The effects of rectangular baffle angles and heights on heat transfer and pressure drop performance in cross-triangular grooved rectangular flow ducts

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Abstract

The improvements in heat exchangers mainly focus on rising energy efficiency. The cross-grooved rectangular flow ducts are largely used for plate heat exchangers. In this study, to enhance the heat transfer and hydraulic-thermal performance in the cross-grooved rectangular ducts with triangular grooves, rectangular baffles were located in the duct, and the influences of the rectangular baffle angles and heights on the features of the heat transfer and pressure drop were numerically analyzed in detail. The equations of Navier-Stokes and energy were solved by employing the Ansys-Fluent program with the k-ε turbulence model as steady and three-dimensional. Air used as working fluid has an inlet temperature of 293 K while the triangular groove's wall temperature is 373 K. Rectangular baffles have various angles of 30°, 60°, and 90°, and heights of 0.25H, 0.5H, and 0.75H. The mean Nusselt number (Num), dimensionless temperature (T*), turbulence kinetic energy (TKE*), pressure (p*), and performance evaluation criterion (PEC) number of the ducts with rectangular baffles were evaluated by comparing with the cross-triangular grooved duct without baffle. Also, the contours of turbulence kinetic energy, temperature, and velocity vector were exhibited for the cross-triangular grooved rectangular ducts with different arrangements of baffle angles and heights. Results were matched with experimental and computational outcomes of the study found in the literature, and it was observed that they were fairly compatible. The increment rate of Num at 90° baffle angle and 0.75H height is 197.56 % higher for Re = 6000 compared to 0.25H. Besides, for Re = 1000, the PEC number is 84.50 % higher at 0.25H baffle height and 30° angle than at 90°.

Keywords: Cross-grooved duct, Rectangular baffle, Triangular Groove, Plate heat exchanger