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THERMAL-HYDRAULIC OPTIMIZATION OF COMPACT HEAT EXCHANGERS WITH LOUVERED FINS AND DELTA-WINGLETS

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ABSTRACT

The combination of multi louvered fins and delta-winglet vortex generators is a promising strategy to enhance heat transfer in fin-tube compact heat exchangers. The present paper focuses on the thermal-hydraulic performance optimization of such heat exchangers. The contribution of parameters such as Reynolds number, louver angle, angle of attack of the delta-winglet and streamwise position of the delta-winglet is also investigated in order to know which of these parameters strongly influences heat transfer and pressure drop. Reynolds numbers of 120 and 240, based on hydraulic diameter, were investigated. A semi parametric function estimation based on ANOVA type decomposition was applied to determine the effects of the input parameters on Colburn and Friction factors. The surrogate-based optimization procedure uses a NSGA-II method (Non-Dominated Sorting Genetic Algorithm) combined with artificial neural networks. The results indicated that the louver angle is the main contributor to increase the Friction factor increase for both Reynolds numbers. At the lower Reynolds number, the most important parameter to heat transfer was the louver angle, and at the higher Reynolds number, the angle of attack of delta winglet resulted in the highest influence on heat transfer. By comparison with baseline geometry (multi-louvered heat exchanger without vortex generator), the results from the optimization procedure showed that the addition of delta winglets increased the heat transfer by 22.45% with associated pressure loss penalty of 32.83% for the lower Reynolds number, while for the higher Reynolds number, the heat transfer and the pressure loss were increased by 23.91% and 49.34%, respectively.

Keywords: Heat transfer enhancement; Multi-louvered fin heat exchangers; Delta winglet vortex generators; Surrogate-based optimization; Compound heat transfer techniques