Estimation of Plate-and-Frame Heat Exchanger surface area targets for specific process conditions

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Nowadays plate heat exchanger (PHE) is recognised as one of the efficient types of heat exchangers with enhanced heat transfer. In most cases of their application in the process industries PHEs require much smaller heat transfer surface area than conventional shell and tube heat exchangers. The principles of their construction and design also are much different. For most tubular heat exchangers those principles are regulated by standards of Tubular Exchangers Manufacturers Association (TEMA), correlations for at least approximate thermal and hydraulic design can be found in open literature, open source and commercial software available. For PHEs such information is much more limited and belongs mostly to manufacturers, who are producing today large variety of PHE heat transfer plates by stamping them from a thin metal. The geometry of plates and corrugations on them considerably different and determines heat transfer characteristics and hydraulic resistance of PHE made from specific plates.

Main feature of the most contemporary produced PHEs is the existence of a big number of contact points between the adjacent plates, which ensure strength of inter-plate channel and its ability to withstand pressure difference between heat exchanging streams. The best suitable for this purpose are plates with straight corrugations inclined to plate longitudinal axis. For PHE formed by such plates the mathematical model is developed. The decomposition of the plate on its main corrugated field, which cause major effect on heat transfer, and distribution zone, which influences mostly the hydraulic performance, is used. Model is validated on experimental data for some commercial plates. Based on this model the optimization algorithm is developed using MINLP method with inequality constraints. The objective function is PHE heat transfer area. Optimizing variables are plate spacing, plate length, the corrugations inclination angle to plate axis and corrugations pitch to height ratio. The resulting optimal solution can be regarded as a target for PHE heat transfer area, when the geometrical parameters of plate and its corrugation are strictly corresponding to calculated optimal values. The algorithm is implemented as PC computer software DLL module, which can be used for multiple calculations when optimizing PHE for the specific industrial processes or as part of heat exchanger network. On a final stage of equipment selection the data can be used for the choice of commercially available PHE with geometrical parameters close to calculated, as well as reference point for heat transfer area. The case study is presented, in which the results are compared to calculations for commercially available PHEs.

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