Simulation of Heat Transfer Improvement Using Artificial Rib Roughness In Solar Air Heater

Vennela Lavanya[1] , U. Jyothirmai[2]
Department of Mechanical Engineering
[1]Student, D.J.R College of Engineering and Technology
[2]Assistant Professor, D.J.R College of Engineering and Technology

Abstract- *There are many ways to improve heat transfer in the solar air heater there are many Valid practices around the world out of them optimizing the rib structure is the most popular and valid theory From years researches from around the world artery to gain the most optimized artificial rib shape in the project In the extension of the Ravi kumar et al I have analyzed the Different Shapes like Oval Semi Oval and Chamfered Rib to Investigate Flow Pattern And temperature Gain at the Outlet The Validation From the Ravi kumar et al is done on the rectangular Ribs successfully to exhibit the skills and gain confidence in our Results out of the three shapes discussed above The simulation is done For Reynolds numbers equal to 3000,6000,9000,12000 to also observe how the Heat transfer is happening if the Velocity Increases Results of all the Cases including outlet Temperature is submitted in the Thesis.*

Keywords- Artificial Roughness , Turbulence , Solar air Heater , Heat transfer , Reynolds Number

I. INTRODUCTION

There is every possibility of the shortage of energy in the near future out of conventional practices of energy generation or convective heat transfer there are many possibilities that one can use by looking upto solar air heater for heating the air in many applications there are many types of heating sources which might produce the better heat transfer but one with the better performance might not have the economical ethics to follow through to the realistic application therefore the solar energy is far more useful in producing heat transfer than the producing energy there are many types of applications which need heat transfer like convection conduction and radiation with which includes the economy there are many types of common practices which might improve the efficiency of an heat transfer system there is a concept of extended fins which might be evolved over the years to produce the heat transfer between solids and fluids for this type of heat transfer the common practice is to use the rib or fin shaped surfaces which can produce the turbulence for the better heat transfer efficiency.

The basic working principle of solar air heater is it takes the heat from the sun absorbed through the glass cover and an insulation as given in figure 1.1 the artificial roughness of the plate has generated with different kind of friction factor the roughness has the effect on flow where the turbulence has the effect of heat transfer with which the heat transfer is effectively considered.

II. LITERATURE REVIEW

There are many instances where the different authors from the different countries and Different authors have already researched about many different criteria's of the well known parametric and experimental studies

Prasad et al & Saini et.al [1] The Turbulent flow study on the solar air heater with the duct in an asymmetry shape was provided with the shape of protruded wires where the collector plate the main intention of this study is to find out the deviation in the friction factor correlations [2] have studied the heat transfer parameters of the duct rectangular duct experimentally with the provided geometrical shapes of square rectangle and semicircular shapes the direction of flow is arranged with respect to the transverse direction to the absorber plate Gupta et al. [3] conducted this calculation and experimentation to find out the characteristics of the flow and heat transfer where the fluid flow domain is a rough or turbulent flow domain in this the authors also calculated the heat transfer efficiency for the different aspect ratios varies from 6.8 to 11.5 with the roughness height increase in 0.018 to 0.052 Stranton number is find [4] conducted this calculation and experimentation to find out the characteristics of the flow and heat transfer with the roughened rectangular duct and the authors also Investigated artificially maintained roughness characteristics and how these characteristic affect the heat transfer rate Karwa et al. [5] conducted this calculation and experimentation to find out the characteristics of the flow and heat transfer with the roughened rectangular duct. The duct ratio modified from 4.8 - 12.0 and the Re was varied from 3000-20000. e/Dh range was 0.0141 - 0.0328, p/e range was 4.5-8.5.Vermaet al and Prasad et al [6] have studied the heat transfer parameters of the duct rectangular duct experimentally with the provided geometrical shapes of square rectangle and semicircular shapes the direction of flow is arranged with respect to the transverse direction to the absorber plate with the periodic repeats . Murata and Mochizuki [7] numerically considered the impact of calculated and transverse ribs on both laminar and turbulent stream in a solar air heater. The space was a rectangular channel warmed just on the best divider. Ahn [8] tentatively inspected on a rectangular channel, the impact of five diverse molded ribs on the warm and fluid stream attributes of turbulent stream (completely created). The channel viewpoint proportion was 2.33 and was steady warmth motion was provided just at the best face of the test area of the pipe. Momin et al. [9] led investigates an angular ribbed solar air heater to think about its warmth exchange and friction properties. The shifted Reynolds number was from 2500 to 18000, point of stream assault from 30 to 90o and relative harshness tallness (e/Dh) from 0.02 to 0.034. The pitch of the game plan was kept settled at 10 Chandra et al. [10] tentatively examined friction and surface warmth exchange execution of turbulent stream of air in a channel of square cross-segment gave transverse ribs on four, three, two and one

III. METHODOLOGY

The current work presented in this thesis is related to the artificaial rib roughness of the solar air heater duct the approach in the project taken as the 2d formulation of the model given from the structure of the turbulence modelling problem.

3.1 Computational Domain

Like every Cfd problem the simplified approach of solving any problem is considered as below

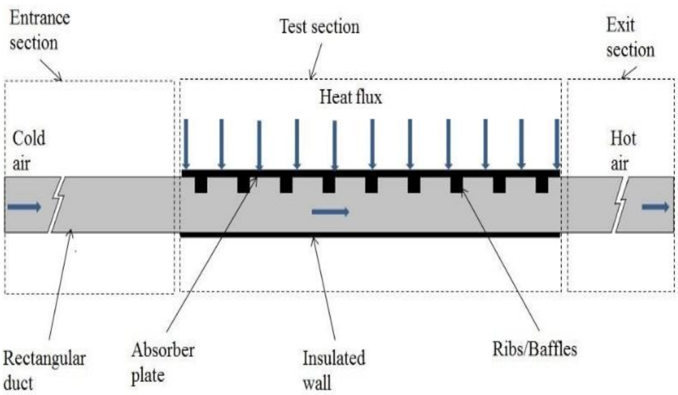


Figure 1 Computational Domain of the Test section

The Current Project is done on the roughness faces like oval semi oval and inclined tib surface where The simulation is done for all the three cases to compare and present the results on finding the best shape of roughness to project and predict the better heat transfer surface.

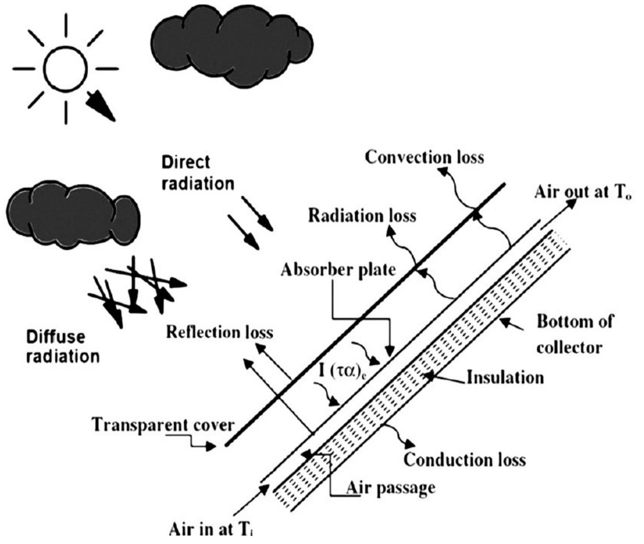
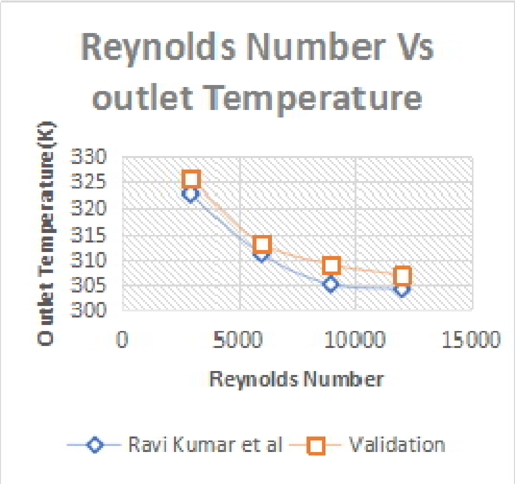


Figure 2 Solar air heater Layout.

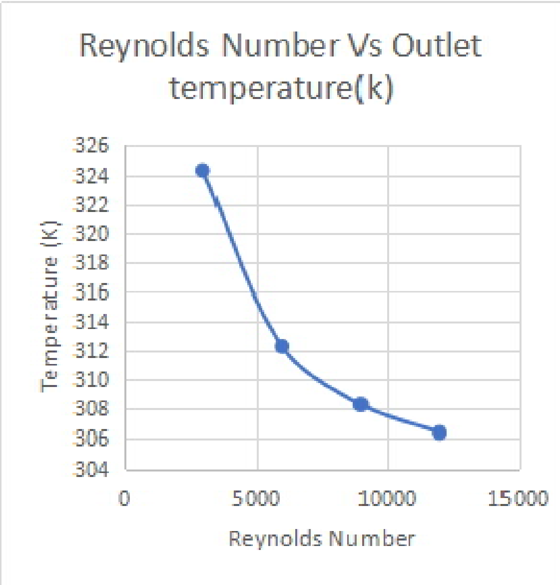
In the Figure 1 where the schematic of the solar air heater is explained . where you can observe an absorber plate with which the radiation loss convective heat transfer which is directly transferred to the air from the solar irradiation from the inlet Ti to the outlet To which also consists of the insulation and collector. The General absorber plat is a flat surface with the materials like Tedlar , paladin and polyester which is commonly used in aerospace industry and weight effective.

IV. RESULTS & DISCUSSIONS

The Results obtained below are undertaken to consideration from the base paper of Ravi Kumar et al. a thorough investigation of results have done to match the results obtained from the paper
Validation



Plot 1 Validation of the Values obtained from the Base paper Ravi Kumar et.al



Plot 2 oval Rib Reynolds Number Vs outlet Temperature (k) Case Semi oval

Iv Re=12000

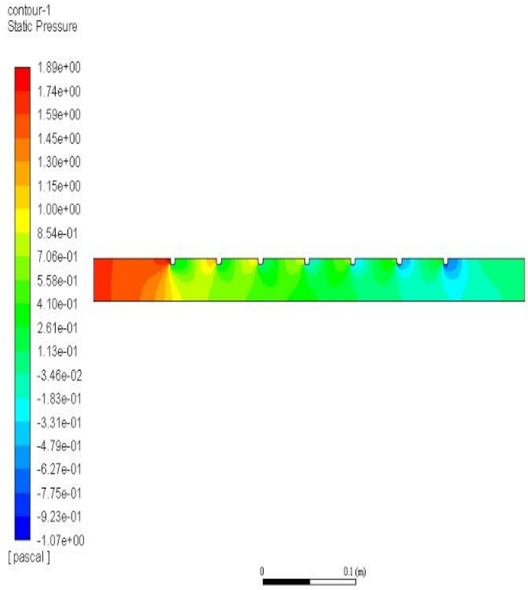


Figure 3 Contours of Pressure with Re=12000 Semi oval ribs

The fig 3 shows the Pressure distribution in the fluid domain with the Reynolds number Re=12000 where the color intensity represents the minimum blue and red as maximum from the legend at the left hand side of the picture where the maximum recorded pressure at the red colour area is 1.89 at the Red colored region in the inlet region rest of the domain represents the color indication on the legend each color represents the distribution between minimum and maximum

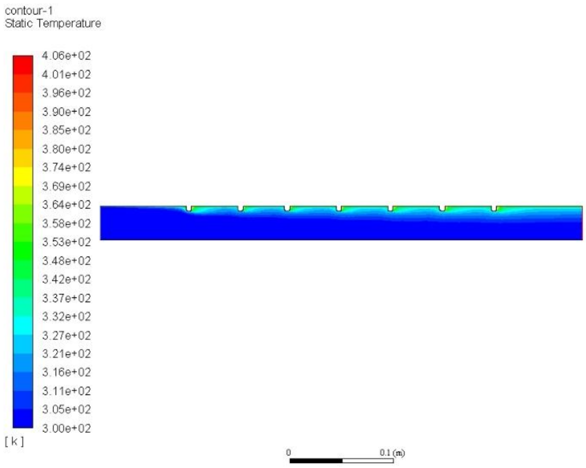


Figure 4 Contours of Static Temperature Re=12000 Semi oval ribs.

The fig 4 shows the Temperature distribution in the fluid domain with the Reynolds number Re=12000 where the color intensity represents the minimum blue and red as maximum from the legend at the left hand side of the picture where the maximum recorded Recorded at the red colour area is 406 K at the Red colored region in the Wall and Rib region rest of the domain represents the color indication on the legend each color represents the distribution between minimum and maximum

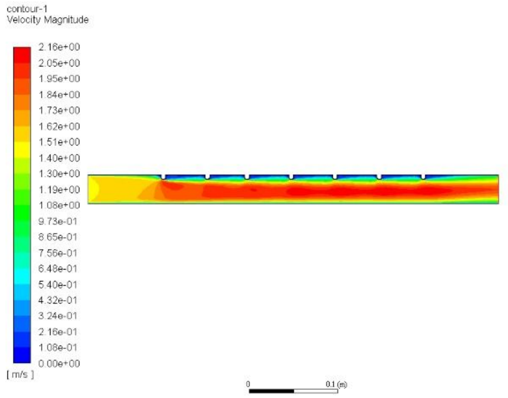
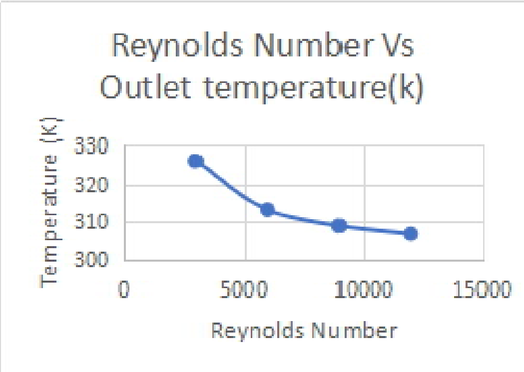


Figure 5 Contours of Static Pressure with re=12000 Semi oval ribs.

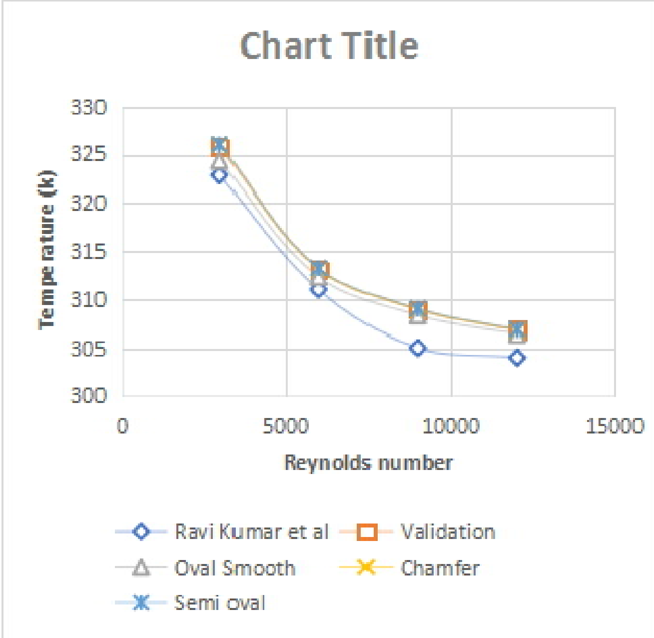
The fig 5 shows the Velocity of the Fluid From inlet to outlet in the fluid domain with the Reynolds number Re=12000 where the color intensity represents the minimum blue and red as maximum from the legend at the left hand side of the picture where the maximum recorded Velocity at the red colour area is 2.16 m/s at the Red colored region in the inlet region rest of the domain represents the color indication on the legend each color represents the distribution between minimum and maximum



Plot 3 Semi oval Rib Reynolds Number Vs outlet Temperature (k)

V. CONCLUSION

The Simulation of the Solar air heater absorber plate heat transfer by using artificial roughness with Chamfered oval and semi Oval ribs causing turbulence will form the highest heat transfer .



Plot 4 Comparison of the artificial Rib roughness geometry.

REFERENCES

[1] Prasad et al and saini et al Thermal performance of artificially roughened solar air heater, SE. Issue 47 volume 2 Pages From 91-96.
[2] T.M. Liou et al & J. J. Hwang 1993 IJHMT Issue 36 Vol 4 Pages from 931 to 940.
[3] D.Gupta et al & SolankiS.C et al 1993 SE Issue 51 vol 1 Pages From 31 to 37.
[4] Saini R.P et al & Saini J.S et al 1997 IJHMT issue 40 Vol 4 pages from 973 to 986.
[5] Karwa R. et, al & Solanki S. C. & Saini, J. S. et al 1999 IJHMT Issue 42 Vol 9 pages from 1597to 1615
[6] Verma S. K. et al & Prasad B.N. et al 2000, RE Issue 20 Vol 1 Pages From 19 to 36.
[7] Murata A.et.al & Mochizuki S et al 2001 IJHMT Issue 44 Vol 6 From pages 1127 to 1141.
[8] Ahn S et al 2001 ICHMT Issue 28 Vol 7 Pages from 933 to 942.
[9] Momin A.M.E et al & Saini J.S & Solanki S. C et al 2002 IJHMT Issue 45 Vol 16 Pages 3383-3396
[10] Chandra P. R., et al & Alexander C.R. et al & Han et al 2003 IJHMT Issue 46 Vol 3 Pages From 481 to 495.
[11] G. Tanda et al 2004 IJHMT Issue 47 Vol 2 Pages from 229 to 243
[12] Sahu et al Bhagoria et al 2005 RE Issue 30 Vol 13 Pages From 2057 to 20173