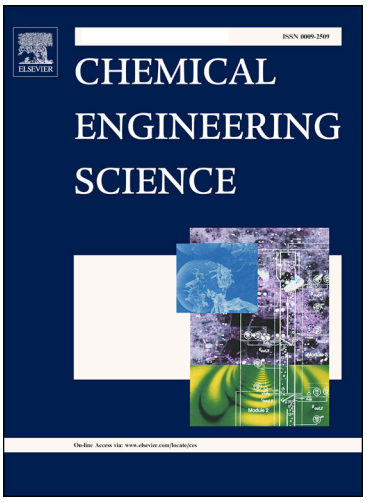

Synthesis of Mass Exchanger Networks in a Two-step Hybrid Optimisation Strategy

Michael Short, Adeniyi J. Isafiade, Lorenz T. Biegler, Zdravko Kravanja

PII: S0009-2509(17)30756-X
DOI: https://doi.org/10.1016/j.ces.2017.12.019
Reference: CES 13954

To appear in: *Chemical Engineering Science*

Received Date: 23 June 2017
Revised Date: 26 September 2017
Accepted Date: 13 December 2017

Please cite this article as: M. Short, A.J. Isafiade, L.T. Biegler, Z. Kravanja, Synthesis of Mass Exchanger Networks in a Two-step Hybrid Optimisation Strategy, *Chemical Engineering Science* (2017), doi: https://doi.org/10.1016/j.ces.2017.12.019

Synthesis of Mass Exchanger Networks in a Two-step Hybrid Optimisation Strategy

Michael Short [A], Adeniyi J. Isafiade [A]*, Lorenz T. Biegler [B], Zdravko Kravanja [C]

[A] *Department of Chemical Engineering, University of Cape Town, Private Bag X3, Rondebosch 7701, Cape Town, South Africa*

[B] *Department of Chemical Engineering, Carnegie-Mellon University, Pittsburgh, PA USA*

[C] *Faculty of Chemistry and Chemical Engineering, University of Maribor, Slovenia*

Abstract

We present a new method for the synthesis of mass exchanger networks (MENs) involving packed columns. Simultaneous synthesis of MENs is typically done through the use of mixed-integer nonlinear program (MINLP) optimization, with simplifications made in the mathematical representations of the exchangers due to computational difficulty in solving large non-convex mixed-integer problems. The methodology proposed in this study makes use of the stage-wise based superstructure MINLP formulation for the network synthesis. This stage-wise superstructure model incorporates fixed mass transfer coefficients, fixed column diameters, no pressure drops, and unequal compositional mixing for models. In this paper, the simplified MINLP model is further improved by including a detailed individual packed column design in a non-linear programming (NLP) sub-optimisation step, where orthogonal collocation is utilized for the partial differential equations, and optimal packing size, column diameter, column height, pressure drops, and fluid velocities. Detailed designs are then used to determine correction factors that update the simplified stage-wise superstructure models to more accurately portray the chosen design. Once the MINLP is updated with these correction factors, the model is re-run, with new correction factors obtained. This iterative procedure is repeated until convergence between the objective function of the MINLP and that of the NLP sub-optimisation is achieved, or until a maximum number of iterations is reached. The methodology is applied to two examples and is shown to be robust and effective in generating new topologies, and in finding superior networks that are physically realizable.

Keywords: mass exchanger networks; MEN; non-linear programming; mathematical programming; orthogonal collocation; packed columns