Research on the Thermal-Hydraulic Performance of Twisted Helical Bundle Heat Exchangers

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A recuperative heat exchanger is an important component in a recuperative cryocooler system, which is commonly applied for the cooling of superconducting electronics, infrared sensors, power systems, etc. Since the flow in this kind of heat exchanger goes through a large temperature span, a twisted helical bundle heat exchanger is being designed and optimized to achieve miniaturization and high effectiveness. The thermo-hydraulic characteristics of flow in the shell side is being explored using CFD simulation. In this geometry, the curve of each inner tube is generated by 3D sinusoidal equations, and the configuration can be specified by the number of bundles, number of tubes per bundle, twist pitch of the bundle and tube diameter. The influence of these parameters on the thermal-hydraulic performance has been investigated. Nusselt number and friction factor correlations have been developed based on Reynolds number and dimensionless geometrical parameters including the conduction shape factor. Compared with spiral wound heat exchangers and staggered stacked slotted plate heat exchangers, the increase of both Nusselt number and friction factor is obvious. The tortuous flow path is assumed to be the reason for the thermal enhancement, due to its promotion of bulk flow mixing and redistribution of energy. The design of the overall heat exchanger includes manufacturability considerations, and a model of the complete heat exchanger will be built to obtain its overall effectiveness.