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Original Research Article

An experimental study on the impact of two dimensional materials in waste disposal sites: What are the implications for engineered landfills?

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ABSTRACT

It is generally accepted that landfilled municipal solid waste develops a heterogeneous and anisotropic structure during placement, degradation and settlement. Flow and transport processes, in traditional and alternative landfills, are strongly influenced by the type of structure developed. The presence of preferential flow has gained research interest, given its impact on landfill processes. This paper describes an experimental investigation carried out on a specimen of degraded municipal solid waste.

Preferential flow was detected and caused by the specimen layered structure composed of two dimensional particles derived from less easily degradable materials such as plastics, textiles and paper which made up more than 50% of the specimen dry mass. The results suggest that two dimensional particles play a role in promoting preferential flow because they modify flow paths and increase the tortuosity. A high content of less easily degradable two dimensional materials suggests incompatibility with better management practices, seeking a more even distribution of fluids to enhance degradation and faster stabilisation rates within engineered landfills. Consequently, there is a need to re-think the types and quantities of materials that are restricted under current landfill policies.

1. Introduction

In total 1.3 billion tonnes of municipal solid waste (MSW) are produced globally, at an average daily rate of 1.2 kg per capita. By 2025 this amount will increase to 2.3 billion tonnes per year [1].

Although final disposal of MSW is considered the least desirable option it remains the predominant solution worldwide [2]. Approximately, 80% of global urban MSW is placed in waste disposal sites, of which only 20% is contained in engineered and controlled landfill sites [3]. This is despite the fact that pollution originating from active and closed landfill sites and open dumps, is likely to persist for centuries, rather than decades [4]. MSW has a heterogeneous composition. Its properties are influenced by the materials that constitute the waste body. The nature of MSW varies within and among countries, although some general tendencies can be drawn [5,6]. In higher income countries, paper and plastics, account for 31 and 11% of the waste matrix, respectively. Under current MSW practices, the entry of paper, plastics and textiles into controlled waste disposal sites is not likely to experience a significant reduction in the short to medium term because their generation is linked to economic growth [1]. Such waste entries are incompatible with waste management practices focused on recycling and recovery [7,8].

The effect of preferential flow (PF) on modern landfill operation is not yet certain, although the effectiveness of leachate and gas collection systems in engineering landfills and the operation of modern landfills, that seeks to improve biodegradation and stabilisation processes, do rely on the fluid flow characteristics of the waste body [2]. Research evidence suggests that certain materials such as paper, plastics and textiles have the potential to affect fluid flow patterns and therefore influence some characteristics within a waste body. The experiments discussed in this paper add further empirical evidence to support this hypothesis.

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