1. Enhancement of Turbulent Heat Transferin a Tube Using Different Types of Twisted Tape Inserts

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Abstract

In this work, effect of insertion modified configurations of twistingtape inside a tube on thermal and hydrodynamic fields were, experimentally and numerically, tested. Many modified tapered configurations of twisted tapes were analyzed. These modified configurations included two types of tapered twisted tapes; increased and decreased and two types of tapered central cut twisted tapes; increased and decreased. The tube surface was subjected to constant heat flux and the air was chosen to be the working fluid with turbulent flow at the range of Reynolds number from 10000 to 40000.

The turbulent flow and heat transfer were governed by continuity, momentum and energy equations. Fluent code in ANSYS Workbench 15 was used as numerical package for studying the problem. Also, RNG k-εturbulent model was used for determining turbulent viscosity. In the experimental part of this study, the modified configurations of tapered twisting tape were designed and manufactured from aluminum, a test rig consisted of many devices was designed and assembled.

The obtained results of Nusselt number and friction factor of flow in a tube equipped with these modified types of twisted tapes were compared with those of plain tube and tube equipped with typical twisting tape as a reference cases. For checking the enhancement in heat transfer attained by these modified twisting tape models, thermal performance factor was obtained for each case. Also, the results of numerical work of plain tube and tube equipped with typical twisting tape were validated with present experimental results and many known empirical correlations. For tapered twisted tapes, the effect of starting width, length of tapered region andinstallation direction on thermal and hydrodynamic fields were examined, while the effects of starting cut ratio, final cut ratio and installation direction on same two fields were examined for tapered central cut twisted tapes. The obtained results of using these modified models of twisted tape showed an increasing in both Nusselt number and friction factor ascompared with those of plain tube. All modified models of tapered central cut twisted tape and many modified models of tapered twisted tapes gave thermal performance factor higher than that of typical twisted tape. Three twist ratios (y) of 3, 4, and 5 were tested and an increasing in Nusseltnumber, friction factor and thermal performance factor were showed as twist ratio is decreased. Also, the results showed an increasing in Nusselt number and a decreasing in Nusselt

number ratio, friction factor, friction factor ratio and thermal performance factor when Reynolds number is increased.

For the tapered twisted tapes, the maximum increasing in numerical results of friction factor and Nusselt number were 375 % and 228 % respectively, while the maximum numerical thermal performance factor was 1.47. These maximum results were obtained for the case of 0.25L, 1-18 ITTT of y = 3 at Re = 10000. In experimental part, tapered twisted tapes of y= 5 gave maximum increasing in friction factor and Nusselt number of 313% and 175 % respectively, while the maximum thermal performance factor was 1.2. Also, these maximum results were obtained from the same case of 0.25L, 1-18 ITTT at Re = 10000. The obtained experimental data of Nusseltnumber, friction factor and factor of thermal performance were correlated by empirical correlations.