Dynamic bioconversion mathematical modelling and simulation of urban organic waste co-digestion in continuously stirred tank reactor

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Abstract

The application of anaerobic digestion (AD) as process technology is increasing worldwide: the production of biogas, a versatile form of renewable energy, from biomass and organic waste materials allows mitigating greenhouse gas emission from the energy and transportation sectors while treating waste. However, the successful operation of AD processes is challenged by economic and technological issues. To overcome these barriers, mathematical modelling of the bioconversion process can provide support to develop strategies for controlling and optimizing the AD process. The objective of this study was to apply a dynamic mathematical model to simulate the co-digestion of different urban organic wastes (UOW). The modelling was based on experimental activities, during which two reactors (R1, R2) were operated at hydraulic retention times (HRT) of 30, 20, 15, 10 days, in thermophilic conditions (55 ^{o}C). Sludge, food waste, grass clippings, garden waste were co-digested with VS-based mixing ratios of 10:67.5:15.75:6.75 and 10:45:31.5:13.5 in R1 and R2 respectively. The BioModel (Angelidaki et al., 1999) was then employed with minor modifications of model parameters. The model outputs were validated with experimental results using AD of mixed sludge as single substrate and UOW as co-substrate. The process parameters values were reasonably predicted by the model, showing good correlation with the measured data. Identification of optimal scenarios for co-digestion of UOW, with changing HRT and feedstock compositions, was performed with multi-parameter pareto optimization. The results of the optimization demonstrated that tradeoff between productivity, methane yield and stable process operation should be taken in to consideration.

Biography: Temesgen Mathewos Fitamo completed Erasmus Mundus Master's double degree from Aalto University (Helsinki, Finland) and Kungliga Tekniska Hogskola (KTH) (Stockholm, Sweden) on August 2013. The thesis topic was ''Biogas production potential of kraft pulp and paper industry effluents'' in collaboration with the University of Toronto and the Finnish company Estora Enso. Currently, Fitamo is a PhD fellow at Technical University of Denmark (DTU) working on a project titled "Systematic quantification of Biogas Production in Urban Areas". Research activities include co-digestion of urban organic waste in CSTR, microbiology, biochemical methane potential assay analysis, emission quantification and LCA of bioenergy systems.

Reference: Angelidaki I, Ellegaard L, Ahring B. 1999. A comprehensive model of anaerobic bioconversion of complex substrates to biogas. *Biotechnol. Bioeng.* **63**:363–372.