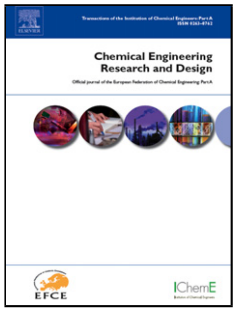

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Process Analysis and Economic Optimization of Intensified Process Alternatives for Simultaneous Industrial Scale Production of Dimethyl Carbonate and Propylene Glycol

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Abstract

Several processes in the chemical and petrochemical industries are limited by chemical and phase equilibria. Therefore, these processes require several steps to produce the desired products with the required purity. These complex steps lead to high production costs due to the high capital investment required. Moreover, the vast utility demand required by most chemical processes contributes to high operating and production costs. Promising alternatives are intensified processes such as hybrid or integrated separation processes, which can reduce the number of apparatuses as well as the utility demand, thereby increasing process sustainability. However, the identification of the final configuration and dimensions of these apparatuses and an optimal operating point is a challenging task. This task usually involves solving a mixed-integer nonlinear programming problem to identify optimal values for the degrees of freedom. This work presents a memetic optimization algorithm and validates its ability to handle such problems by optimizing a benchmark function. This optimization algorithm was applied to economically optimize several intensified process alternatives and compare their capabilities to a base-case process. The transesterification of propylene carbonate with methanol served as a case study with high potential for process intensification and production of dimethyl carbonate in the framework of "green chemistry". Validated rate-based models were used to model four intensified process alternatives consisting of different combinations of reactive distillation, reactive dividing wall columns, pressure-swing distillation and vapor permeation. This study has shown that alternatives using reactive dividing wall columns can improve process economics up to 35 % over the base-case process.

Keywords: hybrid separations, memetic algorithm, rate-based model, reactive distillation, reactive dividing wall column, vapour permeation