Shell-and-Plate Heat Exchangers for Efficient Heat Recovery under the Industrial Application

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The efficient heat recuperation helps to solve the problem of efficient energy usage, to reduce energy consumption and greenhouse gas emissions. The problem of energy saving in industry supposes the application of effective heat transfer equipment with effective HEN for recuperation. It requires considering minimal temperature differences in heat exchangers of reasonable size, what can be satisfied by a Shell-and-Plate Heat Exchangers (SPHE). Such equipment can be used not only as a separate item of equipment, but as elements of heat recuperation systems, that demonstrates the efficient solutions in industry. SPHE can be used for high temperatures and pressures at the same time with the possibilities of cleaning the unit during the operation.

However, the efficient use of SPHEs in complex recuperation systems and heat exchanger networks demand reliable methods for their rating and sizing. This is not only required when ordering the equipment, when proprietary software of PHE manufacturers is used, but also at the design stage by the process engineer.

The developments in design theory of Shell-and-Plate Heat Exchangers, aiming to enhance the heat recovery and efficiency of energy usage, are discussed. The thermal and hydraulic performance of the unit is estimated using two approaches: by adjusting the number of passes for each of exchanging heat streams and by proper selection of plate corrugation pattern, as was discussed earlier in [1]. The optimization problem targeting the minimal heat transfer area under the requirements of proper operating conditions is observed. The optimizing variables include the number of plates with different corrugation geometries in each pass. To estimate the value of the objective function in a space of optimizing variables the mathematical model of Shell-and-Plate HE is developed. To estimate the thermal and hydraulic performance of inter-plates channels with different geometrical forms of corrugations of the adjacent round plates, the heat transfer coefficients and friction factors are used as model parameters. The proposed mathematical model enables to account the fouling effect during the operation period at the design stage and to estimate the operation time between cleanings.

The possibility of Alfa Disk HE application in HEN of distillation unit preheat train of oil refinery are analyzed basing on obtained design parameters. The fouling formation behavior and effect of different geometrical parameters of the heat transfer plates on hydraulic and thermal performance of SPHE are analyzed. The combination of plates with different corrugation height and effect of flow movement arrangement in the unit are discussed.

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References:

1. Arsenyeva O, Kapustenko P, Tovazhnyanskyy L, Khavin G (2013) The influence of plate corrugations geometry on plate heat exchanger performance in specified process conditions. Energy 57: 201-207.