Research topics

Design of Reactor-Separator-Recycle Systems

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Abstract

This project deals with the problem at the core of chemical processes, that of creating a structure for the reaction-separation-recycle system. New methods have been developed for the synthesis of such structures capable of screening a wide range of options and taking account of all of the trade-offs simultaneously. For the first time these methods are capable of fully taking into account the interactions between the reactor design options and the separation system design.

Project description

In most chemical processes, the effluent from the reactor is separated into products, by-products and unreacted feed. The unreacted feed (and in some cases the by-products) can be recycled back to the reactor system. Despite the research effort on process synthesis over the last two decades, very few systematic procedures have been proposed for the synthesis of reactor-separator-recycle systems. Existing approaches mostly use heuristics based on the study of reactors and separation systems in isolation. As a result, the coupling of reactors with separators has not been properly investigated.

Recent work has allowed a more systematic approach to be developed. The approach proposes a general superstructure of different reactor options and separation tasks and features all the potential interconnections among the proposed units. Optimisation techniques are used to determine the trade-offs and the optimal structure and operating conditions of the flowsheet The approach has highlighted the importance of the coupling between the reaction and the separation system and confirmed the potential benefits of an integrated approach.

The separation process often serves to improve the performance of the reactor, for example by providing recycles of suitable purity. On the other hand, the reactor performance may be tailored to facilitate the separation process. These opportunities are also being examined, in particular for highly non-ideal systems, with azeotropes and liquid-phase immiscibility. The resulting composition of the reactor effluent could significantly affect the ease of separation of the products. A systematic approach to flowsheet design that considers both the reactor and separation system is being developed for these types of systems.