



Pilot-scale experimental validation of unsaturated polyesters synthesis by reactive distillation

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HIGHLIGHTS

- Reactive distillation (RD) process for synthesis of unsaturated polyesters.
- Pilot scale experimental validation of the newly proposed RD process.
- Two configurations investigated 1. RD column alone, 2. RD column with pre-reactor.
- Extended rate-based model used for rigorous simulations of the pilot plant.
- Product specification are comparable with the polyester made at industrial scale.

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ABSTRACT

Reactive distillation (RD) is an integrated operation combining both reaction and separation, thus improving the productivity and selectivity, reducing the energy usage, eliminating the need for solvents and leading to intensified highly-efficient systems. In previous work, we performed the conceptual design and modeling of a reactive distillation process for synthesis of unsaturated polyesters. The simulation results of our previous work clearly demonstrated that reactive distillation is a promising alternative for the polyesters synthesis.

This paper presents our pilot scale experimental validation work on the proposed RD process for polyester synthesis. Two configurations are investigated: (1) a RD column alone and (2) a RD column coupled with a pre-reactor. For the first configuration, we demonstrated that mostly monoesters are formed in the RD column, due to the short residence time at pilot scale. Since the combination of a RD column with pre-reactor allows sufficient residence time also at pilot scale, we demonstrated that polyesters are formed in the RD column. The extended rate-based model developed previously was used to simulate the pilot plant RD column. The model adequately predicts and describes the experimental data obtained from the pilot plant. Moreover, the product specification of the polyester produced in the continuous RD column was compared with the polyester product manufactured at industrial scale. Remarkably, it was found that the product specifications of the polyester produced in the RD column is comparable to that of the polyester produced in industry.

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1. Introduction

Most chemical processes involve reaction and separation operations that are typically carried out in different sections of the plant and use different equipment types (e.g. reactors and distillation columns) operated under a wide variety of conditions. Recycle streams between these units are often used to improve conversion

and selectivity, to minimize the production of undesired by-products, to reduce the energy requirements, and to improve the process controllability [15]. Recent economic and environmental considerations have encouraged industry to focus on technologies based on process intensification. Reactive distillation (RD) is such an integrated operation that combines reaction and separation into a single unit allowing the simultaneous production and removal of products, thus improving selectivity and productivity, reducing the energy use and the need for solvents while also leading to high-efficiency systems with *green engineering* attributes [16,19,21,27,29].

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