Accepted Manuscript

Review

Anaerobic co-digestion: a critical review of mathematical modelling for performance optimization

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PII: S0960-8524(16)31421-3
DOI: http://dx.doi.org/10.1016/j.biortech.2016.10.015
Reference: BITE 17170

To appear in: *Bioresource Technology*

Received Date: 30 August 2016
Revised Date: 2 October 2016
Accepted Date: 4 October 2016

Please cite this article as: Xie, S., Hai, F.I., Zhan, X., Guo, W., Ngo, H.H., Price, W.E., Nghiem, L.D., Anaerobic co-digestion: a critical review of mathematical modelling for performance optimization, *Bioresource Technology* (2016), doi: http://dx.doi.org/10.1016/j.biortech.2016.10.015

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Revised Manuscript Submitted to *Bioresource Technology*

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Abstract

Anaerobic co-digestion (AcoD) is a pragmatic approach to simultaneously manage organic wastes and produce renewable energy. This review demonstrates the need for improving AcoD modelling capacities to simulate the complex physicochemical and biochemical processes. Compared to mono-digestion, AcoD is more susceptible to process instability, as it operates at a higher organic loading and significant variation in substrate composition. Data corroborated here reveal that it is essential to model the transient variation in pH and inhibitory intermediates (e.g. ammonia and organic acids) for AcoD optimization. Mechanistic models (based on the AMD1 framework) have become the norm for AcoD modelling. However, key features in current AcoD models, especially relationships between system performance and co-substrates' properties, organic loading, and inhibition mechanisms, remain underdeveloped. It is also necessary to predict biogas quantity and composition as well as biosolids quality by considering the conversion and distribution of sulfur, phosphorus, and nitrogen during AcoD.

Keywords: Anaerobic co-digestion; Biosolids quality; Mathematical modelling; Process stability; Nutrient recovery; Sewage sludge.

1 Introduction

The past 10 years have seen a substantial expansion in anaerobic digestion (AD) applications, particularly co-digestion. The term co-digestion refers to the simultaneous digestion of two or more organic substrates. In comparison to mono-digestion, anaerobic co-digestion (AcoD) offers several advantages such as the