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Optimization of anaerobic digestion of municipal solid waste in combined process and sequential staging

The optimization of anaerobic digestion aims to maximize organic waste stabilization after a short digestion period. This paper presents the optimization performance of the combined anaerobic digestion and sequential staging concept in a thermophilic, solid-state batch system as a treatment technology prior to landfill. The former involves enhanced pre-stage flushing with the addition of microaeration and inoculum in the methane phase. The latter involves leachate cross-recirculation between the mature and fresh waste reactors without conducting a pre-stage operation. The optimized process for combined anaerobic digestion showed that reducing the pre-stage operation with the maximum removal of organics from the waste bed is beneficial. Moreover, the sequential staging concept offers an improved process over the combined anaerobic digestion wherein the specific methane yield of 11.9 and 7.2 L CH_4 kg^{-1} volatile solids (VS) per day was achieved, respectively. After 28 days of operation, the sequential staging process showed an improved waste stabilization with 86 and 79% mass and volume reduction, respectively. A higher methane yield of 334 L CH_4 kg^{-1} VS with 86% VS reduction, which is equivalent to 84% process efficiency was obtained.

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Introduction

Anaerobic digestion is an attractive treatment method for solid waste stabilization with the generation of biogas and waste residue. The stabilized waste residue can be used as a soil conditioner or can be safely disposed of in landfill. This method is especially suitable for the waste characteristics in the Asian region. According to Visvanathan *et al.* (2004), the solid waste composition in most Asian countries is highly biodegradable with high moisture content and mainly composed of food waste. This type of waste is neither appropriate for incineration as it requires extra energy for sustained combustion nor can it be landfilled directly due to the associated negative impacts of landfilling. Direct landfilling of such waste creates nuisance owing to the generation of highly concentrated leachate, methane gas emission, and extreme waste settlement in landfill due to rapid waste decomposition that eventually affects the landfill stability. The appropriate alternative that can surpass these limitations is to subject the waste to a biological (anaerobic) treatment process prior to landfill disposal.

Anaerobic digestion technology encompasses a wide spectrum of procedure types. The optimization process needs further investigation especially during the start-up stage in order