Biorefining of Waste Materials into Biogas, Biodiesel, Bioethanol and Bioelectricity – Exergy Efficiency Analysis

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Abstract

Due to instability in prices of fossil-based resources, coupled with their near exhaustion and high emission potential, the long term sustainability of their refineries becomes questionable. Thus, the valorization of waste materials in a biorefinery concept presents a more sustainable alternative approach to waste management, greenhouse gas (GHG) emission reduction and minimization of reliance on depletable energy resources. In this study, spent coffee grounds (SCG) and food waste (FW) with global annual generation rate of about 4 – 6 million tons and 1.3 billion tons respectively were utilized as waste materials/feedstock to produce multi-valuable products like biodiesel, biogas, bioethanol and bioelectricity in a near zero-waste biorefinery concept. The biorefinery concept was then analyzed for sustainability using the exergy assessment tool. Exergy analysis is a thermodynamic assessment tool which can pinpoint stages in the biorefinery where improvement in terms of quality energy maximization, and waste reduction are needed. Quantification of quality portion of energy (called exergy) and material resources lost in the processes were carried out, which would help process engineers and investors to make rational choices regarding biorefinery sustainability. Overall, sustainability improvement indices estimated the biorefinery concept in this study were able to determine improvement options for high exergy efficiency.

Keywords

Spent Coffee Grounds, Food Waste, Biofuels, Biorefinery, Exergy analysis.