Abstract

This work includes the description and testing an advance shell and tube design with "TWISTED TUBE", the tests were performed to evaluate the enhancements of the forced convective heat transfer and pressure drop at the tube inner surface. An experimental rig was constructed and instrumented to evaluate the enhancement of heat transfer and pressure drop at this surface. Air was used as working fluid, and steam was used as a heating source where constant wall temperature condition (128.5C°) was achieved. Experimental tests were conducted on two commercial "TWISTED TUBES" of trapezoidal shape having different hydraulic diameters (13 and 16mm) of different twisted pitches (440 and 178mm), respectively. To verify the results obtained by the experimental test rig with well-established data in literature, a conventional cylindrical tube of hydraulic diameter of (18 mm) was tested for turbulent flow with a range of Reynolds number of (10000- 24000). Heat transfer and pressure drop associated with flow were measured and presented in terms of average Nusselts number and friction factor. It was shown that the heat transfer was increased by 1.36 times the conventional cylindrical tube, while pressure drop recorded to increase by 1.65 times the conventional cylindrical tube. The degree of enhancement was a function of the Reynolds number where low level was recorded at high Reynolds number. It was found that the twisting increased level of mixing and promoted for a good turbulence level at low Reynolds number.

Thermal, hydrodynamic and flow pattern associated with the trapezoidal "TWISTED TUBE" were numerically studied using commercial code FLUENT13. Numerical results were compared with the experimental results where good agreements were obtained with a maximum deviation of 3.08% was recorded for heat transfer and pressure drop. The numerical study was extended

to test more roust "TWISTED TUBE" of elliptical shape to be used in advance shell and tube heat exchanger. The effects of geometrical parameters on the heat transfer and pressure drop were studied. Two aspect ratios of (0.3 and 0.5) with twisted ratios of (5, 10 and 15) were evaluated for the range of Reynolds number of (100 - 1000) for laminar flow and Reynolds number of (10000 - 20000) for turbulent flow. The results showed that high heat transfer and moderate pressure drop were obtained at low aspect ratio (0.3) and low twisted ratio (5) for both laminar and turbulent flows. The maximum enhancements of heat transfer (average Nusselts number) were (1.8-2.7) times the conventional cylindrical tube for aspect ratios of (0.5-0.3) and (2.7-2.4-2) times the conventional cylindrical tube for twisted ratios of (5-10-15) respectively. The maximum enhancement in heat transfer was obtained for the range of laminar flow where hydrodynamic flow pattern shows that the momentum of secondary flow induced by twisting is dominant over the momentum of axial or core flow which is the dominant in turbulent flow. The experimental and numerical results of heat transfer and pressure drop were gathered, well cast and presented in non-dimensional equations as function of Reynolds and geometrical parameters.