

## **445f Formulation of Search Spaces for Separation Networks**

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The synthesis of separation networks in general and distillation networks in particular has posed computational challenges in process design. One reason for this is the large number of possible networks for a given set of streams to be separated. Another reason is that when this is posed as an optimization problem, there exist discontinuities in the objective function value when separation units are added or removed. Such discontinuities are often handled in practice through the use of binary existence variables for each of the separation units. Several search spaces have been proposed for the synthesis of distillation networks.<sup>1,2,3</sup> These search spaces embed several possible network configurations, one or more of which may be optimal for a given set of feed streams with given molar flow rates and given relative separability ratios.

In this work, we examine the existing search spaces for both completeness (all key network configurations must be embedded) and conciseness (the search space should embed as few networks that are unlikely to be designed by a separation expert as possible). In particular, we look for patterns and methods to reduce the network search space a priori, so that the subsequent search for the optimal network (through mathematical programming or stochastic methods) is accelerated. We also examine the extensibility of the search space to accommodate the possibility of coupled separation units (such as thermally coupled distillation columns), and issues with process control and operability, such as pressure drops across columns. We propose a new search space that we believe has most of these qualities. We then propose methods to extend and generalize this search space to other separation techniques such as membrane separation. We also discuss methods to find the optimal network structure given the search space.

References 1. Sargent, R. W. H., and K. Gaminibandara. *Optimization in Action*; L. W. C. Dixon, Ed.; Academic Press: London, 1976; p 267. 2. Agrawal, R., *Ind. Eng. Chem. Res.* 35 1059 (1996). 3. Rong, B.-G., A. Kraslawski and I. Turunen, *Ind. Eng. Chem. Res.* 42 1204 (2003).