Optimization of heat pump and vapor recompression technologies for high-boiling mixtures

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Abstract

In narrow boiling mixtures, heat pumps and vapor recompression can be used effectively to recycle waste heat and condensation heat within the process. Particularly in distillation processes with high throughputs and reflux ratios (e.g. C2- or C3-splitter), the economic efficiency increases on the one hand due to the cost degression of the specific investment costs of the compressor and on the other hand due to the increasing savings potential of the operating costs.

Innovative solutions must be found in order to be able to use these technologies for wide-boiling mixtures. High temperature differences between head and sump must be overcome, resulting in high compression ratios, increasing compressor performance and lower coefficients of performance. However, in order to achieve the ambitious climate targets of the process industry and society, economically attractive solutions must also be found for wide-boiling mixtures with apparently low savings potential. Simply replacing existing fossil-fired steam generators with electric evaporators would pose even greater challenges to the electrical infrastructure and the (still) limited raw material of green electricity than the installation of heat pumps or vapor recompressions.

Practical examples will be used to show how the electrification of processes can be optimized. Pre-evaporators can also be operated in combination with a vapor recompression/heat pump. Due to the temperature profile within the column, the temperature lift of the compressor for a pre-evaporator is lower than for an evaporator in the sump. The capacity of a multi-stage compressor supplying both evaporators can be reduced and the coefficient of performance optimized by smartly connecting the pre-evaporator and sump evaporator. However, these changes have an impact on the separation task of the process. These interactions, as well as the economic effects, are illustrated by means of sensitivity analyses.