Economical and sustainable production of biodegradable plastic: process design and integrative analyses

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Lactic acid (LA) is an important bio-based precursor of polylactic acid (PLA), which is biodegradable and biocompatible plastic replacing conventional non-biodegradable plastic. In this study, we present the integrated process for the production of LA from both of lignocellulosic biomass (Strategy A) and sugar (Strategy B) and conduct integrative analyses including techno-economic, pioneer plant, uncertainty analyses, and life-cycle assessments to investigate the comprehensive feasibility and sustainability for the proposed process. To reduce utility consumption, heat exchanger network is composed. From the techno-economic analysis, the minimum selling prices (MSPs) of LA for the Strategies A and B are determined to be $1,498/ton and $1,491/ton, which are lower than current market price of LA ($1,526/ton). In addition, uncertainty analysis coupled with Monte-Carlo simulation is performed to quantify the risk and uncertainty in biomass-derived LA production. Through the life-cycle assessment, we evaluate the sustainability by quantifying the environmental impact of the proposed process.