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CFD Analysis of Various Turbulent Parameters in a Radiator by Using Louvered Fins Geometry

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Abstract - Today's louvered fins are extensively used in automobile industry, air conditioner, condensers application etc. In this thesis work outcomes having simulation results and demonstrate that when changed the louvered angle and by changes inlet velocity, various parameters such as turbulent energy, heat transfer rate and turbulent dissipation varies significantly. This thesis performed by CFD (compressible fluid Dynamics) Solidworks software by that we have got the outcomes by taking 24 degree and 29 degree louvered fins of Aluminum material, taking 2-D analysis and taking inlet air velocity is taken between 4 m/s to 8 m/s with in interval of 1 m/s.it is found that when air velocity increases, turbulence increase and due to that turbulent energy increases .it is again found that when air velocity increases heat transfer is also increases for both 24 degree and 29 degree louvered angle. Among this 29 degree gives good results.

Keywords:-CFD, Heat transfer rate, Turbulent dissipation, Turbulent energy, Louvered fins, Solidworks

1. INTRODUCTION

Fins: - fins are the continued surfaces that are used to increase for heat transfer rate. It is used in heat exchangers. In past simple rectangular fins are used but in present days different kind of fins are used such as but most widely used fins in order to increase rate of heat transfer are louvered fins. It is used most widely used for transfer of heat in automotive sector in Radiator. Fins is differentiated in terms of effectiveness, compact in size, low in cost, low in weight etc. from many years heat exchangers is extensively used throughout the world. Current scenario in India peoples are mostly engaged along the development and improvement for small plate fin heat exchangers in various usages such as in aerospace and cryogenic applications. Louvered fin have vast application in automobiles radiators, oil coolers, condensers etc. it have special use in automobile industry.

1.1 Terminology:

a) Louver Angle: In the figure 1.3, "α" shows the louver angle. Louver angle is artificial arrangements for producing of eddy formation that produces turbulence so that is responsible for breaking of the boundary layer and increase the heat transfer related phenomena.

b) Louver Pitch: In the figure 1.3 "Lp" shows the louver pitch. This is the separation between final ends of one louver to final end of adjacent louver. In my work I have taken 34 mm louver pitch.

c) Fin Thickness: In my work I have taken the fin thickness is 0.2 mm. It is shown by "t".

d) Total Fin Length: in this work F_d shows the total fin length. In my work I have taken 306 mm.

Stages:-
Basically, Solid works involved three main stages that have to be considered which include –

(a) Pre- processing

(b) Solving

(c) Post- processing.

Pre-processing
Design Modular:

Open the work bench solidworks there will be a design modular in which geometry can be drawn. In this figure 2 Dimensional louvered fins are taken and fin is taken 306 mm length. Louvered angle is taken 24 degree and there are 10 louvered fins out of which first five fins are 24 degree leftward and remaining five are 24 degree rightward. Then draw a fluid domain. Take all the fins as solid.

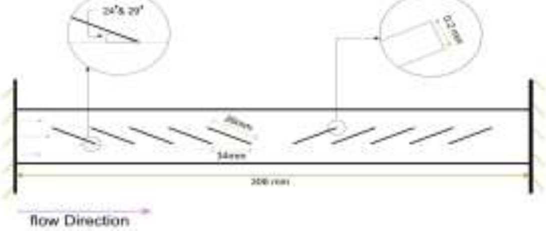

Fig.1 cross sectional view of louvered fins at angle

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Fig.2- 24 Degree Louvered Fin in Design Modular

1.2 Meshing:

After completing the desired shape mesh is generated for fin &fluid volume using solidworks. Select tetrahedral mesh with fine meshing and naming the all boundaries of fins. Programme controlled inflation chosen. Fin mesh is shown the following figure.

Fig.3: Mesh Generation

2. Boundary Conditions:

After meshing, 'solving' is the next stage in which we put the boundary conditions first. There are the boundary conditions in following tables –

Table -1: Shows Boundary Condition

Description	***Condition***
Air Inlet	u = 4 to 8 m/s
Temperature of Air	20 °C
Inlet Pressure	450 pa gauge
Air Outlet Temperature	solved by solver
Air Outlet Pressure	solved by solver
Fin wall Temperature	80 °C
Tube wall Temperature	80 °C
Other fin surfaces	calculated by solver
Air surfaces temperatures	calculated by solver

2.2 SETUP AND SOLUTION

In this work we have taken 10 louvered fins and made an analysis in Solid works Simulation and got simulations results. We have made two geometries of 24^0 louvered angles and 29^0 louvered angles made a comparison between these two.

Table No. - 2 Shows Set-up Details

Name	***Details***
Software	Solid works Simulation
Solver type	Pressure based
Velocity formula	Absolute
Viscous model	K-e
Wall function	Standard
Material of Air chosen as	Fluid
Material of Fin chosen as	Aluminium
Cell zone condition for Air	Fluid
Cell zone condition for Fin	Solid
Solution initialization	Hybrid initialization

Table No. - 3 Properties of the fins and air flow:

	Density (kg/m^3)	**Specific heat (J/kg-K)**	**Thermal conductivity (W/m-K)**	**Dynamic viscosity (kg/m-s)**
Air	1.23	1006.43	0.0242	$1.7894e^{-5}$
Fins	3600	765	36	-

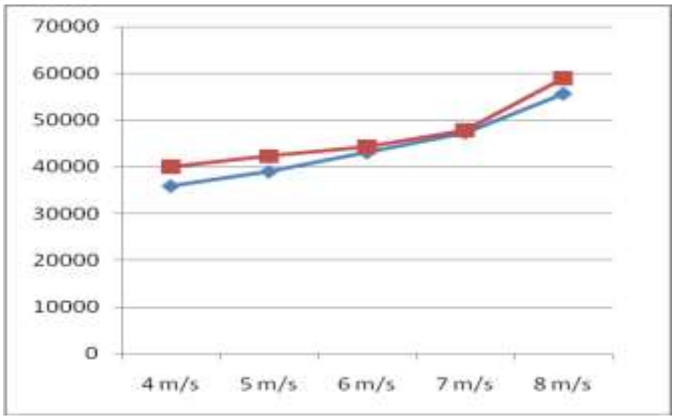
The solution is initialized with hybrid initialization & solution is run with 195 iterations.

2.3 Heat Transfer Rate:-

Table No.4 The Result of Heat Transfer of 24 degree and 29 degree louvered fins

Inlet velocity(m/s)	**Rate of Heat Transfer (Watt)**	
	24°	**29°**
4 m/s	35866	40003
5 m/s	38938	42272
6 m/s	43009	44377
7 m/s	47235	47843
8 m/s	55598	59006

graph.1 Comparison of Heat Transfer rate for 24 degree and 29 degree louvered angle fins

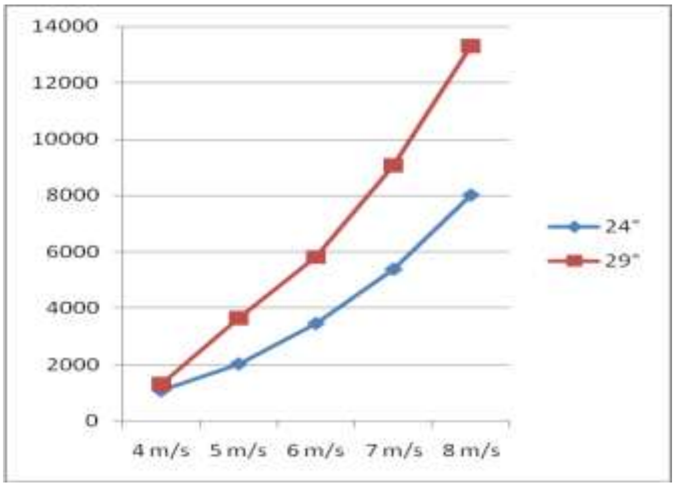


Heat transfer rate is continuously increasing with increasing louvered angle for both 24 degree and 29 degree but after reaching certain angle it start decreasing.

2.4 Turbulent dissipation:

Table No.5 The Result of Turbulent dissipation of 24 degree and 29 degree louvered fins

Inlet velocity(m/s)	Range of turbulent dissipation (w/kg)	
	24° Louvered Angle	29° Louvered Angle
4 m/s	1072.27	1312.03
5 m/s	2020.76	3664.83
6 m/s	3458.95	5824.8
7 m/s	5385.5	9078.15
8 m/s	8019.51	13311.7



Graph .2 Comparison of Turbulent dissipation for 24 degree and 29 degree louvered angle fins

3. CONCLUSIONS

1) For constant louver angle, as the input flow velocity increases, the value of heat transfer rate increase continuously.
2) For constant louver angle, as the input flow velocity increases, the value of turbulent energy increases continuously from 4 m/s to 8 m/s.
3) For constant louver angle, as the flow velocity increases turbulent dissipation rate as the flow velocity increases increased continuously.

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