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Characterization and Treatment of Artificial Municipal Landfill Leachate's: A Review

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Abstract: ***Landfill leachate is one of the major problems in the environment. So the leachate should be treated and disposed to safeguard the environment. In this Paper the artificial landfill leachate characterization and treatment of the leachate. There exists, many treatments of leachate but the RBC system is quite popular among those techniques because there is simplest and low maintenance cost and less space is occupied. The characterization of artificial landfill leachate is the ph, electric conductivity; alkalinity, BOD, COD, TSS, temperature, ammonia and BOD/COD ratio and other parameters are calculated. The leachate was a high concentration of organic and inorganic beyond the permissible limits. The heavy metal concentration is trace amount as the domestic. In this study that the passage of time and seasonal variations particularly during rainy season values of various parameters increased, the reason the time and the solid waste material is degraded and the waste constituents percolated down along with rainwater. (3) Due to the high leachate concentration of all components in the early acid phase due to strong decomposition and leaching. In methanogen phase a more stable leachate, with lower concentration and low BOD/COD ratio.(4) the leachate treatment must be done because the after contamination of environment trace amount of pollutants still exist, , the aerobic system was evaluated at different conditions of rotational speed of the discs(3,6 and 9 rpm), flow rate(14,20,27 and 36 L day^{-1}) and hydraulic retention times of (14,18,24 and 34 h) for highest COD removal rates.(9)***

I. INTRODUCTION

Landfilling of municipal waste is still a very important issue of the waste management system in the world. Waste cause two types of pollution of soil and groundwater contamination and biogas produced by the fermentation of organic matter, a source of air pollution. Leachate is the water percolated through the waste which corresponding to migration into the natural environment. The ill-effects of the Leachate contains toxic and carcinogenic chemicals which may cause harm to both human and environment. Leachate contaminates the groundwater can adversely affect industrial and agricultural activities. The use of contaminated water can decrease soil productivity for irrigation, contaminated crop and moves possible toxic pollutants from the food chain to animals and humans. Landfill leachate can be characterized as a water-based solution of four groups of pollutants. These are dissolved organic matter (expressed as COD or total organic carbon),volatile fatty acids, and more refractory compounds.

A. Inorganic compounds: ca, mg, na, k, fa, mn,cl-, Hco3
B. Heavy metals: Cd, Cr, Cu, Pb, Ni, and Zn
C. Xenobiotic organic compounds originating from household and industrial chemicals and present in low concentration in the leachate. These components include a variety of aromatic hydrocarbons, phenols, and chlorinatedaliphatic.

Some of the alternative methods are used such as recycling, composting incineration is nowadays encouraged. At present, modern landfills are highly engineered facilities designed to eliminate or minimize the adverse impact of the waste on the surrounding environment. The decomposition of the waste in a landfill is mainly due to microbiological processes. The production of landfill gas and leachate are chiefly related to the activity of the microorganisms (Alexander 1961; Senior 1995). The aerobic decomposition landfills are three phases. The first phase is hydrogens which is typically less than one month. In shallow (< 3 m) deposits of waste or when air is pumped into the waste, a longer period may be possible. Significant quantities of carbon dioxide and hydrogen are produced; particularly if the site is dry (Ham 1980).

During the second phase, anaerobic and facultative organisms hydrolyze and ferment cellulose and other putrescible material. Simpler and soluble compounds, such as volatile fatty acids with a high 5 day BOD and ammonia nitrogen are produced. The leachate produced in that period is characterized by high BOD5 values and a high ratio of BOD5 to COD. This indicates a high proportion of organic material is readily degradable (McGinley and Kmet 1984). The leachate also contains high levels of iron, magnesium, manganese, zinc, and calcium. Landfill gas production remains slow and consists of carbon dioxide with less quantity of methane and hydrogen (Johansen and Carlson 1976).

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II. LITERATURE REVIEW

SitiNorFarhanaZakaria, Hamidi Abdul Aziz, (2013) the characterization of leachate at AlorPongsu Landfill Site, are analyzed that according to the standard methods for the examination of water and wastewater. The characterization of leachate is to the following parameters such as color, chemical oxygen demand, biological oxygen demand, ammonical nitrogen, temperature, dissolved oxygen, biodegradability ratio, total dissolved solids, and ph. In this landfill leachate study, the biodegradability ratio is less than 0.1. Compare the allowable discharge for the leachate shows most of the parameters are standard discharge limitations. In this study, the strength of the landfill leachate is higher compared to nearby landfill leachate possible due to the use and source of the landfill of solid waste. (1)

M.I. Al-Wabel, W.S. Al Yehya, A.S. AL-Farraj, S.E. El-Maghraby (2011) "Characteristics of landfill leachates and bio-solids of municipal solid waste (MSW) in Riyadh City", is analyzed that the landfill leachate is ph, electrical conductivity, COD, BOD, total suspended solids, heavy metals. They conclude that the except ph, EC, COD, SAR, values are as well as the concentration of soluble ions were so much higher in Riyadh landfill leachate when comparing with some other countries. The concentration of soluble exceeds in the upper limit other landfills of Taiwan, Hong Kong, Kuwait, USA, Italy, and Germany. The concentration of Fe, Mn, Ni found to be the higher limits in the Riyadh landfill site. (2)

Barjinder Bhalla, M.S. Saini, M.K. Jha effect of age and seasonal variation of leachate characteristics of municipal solid waste landfill'(2013) this paper discusses the various leachate samples are collected and analyze the various physiochemical process to estimate the pollution potential. The leachate was a high concentration of organic and inorganic beyond the permissible limits. The heavy metal concentration is trace amount as the domestic. In this study that the passage of time and seasonal variations particularly during rainy season values of various parameters increased, the reason the time and the solid waste material is degraded and the waste constituentspercolated down along with rainwater.

Peter Kjeldsen, Morton A. Barlaz, Alix P. Rooker'Present and Long-Term Composition of MSW Landfill Leachate' (2002) this paper discuss the landfill leachate is one of the major potential problems in the environment. Landfill leachate is the pollution problem categorized into four types such as dissolved organic matter, heavy metals, inorganic macro components, and xenobiotic organic components.Due to the high leachate concentration of all components in the early acid phase due to strong decomposition and leaching. In the methanogenic phase more stable leachate, with a lower concentration and low BOD/COD ratio. Generally, low concentrations of heavy metals are observed. Leachate contains a broad variety of xenotic organic components. The broad concentration of each pollution is observed in most cases. In this study, most of the aromatic hydrocarbons and chlorinated aliphatic compounds are observed. (4)

Naveen.B.P, Sivapullaiah.P.V, Sitharam.T.G,"the characteristics of municipal solid waste landfill leachate," (2014) this paper discuss the leachate characteristics are analyzed. Depending upon the weather condition the leachate flow can increase in the rainy season and decrease in the summer season.leachate characteristics are analyzed in the standard test. The landfill leachate is categorized into four groups are dissolved organic matter, inorganic macro components, heavy metals, and organic compounds. This paper discusses the high in organic and inorganic constituents. And heavy metal concentration in trace amount as waste in domestic. This study found to have a high significant in salinity and alkalinity as reflected in their values for conductivity and TDS and alkalinity. (5)

J.Wiszniowski·D. Robert·J. Surmacz-Gorska· K. Miksch·J.V. Weber(2005) these are reviewed methods for treating landfill leachate which having higher concentrations of organic and inorganic contaminants including humic acids, ammonia nitrogen, heavy metals, xenobiotic, and inorganic salts, and need to be removed due to unfavorable effect on the environment. The biological process of nitrification and denitrification probably the most efficient and cheapest process to eliminate nitrogen from leachate. Biological treatment is hampered by specific toxic substances such as PAHs-polyaromatic hydrocarbons, AOXs-absorbable organic halogens, PCBs-polychlorinated biphenyls) and/or by the presence of bio-refractory organics such as humic substances. [6]

The rotating biological contractor is an example of the biological treatment process. It consists of circular plastic discs mounted centrally common horizontal shaft. These discs are approximately 40% submerged in a tank containing wastewater and are slowly rotated by either a mechanical or compressed air drive. Microorganisms from the wastewater adhere to the plastic disc surfaces and, within 1-4weeks from start-up, from biofilm ranging from 1to2mm in thickness. this biological growth assimilates organics from the wastewater passing over the surface of the disc and is responsible for most of the treatment which occurs. When the disc rotates out of the wastewater, the biofilm becomes exposed to air and is oxygenated, thereby maintain aerobic conditions.

Saraswati Rana, Nitish Gupta and R.S. Rana (2017) presentthe treatment of phenol containing effluent using a rotating biological contractor. They say that physiochemical treatment methods are costlier because of using sophisticated instruments, sludge production and consumption of large quantities of the various chemicals. For this instance, a rotating biological contractor is

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preferred for its simple, cheap, process, stability and its eco-friendliness. It is provided that for the efficient operating performance of the RBC, various working parameters are optimized like Hydraulic retention time (HRT), Concentration of wastewater, disc submergence and rotations per minute (RPM). [7]

Douglas B. Spengel and David A. Dzombak.el experimented with the treatment of the landfill leachate using rotating biological contactor in bench-scale experiment for the oxidation of the ammonia and soluble organic matter in partially submerged rotating biological contactor. The leachate used in the study was obtained from the major landfill, located in a lower providence township near Philadelphia, Pennsylvania.

Three aerobic bench-scale rotating biological contactors named as RBC-1, RBC-2, RBC-3 were used in this study. In each RBC six discs were arranged with every two discs makes one stage. Leachate is induced from the perpendicular to the surface area of the discs in the RBC. The RBC containment vessels are made of schedule 80, polyvinyl chloride (PVC) and contained 1.4 L (0.30 gal) volume of leachate per stage. The RBC discs are made of high-density polyethylene and sanded for the attachment of the microorganisms. Each two discs are separated by the aluminum shaft lock that secured the discs to a stainless-steel rod running through the center of the discs in the RBC. The total area of the disc area along with the edges was 0.187m^2. 40% of the disc area is submerged for proper treatment. Dome-shaped nylon covers are used to restrict the evaporation of the leachate.

By experimenting, the influent leachate COD concentrations are 320 to 385mg/L. During steady-state, the average COD concentrations were 223,227,241 for RBC-1, RBC-2, RBC-3 and removals of 38, 36, and 32 respectively. (8)

E. Castillo, M.Vergara, Y. Moreno. El researched the technical and operational feasibility of the rotating biological contactor and upward flow sludge blanket reactor in a bench-scale model, which involves aerobic and anaerobic systems respectively. This research for the treatment of landfill leachate involves the evaluation of the various parameters like Suspended Solids (SS), Volatile Suspended Solids (VSS), Total Solids (TS), Total Volatile Solids (TVS) and Chemical Oxygen Demand (COD). All these above parameters are measured according to the standard measurements.

For aerobic treatment: The evaluation of the aerobic system is done in two stages, first one involves three configurations were measured with same conditions of organic load between 9.2 to 17.2g-COD m^{-2} day^{-1} and rotation speed of 4 rpm. In second stage of the aerobic system the biofilm is formed and stabilized, the aerobic system was evaluated at different conditions of rotational speed of the discs(3,6 and 9 rpm), flow rate(14,20,27 and 36 L day^{-1}) and hydraulic retention times of (14,18,24 and 34 h) for highest COD removal rates. These parameters were induced for the best results of organic load removals. (9)

S. Renou, J.G. Givaudan, S. Poulain, F. Dirassouyan, P. Moulin (2009) these are reviewed Landfill leachate treatment nowadays sanitary landfilling is the most common way to eliminate municipal solid waste.In this paper, the biological treatment is simplicity and cost-effectiveness. Biological treatment is commonly used for the removal of the bulk of leachate containing a concentration of BOD. Biodegradation is carried out by microorganisms, which can degrade organics compounds to carbon dioxide ad sludge under aerobic conditions and biogas under anaerobic conditions (9). The characteristics of the landfill leachate can usually be represented by the basic parameters such as BOD, COD, PH, suspended solids (SS), total nitrogen .the values of COD vary from 70900mg/lit with leachate sample from a more than 10 years old landfill. The PH of the leachate lies in the 5.8-8.5.

Shuokr Qarani Aziz, Hamidi Abdul Aziz, Mohd Suffian Yusoff, Mohammed J.K Bashir "Leachate characterization in semi-aerobic and anaerobic sanitary landfills''(2010)this paper studies and analysis of the semi aerobic sanitary landfill Palau burning landfill site and Kulim sanitary landfill in the northern region Malaysia. The raw samples are collected and analyze below parameters such as COD, BOD, total nitrogen, phosphorous, phenols, pH, turbidity, color has been analyzed. The obtained results were compared with previously published data and data from the Malaysia Environmental Quality Act 1974. The results indicated that PalauBurning leachate was more stabilized compared with Kulim leachate. Furthermore, the aeration process in PBLS has a considerable effect on reducing the concentration of several pollutants. (11)

AletteLangenhoff et al.defined the Batch Experiments. Aerobic and anaerobic batch experiments (microcosms) have been performed in duplicate in 120mL bottles with medium and activated sludge from two conventional municipal treatment plants in The Netherlands: (1) adapted sludge from a sewage treatment plant and (2) unadapted sludge from a recently started membrane bioreactor. For the aerobic batch experiments, 120mL bottles were filled with 40mL aerobic medium and 2mL sludge and sealed with butyl rubber or Viton rubber stoppers

For the batch experiments under anoxic conditions, the medium as described for the aerobic batches was prepared anaerobically while continuously flushing with N2 gas and the addition of nitrate (0.85 to 3.4g/L NaNO3). Resazurin, a color indicator to control anoxic conditions, was added at a final concentration of 0.5μg/L. After closing the bottles, the gas phase in the bottles was changed to 80%N 2/20%CO2 (v/v) and brought to1.3 bar. After the addition of effluent to the bottles was incubated on a shaker (100rpm) in the dark at 30∘C. Autoclaved controls were taken along as well [12].

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Chungsying Lu et al., the study of Results showed that the flow was more mixed when the AnRBC system was operated at a higher rotational speed or lower submergence. In the steady-state operating condition, the stage chemical oxygen demand (COD) removal efficiency increased as rotational speed increased in the range of 0 - 12 rpm. The opposite trend was observed at rotational speed values above 12 rpm. The optimal rotational speed values are between 6 and 24 rpm with the overall COD removal efficiencies ranging from 70 to 78%.RBC was observed that dairy wastewater could be treated easily with COD removal efficiencies ranging from 60 to 81%. The stage COD removal efficiency decreased with an increase of stage number and about 90% organic compounds were removed in the first two stages of AnRBC, indicating that a two-stage reactor may be sufficient in practical application. The AnRBC system could be an effective process for treating high-strength organic wastewaters under operating conditions of 12 rpm and 100% disc submergence. (13)

An chin yew et al.,explainthe rotating biological contactors the removal efficiencies of COD and BOD increased as the HRT increased or the influent COD decreased. 90% of organic compounds were removed in the first two stages of anaerobic rotating biological contactors (AnRBC) for all tests, indicating that a two-stage reactor may be sufficient in practical applications

1) *Advantages:* When operated at high organic loading rates, the AnRBC process has higher biomass concentrations and organic removal efficiencies as compared to the anaerobic contact process and the anaerobic filter process. The operation of the AnRBC process is easier as compared to the anaerobic fluidized bed process and the up-flow anaerobic sludge blanket process. Accumulation of sloughed biofilm and non- reactive solids in the AnRBC process is lower compared to the process and the UASB process so that the system can treat wastewater containing high concentrations of non-reactive suspended solids in long term operations. The energy requirements of the AnRBC process are lower as compared to the anaerobic fluidized bed process and the UASB process. (14)

III. CONCLUSION

In this study, I concluded that the characterization of municipal solid waste is an important parameter for treating leachate. The characterization parameters such as ph, alkalinity, TSS, TDS, COD, BOD, BOD/COD ratio, ammonia, nitrogen, conductivity, etc. the leachate concentration of organic and inorganic beyond the permissible limits and heavy metals are trace amount as the domestic. Depending upon the weather condition the leachate flow can increase in the rainy season and decrease in the summer season.The rotating biological contactors are a viable option for treating landfill leachate for its low maintenance cost, less arearequirement, wastewater treating efficiency is high.

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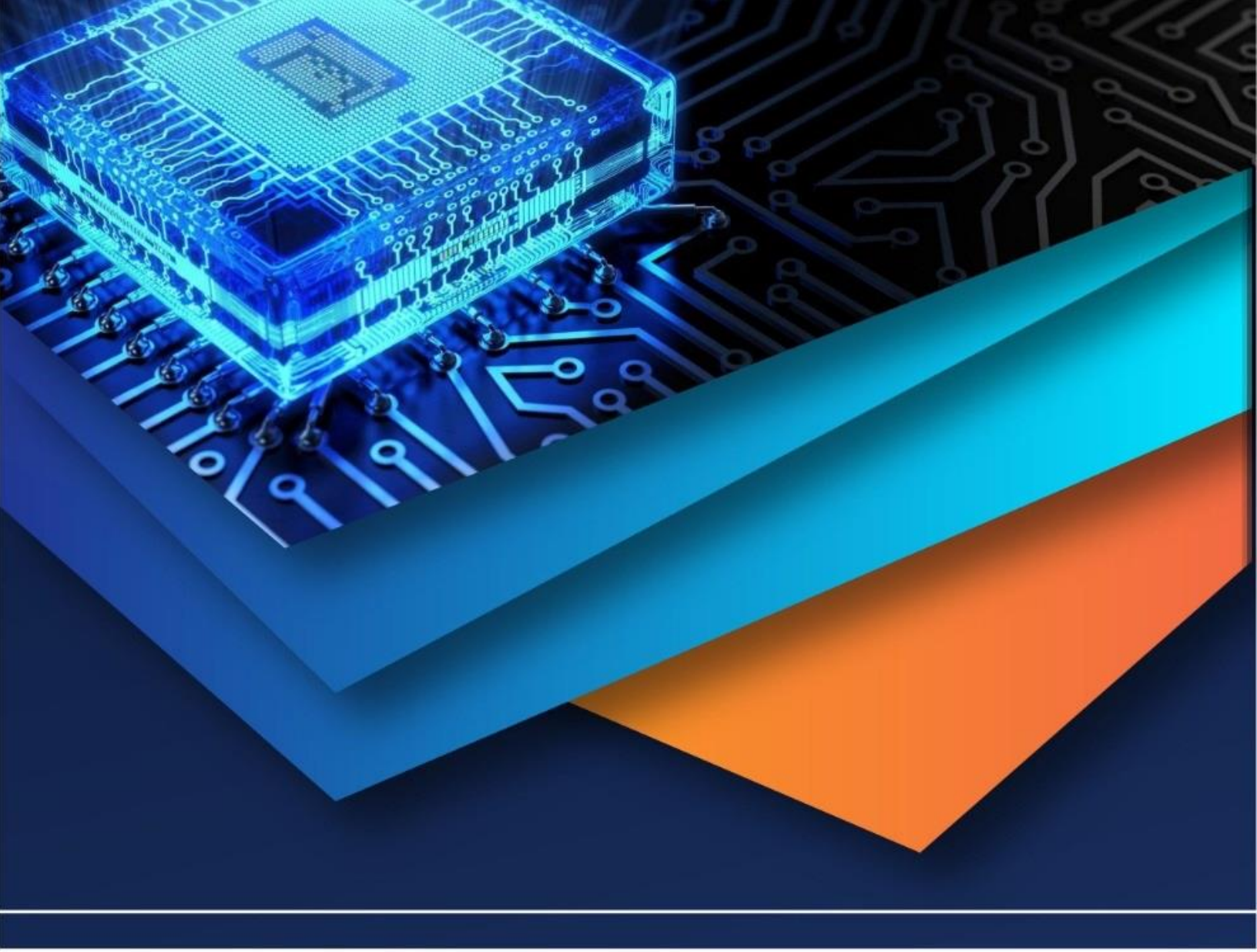

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