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Analyses of groundwater contamination at the Raipur municipal solid waste dumpsite and in its vicinity

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ABSTRACT: *Leachate is the fluid which is formed when water percolates through waste and becomes contaminants with dissolved soluble organic and inorganic compounds as well as suspended particles. Landfill is one of the major sources of water pollution where as unscientific management in municipal solid waste dumpsite has led to generation of voluminous leachate in urban areas. Purely managed disposal of industrial solid waste containing heavy metal needs remediation before discharging in the recognized as one of the major threads to the surrounding ground water. The aim of this study was to determine the impact of leachate contaminates on ground water quality of Raipur region. Assessment of physico-chemical characteristics and heavy metal concentration of in landfill leachate was conducted to determine the impact of leachate on ground water environment. All the samples will be analyzing for various physico-chemical parameter including the heavy metals according to standards method, this includes pH, TDS, TH major citations such as calcium, magnesium, major ions and heavy metals such as zinc, iron, lead etc. The ground water at the site adjacent to the spill way in the landfill was partially contaminants by the emission of leachate, thus improved understanding of ground water contamination around the landfill is beneficial for ground water environment remediation.*

Key Words: *leachate, groundwater, waste water*

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I. INTRODUCTION

The amount of waste generated each year is increasing .Landfilling is the predominant method of disposal in most of the countries because it is the most economical option. Landfills pose a big problem to the environment in which during landfill operations, different kinds of hazards including gas and leachate are produced. The liquid containing innumerable organic and inorganic compounds is called 'leachate'. Areas near landfills have a greater possibility of groundwater contamination because of the potential pollution source of leachate originating from the nearby dumping site.

Landfills are the final repository for a heterogeneous mixture of liquid and solid waste from residential, industrial, and commercial sources, and thus, have the potential to produce leachate a liquid waste product that consists of a diverse mixture of chemicals as precipitation or applied water moves through the waste.Leachate refe rs to the liquid that is produced when water interacts with solid waste or other materials, such as in landfills. It is commonly generated when rainfall or other sources of water come into contact with waste materials, causing the water to percolate through the waste and dissolve or suspend various substances. In the context of landfills, leachate is formed as water seeps through the waste, picking up contaminants and pollutants along the way. These contaminants can include organic matter, heavy metals, chemicals, and other potentially harmful substances.

1. ACTION PLAN & PROBLEM FORMULATION

The literature review shows that significant exploration has been performed to figure out, model and further develop the plan measures for seismic execution of tanks. Be that as it may, a large portion of the work was centered around seismic execution of the Intze type water tank. Raised water tanks are especially powerless against tremor powers because of the huge mass upheld on a slim supporting construction, called organizing. The breakdown of raised water tanks during past tremor have been principally ascribed to disappointment of the organizing. The round, built up concrete R.C.C shaft-type support for raised tanks needs overt repetitiveness, damping and extra strength regularly present in building outlining frameworks and, hence, ought to be intended for bigger seismic obstruction.

Here certain information has been gathered from different counseling engineers. By alluding every one of the literary works, Intze tank is planned. Additionally arranging framework is taken as shaft type and it is intended for quake obstruction. In the event of the Intze type water tank assuming holder would help out, water couldn't be provided around. Thus, two-compartment framework has been utilized. On the off chance that one compartment would help out, the other holder is utilized to supply water around. This sort of framework is planned here. The limits of these compartments are kept same as the Intze type holder. There are two holders upheld on arranging. So model of this kind of tank is two mass framework. The limit of one holder is half than Intze tank.

CHARACTERISTICS OF LEACHATE

Leachate typically exhibits the following characteristics:

High Moisture Content: Leachate is primarily composed of water that has come into contact with waste materials. As a result, it has a high moisture content and appears as a liquid.

Contaminant Load: Leachate contains a variety of contaminants, which can include organic matter, inorganic compounds, heavy metals, pathogens, nutrients, and various chemicals. The specific composition of leachate depends on the type of waste it originates from.

Strong Odor: Leachate often emits a strong and unpleasant odor due to the decomposition of organic matter and the presence of volatile compounds. The odor can be offensive and can contribute to air pollution if not properly managed.

High Biological Oxygen Demand (BOD): Leachate typically has a high biological oxygen demand, which means that microorganisms present in the leachate consume oxygen as they decompose organic matter. This can lead to oxygen depletion in aquatic environments if leachate contaminates water bodies.

Acidity or Alkalinity: The pH of leachate can vary depending on the waste composition. Landfill leachate, for example, is often acidic due to the decomposition of organic materials and the production of organic acids. On the other hand, mine leachate may be highly alkaline due to the presence of minerals and chemicals.

Toxicity: Leachate can contain toxic substances such as heavy metals, organic chemicals, and pathogens, which can pose a risk to human health and the environment. These toxic components can leach into groundwater or be carried by surface water, potentially contaminating drinking water sources and ecosystems.

Variable Composition: The composition of leachate can vary over time and from one waste site to another. Factors such as waste type, age of waste, climate, and waste management practices can all influence the specific characteristics of leachate.

STUDY AREA

- With around 18,17,000 people, Raipur is one of the most inhabited cities. The issue of managing solid waste in Raipur has been growing quickly as a result of urbanization, population growth, changes in lifestyle, and changes in consumption patterns. Municipal Solid Waste While business establishments and educational institutions have increased in the southern part, industries have expanded more quickly in the northern part. The pattern of land usage is drastically altered as a result. (MSW) for the city of Raipur is being disposed of in the Sakri landfill site, one of the largest.
- The Chhattisgarh high court will be asked for an extension of time so that Raipur Municipal Corporation (RMC) can move the waste dumping and processing work to the recently assigned trench land in Sakri. According to an RMC official, the incomplete construction at the Sakri landfill site was to blame for the delay in moving the rubbish disposal zone. The Sarona Trench Ground rubbish is currently being collected and dumped by the Ramki Group, a solid waste management organization.

GROUNDWATER POLLUTION

The movement of contaminants in groundwater depends on various factors, including the properties of the contaminants and the characteristics of the aquifer (the underground rock or soil through which the groundwater flows). Some contaminants may travel relatively quickly through porous or fractured materials, while others may move more slowly or bind to soil particles, reducing their mobility. The impacts of groundwater contamination due to leachate can be severe. Drinking water wells that rely on contaminated groundwater may become unsafe, posing health risks to those who consume the water. Ecologically sensitive areas can suffer from the loss of biodiversity and disruption of ecosystems caused by contaminated groundwater. Additionally, the remediation of contaminated groundwater can be complex, time-consuming, and expensive. To prevent groundwater contamination, proper management of leachate is essential. This includes implementing effective liner systems, leachate collection systems, and treatment processes in landfills or waste management facilities. Regular monitoring and testing of groundwater near landfill sites are crucial to identify and address any potential contamination issues promptly. Environmental regulations and guidelines often dictate the design and operation of waste management facilities to minimize the risk of groundwater contamination. These regulations aim to ensure that leachate is appropriately contained, treated, and disposed of in an environmentally responsible manner.

WASTE GENERATION

- The current MSW generation from the city is about 650-700 t/day. The quantity of waste that is currently dumped in the total area used for dumping is around 67 acres. Approximately the depth of ground water table is 2 meters below the ground level at the dumpsite. Within the boundaries of Raipur city's municipal jurisdiction, a research is conducted addressing every area of the management of municipal solid waste. The many garbage types produced by cities are also investigated. This study is being done to better understand how the waste that is produced in the eight zones of the city of Raipur is managed. The system for collecting, transporting, and disposing of municipal waste is thoroughly studied.
- Waste transportation is carried out via door-to-door collection and vans equipped with waste sorting capabilities. With the aid of a GPS device, the vehicle utilized for collecting and transportation is tracked. The amount of waste collected from different trash cans and door-to-door pickup is analyzed. Method using a fully automated equipment that is installed at the final disposal site, which is situated at Sakari on the outskirts of the city. It has been suggested installing a waste-to-energy facility at the disposal site so that waste can be converted into energy. Waste water collected from wet waste can also be used for a variety of purposes, such as watering the garden at the disposal facility.

CHARACTERISTICS OF AQUIFER SYSTEMS

Porosity: Aquifer systems possess sufficient pore space to store and transmit water. Porosity refers to the volume of voids or open spaces within the rock or sediment, which can hold and transport water. High porosity allows for greater water storage and movement within the aquifer system.

Permeability: Permeability represents the ability of water to flow through the interconnected pore spaces or fractures within an aquifer system. It depends on the size, shape, and connectivity of the pores. Highly permeable aquifer systems allow water to move more freely, facilitating groundwater flow.

Recharge and Discharge Areas: Aquifer systems have areas where water enters the system, known as recharge areas, and areas where water is discharged, known as discharge areas. Recharge areas typically receive water from precipitation, infiltration, or surface water bodies, replenishing the aquifer. Discharge areas can be natural springs, seepage into streams or lakes, or extraction through wells.

2. PROBLEM IDENTIFICATION

Soil Contamination: When leachate seeps into the soil, it can contaminate the soil matrix. This can impact the quality and fertility of the soil, affecting agricultural productivity and posing risks to plants, animals, and humans that come into contact with the contaminated soil.

Air Quality Issues: Leachate can emit odorous gases, especially if it undergoes anaerobic decomposition. These odors can cause nuisance problems for nearby communities, affecting their quality of life. In some cases, the gases emitted from leachate can also contain volatile organic compounds (VOCs), which can contribute to air pollution and pose health risks if inhaled.

Ecological Impact: Leachate contamination can have adverse effects on the local ecosystem. It can harm plants, animals, and microorganisms, disrupting ecological balances and biodiversity. The contamination may also spread through the food chain, affecting higher trophic levels and potentially leading to ecosystem-wide consequences.

Migration and Spread: Leachate can migrate through the subsurface, extending the contamination beyond the immediate vicinity of the waste site. This can pose challenges in terms of containment and remediation efforts, as the contamination may spread to larger areas over time.

Addressing these problems requires effective management and mitigation measures for leachate. This includes implementing proper landfill design and engineering, employing liner systems and leachate collection systems, and ensuring regular monitoring and maintenance. Adequate treatment of leachate before disposal or discharge is also crucial to minimize its impact on the environment. In addition, proactive measures such as site selection criteria, environmental impact assessments, and strict regulatory frameworks can help prevent or mitigate the potential problems associated with leachate in the surrounding areas.

3. LEACHATE COLLECTION SYSTEM

A leachate collection pipe system is designed to manage and remove leachate from landfills or other waste disposal sites. Leachate is a liquid that forms when water interacts with waste materials, such as decomposing organic matter or chemicals, in a landfill. It can contain various pollutants and can pose a threat to the environment if not properly managed. The leachate collection pipe system consists of a network of perforated pipes installed at the base of a landfill or within waste cells. These pipes are typically made of high-density polyethylene (HDPE) or similar materials that are resistant to corrosion and chemical degradation. The pipes are laid in a horizontal pattern, sloping downward to facilitate the flow of leachate.

Here are the key components and features of a leachate collection pipe system:

Collection Pipes: Perforated pipes are placed horizontally along the bottom of the landfill or waste cell. The perforations allow leachate to enter the pipes.

Header Pipes: The collection pipes are connected to a header pipe system. Header pipes are larger in diameter and act as the main conduits for collecting leachate from the collection pipes.

Sumps: Sumps are constructed at regular intervals along the header pipes to collect and temporarily store leachate. Sumps usually have pumps or gravity outlets to transfer the leachate to a treatment facility or storage tank.

Geotextile or Gravel Layer: A layer of geotextile or gravel is placed above the collection pipes to prevent the pipes from becoming clogged with soil or waste materials. This layer allows the leachate to flow freely into the collection pipes.

4. PHYSCICAL & CHEMICAL TEST PROCEDURES FOR LEACHATE

Physical testing of leachate involves conducting various tests to assess the physical properties and characteristics of leachate, which is the liquid that drains or "leaches" from a landfill or waste disposal site. These tests help in evaluating the potential impacts of leachate on the environment and designing appropriate treatment and management strategies. Some common physical tests conducted on leachate include:

pH: The pH of leachate indicates its acidity or alkalinity. It is an important parameter to understand the corrosive potential and suitability of leachate for different treatment processes.

Color and Turbidity: Leachate color and turbidity measurements provide information about the presence of suspended solids and organic matter. High turbidity levels can affect the clarity and quality of receiving water bodies.

Temperature: Monitoring the temperature of leachate helps in understanding the heat transfer characteristics and potential impacts on nearby ecosystems.

Odor: Odor testing is carried out to determine the presence and intensity of unpleasant or toxic odors associated with leachate. It helps in identifying potential health risks and selecting appropriate treatment methods.

Total Dissolved Solids (TDS): TDS measurement quantifies the concentration of inorganic salts and other dissolved substances in leachate. High TDS levels can indicate the presence of contaminants and impact the suitability of leachate for various purposes.

Conductivity: Conductivity testing assesses the ability of leachate to conduct electricity, which can indicate the presence of dissolved ions and salts. It is closely related to TDS measurements.

Density: Determining the density of leachate helps in understanding its specific gravity and potential behavior during treatment and disposal processes.

Settling and Suspended Solids: These tests involve assessing the settling characteristics and concentration of suspended solids in leachate. They provide insights into the potential for sedimentation and clogging issues.

Total Solids (TS): TS testing measures the overall concentration of both dissolved and suspended solids in leachate. It helps in assessing the overall pollutant load and impacts on treatment systems.

Viscosity: Viscosity testing determines the resistance of leachate to flow and provides information on its physical consistency. It is useful for understanding pumping requirements and the design of treatment processes.

These physical tests, along with chemical and biological analyses, provide a comprehensive understanding of leachate characteristics and guide the development of effective management strategies for landfill leachate. It's important to note that specific testing requirements may vary based on regulatory standards and project-specific needs.

HEAVY METAL CONTAMINATION

Analysis: Inject the digested leachate sample into the instrument according to the analytical technique being used. Measure the absorbance or emission intensities for each heavy metal wavelength or mass-to-charge ratio. Compare the signals obtained from the sample to the calibration curve to determine the concentrations of heavy metals in the leachate.

Quality Control: Implement quality control measures during the analysis to ensure reliable results. This may include running blanks, duplicates, and spike recovery samples to assess method precision and accuracy. Follow established laboratory protocols for quality control procedures.

Data Interpretation and Reporting: Record the results of heavy metal concentrations in the leachate sample. Compare the measured concentrations to relevant regulatory limits or guidelines to evaluate the potential environmental impact. Prepare a comprehensive report summarizing the heavy metal analysis, including sample information, analytical methods, and results. Digestion method, and instrumental techniques may vary depending on regulatory requirements and project-specific needs. Always refer to the relevant standards, guidelines, and laboratory protocols for detailed instructions and specific requirements.

COD Test Procedure:

- Collect a representative sample of leachate from the landfill or waste disposal site using appropriate sampling techniques.
- Measure the pH of the leachate using a calibrated pH meter or pH indicator strips. Adjust the pH if necessary to fall within the required range for COD testing (typically pH 6-8).
- Take a known volume of the leachate sample, usually 10 mL or 20 mL, and transfer it into a COD vial.
- Add the COD reagent or a combination of reagents suitable for the leachate sample. The specific reagents depend on the method used (e.g., open reflux, closed reflux, or sealed tube methods).
- Digest the COD vials using appropriate digestion techniques, such as refluxing, heating in a sealed tube, or using a COD reactor. Follow the instructions for the specific method being used.
- After digestion, cool the vials to room temperature and prepare a blank solution using distilled water and the same reagents used for the sample.
- Measure the absorbance of the sample and the blank solution using a spectrophotometer at the appropriate wavelength for the COD reagents being used.
- Calculate the COD concentration using the formula and calibration curve provided by the specific method being used.
- Record the COD concentration and ensure that the measurements fall within the linear range of the calibration curve.
- If necessary, repeat the test with duplicate or triplicate samples to ensure accuracy and reliability.

II. METHODOLOGY

The paper must come before the methodology. The leachate sample needs to be taken from the disposal. The methodology for my project is shown in flow chart form in figure 5.1 below. The technique must come after the project. It is necessary to remove a sample of the leachate from the disposal. Figure 3.3 below depicts the process for my project as a flow chart. of the assemblage of strategies and standards related with a branch of information.

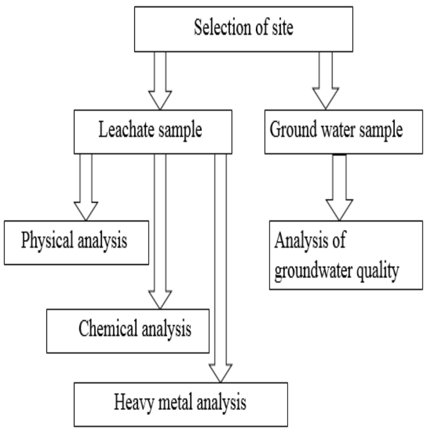

Figure 5.1 Methodology

SAMPLE COLLECTION POINT

For the collection of the specimen, the plastic container was washed and dried outside in the sun. Use gloves when collecting the leachate test sample from the dump yard in accordance with the necessary safety precautions. The landfill yard's water-logged terrain was where the leachate sample was taken. To test the leachate test's parameters, the collected material is brought to the research institution. Leachate test results were obtained and analysed to assess their strengths and attributes. Groundwater samples were collected from a wide range of locations that are close to a disposal site. An aggregate of 20 leachate tests were gathered for observing reason and the physico-concoction investigations were done by the standard strategies. An arbitrary testing approach was used to obtain the groundwater tests with consideration given to how they would relate to land-use plans. These samples were collected in pre-cleaned, 2 liter-capacity polypropylene containers after being flushed with the specimen, sealed shut to prevent disappearance, stored at 4°C, and degraded within two days.

Figure 5.2 Sample collected from Dumpsite

Detailed site surveys, engineering designs, financial analyses, the completion of one or more environmental impact assessments, the outcomes of public hearings, and a realistic evaluation of currently operational landfills are typically the foundations upon which a disposal site is ultimately chosen. New landfills must have the least negative effects on the environment for the longest time possible.

LEACHATE TREATMENT

Leachate is made while water infiltrate through the waste in landfill conveying some of toxins. The objective of this part is presentation of leachate treatment. Natural, physical and concoction treatment of leachate is most regular technique. The accompanying treatment are utilized for examination of the specimens:

Chemical analysis: Leachate and groundwater test were broke down for pH, COD (synthetic oxygen request), BOD (biochemical oxygen request), sulfate, chloride, calcium, alkalinity, sodium, potassium these all parameter was dissected in research facility.

Colour and Odor: The shade of leachate tests were orange darker or dim dark colored. Related with the leachate was a rank scent, for the most part because of the nearness of natural acids, which originated from the high convergence of natural matter when decayed. The high convergence of shading in landfill leachate is because of the nearness of high natural substances. By and large, leachate delivered by an old landfill with low biodegradability is named settled leachate. Balanced out leachate contains elevated amounts of natural substances, for example, hemic and fluvic mixes, which can be demonstrated by leachate shading.

Heavy metals: Concentration of substantial metals in landfill is by and large higher on account of higher dissolvability. Civil leachate is exceptionally unpredictable effluents which contain broke up natural matters, inorganic matters and substantial metals, for example, press, copper, lead. Zinc, nickel.

III. RESULTS AND DISCUSSION

The results of the study focus on analysis of carried out the physical and chemical analysis of the leachate sample and calculating the all parameter of leachate.

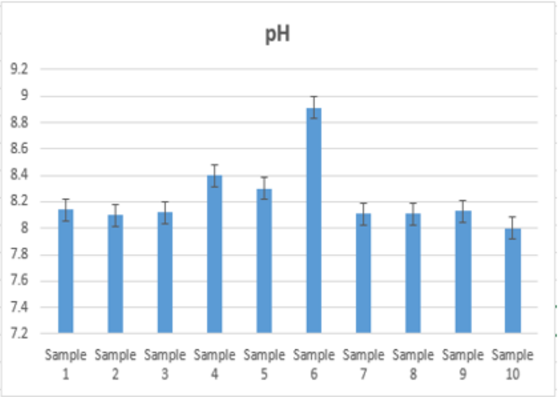

Figure 6.1 pH of 10 leachate sample

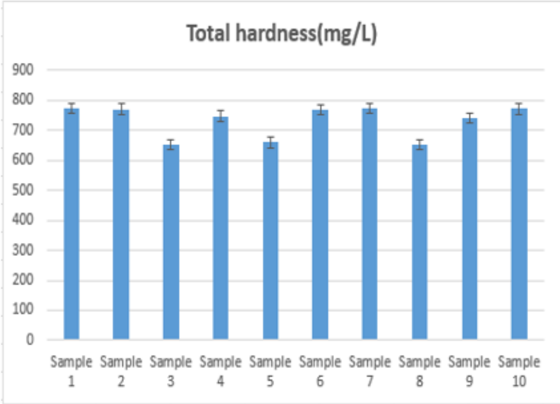

Figure 6.2 Total hardness of 10 leachate samples

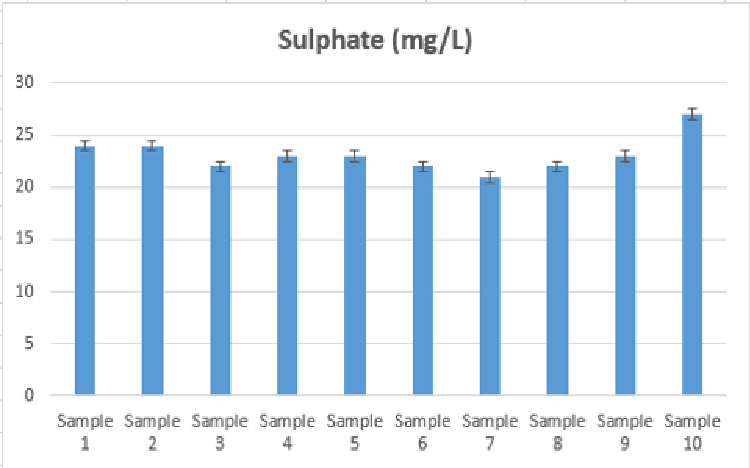

Figure 6.3 Sulphate of 10 leachate samples

Representing the all chemical and heavy metal analysis of ground water samples. The permissible limit for cadmium is 0.003 mg/L. Beyond this the water becomes toxic. Sample S1, S3, S6, S8, S9 and S10 are beyond the limits.

The permissible limit for chromium is 0.05 mg/L. All the water samples are beyond the permissible limits. Hence the Cr content is more in all most all the surrounding places.

The ideal copper concentration is 0.05 mg/L. Astringent taste, staining, and corrosion of pipes, fittings, and kitchenware are the unfavourable effects that occur when they exceed the desirable limit. The copper content of the current water sample ranges from 0.02 mg/L to 0.05 mg/L. As a result, the water samples are safe to consume. Iron levels must not exceed 0.3 mg/L.

The presence of organic matter in ground water is indicated by the significantly high levels of total and faecal coliforms in water samples. Numerous water-borne diseases, including cholera, typhoid, paratyphoid, hepatitis A, dermatitis, enteric fever, and others, offer long-term health risks to the local people, especially the elderly and small children. The significant risk of watery gastroenteritis is a result of bacterial contamination levels. Open dumping sites are thought to pose a major threat to the ecology from all directions, especially since ground water is an important source of natural water.

IV. CONCLUSION

The nature of the groundwater was found to move forward with the expansion top to bottom and separation of the well from the landfill site. In spite of the fact that, the convergences of couple of contaminants try not to surpass drinking water standard even at that point the groundwater quality speak to a huge risk to general wellbeing. The open disposal sites are considered a serious deadline for the environment from all angles, especially with regard to groundwater, a priceless source of freshwater. It is evident from the outcome that contaminants, as a result of leachate movement, are a significant component of water. The state of groundwater is bad as compared to sites far from disposal sites. The presence of heavy metals and microbial contaminants in water poses a very serious hazard to public health.

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