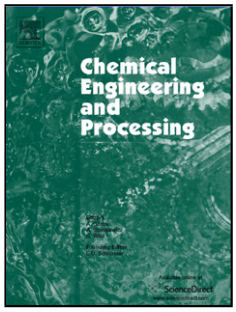

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Integrated Batch Reactive Distillation Column Configurations for Optimal Synthesis of Methyl Lactate

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Abstract

Although batch reactive distillation process outperforms traditional reactor-distillation processes due to simultaneous reaction and separation of products for many reaction systems, synthesis of Methyl lactate (ML) through esterification of lactic acid (LA) with methanol in such process is very challenging due to difficulty of keeping the reactants together when one of the reactants (in this case methanol) has the lowest boiling point than the reaction products. To overcome this challenge, two novel reactive distillation column configurations are proposed in this work and are investigated in detail. These are: (1) integrated conventional batch distillation column (i-CBD) with recycled methanol and (2) integrated semi-batch and conventional batch distillation columns (i-SBD) with methanol recovery and recycle.

Performances of each of these configurations are evaluated in terms of profitability for a defined separation task. In i-SBD column, an additional constraint is included to avoid overflow of the reboiler due to continuous feeding of methanol into the reboiler as the reboiler is initially charged to its maximum capacity. This study clearly indicates that both integrated column configurations outperform the traditional column configurations (batch or semi-batch) in terms of batch time, energy consumption, conversion of LA to ML, and the achievable profit.

Keywords: Dynamic Modelling; Optimization; Methyl Lactate; i-CBD; i-SBD; Esterification

1. Introduction

Batch reactive distillation process is extensively employed in the chemical industry, particularly for seasonal demand and/or low-volume production. The integration of reaction and distillation in a single vessel (reactive distillation) has offered a number of specific advantages over conventional process of chemical reaction followed by separation (Mujtaba and Macchietto, 1997). It can save the thermal heat consumption, reduce capital and operating costs, overcome the chemical reaction