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Parametric Study of 3D Micro-Fin Tubes on Heat Transfer and Friction Factor

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Abstract : One area of special importance for surface-level study of heat exchangers is tubes with internal micro-fins (< 0.5 mm tall). Micro-finned surfaces are a kind of extended solid surface in which energy is exchanged with water that acts as the source or sink of energy. Significant performance gains are possible for either shell, tube, or double pipe heat exchangers if the best surfaces are identified. The parametric studies of micro-finned tubes that have appeared in the literature left some key parameters unexplored. Specifically, they ignored three-dimensional (3D) micro-fin configurations, conduction heat transfer in the fins, and conduction in the solid surface below the micro-fins. Thus, this study aimed at implementing a parametric study of 3D micro-finned tubes that considered micro-fin height and discontinuity features. A 3D conductive and convective heat-transfer simulation through coupled solid and periodic fluid domains is applied in a commercial package, ANSYS Fluent 19.1. The simulation is steady-state with turbulent water flow cooling inner wall of a tube with micro-fins. The simulation utilizes a constant and uniform temperature on the tube outer wall. Performance is mapped for 18 different simulation cases, including a smooth tube using a realizable k-ε turbulence model at a Reynolds number of 48,928. Results compared the performance of 3D tubes with results for the similar two-dimensional (2D) one. Results showed that the micro-fin height has greater impact on performance factor than discontinuity features in 3D micro-fin tubes. A transformed 3D micro-fin tube can enhance heat transfer and pressure drop up to 21% and 56% compared to a 2D one, respectfully.

Keywords : three-dimensional micro-finned tube, heat transfer, friction factor, heat exchanger
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