Abstract The objective of this work is to enhance the economic performance of a batch transesterification reactor producing biodiesel by implementing advanced, model based control strategies. To achieve this goal, a dynamic model of the batch reactor system is first developed by considering reaction kinetics, mass balances and heat balances. The possible plant-model mismatch due to inaccurate or uncertain model parameter values can adversely affect model based control strategies. Therefore, an evolutionary algorithm to estimate the uncertain parameters is proposed. It is shown that the system is not observable with the available measurements, and hence a closed loop model predictive control cannot be implemented on a real system. Therefore, the productivity of the reactor is increased by first solving an open-loop optimal control problem. The objective function for this purpose optimizes the concentration of biodiesel, the batch time and the heating and cooling rates to the reactor. Subsequently, a closed-loop nonlinear model predictive control strategy is presented in order to take disturbances and model uncertainties into account. The controller, designed with a reduced model, tracks an offline determined set-point reactor temperature trajectory by manipulating the heating and cooling mass flows to the reactor. Several operational scenarios are simulated and the results are discussed in view of a real application. With the
proposed optimization and control strategy and no parameter mismatch, a revenue of 2.76 $ \text{min}^{-1}$ can be achieved from the batch reactor. Even with a minor parameter mismatch, the revenue is still 2.01 $ \text{min}^{-1}$. While these values are comparable to those reported in the literature, this work also accounts for the cost of energy. Moreover, this approach results in a control strategy that can be implemented on a real system with limited online measurements.

Stichworte:
Transesterification, Optimal control, Nonlinear model predictive control, Parameter estimation

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