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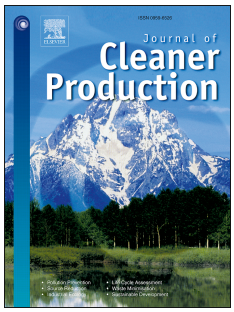

Life cycle assessment of combined bioheat and biopower production: An eco-design approach

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ABSTRACT

Life cycle assessment (LCA) can be conducted in coordination with a process simulation and used as an eco-design (green design) tool by quantifying the relations between eco-design parameters and environmental impact categories. The purpose of this article is to minimize environmental life cycle impacts of combined bioheat and biopower (CBHBP) production at its design stage, and thereby ensure sustainable CBHBP production. In this study, the aim is to conduct an LCA study in coordination with a process simulation and introduce an eco-design approach to determine the environmental sustainability of a combustion-based in situ CBHBP plant based on a simulated case study.

Eco-design approach in this study enabled to quantify the effect of changes in feedstock moisture content, excess air ratio, and furnace temperature on the selected LCA results (based on the contribution analysis performed) for the simulated CBHBP case study. Feedstock supply chain is the stage most affected by increases in moisture content due to the consequent higher transportation requirements. For example, increasing moisture content from 30% to 50% causes about an 18% increase in global warming (GW). Excess air ratio and furnace temperature affected the importance of CBHBP plant operation mostly due to nitrogen oxides (NO_x) emission increases. As an example, the higher increases in eutrophication (ETR) (~56%) and acidification (ACD) (~17%) are observed between the excess air ratios of 1.2 and 1.5. In addition, with increasing furnace temperature, high increases occur in mainly ETR and then ACD. For instance, an increase from 900 to 1000°C increases ETR ~78%; an increase from 1100 to 1200°C increases ACD ~38%. The methodology proposed here can be applied to any system for a better environmental performance. The study ultimately incorporates a biorefinery concept intended to advance the building of a bio-based (low carbon) economy.

Keywords:

Life cycle assessment
Eco-design
Bioelectricity
Biomass CHP
Biomass cogeneration
Process simulation