Numerical Simulation of Heat Transfer Performance of Water: Ethylene Glycol Mixture (W:EG) Through Turbine-Like Decaying Flow Swirler

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Abstract The propeller-type swirler has been mentioned several times in the literature as one of the decaying flow swirlers designed to improve heat transfer performance while maintaining a low friction factor. However, the distance travelled by swirling flow varies according to the swirler's design configuration. As a result, the purpose of this paper is to investigate the heat transfer performance and friction factor of a new turbine-like decaying flow swirler (TDS). The distance traversed and decays downstream the tube by the created swirling flow will then be determined. The TDS is a rigid turbine or compressor consist of four twisted blades at 172.2° set at the entrance of a fully developed 1.5 m tube with a dimensionless length (L/D) of 93.75. A 60:40% water and ethylene glycol mixture was employed as a working fluid for the turbulent flow with Reynolds numbers ranging from 4583 to 35,000. The results indicate that the maximum relative heat transfer is 1.16 and the highest relative friction factor is 1.47 at the lowest Reynolds number tested. For Reynolds numbers less than and equal to 10,136, the thermal hydraulic performance achieved unity. The obtained relative heat transfer is deemed to be poor in comparison to several publications. The swirl flow finally entirely decays after L/D = 70.32 after being visualised through the vortex core and cross-sectional plane of the tube, contributing to a reduced heat transfer performance. In conclusion, TDS performance can be optimised for a lower dimensionless length using the same design configuration, or the design configuration should be modified to increase the generated swirl flow intensity.

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