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Methodology to assess end-of-life anaerobic biodegradation kinetics and methane production potential for composite materials

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Abstract

Composites made with bio-based resins are promising candidates for replacement of conventional plastic composites made with petroleum-based resins in many applications (e.g., decking, paneling, furniture, molded automotive parts). For any such applications, end-of-life management needs consideration. Here, we describe a methodology to assess end-of-life anaerobic degradation to methane (CH_4) within landfills or anaerobic digestion (AD) facilities in batch anaerobic microcosms. The core methodology combines stoichiometric considerations, chemical oxygen demand (COD) analysis, a CH_4 production assay, and modeling. Additional analyses, such as thermogravimetric analysis (TGA), can complement this core set of analyses. We apply the methodology to injection molded poly(hydroxybutyrate-*co*-hydroxyvalerate) (PHBV) composites with wood fiber (WF) (0%, 20%, 40%) and two fiber-matrix compatibilization treatments that enhance in-service performance: (1) hydrophobic silane treatment of the WF and (2) grafting of hydrophilic maleic anhydride groups to the PHBV matrix. The methodology successfully quantifies process kinetics, ultimate CH_4 production capacity, and biodegradability, and allows comparison to reference materials (positive controls).

Keywords: A. Biocomposite, B. Environmental degradation, A. Polymer-matrix composites (PMCs), A. Natural fibers

1. Introduction

Growing concern over non-renewable petroleum-based plastics and the fate of these materials in the environment and landfills has led to increased interest in biobased and biorenewable plastics and composites as replacements for less sustainable options [1, 2]. Building and construction materials are of particular interest because debris from construction and demolition operations comprises approximately 40% of the US landfill volume [3]. To date, performance studies with composite materials have largely focused on in-use processing and material properties. This evaluation is a necessary first

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