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CFD ANALYSIS AND COMPARISON OF VERTICAL RIBBED TUBE WITH SMOOTH TUBE

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ABSTRACT

Computational Fluid Dynamics (CFD) simulation of heat transfer and fluid flow analysis in the turbulent flow regime in a spirally ribbed tube and a smooth tube in vertical orientation are simulated in this project using ANSYS Fluent. The ribbed tube has outside diameter of 25mm, maximum inner diameter of 18.80mm, minimum inner diameter of 17.50mm and pitch varied from 2m to 0.25m. The smooth tube has outside diameter of 26.7mm and inner diameter of 18.88mm and helix angle of 60° . Both tubes were uniformly heated by passing an electrical current along the tube with a heated length of 1m. CFD meshing is carried out using ANSYS Meshing Platform.

The CFD simulation is performed on a vertical orientation of the steel tubes (rifled and smooth) under six different inlet velocities of 0.893m/s, 1.786m/s, 2.38m/s, 2.976m/s, 3.57m/s and 4.166m/s. The main objective of this thesis is to determine the heat transfer and pressure drop in both vertical smooth and ribbed tubes. The fluid used is water and the initial temperature is 25°C. The heat flux that for heating the tube is equal to 150KW/m². During the CFD simulation analysis it was found that for smooth tube at lower inlet velocity, the temperature increases from 298K(25°C) to 310.4K(37.4°C) while the pressure drop between inlet and outlet is equal to 598 Pa(0.00598bar). At higher inlet velocity, the temperature for smooth tube is found increasing from 298K (25°C) to 301.53K (28.53°C), with the pressure drop is equal to 7368.1 Pa (0.073681bar). Smooth tubes results are validated again analytical calculation; it is agreed well with analytical results. For the ribbed tube at lower inlet velocity the temperature is increasing from 298K (25°C) to 313.5K (40.5°C), with the pressure drop is found to be 622.1 Pa (0.006221bar) for 0.25m pitch. In the case of a higher inlet velocity, the temperature increase in ribbed tube is increasing from 298K (25°C) to 304.5K (31.5°C), while the pressure drop is equal to 8087.1 Pa (0.080871bar). This result indicates that the ribbed tube has higher heat transfer efficiency than the smooth tube. The pressure drop in the ribbed tube is found to be higher than that of the smooth tube. This clearly shows that the characteristic of ribbed tube is much better than smooth tube. Thus the ribbed tube is able to enhance the heats transfer capability for fluid flow in the tube.