Comparison of Fuller's Earth & China Clay for the Control of Leachate Generated from Municipal Solid Waste-A Review

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ABSTRACT: *Leachate generation is a major problem for municipal solid waste (MSW) landfills and causes significant threat to surface water and groundwater. Leachate is defined as a liquid, which passes through a landfill and has extracted dissolved and suspended matter from it. Leachate is the outcome from precipitation entering the landfill from moisture that exists in the waste when it is composed. A comparative evaluation between the china clay and fullers earth is performed to control the leachate, generated from the solid waste.*

Permeability and type of bonding are the major factors, which are affecting the water movement from surface to below the clay liners. In this study the effect of china clay and fuller's earth clay are compared to control the leachate from MSW. The china clay has advantages over fuller's earth.

Keywords: Leachate, Fuller's Earth, China Clay, MSW, permeability, Clay Liner, Landfill, kaolinite, bentonite

1. INTRODUCTION

Waste management is one of the major challenges faced by municipality officials, public health engineers and environmentalists in their quest to protect and preserve our environment. The wastes that generate in cities dispose their wastes in different ways. Historically waste is disposed of unscientifically leading to the development of many waste dumps around. These general natural anomalies in the ground where trash is disposed of with very little or no environmental regulations. One of the major pollution problems caused by the municipal solid waste landfill leachate can be defined as a liquid that is generated when water or another liquid comes in contact with solid waste. It contains number of dissolved and suspended materials. After municipal solid waste landfill site is closed, landfill will continue to produce contaminated leachate process could last for 30-50 years. Due to increase growth of population and development of the industry, the landfill leachate problem becomes increasingly serious. Leachate has potential to contaminate ground and surface water and threaten human health which migrating from the landfill and contaminates surrounding lands and water. Once the leachate enters the water bodies, it is very difficult and expensive to clean up the contaminated water.

In this, the performance of a landfill clay liner is generally evaluated; the design and maintenance of landfills for waste disposal are the concerns over the last few decades due to increasing awareness towards environment protection issues, such as ground and ground water protection. For last few decades, the landfill liner construction has developed and advanced technology has emerged such as the addition of engineered clays, synthetic lining material and designing of more sophisticated leachate collection systems etc. The main aim of these technology and methods are to improve the landfill liner performances as a hydraulic resistant and to minimize or prevent the migration of landfill leachate into surrounding environment. Clay minerals are available in bulk, these are inexpensive, and are safe materials for environmental applications. Because of their high porosity, surface charge, large specific surface area, and surface functional groups, clay minerals function as adsorbents, filters, flocculates, and carbon stabilizers.

Fullers earth (palygorskite) and china (kaolin) clay is taken for the clay liner. Fuller's earth is any clay material that has the capability to decolorize oil or other liquids without chemical treatment. Fuller's earth typically consists of palygorskite or bentonite. Palygorskite is hydrated Mg-Al silicate material. This mineral actually resembles the amphiboles more than it does clay minerals, but has a special property that smectite lacks - as a drilling fluid, it is stable in salt-water environments. When drilling for offshore oil, conventional drilling mud falls apart in the presence of salt water. Fuller's earth (palygorskite) consists primarily of hydrous aluminum silicates (clay minerals) of varying composition. Common components are montmorillonite, kaolinite and attapulgite. Small amounts of other minerals may be present in fuller's earth deposits, including calcite, dolomite, and quartz. In some localities fuller's earth refers to calcium bentonite, which is altered volcanic ash composed mostly of montmorillonite. Kaolinite is this clay mineral is the weathering product of feldspars. It has a white, powdery appearance. Kaolinite is named after a locality in China called Kaolin, which invented porcelain (known as china) using the local clay mineral. The ceramics industry uses it extensively. Because kaolinite is electrically balanced, its ability of adsorb ions is less than that of other clay minerals.

2. LATEST RESEARCH TRENDS

Uma S M et. al [1]; Comprehensive review of geosynthetic clay liner and compacted clay liner; Human activity inevitably produces waste materials that must be managed. Some waste can be reused. However many wastes that cannot be used beneficially must be disposed of ensuring environmental safety. One of the common methods of disposal is land filling. The most common problems of the landfill site are environmental degradation and groundwater contamination caused by leachate produced during the decomposition process of organic material and rainfall. Liner in a landfill is important components which prevent leachate migration and prevent groundwater contamination. Earthen liners have been widely used to contain waste materials in landfill. Liners and covers for municipal and hazardous waste containment facilities are often constructed with the use of fine–grained, low plasticity soils. Because of low permeability geosynthetic clay liners and compacted clay liners are the main materials used in waste disposal landfills. These paper summaries the important geotechnical characteristics such as hydraulic conductivity, liquid limit and free swell index of geosynthetic clay liner and compacted clay liner based on research findings. This paper also compares geosynthetic clay liner and compacted clay liner based on certain criteria such as thickness, availability of materials, vulnerability to damage etc.

Oluwapelumi et. al [2]; Geotechnical Characterization of some Clayey Soils for Use as Landfill Liner; Waste management is one of the major challenges faced by municipality officials, public health engineers and environmentalists in their quest to protect and preserve our environment. Construction and operation of an engineered sanitary landfill ensures proper waste management with the protection of human and ecosystem health. This paper presents the results of geotechnical investigation carried out on clayey soils from three selected pottery areas in Oke Ogun, Oyo State; to assess their suitability for use as landfill liner. Samples were collected at three locations namely: Ajetunmobi village, sample A; Adegbite area, sample B; and Arigangan area, sample C. Basic index characterization tests conducted on the samples revealed percentage fines for samples A,B and C were 32.7%, 28.3% and 37.0% respectively. Specific gravity ranged between 2.71 and 2.74 . Sample A had Cation Exchange Capacity (CEC) value of 10.58 milli-equivalents/100g (Meq./100g), sample B had CEC value of 11.76 (Meq./100g) and sample C had CEC value of 12.18 (Meq./100g) Geotechnical tests conducted on samples resulted in hydraulic conductivity (k) of 1.86 for sample A ; for sample B and, for sample C. The results obtained from the study show that sample A is the best material for a landfill liner based on the hydraulic conductivity criterion, however all the other samples are also useful and can be improved by addition of little percentage of bentonite. The compaction and compressibility characteristics needed in the specifications for the construction and operation of an engineered landfill using these clayey soils are presented.

Jun H el. Al [3]; Effects of leachate infiltration and desiccation cracks on hydraulic conductivity of compacted clay; Both cracks in clay liner and the complex composition of landfill leachate might have effects on the hydraulic conductivity of a compacted clay liner. In this study, the hydraulic conductivities of natural clay and bentonite-modified clay with and without desiccation cracks were measured, respectively, using three types of liquids as permeating liquid: 2 500 mg/L acetic acid solution, 0.5 mol/L CaCl2 solution, and tap water. When tap water was adopted as the permeating liquid, desiccation cracks resulted in increases in the average value of hydraulic conductivity: a 25-fold increase for the natural clay and a 5.7-fold increase for the bentonite -modified clay. It was also found out that the strong self-healing capability of bentonite helped to reduce the adverse impact of cracks on hydraulic performance. In contrast to tap water, simulated leachates (acetic acid and CaCl2 solutions) show no adverse effect on the hydraulic conductivities of natural and bentonite-modified clays. It is concluded that desiccation cracks and bentonite have more significant effects on hydraulic performance than simulated leachates.

Liu .Y et al [4]; Hydraulic performance of geosynthetic clay liner to sulfuric acid solutions; The ability of geosynthetic clay liners (GCLs) to contain acidic mining leachates is examined. The results of saturated hydraulic conductivity (k) of two GCLs permeated with sulfuric acid solutions (H2SO4) at 0.015 M, 0.125 M and 0.5 M concentrations are reported. Also, the saturated k values of consolidated (35 kPa) bentonite cakes made from sodium bentonite extracted from both GCLs were compared to a commonly used magnesium sodium form bentonite. Chemical compatibility and effects of pre hydration and effective stress were assessed as part of this study. Results indicated that an increased acid concentration (ionic strength) increased the k of all tested specimens. The ratio of the k0.5 values for non-pre hydrated specimens permeated with 0.5 M H2SO4 to the kw values for specimens permeated with deionized (DI) water (k0.5/kw) ranged from 10 to 110. Pre-hydration (50e140% water content) and effective stress (35e200 kPa) improved the performance of GCLs (lower k). Strong correlations were observed between k and liquid limit and swell index parameters independent of pre-hydration and effective stress in this study. However, care should still be taken when using these correlations to evaluate hydraulic performance because the intrinsic micro-structure properties of bentonite, such as porosity, should also be considered. This work showed that, for example, high SI of bentonite does not translate necessarily to a better hydraulic performance of GCLs.

Xue Q. et al [5]; 'Experimental study on anti-seepage grout made of leachate contaminated clay in landfill; In the study, leachate-contaminated clay was used as the

base material, where cement and the self-developed clay curing agent were added to form an anti-seepage grout that can repair the leachate-contaminated clay in landfills, exhibit low permeability, and retard pollutants in the leachate. The effect of grout formula on the concentration of leaching pollutants, concretion rate, compressive strength, and permeability coefficient of concretion bodies was studied through a series of laboratory experiments. The efficiency of concretion bodies in retarding the leachate pollutants was investigated through a permeability test. The results indicated that the pollutants in the leachate-contaminated clay were controlled effectively. At 20% cement, 2% clay curing agent, and 1:1 water–soil ratio, the permeability coefficient of the concretion bodies after 7 days is ~ 10− 7 cm/s, with > 1 concretion rate and > 1.2 MPa unconfined compressive strength. In addition, the concretion bodies reached > 85% retardation rate for COD in the leachate and > 99.8% for NH3-N (including heavy metals such as Pb and Cd, among others). The retardation rate of the concretion bodies for the heavy metals is proportional to the ionic radius. As the cement content increased (clay curing agent = 10% cement), the concretion rate and permeability of the concretion bodies decreased, whereas its compressive strength increased.

Bhalla B. [6]; Characterization of Leachate from Municipal Solid Waste (MSW) Landfilling Sites of Ludhiana, India: A Comparative Study; The paper discusses the characteristics of leachate generated from municipal solid waste land filling sites of Ludhiana City, Punjab (India). Leachate samples were collected and analyzed for various physico-chemical parameters to estimate its pollution potential. This study aims to serve as a reference for the implementation of the most suitable technique for reducing the negative environmental effects of discharge leachate. All the three landfilling sites of Ludhiana city are non-engineered low lying open dumps. They have neither any bottom liner nor any leachate collection and treatment system. Therefore, all the leachate generated finds its paths into the surrounding environment. It has been found that leachate contains high concentrations of organic and inorganic constituents beyond the permissible limits. While, heavy metals concentration was in trace amount as the waste is domestic in nature. The data presented in this study indicated that the age of the landfill has a significant effect on leachate composition. In older landfills, the biodegradable fraction of organic pollutants in the leachate decreases as an outcome of the anaerobic decomposition occurring in the landfill. The concentration of leachate contaminants at Jamalpur and Noorpur belt landfilling site were comparative greater than that of Jainpur landfilling site which is older than both. Based on the characterization of landfill leachate, Jamalpur and Noorpur belt landfilling site demonstrated low bio-degradability i.e. BOD5/COD=0.19 and BOD5/ COD=0.20 compared with Jainpur landfilling site i.e. BOD5/COD=0.24. Indiscriminate dumping of municipal solid waste without proper solid waste management practices should be stopped or some remedial measures were required to be adopted to prevent contamination.

Francis R. C. et al [7]; Solid Waste Management and Characteristics in Lucknow, Uttar Pradesh, India; Increasing population levels, rapid economic growth and rise in community living standard accelerates the generation rate of muni-cipal solid waste (MSW) in Indian cities. Improper management of SW (Solid Waste) causes hazards to inhabitants. The objectives of the study areto determine the quantitative and qualitative characteristics of SW along with basic information and to create GIS maps for Lucknow city. The samples have been randomly collected from various locations and analyzed to determine the characteristics of SW. A ques-tionnaire survey has been carried out to collect data from inhabitants including SW quantity, collection frequency, satisfaction level etc. The Geographic Information System (GIS) has been used to analyze existing maps and data, to digitize the existing sanitary ward boundaries and to enter the data about the wards and disposal sites. The total quantity of MSW has been reported as 800 ton/day, and the average generation rate of MSW has been estimated at 0.65 kg/capita/day. The generated Arc GIS maps give efficient information concerning static and dynamic parameters of the municipal solid waste management (MSWM) problem such as the generation rate of MSW in different wards, collection point locations, MSW transport means and their routes, and the number of disposal sites and their attributes.

Raghab S. M. et. al [8]; Treatment of leachate from municipal solid waste landfill; Leachate generation is a major problem for municipal solid waste (MSW) landfills and causes significant threat to surface water and groundwater. Leachate can be defined as a liquid that passes through a landfill and has extracted dissolved and suspended matter from it. Leachate results from precipitation entering the landfill from moisture that exists in the waste when it is composed. This paper presents the results of the analyses of leachate treatment from the solid waste landfill located in Borg El Arab landfill in Alexandria using an aerobic treatment process which was applied using the mean of coagulation flocculation theory by using coagulant and accelerator substances for accelerating and improving coagulation and flocculation performance. The main goal of this study is to utilize a natural low-cost material “as an accelerator additive to enhance the chemical treatment process using Alum coagulant and the accelerator substances were Perlite and Bentonite. The performance of the chemical treatment was enhanced using the accelerator substances with 90 mg/l Alum as a constant dose. Perlite gave better performance than the Bentonite effluent. The removal ratio for conductivity, turbidity, BOD and COD for Perlite was 86.7%, 87.4%, 89.9% and 92.8% respectively, and for Bentonite was 83.5%, 85.0%, 86.5% and 85.0% respectively at the same concentration of 40 mg/l for each.

3. CONCLUSION

Leachate means any liquid percolated through the deposited waste and emitted from or contained within a landfill. The leachate consists of many different organic and inorganic compounds that may be either dissolved or suspended. They will bring potential pollution issues for groundwater and surface waters in nature. The landfill leachate is a secondary contamination related to landfills. Clay liners are useful to prevent passing of water from ground surface to the inner surface of the earth. depending upon the physical and mechanical properties of the clay liners. In current study, the experimental setup is obtained and soil, China clay and fuller's earth clay are evaluated for controlling leachate generated from municipal solid waste. Home garbage is used as a specimen.

It is evident from the experiment that the China clay is better than the fuller's earth clay as the permeability of china clay is lower than the fuller's earth clay. The bonding between the china clay's units are hydrogen bonding and the fuller's earth's units have Van der Waals bonding, the former clay is have strong bonding, which does not allow leachate to pass from the layers and because of low permeability the is difficult to pass the leachate from its layer. Due to these two parameters the china clay has advantage over fuller's earth and over the soil.

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