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Techno-economic evaluation of transesterification processes for biodiesel production from low quality non-edible feedstocks: Process design and simulation

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Techno-economic evaluation of transesterification processes for biodiesel production from low quality non-edible feedstocks: Process design and simulation.

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Abstract

The global demand for fossil fuels has led to increased pollutant emissions and depleted fossil fuel resources. Biodiesel, a fossil fuel alternative, is widely produced via transesterification. This study assesses the techno-economic performances of three transesterification processes (alkaline, acid, and CaO catalytic) for biodiesel production from low-quality non-edible feedstocks. The study explores effects of elevated free fatty acids (FFAs) and oil/ethanol flow rates on these processes, focusing on their impact on yield, purity, economics and energy aspects. Aspen Plus® V10 software was used for simulations. Despite meeting international biodiesel standards, significant technical and economic variations exist among the processes. The acid catalytic process exhibits energy requirements surpassing those of alkaline and CaO catalytic processes by over 29.58%, leading to operational costs exceeding those of CaO catalysis by 13.11%. The study establishes CaO catalysis as the most feasible option due to its simplicity, adaptability, and substantial energy and cost reductions. By introducing a closed-loop blending setup configuration, the study reveals that CaO catalysis outperforms alkaline and acid catalysis, achieving 11.59% cost reduction and 13.31% energy decrease in closed-loop configurations. The overall results highlight the potential of non-edible feedstocks in biodiesel production for a more environmentally friendly and sustainable energy future.