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Anaerobic digestion of municipal solid waste as a treatment prior to landfill

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Abstract

Anaerobic digestion of organic fraction of municipal solid waste was conducted in pilot-scale reactor based on high-solid combined anaerobic digestion process. This study was performed in two runs. In Run 1 and Run 2, pre-stage flushing and micro-aeration were conducted to determine their effect in terms of enhancing hydrolysis and acidification in ambient condition. In Run 2, after pre-stage, the methane phase (methanogenesis) was started-up after pH adjustment and inoculum addition in mesophilic condition. Acidified leachate produced in pre-stage was used for percolation during active methane phase. At the end of methane phase, air flushing was conducted before unloading the digesters. Hydrolysis and acidification yield of 140 g C/kg TS and 180 g VFA/kg TS were achieved, respectively in pre-stage. Micro-aeration exhibited an equivocal result in terms of enhancing hydrolysis/acidification; however it showed a positive effect in methane phase performance and this needed further investigation. Leachate percolation during methane phase showed an enhanced methanization when compared to the reactors without leachate percolation. After 60 days, 260 l CH_4/kg VS was obtained. Based on the waste methane potential, 75% biogas conversion and 61% VS degradation were achieved.
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Keywords: Anaerobic digestion; Flushing; Micro-aeration; Hydrolysis; Acidification; Methane phase

1. Introduction

Direct landfilling of municipal solid waste (MSW) was known to create lasting detrimental impacts to the environment. Among the major issues associated with landfills are the consequential emissions to the atmosphere, hydrosphere, and pedosphere; risk in landfill stability; and scarcity of land. Since landfill was regarded as an integral part of solid waste management in Asia, it was realized that waste treatment prior to landfill is indispensable. In this regard, biological pre-treatment of waste like anaerobic digestion is an attractive method especially in Asian countries, because of its suitable waste characteristics. According to Visvanathan et al. (2004), municipal solid waste stream in Asian cities is almost similar, composed of high fraction of biodegradable material of more than 50% with high moisture content, and the generation rate is increasing with time. For example, in Thailand, the organic fraction in MSW consist of food waste (50%), paper (10%), and yard waste (5%) and the remaining inorganic fraction is composed of plastics (14%), glass/stone/can (5%), wood (4%), metals (3%), textile (3%), rubber/leather (2%), and soil/other (4%).

Anaerobic digestion of organic fraction municipal solid waste (OFMSW) has been studied in recent decades, trying to develop a technology that offers waste stabilization with resources recovery. In the complex process of anaerobic digestion, hydrolysis/acidification and methanogenesis are considered as rate-limiting steps. However, it is possible to increase the hydrolysis rate with the application of micro-aerophilic conditions (Capela et al., 1999; Wellinger et al., 1999). Moreover, Dayanthi et al. (2004) studied the leaching experiment on organic fraction of MSW showed that flushing the waste bed could enhance hydrolysis and acidification. Specific features of high-solid

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