

Chapter 6

Leachate Generation, Transport, and Control

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ABSTRACT

This chapter will discuss in detail on the primary aspect influencing leachate generation, transport and control within the landfill area. The leachate generation will look into the various factors that contribute toward increment and reduction of water balance in the landfill cell cause by the physical, chemical and biological activities. The topic will include discuss on common methods and models for estimating water input and transformation into/inside the landfill layer. Meanwhile, leachate transport part would emphasis on the leachate movement and mobility due to the effect of waste percolation, moisture field capacity and the gravity pull. Dominant flow type and the effect upon solute transport as well as other landfill components would be emphasize within the discussion. Lastly, this chapter will elaborate on the conventional and advanced techniques that being utilized for the control of the leachate for further treatment system or as beneficial advantages in the landfill management system.

INTRODUCTION

In the past, the concern is primarily on the amount of leachate that would be generated from the landfill site as it would signify the environmental risk of the landfill area. Nowadays, leachate is being considered as multi-dimension pollutant that potentially can affect the land/soils, water and even air (either directly or indirectly). Because of that, the regulatory upon leachate was stringent for leachate treatment and the landfill gases are meant to be collected; that require the need to investigate into the waste layer moisture and leachate mobility within the landfill cell. Protection from leachate contamination has been

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imposed into various countries legislations such as “Regulation 15 of the Waste Management Licensing Regulations” (UK), “Groundwater Regulations”(UK), “Pollution Prevention and Control Act” (England and Wales), “Landfills Regulations” (England and Scotland), “EU Directive on IPPC”, “EC Directive on EIA”, “Water Framework Directive”, “Strategic Environmental Assessment (SEA) Directive” and many mores (Butt, et al., 2014). These legal requirements push toward getting better understanding onto the reactions occurs inside the landfill layer especially on the generation and mobility of leachate. Such information open a more understanding onto the reactions occurs inside the landfill layer especially toward the waste anaerobic degradation and for optimal methane production. At the same time, it is also providing the essential knowledge to maintain and controlling the flow of leachate within the landfill containment and thus preventing leakage into the surrounding environment. In the long run, managing the leachate generation and flow would account into the reduction the treatment cost and maximize the biogas production if necessary.

LEACHATE GENERATION

Leachate generation is an important and necessary aspect to estimate for potential leachate leakage prevention especially into the groundwater system. Potentially leachate leakage could occur if the leachate head in the bottom liner happen to exceed 30 cm which could easily be measure by placing pressure transducer in the leachate collection well. Looking from this aspect, greater leachate generation rates would significantly increase the leachate accumulation at the bottom liners due to the downward, vertical movement of the leachate flow and mostly probably increasing the chances of leakage into the groundwater aquifer.

Leachate is produced mostly from the incoming or water input from outside primarily through rainwater infiltration apart from the water which is already present as moisture in the deposited waste stream and small fraction that could be produced from the multiple reactions inside the landfill. Usually sanitary landfills are well designed to prevent or at least minimize the water infiltration through various approaches and practices depending on the landfill owner or contractors. Therefore, overall leachate generation modeling would require information on all these aspects for overall estimation; which include the type of wastes being disposed, landfilling practice, landfill cover practices, leachate collection system and leachate recirculation (if being employed) as summarized in Table 1.

Leachate generation prediction would have to look into the conceptual model and the numerical model of each landfill aspects. Normally, estimation can be made by looking at water balance or water budget in the landfill cell, treating the cell as a spatial lump system and calculate the leachate volume from the water balance. Figure 1 shows water balance for a landfill site.

The water balance is influenced by the outside water entering into the landfill layer (rainfall, water infiltration, and surface runoff), the water presence in the deposited waste layer (moisture, field capacity) and the water addition or loss through physical process, chemical reaction and microbiological activities within the landfill layer. In a properly covered sanitary landfill, water infiltration by the rainfall will be minimized as it is shed away as surface runoff, evaporated or transpire away by the surface vegetation. Standard hydrological tools can be used to determine the amount of water rainfall infiltration into the landfill layer. The tools require hydrological data of the landfill site including climate and site condition. There are many other complex landfill water balance models are being developed that incorporate more advanced hydrologic techniques and climatological databases. The most commonly applied landfill

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