Economic aspects of heat pump integration in thermally coupled hybrid separation

Šulgan B.[1], Labovská Z.[2]

[1, 2] *Institute of Chemical and Environmental Engineering, Faculty of Chemical and Food Technology, STU Bratislava, Slovakia*

A promising pathway for process integration and intensification is hybrid separations. In this field, thermally coupled systems are studied in various applications. Production of ethyl acetate via reactive distillation can be listed as an example. The basic process design is adopted from a reactive distillation column with a stripper column (RDS) which allows producing pure ethyl acetate in two columns. The reactive distillation column has a condenser and a reboiler and the stripper column has a reboiler only. In addition, no auxiliary regeneration equipment such as a decanter or a regeneration column is required. On the other hand, despite the RDS process being highly integrated, it has several bottlenecks, namely, large equipment (columns and heat exchangers), high external energy requirements for both cooling and heating. Also, it is known for large recycles of both liquid and vapor. Therefore, the scope of this work is focused on further streamlining of the RDS process assuming the possibility of mechanical vapor recompression heat pump (MVRHP) integration. The idea of using the MVRHP is based on reduction of external cooling and heating requirements by eliminating large condenser from the reactive distillation column and replacing heating steam in the stripper column reboiler by overheated vapor from the compressor. Consequently, utilities consumption changes. The effect of MVRHP integration is studied via economic aspects: capital cost, utilities cost, and pay-back period. Results show that MVRHP can be deployed in the RDS process effectively reducing energy requirements while no equipment size changes (columns) are needed. Despite increased capital cost due to the compressor addition, overall process economic aspects improved significantly.

Acknowledgement
This research was funded by the Slovak Research and Development Agency, under the contract No. APVV-18-0134.