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ANALYSIS OF HEAT TRANSFER THROUGH EXTERNAL FINS USING CFD TOOL

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Abstract-The rate of heat transfer of a fluid flowing in a closed enclosure can be increased with the modification in the external enclosure. One of the approaches is by the use of External fins. The present work, the vertical tubes carrying fluids by providing helical fins and checks its impact when subjected to natural convection heat transfer. All the main parameters which can significantly influence the heat transfer performance of finned tube has been analyzed. Natural convection in a vertical tube without fins was taken as the reference tube and different internal fin patterns such as a single fin with large no. of turns like coiled shape and large no. of fins with single turn is compared with reference tube on the basis of different parameters such as heat transfer rate, surface nusselt number, heat transfer coefficient, fin effectiveness etc. After getting best fin configuration compared it with a fin profile of rectangular cross section. All the computer simulation has been done on the ANSYS 13.0. Aluminium is used for the fin material and air is taken as the fluid flowing inside the tube and the flow is taken as laminar. It was found that the large number of fins with single turn is more efficient than other fin patterns, as there is less flow resistance, high heat transfer rate.

Keywords- External helical fins, heat transfer rate ,naiver stoke.

I. INTRODUCTION

The process which involves mass movement of fluids is called convection. The convection which occurs due to temperature difference which produces the density difference which results in mass movement, this process is called natural or free convection. The need of heat transfer enhancement is to reduce the size and cost of heat exchanger equipment, or increase the heat duty for a give size heat exchanger. This goal can be achieve in two ways active and passive enhancement. The active enhancement is less common because it requires addition of external power (e.g., an electromagnetic field) to cause a desired flow modification. In the passive enhancement, it consists of alteration to the heat transfer surface or incorporation of a device whose presence results in a flow field modification. The most popular enhancement is the fin.

To enhance the rate of heat transfer dissipation from heated surfaces to air fins used which are the extended surfaces which can be placed on plane surfaces, tubes, or other geometries. These surfaces have been used to increase heat transfer rate by adding additional surface area and encouraging mixing. When number of fins are used to enhance heat transfer under natural convection conditions the optimum geometry of fins (corresponding to a maximum rate of heat transfer) should be used, provided this is compatible with available space and financial limitations. The common fins used extensively to increase the rates of natural convection heat transfer from systems are rectangular fins because such fins are simple and cheap, to manufacture. The heat transfer to the fluid flowing through a cylindrical pipe by the heat dissipating surfaces can be obtained mainly by using the mechanisms of heat transfer by forced convection, natural convection and by radiation heat transfer. This work is concerned with those issues related to the heat transfer obtained mainly by natural convection. Convection heat transfer in External fins has been for several geometries in literature. The theoretical and analytical investigations were

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performed for smooth and finned-tube in order to find the optimum geometric parameters for achieving maximum Nusselt number and heat transfer rate.

Bahadori et al.[1]attempted to formulate a novel and simple-to-use correlation for the prediction of efficiencies for uniform thickness finned tubular sections as well as fin tip temperature for wide range of conditions(covering finned pipe diameter to pipe diameter ratios of up to 3).Secondly, another simple correlation was developed to approximate external convection heat transfer coefficients for nominal pipe size(NPS)steel pipes of 75,100,and150 mm arrange in staggered rows surrounded by combustion gases for temperature up to 600^0C and gas mass flow rates of up to 3kg/m^2 s.Naphon et al.[3] studied the thermal performance and pressure drop of the helical-coil heat exchanger with and without helical crimped fins are studied. The heat exchanger consisted of a shell and helically coiled tube unit with two different coil diameters. Each coil was fabricated by bending a 9.50 mm diameter straight copper tube into a helical-coil tube of thirteen turns. Cold and hot water are used as working fluids in shell side and tube side, respectively. The experiments were done at the cold and hot water mass flow rates ranging between 0.10 and 0.22 kg/s, and between 0.02 and 0.12 kg/s, respectively. The inlet temperatures of cold and hot water were between 15 and 25 °C, and between 35 and 45 °C, respectively. The cold water was entering the heat exchanger at the outer channel flows across the helical tube and flows out at the inner channel. The hot water entered the heat exchanger at the inner helical-coil tube and flows along the helical tube. The effects of the inlet conditions of both working fluids flowing through the test section on the heat transfer characteristics were discussed.

Description and working of External fins:

Natural convection in a vertical tube without fins was taken as the reference tube and different fin patterns such as a single fin with large no. of turns like coiled shape and large no. of fins with single turn is compared with reference tube on the basis of different parameters such as heat transfer rate, surface nusselt number, heat transfer coefficient, fin effectiveness etc. There are some dimensionless numbers which affect the natural convection such as Nusselt number which is the function of Reynolds number, grashof number and Prandlt number, Rayleigh number which is the product of grashoff and prandtl number. After getting best fin configuration compared it with a fin profile of rectangular cross section. All the computer simulation has been done on the ANSYS 13.0. Aluminium is used for the fin material and air is taken as the fluid flowing inside the tube and the flow is taken as laminar.Analysis has been done on two tubes of same dimensions but having different fin configuration or fin profile with same fin height.

Description of the Tubes:

Tube1: This tube is the plane vertical tube without fins.

Tube2: this tube is a vertical tube having a single helical fin of rectangular fin profile with large number of turns along the length.

Tube3: this tube is a vertical tube having ten helical fins of rectangular cross sectional area with single turn along the length.

Table 1: Data considered for different Fin configurations

Tube no.	Inner Diameter (mm)	Outer Diameter (mm)	Fin Profile	Fin Height (mm)	Fin Thickness (mm)
1.	200	220	Without fin	-	2

2.	200	220	One rectangular fin	6	2
3.	200	220	10 rectangular Fin	6	2

II. RESULTS AND DISCUSSION

The tube wall was maintained at a temperature of 300 K. The enclosure wall were maintained at 280 K ambient temperature. The tube upper surface and lower surface were also maintained at 300K.

Table 2: Materail Properties

Material: air (fluid)				
Property		**Units**	**Method**	**Value(s)**

Density		**kg/m3**	**boussinesq**	**1.54**
Cp (Specific Heat)		**j/kg-k**	**constant**	**1004.43**
Thermal Conductivity		**w/m-k**	**constant**	**0.0**
Viscosity		**kg/m-s**	**constant**	**1.649511e-05**
Molecular Weight		**kg/kgmol**	**constant**	**28.966**
Thermal Expansion Coefficient		**1/k**	**constant**	**0.0034**
Speed of Sound		**m/s**	**None**	**--**
Material: aluminum (solid)				
Property	**Units**	**Method**	**Value(s)**	
--				
Density	**kg/m3**	**constant**	**2719**	
Cp (Specific Heat)	**j/kg-k**	**constant**	**871**	
Thermal Conductivity	**w/m-k**	**constant**	**202.4**	

Following are the graphs that were obtained by simulation on ansys 13.0 for various fin configurations

Case 1: the tube wall has no fins

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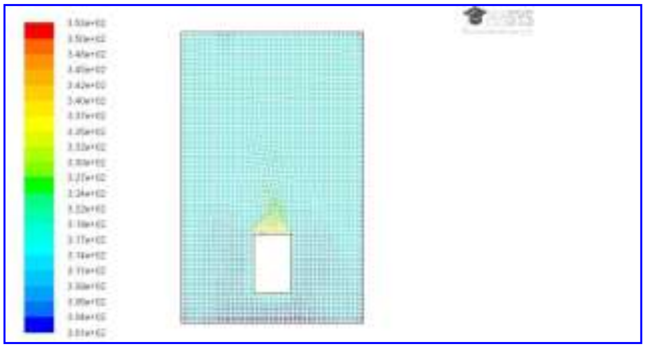
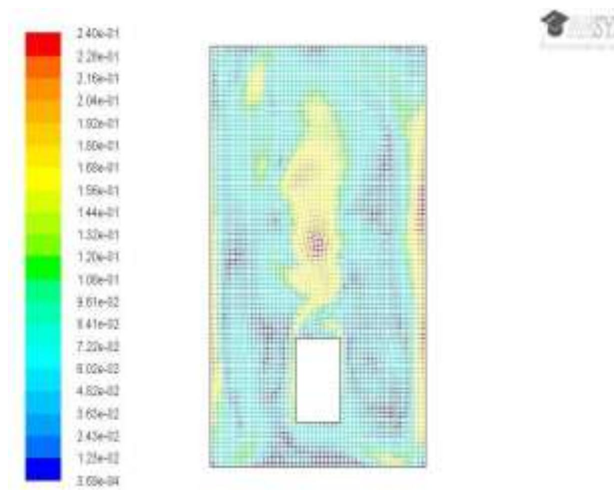
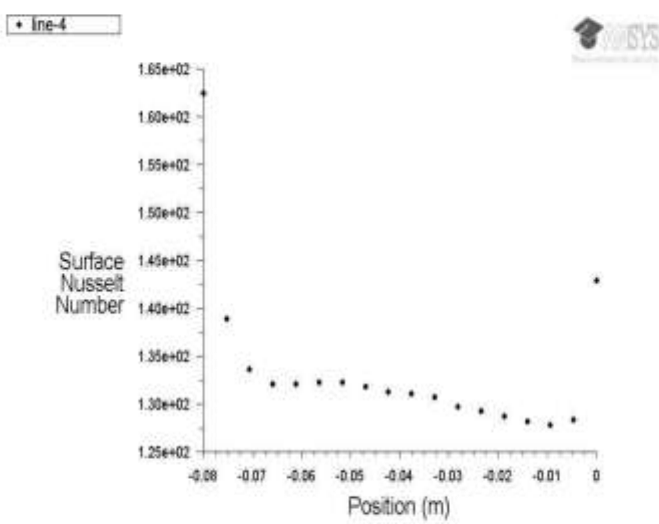
(A) Temperature contours



(B) Velocity vectors



(C) Nusselt number plot on the tube surface



Case 2: the tube wall has trapezoidal fins

(A) Temperature contours

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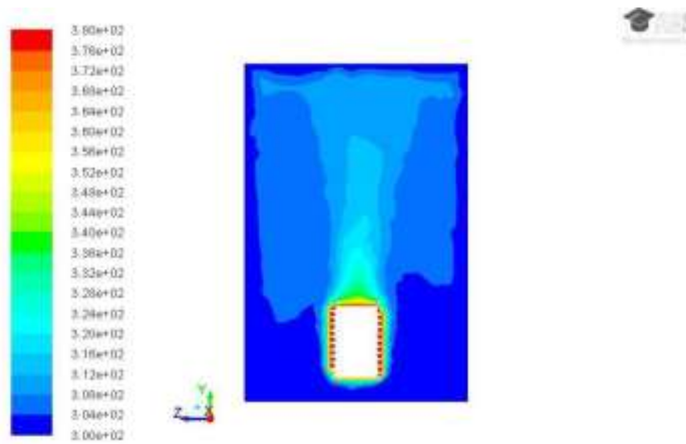
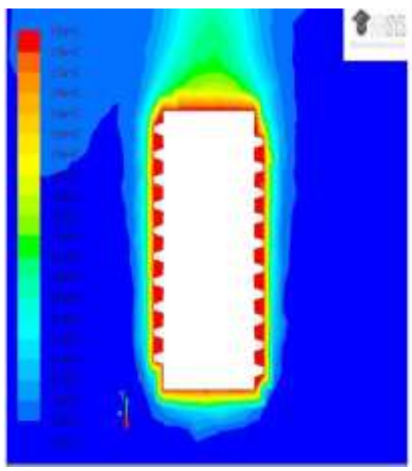


Here is the zoomed view of the temperature contours around the fins



Case 3: Tube with straight rectangular fins

(A) Temperature contours

SL NO		HEAT TRASFER RATE (W)
1.	No fins	wall1(side walls) 45.995014 wall2(top and bottom) 39.19244 Net 80.187454
2.	Trapezoidal fins	fins 47.6348 wall 42.270599 Net 89.905399
3.	Straight fins	fins 48.984829 wall 38.575317 Net 85.5601

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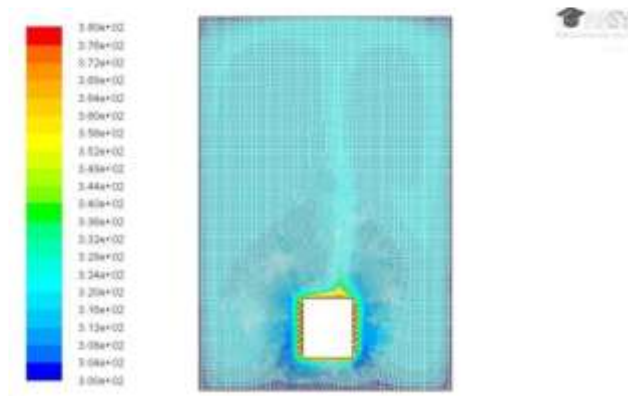
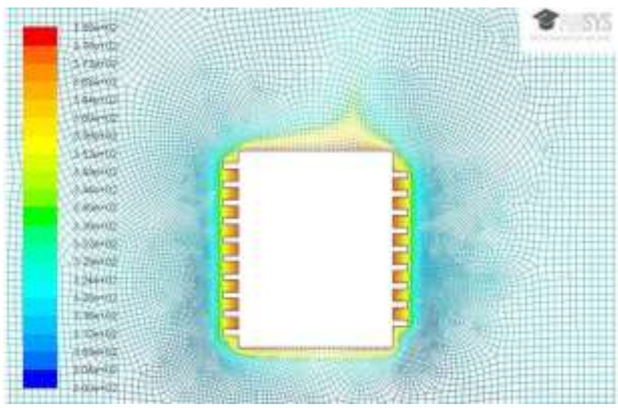
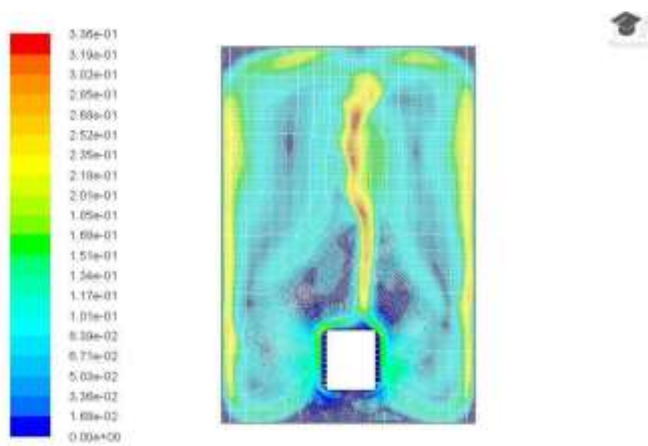


Here is the zoomed in view of the contours



(B) Velocity vectors



Total Heat Transfer

III. CONCLUSION

Heat transfer analysis on the External fins attached to the outside surface of the tube is studied.

- Based upon the results obtained by conclude that the fin geometry with trapezoidal profile fins are the most effective in increasing the heat transfer from the tube. The nusselt number values in this case were around 130-135, which is the highest The second case with the rectangular fins also increased the heat transfer rate but not to a large extent. The nusselt number values in this case were around 120-130. While in the case of tube with no fins the nusselt number values could reach upto

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only 110. Hence from the above anaylsis we can conclude that the to effectively increase the heat transfer rate in heat exchangers or air cooled condenser the profile of fins to be chosen should be trapezoidal.

- Hence the results showed that, for tubes having different fin configurations, the tube having ten equally spaced External helical fins is more effective as compared to the tube without fin and tube2 which has one helical External fin with large number of turns.

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