Life cycle assessment of the combined process of pressurized torrefaction and gasification of biomass for electricity and/or methanol production

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Abstract

Gasification has been identified to be one of the most effective thermo-chemical conversion processes for transforming bagasse biomass into syngas and high-valued products such as methanol and electricity. This study evaluated a comprehensive process to produce methanol and electricity from bagasse biomass. A total of four main scenarios (S1-S4) were considered in this study, that is, methanol and electricity production through the process of gasification without torrefaction (S1), and methanol and electricity production through the combined process of torrefaction and gasification (S2) while (S3) involved electricity production from a combined process of torrefaction and gasification and (S4) involved electricity production from syngas only via gasification process. The gasification process was modelled using Aspen kinetic-free equilibrium model using steam and pure oxygen as the gasification agent. The attained results from the simulation were then employed in the openLCA software. Based on the conducted analysis, S2 had the lowest CO_2 emission rate at 16630,9kg/h while S4 had the highest CO_2 emission rate at 42486,1kg/h. Grid quality electricity had the highest carbon dioxide emission rate at 2672.2kg/h in contrast with bagasse transportation at 45,69kg/h. According to preliminary study results, the combined process of pressurized torrefaction and gasification, as opposed to conventional fossil-based power and methanol generation, as opposed to conventional fossil fuel-based power and methanol generation, has the potential for considerable reductions in greenhouse gas emissions.

Keywords: Electricity; Gasification; Methanol; Life Cycle Assessment; Torrefaction