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## Techno-economic analysis of biodiesel production process from waste cooking oil using catalytic membrane reactor and realistic feed composition

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### Highlights

- Biodiesel processes using realistic composition of waste cooking oil are designed.
- Reaction yield and free fatty acids contents are the most sensitive parameters.
- Combined approach of process flowsheets, design of experiments, and Monte Carlo simulations are developed.
- More selective membrane and better separation process is required for future work.
- Catalytic membrane reactor process is more robust and more profitable.

### Abstract

Since the use of virgin oil as feedstock to biodiesel production leads to competition between food and energy sources, waste cooking oil (WCO) has been proposed as an alternative. However, due to its high concentration of free fatty acids (FFA), its use in the conventional process that uses alkali catalyst has been limited. Catalytic membrane reactor (CMR) process is proposed to overcome these issues as well as to intensify the process. The objectives of this study are to perform techno-economic analysis and to compare the CMR and conventional processes to produce biodiesel and high purity glycerol. Unlike previous reports that applied simplified feed composition, this study employs realistic component mixtures during the process development to better reflect practical situations and anticipate potential technical challenges. The results show that the CMR process is economically more attractive. Reaction yield and FFA content are the most sensitive parameters in the conventional and in the CMR process, respectively. Sensitivity analysis are performed via a combined approach of design of experiments on the process simulation flowsheets and Monte Carlo simulations. The results show that the CMR process is more robust and more profitable by at least 50% in all scenarios than the conventional one. Due to its importance, more selective membrane towards biodiesel and better separation techniques for separating biodiesel and FFA still need to be developed to improve the economics of the process.

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