Veerayut Lersbamrungsuk 2008: Development of Control Structure Design and Structural Controllability for Heat Exchanger Networks. Doctor of Engineering (Chemical Engineering), Major Field: Chemical Engineering, Department of Chemical Engineering. Thesis Advisor: Associate Professor Thongchai Srinophakun, Ph.D. 94 pages.

Heat exchanger networks (HENs) are the heart of heat-integrated plants. This thesis is devoted to two issues on HENs. The first issue concerns optimal operation of HENs, whereas the second issue concerns controllability improvement in HEN synthesis.

In the first issue, the term "optimal operation of HENs" requires that (a) all target temperatures can be satisfied and (b) utility cost is minimized. For certain HENs in which only single bypasses and utility duties are considered as manipulated variables, the optimal operation problem can be categorized as an active constraint control problem. To handle this problem is to propose a robust rule for switching among active constraint regions. A simple split-range control scheme was suggested to implement the switching. Two approaches to design an optimal split-range control structure were studied. The first approach is based on the information of directional effect among manipulated variables and controlled variables. The second approach requires the information of active constraint regions in a given disturbance window that is used in the proposed integer linear program (ILP) to determine an optimal split-range control structure. Three case studies were used to illustrate the application of the proposed approaches.

In the second issue, two methods to improve controllability in HEN synthesis stages were proposed. The first method is based on a sequential approach, that is, among the economically reasonable solution set obtained from a number of HEN synthesis techniques, the solution with the best structural evaluation is more favorable. The structural analysis tools used are structural singularities, parallel opposing effects, relative orders and decoupling indices in which the evaluation is formulated as an ILP problem. The second method is based on a simultaneous approach. The concept is to search for the HEN structure with a number of subnetworks. Additional binary variables and corresponding constraints are introduced into the MINLP HEN synthesis models, such as the single-period model of Yee and Grossman and the multi-period model of Aalota, to enforce solutions to have at least user-specified number of subnetworks. With a number of runs of varying user-specified number of subnetworks, the economically reasonable solution with the highest number of subnetworks is favorable.

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