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Techno-economic Feasibility and Life Cycle Assessment of Dairy Effluent to Renewable Diesel via Hydrothermal Liquefaction

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Abstract

The economic feasibility and environmental impact is investigated for the conversion of agricultural waste, delactosed whey permeate, through yeast fermentation to a renewable diesel via hydrothermal liquefaction. Process feasibility was demonstrated at laboratory-scale with data leveraged to validate systems models used to perform industrial-scale economic and environmental impact analyses. Results show a minimum fuel selling price of $4.78 per gallon of renewable diesel, a net energy ratio of 0.81 and greenhouse gas emissions of 30.0 g-$CO_{2\text{-eq}}$ MJ^{-1}. High production costs and greenhouse gas emissions can be attributed to operational temperatures and durations of both fermentation and hydrothermal liquefaction. However, high lipid yields of the yeast counter these operational demands, resulting in a favorable net energy ratio. Results are presented on the optimization of the process based on economy of scale and a sensitivity analysis highlights improvements in conversion efficiency, yeast biomass productivity and hydrotreating efficiency can dramatically improve commercial feasibility.