Chapter 9
Application of Graded Limestone as Roughing Filter Media for the Treatment of Leachate

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ABSTRACT

This chapter examined limestone performance as a roughing media for pollutant removal from leachate using a filtration column. Limestone with a density of 2554 kg/m3 was crushed and graded between 4-6, 8-12 and 12-18 mm as filter media. The length of run for each experiment of the various individual media sizes and combination sizes was 10 days. Test analysis was performed at intervals of 24 hours to ascertain the percentage removal efficiency for the parameters desired. The observed best removal occurred when a combination of 4 – 8mm, 8 – 12mm and 12 – 18mm, media top to bottom was used. This obtained a BOD removal in the range of 22 to 81%, COD was 22 to 75%, and turbidity was 32 to 86% while the colour was 36 to 62%, respectively. A general decline in removal efficiency was observed after the sixth day showing maximum adsorption and breakthrough had been achieved. The study indicates that limestone is an effective adsorbent that can be used for short-term treatment of leachate.

BACKGROUND OF STUDY

Land disposal of solid wastes has been practiced for centuries, dating back to prehistoric times. Municipal, industrial, agricultural, and urban activities produce huge amounts of wastes which require permanent disposal. Returning some of the solid wastes to the land is a practical approach for waste disposal. Human

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population rate increases every year and as such the solid waste generated increases. As the amount of waste produced rapidly increases, space for permanent disposal becomes crucial. Since the production of solid waste is increasing much more rapidly than it degrades, land space for disposal has become more difficult and expensive to attain. There are several waste management options that can be used to reduce the amounts of waste requiring land disposal. Incineration of solid waste can be used but this is expensive and the emissions are of health concern. This is why landfills remain the major solid waste disposal option for most countries. Solid waste in a landfill is degraded through aerobic and anaerobic processes. Stabilization of the wastes is a very complex and variable event due to the site-specific characteristics of each landfill. The degradation products generated from the stabilization process include leachate and gas. Landfill gas is generated due to the anaerobic biological degradation of organic material (Wei et al., 2013; Tchobanoglous and Kreith, 2003). Leachate is formed from the contact of water with refuse or solid waste. The water mainly from precipitation, dissolves soluble organics and inorganics including some toxic compounds if present in the landfill material. Solid waste should be properly disposed in order to protect environmental quality and human health, as well as to preserve natural resources. With the rapid socio-economic development, the contradiction between increasing waste generation rates and decreasing waste-disposal capacities is becoming more and more acute. In response to this concern, effective solid waste management models are desired to be developed. This will help to provide sound management strategies with satisfactory economic and environmental efficiencies. Solid waste management is a complex, multidisciplinary problem involving economic and technical aspects, normative constraints about the minimum requirements for recycling and sustainable development issues. Most industrialized countries have adopted the philosophy of the 'Waste Management Hierarchy' (prevention/ minimization, materials recovery, incineration and landfill) as a guide for developing municipal or industrial solid waste management strategies (Van Ewijk & Stegemann, 2016; Sakai et al., 2000).

A leachate stream can be compared to a complex wastewater stream with varying characteristics. Leachate characteristics not only vary because of the different kinds of waste present, but vary according to the landfill age. Usually leachate from old landfills is rich in ammonia nitrogen due to the hydrolysis and fermentation of the nitrogenous fractions of the biodegradable wastes (Siti and Aziz, 2018; Kamaruddin et al., 2013; Onay and Pohland, 1998). Leachate from young landfills contains high dissolved solids as well as high concentrations of organic matter compared to domestic wastewater (Abd El-Salam and Abu-Zuid, 2015; Reinhart and Townsend, 1998). The leakage of leachate which contains high organic, inorganic suspended solids, heavy metals and other pollutants will contaminate the ground water and surface water sources (Naveen et al., 2018; Qasim and Chiang, 1994). Contamination of water resources by landfill leachate is a growing problem. Waste management companies often struggle with the challenge of containing and controlling leachate migration. Leachate containment structures built in recent years have improved water quality conditions however problem areas within the site may continue to exist. Analysis have found that high water table levels on site are causing the leachate management structures to under-perform. Leachate from the landfill is migrating through and bypassing containment walls and re-circulation systems resulting in local and downstream surface and groundwater contamination. Landfill leachate migration is a long-standing problem that is expected to increase with the growth of urban populations and resulting landfills. (Izabela and Biedka, 2016).

Although attention has been drawn to increase recycling, waste reduction and incineration, the sanitary landfill will remain dominant in solid waste disposal for many more decades due to rapid population growth (Oasim and Chiang, 1994). The high level of chemical oxygen demand (COD), biochemical oxygen demand (BOD), turbidity and other impurity components of landfill leachate make it very important