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CFD ANALYSIS OF TUBE IN TUBE HEAT EXCHANGER WITH FINS

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Abstract-*The present study reports the heat transfer enhancement in a heat exchanger tube by installing fins on the outer surface of hot water tube. Design process for heat exchanger and insert has been carried out in AUTODESK INVENTOR, fluid domain is formed in ANSYS workbench, followed by meshing in default mesh tool of ANSYS. Boundary conditions were defining with appropriate material property in fluent software. After finding the solution the results are compared between the two designs for counter flow. According to results, it concluded that in case of fin is used, effectiveness also increases. The reason behind maximum effectiveness was that due to use of fins, turbulence was increased as they allow more mixing of fluid layers and resulted in increase of heat transfer through the heat exchanger tube.*

Key Words: Heat Exchanger Tube, Turbulent Flow, CFD, Fluent, Simulation, Turbulence

1.INTRODUCTION

Heat exchanger is a device to facilitate to exchange heat between two fluids without mixing at different temperature. In heat exchanger two modes of heat transfer occurs such as convection and conduction. Usually convection occurs in both working fluids and conduction through walls of heat exchanger which separates the fluids. Heat exchangers are used in a wide range of engineering applications, such as HVAC, aerospace industry and power generation. The main purpose of a heat exchanger is to efficiently transfer the heat from one fluid to the other. The performance of heat exchanger can be improved by improving the heat transfer between the heat exchanger fluids. There are so many ways to increase the heat transfer which include treated surfaces, rough surfaces, extended surfaces, surface vibration, and fluid vibration. The use of fins are recognized as one of the most effective means of increasing the heat dissipated. The objective of this study was to find out optimum type of fin arrangement used for maximum heat transfer rate. Experiments were conducted by varying the pitch. This task was performed by using CFD as a tool. CFD is a modeling technique that breaks down the governing equations (continuity, momentum and energy) for fluid flow into simpler forms that can be solved using numerical techniques. The mathematical resolution of the governing equations is still not fully resolved. CFD must then circumvent this by using models to approximate some components of the flow. This data acquiring from the different analysis is checked and choose the most effective way to increase heat transfer.

2.PROBLEM SETUP AND MODELING

In this 3 dimensional CFD study analysis was done for double tubes with constant depth and varying pitch length. Figure 1 shows geometry of tube in tube with 50,75,100mm pitch length respectively. The inlet tube material is aluminium and inner tube is steel. The commercial CFD software employs a control volume based technique to convert the governing equations which are solved numerically using the implicit method. The tube geometry details and operating conditions are given below. Mesh generation plays an important role in obtaining accurate results. Quadrilateral, tetrahedral, hexagonal, mesh was created uniformly throughout the area and analyzed using FLUENT, ANSYS 14.5 package.

Number of revolutions : 12,8,6

Height of fin : 4mm

Width of fins: 2mm

Length of pitch : 50,75,100mm

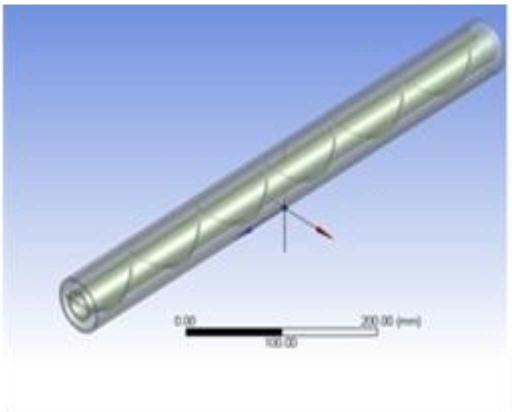

Figure1

3.SIMULATION OF THERMAL FLOW

3.1 BOUNDARY CONDITION

The flow and thermal variables are defined by the following boundary conditions.

Inlet hot water temperature: 355K

Inlet cold water temperature: 307.4K

Inner inlet velocity: 0 .042147m/s

Outer inlet velocity: 0.0173m/s

The solution convergence is obtained by monitoring the continuity, momentum, energy, equations. Figure 2, 3 and 4 represent the temperature variation inside the tubes. The temperature distribution inside the tube is affected by the pitch length.

4.RESULT AND DISCUSSION

CFD computations were done for three different pitch length of fin. Performance parameters adopted for comparison are outlet temperature of water, heat transfer rate, effectiveness and LMTD in the three cases. From the calculation it is clear that temperature drop higher for fins with higher pitch length. Following figures shows the temperature contours of different pitch length.

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Table-1

Pitch length ,mm		50	75	100
Hot water flow rate ,Kg/s	m_h	.0213178	.0213178	.0213178
Cold water flow rate, Kg/s	m_c	.0213178	.0213178	.0213178
Temp of cold water , ° c	Inlet, T_{ci}	34.5	34.5	34.5
	Outlet,T_{co}	41.37	41.08	41.38
Temp of hot water , ° c	Inlet,T_{hi}	82	82	82
	Outlet,T_{ho}	72.44	73.43	73.74
LMTD		39.27	39.92	40.97
Overall heat transfer coefficient	U_o	425.53	385.98	375.85
Effectiveness	ε	.2013	.18	.173

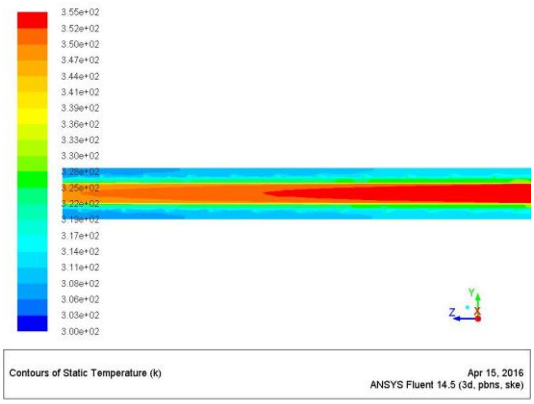

Figure-2: Temperature contour of 50mm pitch length

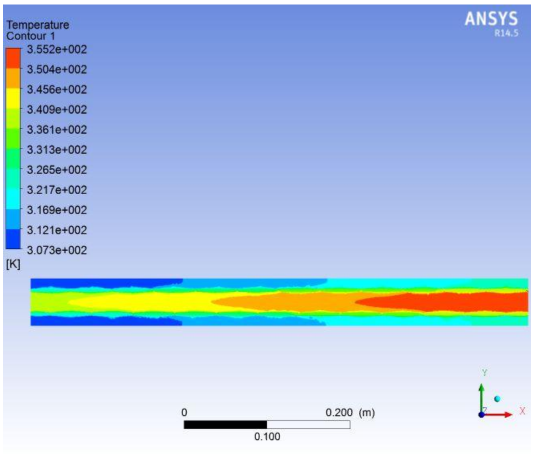

Figure-3: Temperature contour of 75mm pitch length

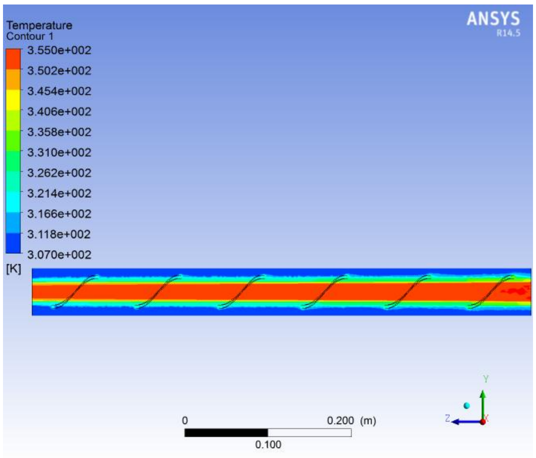

Figure-4: Temperature contour of 100mmpitch length

5.CONCLUSIONS

In the present work CFD analysis for a tube in tube heat exchangers with fins of different pitch length was carried out under operating conditions. Effectiveness of heat exchanger with 100 mm pitch is higher than that of others. As pitch length increases with constant depth effectiveness of the heat exchanger also increases.

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