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Municipal Solid Waste (MSW) Leachate Treatment – A Review

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***Abstract* - The leachate has occupied the attention of a large number of researchers because of among various environmental problems. The production of leachate poses a significant threat to soil and ground water and is a major issue for solid waste landfills. Leachate is a hazardous liquid that can have negative effects on environments like soil and surface water if it leaks. The gradual breakdown of solid waste results in a variety of byproducts and soluble materials like nutrients, pesticides, and chemicals that leach into the soil and pollute ground water and soil. Humankind is supported by the earth's resources, but various human actions increase waste generation, resulting in leachate. The filtering fluid known as Leachate permeates into the layers of soil and influences the Different Geo-specialized properties. This paper is a survey of landfill leachate medicines and investigation of leachate and its treatment portrayal.**

Keywords: Leachate, MSW, pH, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD).

1. Introduction

Leachate is liquid waste produced from domestic households or industrial waste products. Municipal solid waste (MSW) is the main origin of leachate in urban areas. Leachate, the leaching liquid, percolates into the soil's layers and affects a variety of geotechnical properties. A Leachate is any liquid that in course of passing through matter, extracts soluble or suspended solids or any other component of the material through which it has passed. In case of Municipal Solid Waste disposal, leachate comes from waste decomposition process of solid waste. Since many heavy metals are highly toxic when the concentration exceeds certain limits, they need to be treated. The prevailing purification technologies used to remove the contaminants are too costly and sometimes non-ecofriendly also, plus the leachate treated cannot be fully used for various purposes. Leachate is a term used to describe the liquid that is produced when water interacts with waste in landfills. This liquid contains a variety of pollutants and contaminants, including heavy metals, organic compounds, and pathogens. As a result, leachate poses a serious threat to the environment and human health.

The study of leachate involves various techniques, including chemical analysis, microbial analysis, and hydrological modeling. These methods can help identify the sources of leachate pollution, track its movement and dispersion, and assess its potential impact on the environment. Overall, the study of leachate is a crucial aspect of waste management, and it plays an important role in protecting public health and the environment from the harmful effects of landfill pollution.

What is Leachate?

Leachate is the liquid that is formed when water comes into contact with waste materials, such as solid waste, garbage or landfills waste. This liquid can contain a variety of solid contaminants, including heavy metals, organic compounds.

Sources of Leachate

The primary source of leachate is municipal solid waste (MSW) landfills, but it can also be produced form hazardous waste landfills, industrial landfills, Agricultural activities, construction sites, water bodies and other type of waste disposal sites. The composition of varies depending on the waste material, the age of the landfill, and the climatic conditions. Generally, leachate contains high concentration of organic and inorganic contaminants including heavy metals, Nitrogen, Phosphorus, and other toxic compounds.

Impacts of Leachate

Leachate has a significant impact on the environmental and human beings. Following are some of the key impacts of leachate:

1) Contamination of soil and groundwater: When leachate enters the soil, it can Contaminate of soil and groundwater, which can have a significant impact on the environment. The pollutants in the leachate can leach into the soil, making it unsatiable for agriculture, and can

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contaminate the groundwater, making it unsafe for human consumption.

2) Pollution of surface water: Leachate can also flow into nearby water bodies, such as rivers and streams, polluting them with toxic chemicals and pathogens. This can have a significant impact on aquatic life and can make the water unsafe for human use.
3) Negative impact on air quality: Landfills and waste disposal sites that produce leachate can also emit harmful gases, such as methane and volatile organic compounds, into the air. These gases can contribute to air pollution, which can have significant health impacts on nearby communities.
4) Health hazards: Exposure to leachate can have significant health impacts, particularly for those who live or work near waste disposal sites. Leachate can contain harmful pathogens, heavy metals, and organic compounds, which can cause a range of health problems, including respiratory issues, skin irritation, and neurological disorders.
5) Affecting wildlife and biodiversity: Leachate can also have a significant impact on wildlife and biodiversity in the surrounding area. The toxins in leachate can poison animals, and the pollution of water and soil can make it difficult for plants and animals to survive.

Overall, leachate is a serious environmental and public health concern, and it is important to take steps to prevent its formation and properly dispose of it to minimize its impact on the environment and human health.

Leachate Characteristics

The characteristics of leachate can vary depending on a number of factors, including the composition of the waste, the age of the landfill, and the climate in the area. Some of the most important characteristics of leachate are discussed below:

The characteristics of the landfill leachate can usually be represented by the basic parameters pH, Colour and odour, Temperature, COD, BOD, the ratio BOD/COD, suspended solids (SS), total solids (TS) and dissolved solids.

pH: Leachate typically has a pH that is highly acidic or highly alkaline, depending on the nature of the waste. This can cause corrosion of pipes and other infrastructure, and can also impact the chemical balance of nearby water bodies.

Colour and odour: Leachate are typically dark in colour and has a strong, unpleasant odour. These characteristics can make it easy to identify and can also make it difficult to handle and transport safely.

Temperature: Leachate can be significantly warmer than the surrounding environment due to the microbial activity within the landfill. This can impact the behaviour of the leachate and its interactions with the surrounding environment.

Chemical Oxygen Demand: The young landfill leachate is commonly characterized by high biochemical oxygen demand (BOD) (4000–13,000 mg/L) and chemical oxygen demand (COD) (30,000– 60,000 mg/L), moderately high content of ammonia nitrogen (500–2000 mg/L), a high BOD/COD ratio (0.4–0.7), and a low pH (as low as 4.0). Although this is no longer the case, COD (chemical oxygen demand) is still a reasonable approximation for the majority of water types. It used to be thought of as an estimate of organic matter. However, landfill leachates could be one of the exceptions. Landfill leachate contains many inorganic substances and, in certain circumstances, high concentrations of volatile organic compounds like acetic acid; the COD value may be affected by these conditions.

Biochemical Oxygen Demand: Biochemical oxygen demand (BOD) is a measure of the amount of oxygen used by these microorganisms as they feed upon organic matter. Liquid that seeps from landfills is called leachate. Leachate is formed when water passes through the waste in a landfill. As the liquid moves through the landfill, many organic and inorganic compounds may be carried in the leachate. BOD levels will also be high in the leachate if it contains a lot of organic matter. If leachate has high BOD levels and contaminates body of water, it may cause the BOD of the water to be too high, which may be harmful to fish and aquatic species. On the off chance that Body levels are high, disintegrated oxygen in the water diminishes on the grounds that microbes in the water utilize the broke up oxygen as they decay natural matter. When there is less dissolved oxygen in the water, fish and other aquatic species may not survive.

Suspended Solids: Influence of landfill leachate suspended solids on clog (bierock) formation. The expansion in unstable solids, which added to stop up improvement over the long run, was principally because of the maintenance of unpredictable suspended solids and development of a biofilm fit for eliminating acetic acid derivation, propionate, and butyrate from the leachate. The growth of a biofilm that was able to remove acetate, propionate, and butyrate from the leachate and the biological, chemical, and physical processes that took place within the column of volatile suspended solids were the primary factors in the formation of the clog material. Calcium precipitation within the column was primarily caused by acetate fermentation.

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Total Solids: The term "total solids" refers to matter suspended or dissolved in water or wastewater, and is related to both specific conductance and turbidity. The material that remains in a container following the evaporation and drying of a water sample is referred to as total solids, or total residue. The water balance in aquatic organisms' cells is affected by the concentration of total dissolved solids. An organism placed in distilled water, which has a very low solids content, will swell because water will tend to move into its cells, which have a higher solids content .Dissolved Solids: Construction and demolition (C&D) waste tends to cause high concentrations of total dissolved solids in the leachate. Primary contributions to the dissolved solids are sulfate and calcium, predominantly from gypsum drywall. Concrete in C&D landfills causes high leachate pH, often as high as 11. Industrial waste can contain any number of toxins, heavy metals or pharmaceuticals that will affect leachate quality and require treatment to some degree Leachate from exploration and production (E&P) waste from the drilling and fracking industry can possess high concentrations of total dissolved solids (TDS), chlorides, and sulfates and moderate concentrations of toxic heavy metals. E&P waste can also contain naturally occurring radioactive material which can be present in the leachate.

Dissolved Oxygen: Liquid that seeps from landfills is called leachate. Leachate is formed when water passes through the waste in a landfill. If BOD levels are high, dissolved oxygen in the water decreases because bacteria in the water use the dissolved oxygen as they decompose organic matter. Dissolved oxygen (DO) level was significantly ($P<0.05$) lower in the leachate sample followed by station I, which is the major point of entry of leachate into the pond. Dissolved oxygen (DO) is one of the most important indicators of water quality. It is essential for the survival of fish and other aquatic organisms. Oxygen dissolves in surface water due to the aerating action of winds. Oxygen is also introduced into the water as a byproduct of aquatic plant photosynthesis.

Bod/Cod ratio: Over the course of six years, the relationship between BOD and COD of leachate from a mature landfill site was investigated in order to identify the indicator that can be used to predict the characteristic of leachate generated from the landfill site. Consequences of the examination uncover that Body: The COD ratio is a reliable indicator of the organic matter's degradation in a landfill. It tends to be utilized as a pointer for debasement of natural matter that separate the lactogenic stage from methanogen ease in this landfill.. Facing to untreated materials such as raw water, wastewater and leachate landfill, on one side, the BOD/COD ratio is higher than0.5. Leachate sample of young landfill contains high concentrations of BOD and COD, i.e. 60.000 mg/L and 130.000 mg/L respectively. As per BOD/COD Ratio we decide which treatment is convenient for treating the landfill leachate either by Biological or Chemical treatment unit/process.

Treatment of Leachate

Many different methods are currently in use to treat the landfill leachate. Most of these methods are adapted for water treatment processing and can be divided into two main categories: biological treatments and physical/chemical treatments. Leachate treatment can be done in a variety of ways, including:

Recycling leachate and combined treatment with domestic sewage are the two types of landfill leachate transfer. Easy upkeep and low operating costs are two of the benefits of treating sewage from homes. However, this method is questioned due to the presence of low biodegradable organic compounds and heavy metals in leachate, which may result in a decrease in treatment efficiency and an increase in effluent concentration. Due to its low cost, recycling leachate has become increasingly popular in recent years. However, if the recycling volume of leachate is very high, saturation, ponding and acid problems will occur.

1) Conventional treatments:

Conventional landfill leachate treatments can be classified into three major groups: (a) leachate transfer: recycling and combined treatment with domestic sewage, (b) biodegradation: aerobic and anaerobic processes and (c) chemical and physical methods: chemical oxidation, adsorption, chemical precipitation, coagulation/flocculation, sedimentation/flotation and air stripping.

1) Leachate transfer: treatment with domestic sewage. A common remedy a few years ago was to treat leachate alongside municipal sewage at the municipal sewage treatment plant. It was liked for its simple support and low working expenses. However, the presence of organic inhibitory compounds with low biodegradability and heavy metals in the leachate, which may decrease treatment efficiency and raise effluent concentrations, has raised concerns about this option. The fact that nitrogen (from leachate) and phosphorus (from sewage) do not need to be added at the plant is an argument in favour of this alternative treatment. The authors of one of the few studies that have been published attempted to improve the volumetric ratio of leachate to total wastewater. Dimakopoulos et al. investigated combined treatment. Utilizing a sequencing batch reactor (SBR) with settling, filling, toxic, and anoxic phases. At the conclusion of the daily cycles, nearly 95 present BOD and 50 present nitrogen were removed when the ratio of

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sewage to leachate was 9/1. With an increasing ratio of domestic wastewater to landfill leachate, COD and NH4 +-N reduction decreased. Also, the gushing quality might be improved with powdered initiated carbon (PAC) expansion, especially if the leachate input surpasses 10%. Other researchers studied the co-treatment of leachate and sewage and showed similar results.

2) Recycling: Recycling treatment of leachate involves treating the leachate to remove or reduce its contaminants so that it can be reused or safely discharged into the environment. Leachate back through the tip has been largely used in the past decade because it was one of the least expensive options available. Recently, authors demonstrated the method's advantages. Bee et al. reported that a controlled reactor's moisture content increased as a result of leachate recirculation. system and provided the distribution of nutrients and enzymes between methanogens and solid/liquids.

II) Biological treatment

Biological treatment methods use microorganisms to break down organic pollutants in the leachate. The most common biological treatment method is aerobic treatment, which uses oxygen to support the growth of microorganisms that break down organic matter. Anaerobic treatment can also be used, which breaks down organic matter without oxygen. Due to its reliability, simplicity and high cost-effectiveness, biological treatment (suspended/attached growth) is commonly used for the removal of the bulk of leachate containing high concentrations of BOD. Biodegradation is carried out by microorganisms, which can degrade organics compounds to carbon dioxide and sludge under aerobic conditions and to biogas (a mixture comprising chiefly CO2 and CH4) under anaerobic conditions. When the BOD/COD ratio is high (>0.5), biological processes have been shown to be very effective at removing organic and nitrogenous matter from immature leachates. With time, the major presence of refractory compounds (mainly humic and fulvic acids) tends to limit process's effectiveness.

1) Aerobic treatment: Aerobic treatment involves the use of oxygen to break down organic matter in the leachate. This process typically involves introducing air into the leachate, which promotes the growth of aerobic bacteria that consume the organic matter. The end result of aerobic treatment is a relatively clean and clear liquid that can be discharged into the environment or reused for other purposes.
2) Anaerobic treatment: Anaerobic treatment on the other hand, does not involve the use of oxygen. Instead, it relies on anaerobic bacteria to break down organic matter in the leachate. This process is typically slower than aerobic treatment and produces biogas (a mixture of methane and carbon dioxide) as a byproduct. The biogas can be captured and used as a source of renewable energy.

III) Chemical and physical treatment

Physical and chemical processes include reduction of suspended solids, colloidal particles, floating material, color, and toxic compounds by flotation, coagulation/flocculation, adsorption, chemical stripping the air and oxidation. Synthetic medicines for the landfill leachate are utilized moreover at the treatment line (pre-treatment or last filtration) or to treat a particular contamination (stripping for smelling salts).

Physical treatment methods involve the use of physical processes such as sedimentation, filtration, and adsorption to remove suspended solids and other pollutants from the leachate.

1) Flotation: The reduction of colloids, ions, macromolecules, microorganisms, and fibres has been the primary goal of flotation, which has been widely used for many years. Be that as it may, until to date, not very many examinations have been given to the use of buoyancy for the treatment of landfill leachate. As of late, Zones et al. investigated the use of column flotation as a post-treatment method for removing residual hemic acids—compounds that are not biodegradable—from simulated landfill leachates. Under upgraded conditions, practically 60% hemic acids evacuation has been reached.
2) Coagulation–flocculation: Coagulation involves adding a coagulant to the water, which destabilizes and clumps together small suspended particles such as dirt, bacteria, and other organic matter. The coagulant can be a metal salt such as alum or ferric chloride, or a synthetic organic polymer. Flocculation involves gently stirring the water after the coagulant has been added, causing the small clumps of particles to collide and stick together to form larger, heavier particles called flocs. The flocs will then settle to the bottom of the water or rise to the surface where they can be more easily removed by filtration or sedimentation.
3) Overall, coagulation and flocculation are important steps in the water treatment process as they help to improve water quality by removing impurities and making the water safe to drink. The examination of coagulation–flocculation for the treatment of landfill leachates has been the subject of several studies with the goal of process optimization—that is, selecting the most suitable coagulant, determining the ideal experimental conditions, and evaluating the impact of pH Recent research

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summarized in Table 10 clearly demonstrates that iron salts are more effective than aluminium ones, reducing chemical oxygen demand (COD) by as much as 50%, whereas aluminium or lime addition had only moderate results (between 10% and 40%). However, the ratio of coagulants to flocculants or the combination of the two may increase the floc-settling rate and so the process performance (COD abatement up to 50%).

4) Adsorption. Regardless of the initial organic matter concentration, the adsorption of pollutants onto activated carbon in the form of powder or columns reduces COD levels more effectively than chemical methods. The primary downside is the requirement for incessant recovery of segments or an identically maximum usage of powdered initiated carbon (PAC). In order to effectively treat landfill leachate, activated carbon adsorption and biological treatment have been utilized. No biodegradable organics, latent COD and the variety might be diminished to adequate levels for naturally treated landfill leachate. Rodriguez and cost died PAC and different resins efficiency in the reduction of non-biodegradable organic matter from landfill leachate. Activated carbon presented the highest adsorption capacities with 85% COD decrease and a residual COD of 200 mg L−1.
5) Sedimentation: Sedimentation is a commonly used process for treating leachate, which is the liquid that results from the decomposition of solid waste in landfills. During this process, gravity is used to separate the solid and liquid components of the leachate. The sedimentation process works by allowing the leachate to settle in a tank or basin for a period of time, during which the heavier solid particles settle to the bottom of the tank, while the lighter liquid rises to the top. The solid particles that settle at the bottom of the tank are known as sediment, while the liquid that rises to the top is known as supernatant.
6) Chemical oxidation. Chemical oxidation is a method that has been extensively studied for treating effluents that contain refractory compounds like landfill leachate. In recent years, advanced oxidation processes (AOP) have attracted a growing amount of attention. Except for simple ozonation (O_3), the majority of them employ a combination of strong oxidants, such as O_3 and H_2O_2, irradiation (such as ultraviolet, ultrasound, or electron beam), catalysts (such as transition metal ions or photo catalyst), and The typical AOP systems that have been reported in the literature are listed in Table 13. This multitude of cycles have been as of late explored by Wang et al. The authors confirmed that AOP is used on: - Old or well-stabilized leachate oxidize organics substances to their most elevated stable oxidation states being carbon dioxide and water (i.e., to reach complete mineralization), - improve the biodegradability of recalcitrant organic pollutants up to a value compatible with subsequent economical biological treatment.
7) Chemical precipitation: Chemical precipitation is a common method used to treat leachate from landfills. Leachate is the liquid that forms when water filters through waste materials, picking up various pollutants and contaminants along the way. Chemical precipitation involves adding chemicals to the leachate to cause the precipitation of the contaminants, which can then be separated and removed from the water. The specific chemicals used in chemical precipitation depend on the types of contaminants present in the leachate. Commonly used chemicals include lime, ferric chloride, aluminum sulfate, and sodium hydroxide. The choice of chemical is based on factors such as the pH of the leachate, the types of contaminants present, and the desired outcome of the treatment process.

The process of chemical precipitation typically involves several steps. First, the pH of the leachate is adjusted to a level that will promote the precipitation of the contaminants. This is usually done by adding an alkaline chemical such as lime or sodium hydroxide. Next, the appropriate chemical is added to the leachate to precipitate the contaminants. The mixture is then stirred or agitated to ensure that the chemicals are thoroughly mixed and that the contaminants are evenly distributed. After the contaminants have been precipitated, the mixture is allowed to settle. The solid particles will settle to the bottom of the container, leaving the clarified water on top. The clarified water can then be removed and treated further, if necessary, to remove any remaining contaminants. The solids can be disposed of separately. Overall, chemical precipitation is a widely used method for treating leachate from landfills. It is an effective way to remove many types of contaminants and pollutants from the water, making it safe for disposal or reuse.

IV) Membrane Process

In recent years, due to the complex composition of the landfill leachate, the biochemical treatment is difficult, and numerous rapidly developing membrane materials. The following four categories of membrane processes can be distinguished based on the pore size of membrane materials: reverse osmosis (RO), ultrafiltration (UF), nanofiltration (NF), and microfiltration (MF). The last three membrane materials are widely utilized in landfill leachate treatment, whereas microfiltration has few applications in leachate treatment due to its excessively large pore size. Membrane technology is typically applied toward the end of the treatment process for landfill leachate. One side membrane process can effectively eliminate macromolecule refractory organic matter and total

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nitrogen and ensure effluent quality. The other side membrane processes have the characteristics of stable effluent quality.

Colloids and suspended solids can be removed through microfiltration (MF). Microfiltration can only be used in conjunction with other membrane processes (UF, NF, or RO) for pre-treatment or chemical treatment.

In large-scale membrane bioreactors, ultra filtration (UF) membrane has been used to successfully remove macromolecules, particles, suspended solids, and bacteria from landfill leachate. Like RO, UF also generates a concentrated waste stream that requires further treatment. Ultra filtration can be used to separate organics from leachate and determine the predominant molecular mass of organic pollutants. As a general rule, ultrafiltration can be utilized as pre-treatment of converse assimilation or put after natural treatment.

The membrane of nanofiltration (NF) is capable of filtering contaminants that are microbial, inorganic, and organic.NF membranes have smaller pore sizes than UF membranes and can remove dissolved organic matter, as well as some heavy metals and other contaminants. NF also generates a concentrated waste stream. It reduces the volume of concentrate by having a high rejection rate for sulphate ions and dissolved organic matter and a very low rejection rate for chloride and sodium. Regardless of the geometry of the membrane material (flat, tubular or spiral damage), nanofiltration can remove nearly 60-70% of COD and 50% of ammonia. If the physical method is combined with nanofiltration effectively, 70-80% COD in landfill leachate can be removed. Notwithstanding, nanofiltration film might be dirtied by numerous sorts of substances during the treatment processes: colloids, suspended particles, and dissolved substances of both organic and inorganic nature.

A pressure-driven process between the two sides of a semipermeable membrane is reverse osmosis (RO). The solvent may be able to penetrate the membrane thanks to the difference in pressure between the two sides, resulting in the separation of solvent and solute. The energy consumption of a reverse osmosis membrane is low and does not involve phase change. It is crucial in the process of making ultra-pure water and desalinating brackish water. Reverse osmosis used in desalination accounts for more than 50% of the new desalination capacity in the world. But reverse osmosis has two disadvantages: membrane pooling and the generation of large volume of concentrate. Membrane fouling may lead to the short service life of membrane and reduce the productivity of reverse osmosis process, which requires extensive pretreatment or chemical cleaning of membrane. When a large amount of concentrate is generated, reverse osmosis cannot be used, so concentrate must be discharged or further treated. The purified water is collected on the other side of the membrane, and the concentrated contaminants are removed as a waste stream.

Membrane bioreactors (MBRs) are a combination of membrane processes and biological treatment. In an MBR, the leachate is treated by microorganisms that break down organic matter and other contaminants. The treated water is then filtered through a membrane to remove remaining pollutants. MBRs can achieve very high levels of treatment, but they are also more complex and expensive than other membrane processes.

Overall, membrane processes offer a reliable and effective way to treat leachate from landfills. The choice of membrane process depends on the specific characteristics of the leachate and the desired level of treatment.

2. Objectives of Study

1) To investigate and understand the properties and characteristics of leachate, which is a liquid that results from the decomposition of organic waste in landfills.
2) To identify the composition, quantity, and toxicity of leachate, as well as the factors that influence its formation, transport, and treatment.
3) To develop effective strategies and technologies for the management and treatment of leachate to minimize its impact on the environment and public health.

3. Problem Statement

1) The study of leachate has gained significant attention in recent years due to its potential impacts on the environment and human health. Several studies have been conducted to investigate the physical, chemical, and biological properties of leachate from different landfill sites worldwide. However, the data on the composition and behavior of leachate vary significantly depending on the landfill's location, age, and waste composition. Leachate is a significant environmental issue, particularly for landfills, where it can contaminate groundwater and soil, leading to severe health and environmental consequences. The generation of leachate from landfills is influenced by various factors, including waste composition, moisture content, and landfill design.
2) The primary goal of this research is to investigate in order to the sources and composition of leachate from a landfill site and to evaluate the effectiveness of various treatment and management options, with the aim of minimizing the impact of leachate on the environment and public health.

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4. Literature Review

Numerous studies have been conducted on leachate to determine its composition, toxicity, and impact on the environment. These studies have used various methods, including laboratory experiments, field studies, and mathematical modeling, to investigate the properties of leachate and its behavior in different environmental conditions.

Won-Young Ahn, Moon-Sun Kang, Seong-Keun Yim, Kwang-Ho Choi (2002) In this study used the integrated membrane process and adopted both MBR to enhance the rate of nitrification and RO removal of the remaining inorganic nitrogenous ions and non-biodegradable substances, as well as the removal efficiency of biodegradable organic substances. As the result, the effluent water quality met the enhanced regulation limits and continual public complaint was resolved.

Zhang et al. (2021) This paper investigated the effect of leachate on soil properties and found that leachate significantly reduced soil fertility and increased soil salinity. The study recommended implementing measures to prevent leachate from reaching the soil to protect soil health and improve crop productivity.

S. Renou, J.G. Givaudan, S. Poulain, F. Dirassouyan, P. Moulin (2007) They suggested and conclude that, Optimal leachate treatment, in order to fully reduce the negative impact on the environment, is today’s challenge. But, the complexity of the leachate composition makes it very difficult to formulate general recommendations. The most effective treatment should be straightforward, adaptable, and applicable to all leachates, particularly those that vary over time and from site to site.

Tu Anqi, ZHANG Zhiyong, Hao Suhua, Li Xia (2020) this paper study that, how to discharge The standardization of landfill leachate is a recognized issue in the global water treatment industry. Landfill leachate contains high concentration of organic and inorganic constituents which can cause persistent and potentially hazardous to environmental.

C. Ramprasad, Karthik Sona, Mohammed Afridhi, Ram Kumar and Naveenatha Gopalakrishnan (2019) The present study showed the feasibility and comparison of electrocoagulation and conventional chemical coagulation methods for the treatment of sanitary landfill leachate. The better performance in the electrocoagulation was obtained for titanium coated with platinum/stainless steel electrode with a removal efficiency of turbidity, chemical oxygen demand, chloride, alkalinity and dissolved solids to the extent of 98throughout the country on the basis of the reported literatures, current practice of landfill leachate treatment in the country, and technological development of leachate treatment for possible implementation in the future.

Damaraju Lakshmi Lavanya (2021) The study confines to identify the effects of the leachate on soil properties also to investigate the variations in the recirculation method of treating the leachate to lower concentrations. By collecting the waste, an artificial dump yard is created and water is added to the waste for formation of leachate.

Nikolaos Remmas, Nicola Manfe, Ioanna Zerva, Paraschos Melidis, Roberto Raga and Spyridon Ntougias (2023) In the In this review, ecological considerations that influence the treatment of landfill leachate are stated and the significant role that the microbial ecology plays in the depurification and detoxification of landfill leachate in activated sludge and anaerobic systems is interpreted. This study provides a comprehensive overview of microbial communities performing important biological processes during landfill leachate treatment, such as nitrification-denitrification, anammox, and anaerobic digestion, in addition to assessing the toxicity of landfills to specific model organisms.

This review paper, written by Hamidi Abdul Aziz, Siti Fatihah Ramli, and Yung-Tse Hung (2023), discussed the application of current remediation methods.landfill leachate with an emphasis on concentrated COD, color, and NH_3 -N levels with low biodegradability that is normally present in old landfill or dumping grounds in developing countries.

J. Wiszniowski • D. Robert • J. Surmacz-Gorska • K. Miksch • J.V. Weber (2006) This study is briefly explained that, the generated leachate must be appropriately treated before being discharged into the environment. There are two categories of technologies for treating leachate: biological methods and chemical and physical methods. Here we review briefly the main processes currently used for the landfill leachates treatments.

Peter Kjeldsen, I Morton A. Barlaz,2 Alix P. Thomas H., Rooker, Anders Baun, Anna Ledin, and. Christensen (2002) This paper concluded that, the release of leachate to the environment is one of the major environmental impacts related to disposal of waste. Disposed waste in landfills undergoes a series of phases where the waste is decomposed. During the decomposition leachate is generated by excess rainwater infiltrating the waste. The leachate contains four groups of pollutants: dissolved organic matter, inorganic macro components, heavy metals, and xenobiotic organic compounds.

Abdulhussain A. Abbas, 1 Guo Jingsong, 1 Liu Zhi Ping, 1 Pan Ying Ya and 2 Wisaam S. Al-Rekabi (2009) The major

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fraction of old or biologically treated leachate was large recalcitrant organic molecules that are not easy removed during biological treatment. So that, in order to meet strict quality standards for direct discharge of leachate into the surface water, a development of integrated methods of treatment, a combination of biological, chemical, physical and membrane process steps, were required%, 78.1%, 84.5%, 77.9% and 75.8% respectively.

Nelson-Kalu, Amangabara, Owuama, Nzeh, and Uyo, (2021) The study results showed that the landfill leachates are characterized by high concentrations of heavy metals and other disease-causing elements and therefore require urgent treatment to forestall the contamination of groundwater system and the nearby Otamiri River.

N Emalya1, E Munawar2, W Rinaldi2 and Y Yunardi (2019) This paper presents an overview of landfill leachate management in Indonesia, discussing the characteristics of the leachate from different landfills

Harun, S. N., Ali Rahman, Z., Rahim, S. A., Lihan, T. and Idris, W. M. R. (2013) This paper presents the preliminary results of the effects of leachate on the Atterberg limit, compaction and shear strength of leachate-contaminated soil. The contaminated soil samples were prepared by mixing the leachate at ratios between 0% and 20% leachate contents with soil samples. Base soil used was residual soil originated from granitic rock and classified as sandy clay soil (CS).

Ana-Maria Şchiopu, Brînduşa Mihaela Robu, Ion Apostol, Maria Gavrilescu (2009) The paper describes some aspects regarding characterization of the leachate originating from the Taking into account the findings of this study, a quality assessment of the local environment and the Tomesti landfill, which is located in Iasi County, Romania. The experimental results showed that most of the parameters examined in the leachate samples such as color, BOD, pH, heavy metals concentration was found at high levels. Therefore, the storage of any waste material in the landfill poses environmental problems.

Gourishankar B B, Asst. Proff. M.D Khaja (2018) the project comprises of comparative analysis of three different soil samples in order to emphasize the contrast in the affected soil's altered properties. Environmental science is conducting extensive research to address the issue of leachate and treat the affected soil.

5. Summary of Observation

As per the data analyze & studied by authors in the various papers, A study conducted on leachate focused on the characterization and treatment of leachate to mitigate its negative environmental impact. The study found that leachate can contain a wide range of contaminants, including heavy metals, organic compounds, and pathogens, which can pose a threat to human health and the environment. Various treatment methods were evaluated, including physical, chemical, and biological treatment processes. Physical methods, such as sedimentation, filtration, and evaporation, were found to be effective in removing solid and some dissolved contaminants from the leachate. Chemical treatment methods, such as coagulation-flocculation, ion exchange, and adsorption, were effective in removing dissolved contaminants, such as heavy metals and organic compounds. Biological treatment methods, such as aerobic and anaerobic digestion, were effective in removing organic compounds and nutrients from the leachate. However, the effectiveness of biological treatment methods can be limited by the presence of inhibitory compounds and high levels of dissolved solids. Overall, the study highlights the importance of proper leachate management and treatment to protect human health and the environment. It also emphasizes the need for further research to develop more efficient and cost-effective treatment methods for leachate.

After the above study of more than 15 papers from various countries, conclude that more focus on One common observation from these studies is that leachate is highly variable in terms of its composition. The exact makeup of leachate can depend on a number of factors, including the type of waste being decomposed, the age of the landfill, and the amount of precipitation in the area. However, some common components of leachate include heavy metals, organic compounds, and pathogens. Another key observation from leachate studies is that its impact on the environment can be significant. Leachate can contaminate groundwater sources, which can in turn impact drinking water quality and harm aquatic ecosystems. Additionally, leachate can contribute to the formation of greenhouse gases, which can contribute to climate change. To address these concerns, researchers have investigated a number of different strategies for managing leachate. These can include everything from improved landfill design and management practices to the use of specialized treatment systems to remove contaminants from the leachate before it is released into the environment. While there is no single solution that will work in all cases, continued research on leachate can help inform effective strategies for managing this potentially harmful waste product.

Leachate is a complex mixture of organic and inorganic compounds that can originate from a variety of sources, including landfills and industrial facilities. Leachate can have significant negative impacts on the environment, including contamination of groundwater and surface water, soil degradation, and air pollution. Various treatment methods, such as physical, chemical, and biological processes, can be

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effective in removing or reducing the harmful effects of leachate. However, the management and disposal of leachate remains a major challenge, particularly in developing countries with limited resources and infrastructure. Overall, it is clear that effective management of leachate is essential to protect human health and the environment, and more research is needed to improve our understanding of this complex issue.

6. Conclusion

After review of literature from various research papers it is concluded that;

1) Leachate management is a significant challenge for waste disposal facilities, and its proper management is essential to prevent pollution.
2) The choice of leachate treatment technology depends on the composition of the leachate and the desired level of treatment.
3) Physical, chemical, and biological treatment technologies are commonly used to treat leachate, and emerging technologies such as membrane bioreactors and reverse osmosis are.
4) Effective treatment of leachate requires careful monitoring and management to ensure that the treatment process is efficient and the discharged effluent meets the required standards.

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REFERENCES

[1] Won-Young Ahn*, Moon-Sun Kang, Seong-Keun Yim, Kwang-Ho Choi, “Advanced landfill leachate treatment using an integrated membrane process”, International Congress on Membranes and Membrane Processes (ICOM), Toulouse, France, July 7-12, 2002.

[2] Zhang et al. (2013) “Investigation on characteristics of leachate and concentrated leachate in three landfill leachate treatment plants”, August 2013Waste Management 33(11) DOI: 10.1016/j.wasman.2013.07.021.

[3] S. Renou, J.G. Givaudan, S. Poulain, F. Dirassouyan, P. Moulin (2007), “Landfill leachate treatment: Review and opportunity”, doi: 10.1016/j.jhazmat.2007.09.077.

[4] Tu Anqi, ZHANG Zhiyong, Hao Suhua, Li Xia (2020), “Review on landfill leachate treatment methods”, 2020 6th International Conference on Energy Science and Chemical Engineering, doi:10.1088/1755-1315/565/1/012038.

[5] C. Ramprasad, Karthik Sona, Mohammed Afridhi, Ram Kumar and Naveenatha Gopalakrishnan (2019), “Comparative Study on the Treatment of Landfill Leachate by Coagulation and Electrocoagulation Processes”, An International Quarterly Scientific Journal Vol.18, No3, 2019.

[6] Nelson-Kalu, Amangabara, Owuama, Nzeh, and Uyo, (2021), “characteristics of leachate at ihiagwa dumpsite, imo state nigeria and their implications for surface water pollution”, International Journal of Advanced Academic Research | ISSN: 2488-9849 Vol. 7, Issue 3 (March, 2021).

[7] N Emalya1, E Munawar2 , W Rinaldi2 and Y Yunardi (2019), “Landfill Leachate Management in Indonesia: A Review”, IOP Conf. Series: Materials Science and Engineering 845 (2020) 012032 doi:10.1088/1757-899X/845/1/012032.

[8] Damaraju Lakshmi Lavanya (2021), “Study on Leachate and Its Effects on Soil Properties”, IOP Conf. Series: Materials Science and Engineering 1026 (2021) 012006 IOP Publishing doi:10.1088/1757-899X/1026/1/012006.

[9] Nikolaos Remmas, Nicola Manfe, Ioanna Zerva, Paraschos Melidis, Roberto Raga and Spyridon Ntougias (2023), “A Critical Review on the Microbial Ecology of Landfill Leachate Treatment Systems”, Sustainability 2023, 15, 949. https:// doi.org/10.3390/su15020949.

[10] Hamidi Abdul Aziz, Siti Fatihah Ramli and Yung-Tse Hung (2023), “Physicochemical Technique in Municipal Solid Waste (MSW) Landfill Leachate Remediation: A Review”, Water 2023, 15, 1249. https://doi.org/ 10.3390/w15061249.

[11] J. Wiszniowski • D. Robert • J. Surmacz-Gorska • K. Miksch • J.V. Weber (2006), “Landfill leachate treatment methods: A review”, Environ Chem Lett (2006) 4: 51–61 DOI 10.1007/s10311-005-0016.

[12] Peter Kjeldsen,I Morton A. Barlaz,2 Alix P. Rooker,2 Anders Baun,' Anna Ledin,' and Thomas H. Christensen (2002), “Present and Long-Term Composition of MSW Landfill Leachate: A Review”, Critical Reviews in Environmental Science and Technology, 32(4):297-336 (2002).

ISSN (online): 2581-3048

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[13] Abdulhussain A. Abbas, 1 Guo Jingsong, 1 Liu Zhi Ping, 1 Pan Ying Ya and 2 Wisaam S. Al-Rekabi (2009), "Review on Landfill Leachate Treatments", American Journal of Applied Sciences 6 (4): 672-684, 2009 ISSN 1546-9239.

[14] Harun, S. N., Ali Rahman, Z., Rahim, S. A., Lihan, T. and Idris, W. M. R. (2013), "Effects of leachate on geotechnical characteristics of sandy clay soil", AIP Conference Proceedings 1571, 530 (2013); https://doi.org/10.1063/1.4858709.

[15] Ana-Maria Şchiopu, Brînduşa Mihaela Robu, Ion Apostol, Maria Gavrilescu (2009), "impact of landfill leachate on soil quality in iasi county", Environmental Engineering and Management Journal • September 2009 DOI: 10.30638/eemj.2009.169.

[16] Gourishankar B B, Asst. Proff. M.D Khaja (2018), "Effect of Leachate on Index Properties of Soil", Volume 4 | Issue 1 ©2018 IJIRCT | ISSN: 2454-5988.

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