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Co-disposal of electronic waste with municipal solid waste in bioreactor landfills

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ABSTRACT

Three pilot scale lysimeters were adopted to evaluate the stability pattern and leaching potential of heavy metals from MSW landfills under the E-waste co-disposed condition. One lysimeter served as control and solely filled with MSW, whereas the other two lysimeters were provided with 10% and 25% of E-waste scraps (% by weight), respectively. The reactors were monitored over a period of 280 days at ambient settings with continuous leachate recirculation. Stabilization pattern of carbon appears to be more than 50% in all the three lysimeters with irrespective of their operating conditions. Iron and zinc concentrations were high in leachate during bioreactor landfill operation and correlating with the TCLP leachability test results. In contrast, Pb concentration was around <0.6 mg/L, but which showed maximum leaching potential under TCLP test conditions. But, no heavy metal accumulation was found with leachate recirculation practices in lysimeters. Mobility of the metal content from the E-waste was found to be amplified with the long term disposal or stabilization within landfills. The results showed that the TCLP test cannot be completely reliable tool for measuring long-term leachability of toxic substances under landfill condition; rather landfill lysimeter studies are necessary to get the real scenario.

1. Introduction

Disposal of electrical and electronic waste (E-waste) in municipal solid waste (MSW) landfill is still under debate due to the environmental concerns. The developing Asian countries are receiving more than 80% of the generated E-waste from worldwide, which is mainly recycled by the informal sectors. These informal recycling centers are neither using the appropriate recycling technology and nor managing the E-waste properly. Finally, the unmanaged, poorly processed E-waste end up in MSW disposal facilities. Most of the disposal facilities from developing countries are not sanitary landfills and they are located near to the water logged areas, ultimately leading to major environmental degradation. Few researchers suggested that the modern sanitary landfill facilities can be considered for disposal of E-waste along with MSW, since it is capable of isolating the pollutants from the environment (Spalvins et al., 2008; Li et al., 2009).

Operation of sanitary landfill as a bioreactor with leachate recirculation has been proven beneficial, because it enhances the waste degradation along with improved biogas yield and evades the leachate treatment cost. But the waste stabilization is governed by various physico-chemical conditions prevailed within the landfills and that need to be maintained as optimum. Various toxic and hazardous substances are expected to mobilize from the MSW to leachate during landfilling operation. These pollutants are expected to get amplified within the landfill, when continuous leachate recirculation put into practice for waste stabilization are of great concern when E-waste is co-disposed.

E-waste generally contains more than hundred toxic substances, including beryllium in computer motherboards, cadmium in semiconductors, chromium in floppy disks, lead in batteries and computer monitors, and mercury in alkaline batteries and fluorescent lamps etc. Hence, the leaching behaviour of heavy metals from the E-waste under landfilled condition will be of great interest in terms of toxicity to methanogenic activity and waste stabilization view points. The toxicity characteristic leaching procedure (TCLP) is commonly employed leaching test and designed to study hazardous nature of the waste under the worst landfill conditions. It is a batch test, uses buffer solution with a pH of 3 or 5, made of glacial acetic acid and 1 N sodium hydroxide, and particle size of less than 10 mm. A liquid to solid ratio of 20:1 employed with a total run time of 18 h under continuous agitation by mechanical rotor for pollutant extraction. But it has been criticized for the over exaggerated test conditions that rarely occur in landfills (Jang and Townsend, 2003).

But these laboratory TCLP conditions only provide rapid leachability potential of toxic contaminants from waste/hazardous substrates and cannot mimic the conditions that are expected to occur in real landfill like sorption, precipitation and biological reduction etc. Construction and operation of simulated landfills i.e., lysimeter study, can be a possible means to study the real facts concerning co-disposal of E-waste, its associated effect upon waste

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