as the pretreatment technology of leachate, and NF and RO are mainly used as its advanced treatment technology.

II. LITRATURE SURVEY

Ahsan, A., Alamgir, M., El-Sergany, M. M., Shams, S., Rowshon, M. K., & Daud,
N. N. (2014). Assessment of municipal solid waste management system in adeveloping country. Chinese Journal of Engineering, 2014(1-11), 561935.
This study was conducted to know the solid waste management steps like storage of sources, separation, on-site storage, collection, transportation, treatment, reuse, recycling and disposal.In this basic step he studied about how to solve the emerging socioenvironmental issue and also identified about the sustainable management concept for developing cities of country andhe studied about the general setup of MSW management in the city corporation areas. He researched overview of municipal solid wastes in densely populated areas. After researching about how to manage the SWM in study areas, he also studied about integrated SWM management approach to seek improvement of WM by structural dialogue between stake holders and planning and implantation of change. Also, he gave the conclusions for how to manage the MSW in densely populated areas of developing country, he researched some majorelements of integrated MSW management to improve the MSW management in densely populated areas of developing count

Blessy baby Mathew, Jaishankar, M., Biju, V. G., & Beeregowda, K. N. (2016). Role of bio adsorbents in reducing toxic metals. Journal of toxicology, 2016.
Industrialization and Urbanization have led to the release of increasing amounts of heavy metalsinto the environment. Metal ion contamination of drinking water and waste water is a serious ongoing problem especially with high toxic metals such as lead and cadmium and less toxic metals such as copper and zinc. Several biological materials have attracted many researchers research and scientists has they offer both cheap and effective removal of heavy metals from wastewater or leachate. Therefore, they used the agro based in expensive absorbents for their feasibility in removal of heavy metals. They used by observants like various agriculture wastesSuch as sugarcane bagasse, rice husk, oil palm shell, coconut shell and coconut husk in eliminating heavy metals from wastewater or leachate. So, the existing technology or methodsfor leachate treatment like physical method, chemical method and biological methods. These treatment technologies have major problems in cost and uneconomical, consume lot of space and have disposal

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problems. So overcome from these problems some alternative method to treat wastewater or leachate by using the bio adsorbent is an effective method to observe toxic metals from effluents not polluting the groundwater and which this method not only require any energyinput, less labour and low investment so this method is adopted to removal of heavy metals from the wastewater or leachate.

El-Fadel, M., Findikakis, A. N., & Leckie, J. O. (1997). Environmental impacts ofsolid waste landfilling. Journal of environmental management, 50(1), 1-25.
This study represents the practice of disposal in landfills and also the studied about gas and leachate generation due to primarily to microbial decomposition, climatic conditions, refuse characteristics and landfilling operations. They studied typical solid waste composition and chemical solid waste composition and they discussed about the migration of gas and leachate away from the landfill boundaries and also discussed how the gas and leachate formation leads environmental impact. They discussed about the potential health hazards, fires and explosions, vegetation damage, unpleasant odors, landfill settlement, ground water pollution and air pollution. This paper presents an overview of gas and leachate formation mechanisms in landfills and their adverse environmental impacts and describes the control methods toeliminate or minimize these impacts.

Emalya, N., Munawar, E., Rinaldi, W., & Yunardi, Y. (2020, May). Landfill leachate management in Indonesia: a review. In IOP Conference Series: MaterialsScience and Engineering (Vol. 845, No. 1, p. 012032). IOP Publishing.
The landfill leachate generation and its treatment have been one of main focus in the landfill management and leachate contains suspended and dissolved solid pollutants. Chemical both organic and inorganic of high concentration such as ammonia nitrates sulfides, heavy metals, nitrogen and others. They presented the quality standards of leachate that allowable to be discharged to the water body in accordance to the regulation of the govt of Indonesia. Here, considered the age of leachate is depends upon the various influence factors are type of solid waste dumping, degree of compaction in landfill, climate etc..

Z. Shamsollahi, & Partovinia, A. (2019). Recent advances on pollutants removal by rice husk as a bio-based adsorbent: A critical review. Journal of environmentalmanagement, 246, 314-323.
Rice husk is an attractive bio based absorbent material for pollutant removal since it is one of the lowest cost and renewable resources. According to this rice husk has the removal potentialof various pollutants and it can be more used in wastewater or leachate treatment. Nowadays, preservation of water quality due to reduction of water resources and population increases is one of the important environmental issues. Groundwater contaminated by organic and inorganic pollutants as risk to the human health. The conventional methods for removing these pollutants based on biological, chemical, physical methods and these techniques have disadvantage such as high cost, less flexibility, low efficiency. So, a suitable adsorbent is usedwhich is low cost, effective, eco-friendly and high adsorption capacity. So, the adsorbent has the rises the choose to remove the pollutants AV metals and activated carbon from wastewater or leachate. These rises give good result as an effective factor in adsorption process.

III. LANDFILL SITE

This is a process of visit the landfilling area and collect information about procedure of dumping of solid waste and leachate management. The site visit process is done by visiting landfilling areawhich is located at near Haraginadoni, Ballari dist, Ballari taluk.
Leachate forms in landfill sites as a result of rainwater percolating through the waste materials. When water comes into contact with decomposing organic matter, chemicals, and other substancesin the landfill, it picks up contaminants and becomes leachate. This liquid mixture often contains various pollutants, including heavy metals, organic compounds, and pathogens. Leachate can poseenvironmental risks if not properly managed, as it can seep into soil and groundwater, potentially contaminating surrounding areas. Landfill operators typically employ measures such as liners, collection systems, and treatment processes to mitigate the generation and impact of leachate.

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Fig 1: Formation of Leachate in Landfill Site

Based on the information provided:

- The landfilling process in Ballari began in 2014, meaning it has been ongoing for approximately10 years.
- The total area designated for the landfill is 84.33 acres, with only 10 acres currently in use.
- The landfill area primarily consists of red soil.
- There is a future design plan for the landfill area that aims to accommodate waste disposal forapproximately 100 years.
- Additionally, there is an incineration facility for medical waste located within the landfill area.
- The owner of the landfill area is the Municipal City Corporation of Ballari.
- The waste disposal method currently employed involves simple dumping of waste, followed by covering it with soil to prevent fires.

IV. TREATMENT OF LEACHATE

The objective of preparing the setup is to treat leachate using bio-absorbents such as rice husk, peanut shell, and coconut coir. the testing procedure entails conducting tests to evaluate the treatment efficiency of leachate both before and after passing through the prepared experimental setup.

Conducting tests is essential for determining the actual characteristics of a sample. After passing a sample through an experimental setup, tests are conducted to ascertain the specific characteristics of that sample. The main objective of this process is to treat wet leachate for its use in irrigation purposes.

The following Bio-absorbents are used to Treat Leachate,

Rice husk

Rice husks are the hard protective coverings of rice grains which are separated from the grains during milling process. They found that rice husk is used as an adsorbent to remove heavy metals from wastewater. These husks are sourced from Maharaja mill industry in Ballari.

Peanut shell

Peanut shell is the hard, fibrous shell that surrounds the peanut kernel. It consists mainly of cellulose and lignin and has a low nutritional value. These shells are obtained from **Shiva** mill industry in Ballari.

Coconut coir

Coconut coir is a byproduct that comes from coconuts, is a fibrous material that exhibits excellent water absorption properties. It is used in gardening, and as a substrate for mushroom cultivation. Coconut husk can also be used as a bio absorbent in water filtration systems. The coconut coir is collected from Kiran stores in Ballari

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Based on data given by Municipal Authority,

- A sample of leachate is gathered from the municipal city corporation vehicle yard in Ballari.
- A leachate sample is obtained with a volume of 1.2 liters.
- Collecting leachate samples is challenging in Ballari due to high temperatures, leading to rapidevaporation.
- As the samples will share same characteristics from the leachate of landfill site, the project iscontinued with the sample collected vermicomposting pit from municipality.
- The collected sample is quantity of 40 liters from municipality.

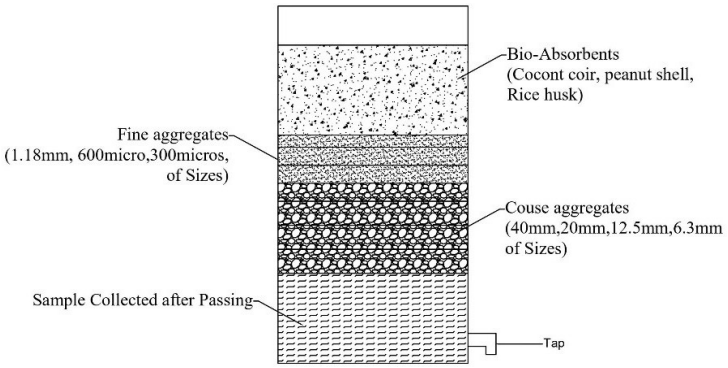

Fig 2: Experimental Setup for Treatment Leachate

The sample of leachate is sprinkling uniformly on Bio-absorbents which is placed at top most layer unitand remaining layers are filled with Coarse aggregate (sizes of 40mm, 20mm, 12.5mm and 6.3mm) and Fine aggregates (sizes are 1.18mm, 600micro, 300micro). The leachate is passing through treatment unit and collected at the bottom of unit, The collected sample is analysed to know the ranges of concentrations presence in sample after treated by various Bio-absorbents.

Instruments Required for Experimental Setup

- Water Drums
- Steel Mesh
- Iron Rods (10mm Dia)
- Binding Wires
- Coarse Aggregates
- Fine Aggregates

Results after Treated of Leachate is obtained from Treatment Unit of Various bio-absorbents

Table 1: Result of Both Diluted Untreated and Treated Leachate

Sl. No	Parameters	Units	Untreated sample	Treated Sample (CA+SAND+ COCONUT COIR)	Treated Sample (CA+SAND+ RICE HUSK)	Treated Sample (CA+SAND + PEANUTSHELL)
1	Lead as Pb	Mg/L	0.84	0.66	0.10	0.11
2	Cadmium as Cd	Mg/L	0.62	0.84	0.22	0.20
3	Turbidity	NTU	150	52	58	49
4	Bio-Chemical Oxygen Demand	Mg/L	7301	5890	3328	2050
5	Ammonical Nitrogen	Mg/L	45.6	64.4	48.7	36.8
6	Phosphorous as P	Mg/L	2.14	9.20	7.50	9.4
7	Potassium as K	Mg/L	86.6	120.8	140.6	156.8
8	Mineral Acidity	Mg/L	1126.4	752	852	933

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9	Alkalinity (Methyl orange indicator)	Mg/L	800	734.8	649.2	694.4
10	Alkalinity (phenolphthalein indicator)	Mg/L	953.2	816	978.8	894.4
11	Suspended solid	Mg/L	0.004	0.004	0.008	0.01

Note

CA (Coarse Aggregates)

The Leachate contains a high concentration of biochemical oxygen and lead, making it challenging to treat with our current experimental setup. Therefore, the sample was diluted with tap water and the dilution ratio is 1 in 10 (i.e. 1liter of sample was diluted with 10liter of water)

V. CONCLUSION

The leachate sample from the landfill site is unavailable, Due to high temperatures causing rapid evaporation, Therefore, we are proceeding with samples collected from the vermicomposting pit in the municipality, as they share similar characteristics. However, these samples pose a challenge due to high concentrations of BOD and heavy metals, making treatment difficult with our current experimental setup. As a solution, the samples are diluted with tap water at a ratio of 1 liter sample to 10 liters of water.

In this case, concentrations of the sample reduced by using Coconut coir, Rice husk, and Peanut shell as bio-absorbents and prepared experimental setup.

- Coconut coir exhibits superior performance in removing Potassium (120.8 mg/L), mineral acidity (752 mg/L), Alkalinity (as indicated by phenolphthalein) (816 mg/L), and Suspended solids (0.004 mg/L) in comparison to other bio absorbents.
- Rice husk proves to be particularly efficient in the removal of Lead (0.10 mg/L), Alkalinity (as indicated by methyl orange) (649.2 mg/L), and Phosphorous (7.50 mg/L) when compared to other bio absorbents.
- Peanut shell proves to be particularly effective in the removal of Cadmium (Cd) (0.20 mg/L), reduction of Turbidity (49 NTU), Bio-chemical oxygen demand (2050 mg/L), and Ammonical nitrogen (36.8 mg/L) when compared to other bio absorbents.

Upon analyzing the reduction values obtained through the utilization of bio absorbents, it is evident that Peanut shell is notably efficient in removing characteristics from leachate compared to rice husk and coconut coir.

Treatment with bio-absorbents such as Coconut coir, Peanut shell and Rice husk show promising results in heavy metal removal, Further studies on the Bio-absorbents is recommended.

REFERENCES

[1]. Ahsan, A., Alamgir, M., El-Sergany, M. M., Shams, S., Rowshon, M. K., & Daud, N. N. (2014). Assessment of municipal solid waste management system in a developing country. Chinese Journal of Engineering, 2014(1-11), 561935.

[2]. Blessy baby Mathew, Jaishankar, M., Biju, V. G., & Beeregowda, K. N. (2016). Role of bio adsorbents in reducing toxic metals. Journal of toxicology, 2016.

[3]. El-Fadel, M., Findikakis, A. N., & Leckie, J. O. (1997). Environmental impacts of solid waste landfilling. Journal of environmental management, 50(1), 1-25.

[4]. Emalya, N., Munawar, E., Rinaldi, W., & Yunardi, Y. (2020, May). Landfill leachate management in Indonesia: a review. In IOP Conference Series: Materials Science and Engineering (Vol. 845, No. 1, p. 012032). IOP Publishing.

[5]. Singhal, S., Agarwal, S., Bahukhandi, K., Sharma, R., & Singhal, N. (2014). Bioadsorbent: A cost- effective method for effluent treatment. International Journal of Environmental Sciences and Research, 3(1), 151-156.

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[6]. W. S. Al-Rekabi. (2009). Jingsong, G., Ping, L. Z., Ya, P. Y., & Abbas, A. A (2009). Review on LandWll leachate treatments. Journal of Applied Sciences Research, 5(5), 534-545.

[7]. Y. Choden, Pelzang, K., Basnet, A. D. R., & Dahal, K. B. (2022). Modeling of Leachate Generation from Landfill Sites. Nature Environment & Pollution Technology, 21(3).

[8]. Z. Shamsollahi, & Partovinia, A. (2019). Recent advances on pollutants removal by rice husk as a bio-based adsorbent: A critical review. Journal of environmental management, 246, 314-323.