Minimum Energy Demand and Split Feasibility for a Class of Reactive Distillation Columns

Rosa Y. Urdaneta, Jürgen Bausa⁺ and Wolfgang Marquardt^{*}

Lehrstuhl für Prozesstechnik

RWTH Aachen University, Templergraben 55, 52056 Aachen, Germany

Abstract

The integration of reaction and separation in a single vessel is known as reactive distillation. The use of reactive distillation operations in the chemical and the petrochemical industry have successfully reduced process costs and environmental emissions, as well as allowed the improvement of product purities. However, the complex behavior of the combination of reaction and separation demands simple calculation tools to be applied for conceptual design, like shortcut methods, in order to allow a quick evaluation of the separation, gain insight in the process and provide reliable initial values for rigorous procedures to be applied subsequently.

This work presents a new approach for the calculation of the minimum energy demand (MED) of reactive distillation columns. Continuous distillation boundaries in the limit of chemical reaction equilibrium are used to determine minimum energy demand of the process. At the same time, split feasibility can be confirmed. The method is applicable to mixtures without or with phase split if the number of independent components equals two. A similar concept has been applied to conceptual design of heteroazeotropic distillation columns. It carries over to reactive distillation because both processes are characterized by strongly curved composition profiles in composition space. The method is illustrated by two esterification examples, one of them showing liquid phase split in the rectifying section.

Keywords: reactive distillation, conceptual design, shortcut methods, continuous distillation boundaries, minimum energy demand, split feasibility.

⁺ Present address: Bayer Technology Services, Leverkusen, Germany

^{*} Author to whom correspondence should be addressed : marquardt@lpt.rwth-aachen.de