다성분계 분리를 위한 연속 모사이동층 크로마토그래피의 설계

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Designs of simulated moving bed systems with less than N-1 cascades

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Abstract

Although basic architecture is important for all simulated moving bed (SMB) systems, it is particularly important for separation of multicomponent mixtures since there are not yet standard schemes. Simulated moving beds with less than N-1 cascades are studied for separation of quaternary mixtures within the linear range. Design parameters, operating conditions are determined with the local equilibrium theory and detailed Aspen Chromatography simulations are done to determine purities. A series of initial feed compositions are simulated to determine the optimal regions

Introduction

Since distillation is the most widely used method for separation of liquid mixtures, it has been extensively studied. For separations of multicomponent mixtures, most systems use N-1 columns. Where N=number of components.

On the other hand, the system with less than N-1 column has not been extensively studied. Tedder and Rudd[1] extensively studied single distillation towers (less than N-1) column for separations of ternary mixtures. When some of the feed components are present in only trace amounts or only low product purities are required, these column designs may be the most economical alternatives. They suggested that a single distillation tower with a vapor side stream below the feed is favored when the feed is more than 50% B and less than 5% C. The single distillation tower with a liquid side stream above the feed is favored when the feed is more than 50% B and less than 5% A. The components in the mixture are ranked according to their relative volatility, that is, A is the most volatile component and C is least volatile component.

The weak analogy between distillation and SMB systems can be used to develop designs of new SMB systems and qualitatively predict their behavior for separation of multicomponent mixtures. Wankat[2] developed seven cascades of SMB systems for ternary separations with linear isotherms and determined the minimum desorbent usage and the productivity using the well-known equilibrium model. Nicoud[3] discussed a five-zone SMB with side streams for separation of ternary mixtures. Beste and Arlt[4] derived rules for five-zone SMBs with side streams for separation of ternary mixtures based on the triangle method, and they compared simulations with experiments. Kim et al.[5] studied single-cascade SMB systems for separation of ternary mixtures that correspond to their distillation analogs.

The objective of this study is to develop SMB systems with less than N-1 cascades for separation of quaternary mixtures and to determine the favorable conditions for these designs.

New designs

The configurations in Figure 1a and 1b are distillation and SMB with N-1 cascades for separation of quaternary mixtures. The sequence shown in Figure 1 is A→B→C/E. Three different distillation and SMB systems with less than N-1 cascades for separations of quaternary mixtures are shown in Figure 2 to 4. The configurations in Figure 2 have two products stream for each cascade (A/E→B/C). The configurations in Figure 3 have two products stream for each cascade (A/B→C/E). The configurations in Figure 4 have one product stream for the first cascade and three product streams for the second cascade (E→A/B/C). The distillation systems in Figures 1a to 4a were analyzed and compared by Kim and Wankat[6].

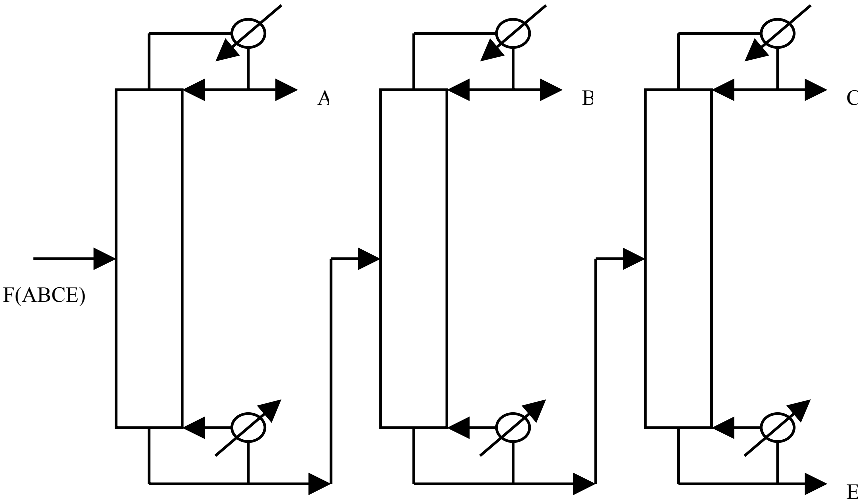

Figure 1a. Distillation with N-1 columns

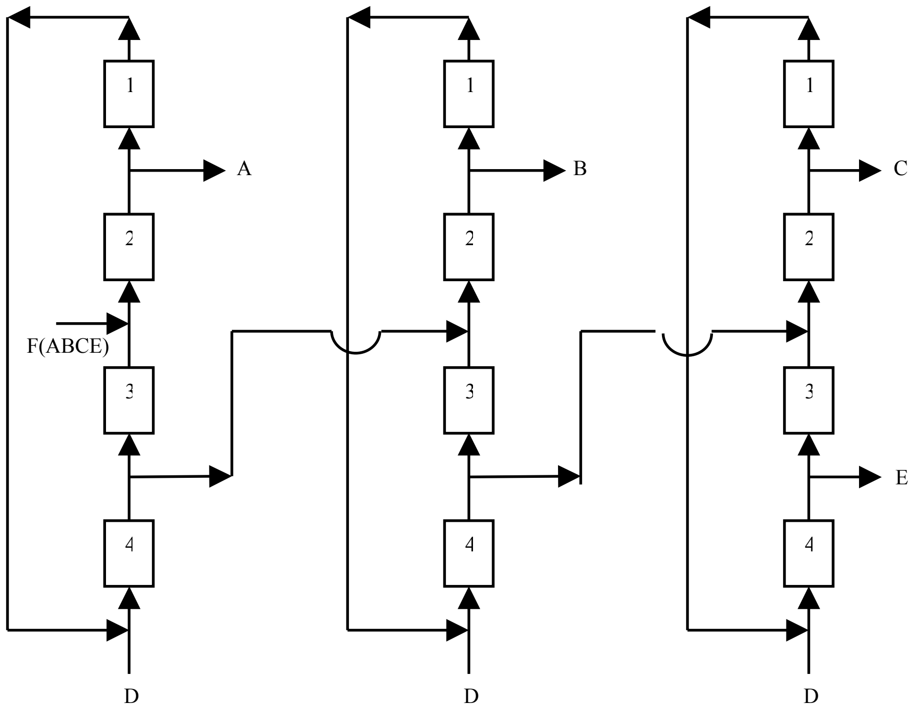

Figure 1b. Simulated moving bed with N-1 cascades

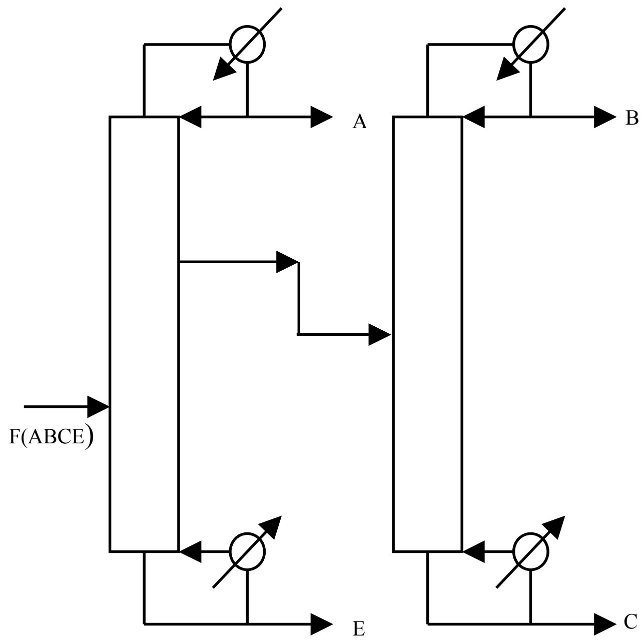

Figure 2a. Distillation with less than N-1 columns

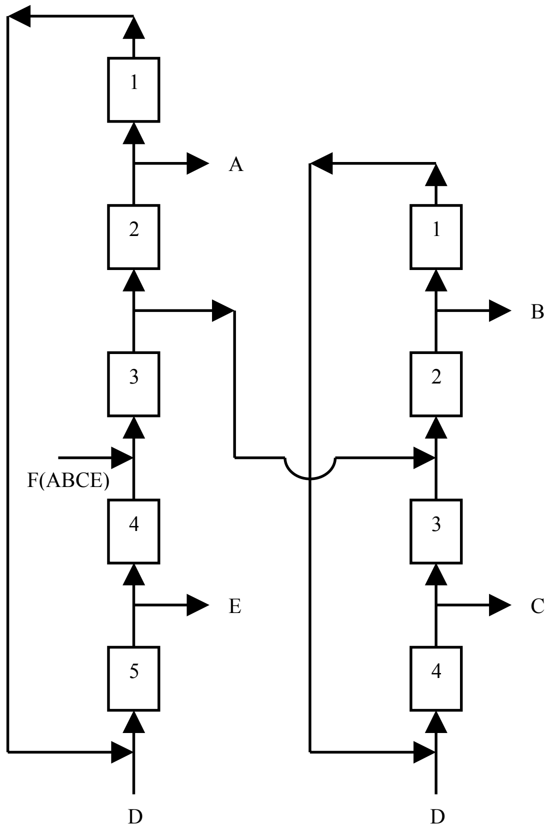

Figure 2b. Simulated moving bed with less than N-1 cascades

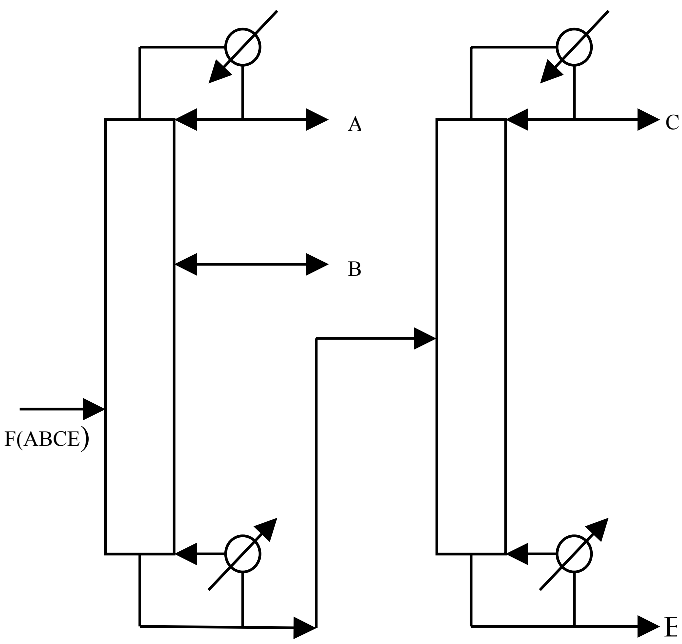

Figure 3a. Distillation with less than N-1 columns

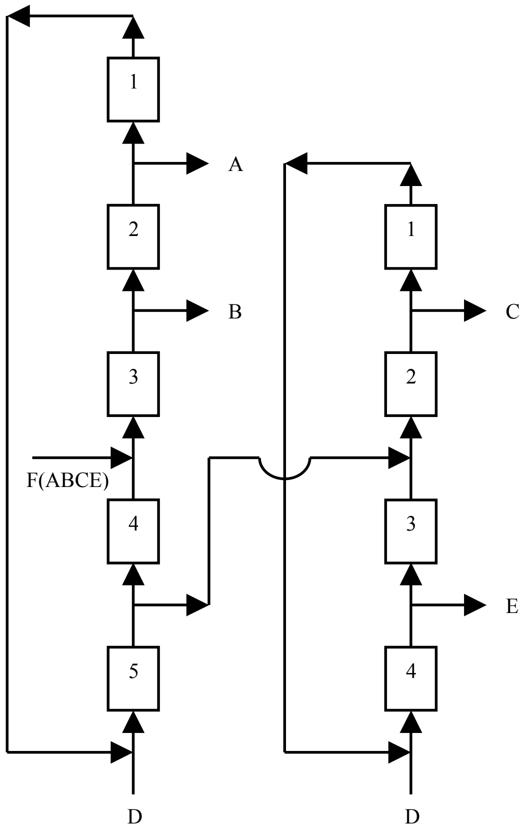

Figure 3b. Simulated moving bed with less than N-1 cascades

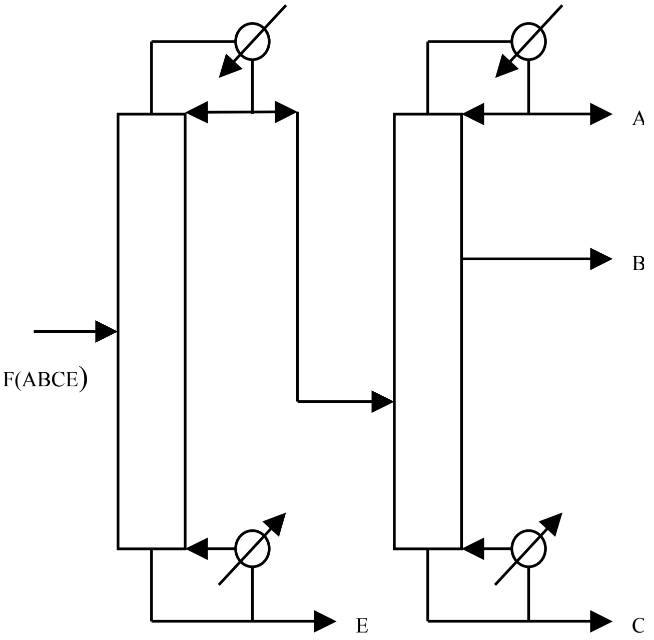

Figure 4a. Distillation with less than N-1 columns

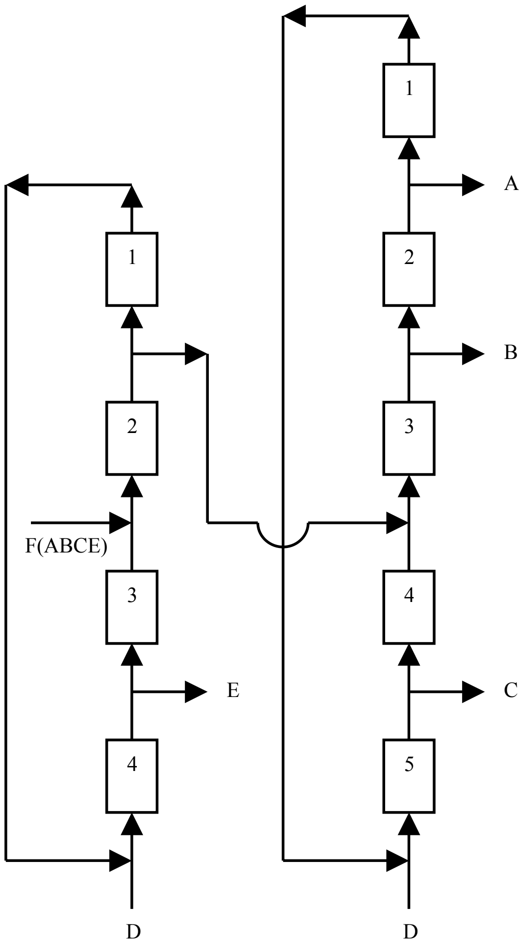

Figure 4b. Simulated moving bed with less than N-1 cascades

Conclusion

The results of this work will provide guidelines to design simulated moving bed with less than N-1 cascades for separation of multicomponent mixtures.

Reference

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