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Techno-economic and life cycle analysis of biobutanol production from sugarcane bagasse via ternary deep eutectic solvent pretreatment

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ABSTRACT

As the switch towards sustainable energy solutions is the need of the hour due to climate change and increasing global energy demand, biobutanol emerges as a superior biofuel candidate. Biobutanol has higher energy density and compatibility with existing infrastructure than ethanol. However, the conversion from lignocellulosic biomass to biobutanol is hindered by its recalcitrant nature. Deep eutectic solvent pretreatment is gaining attention due to its green properties and enhancing biomass digestibility under milder conditions. This work uses a detailed techno-economic and life cycle analysis of biobutanol production from sugarcane bagasse via ternary deep eutectic solvent pretreatment to identify process improvement opportunities.

The biobutanol process was developed from sugarcane bagasse via ternary deep eutectic solvent choline chloride, ethylene glycol and nickel chloride in a molar ratio of 1:2:0.016. The process pathway consists of DES pretreatment, DES separation and water washing, enzyme hydrolysis, and fermentation, followed by separation and purification of biobutanol. For the scale-up study, 100 tons per day biobutanol production plant capacity was considered. Experimental data for the upstream process is combined with ASPEN Plus simulation for a downstream process for a commercial plant producing 100 tons per day of biobutanol. Equipment sizing and costing are done using standard approaches. A life cycle analysis of the process was carried out in OPENLCA using the Ecoinvent database to quantify the life cycle impacts of 1 kg of butanol.

KEY WORDS

Biobutanol, techno-economic analysis, life cycle analysis, deep eutectic solvent

BIOGRAPHY

Neethu Joshikumar is a joint PhD scholar at The University of Queensland IIT Delhi Research Academy, dedicated to pioneering sustainable energy solutions. With a master's degree in Chemical Engineering from IIT Kharagpur, their research harnesses process modelling and sustainability tools to advance biofuel production. Her PhD thesis is on the conversion of biomass to value-added chemicals, techno-economic analysis and life cycle analysis of the developed process. Her work aims to reduce costs and environmental impacts, contributing to the global shift toward renewables.

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