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Heat Transfer Analysis of a Radiatively Participating In a Channel Flow

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Abstract

The main aim of this project is to investigate heat transfer by radiation and convention simultaneously in a channel flowof solar flat plate collector.The effect of radiation on the heat transferis determined. The parameters thickness of plate 5mm, 10mm, the time zones 8.55AM, 1.55PM on a certain day of summer season are considered and compared for the heat transfer.3D models of the flat plate collector are done in Creo 2.0. CFD and thermal analysis is done in Ansys to determine radiation heat transfer, heat flux.

I. Introduction

Radiation is that the method by that energy is emitted as either particles or waves. Broadly, it will take the shape of sound, heat, or light. However, the majority typically use it to see radiation from electromagnetic waves, ranging from radio waves, tho' the visible radiation spectrum, and up through to gamma waves.

Solar Water Heating

Solar water heaters use 2 natural phenomena to work: rises hot water since heat is absorbed by dark-coloured objects. Technology has currently made it attainable so that these phenomena is harnesses so that a reliable supply of hot water in our houses is produced.

II. Literature Survey

In the paper byDeodatMakhanlall, PeixueJiang[1],to assess the losses in channel flows with combined convection and radiation heat transfer, the fictional head loss parameter is done during this study. A 3D turbulent channel flow is applied to the analysis and identifies the important locations within the flow domain wherever the losses are focused. The influence of Boltzmann no. is mentioned, and also the best geometry of channel for flows with combined heat transfer modes is additionally determined.In the paper byndzanabenoit [2], investigates heat transfer by convection and radiation simultaneously during a channel flow between 2 infinite black parallel plates. The impact of radiation on the heat transfer and therefore the full thermal development of the flow is studied. The impact of parameter of conduction-radiation, scattering albedo, and therefore the optical thickness are determined. The radiation is shown to well alter the heat transfer downstream before the fully thermally developed conditions. For constant wall temperature case, the full thermal development is shown to be existed, while it's pushed downstream further and will not be seen for the constant wall heat flux case. While the radiation affects greatly the heat transfer once the fluid is heated, for the cooling case radiation impact decreases on the stream wise direction and vanishes at the fully developed conditions.

III. 3D Modeling of Solar Flat Plate Collector

http://www.alternative-energy-tutorials.com/solar-hot-water/flat-plate-collector.html

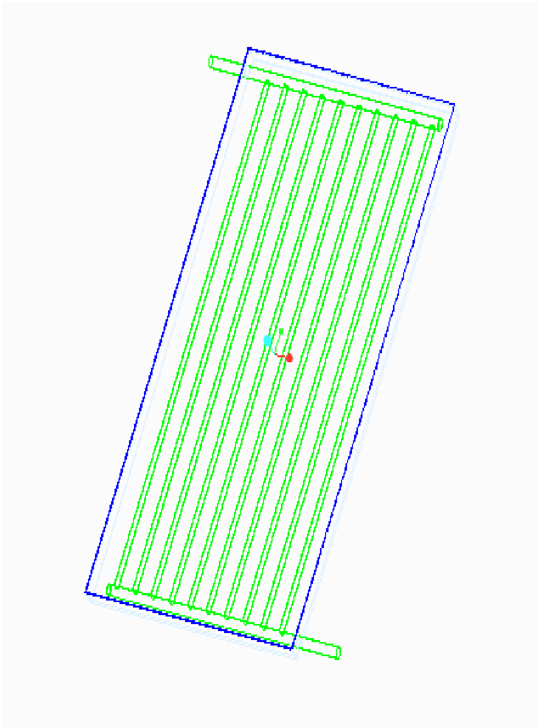

Fig.1. final assembly of the plate, tubes and insulation body

Boundary Conditions

Taking the radiation plates, which are exposing to the sun radiation and the plates are transferring energy to the pipe which converts cold water to the hot water.In our project, we are taking the radiation in summer season in India, dated APRIL 25th at 8:55 AM and 1:55PM. Temperature at morning is around 30 to 33^{0}c and afternoon is near to 45^{0}C, Time zone for Kharimnagar is latitude – 18^{0} 48^{1} and longitude – 79^{0} 06^{1}, For insulation – the material is glass epoxy.

IV. Radiation Analysis of A Channel Flow In A Solar Flat Plate Collector

Thickness of Plate – 10mm

TIME - APRIL 25th, 1:55 PM

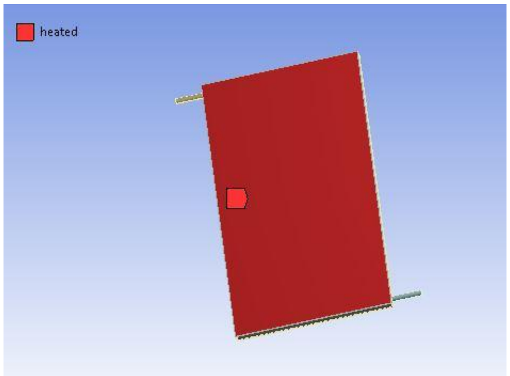

Fig.2. Heated region

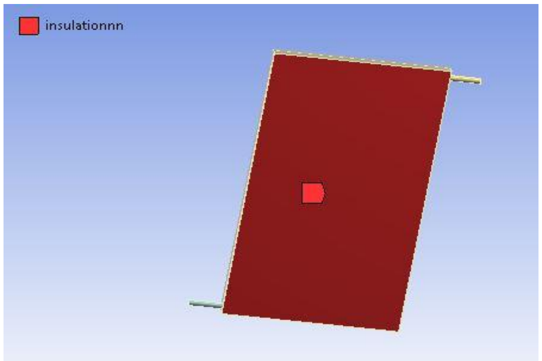

Fig.3.Insulation

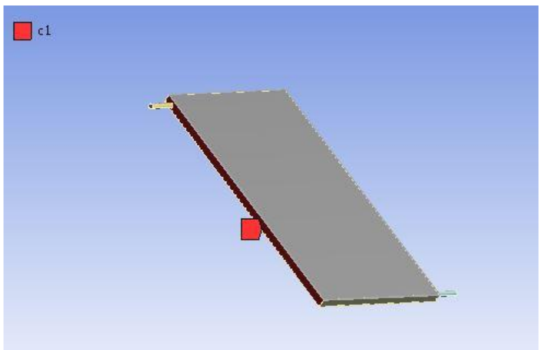

Fig.4. Convection side 1

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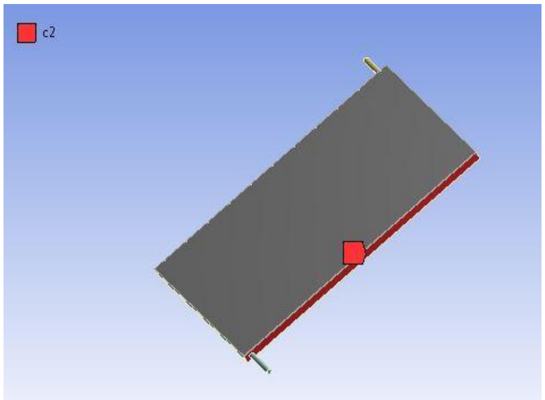

Fig.5. Convection side 2

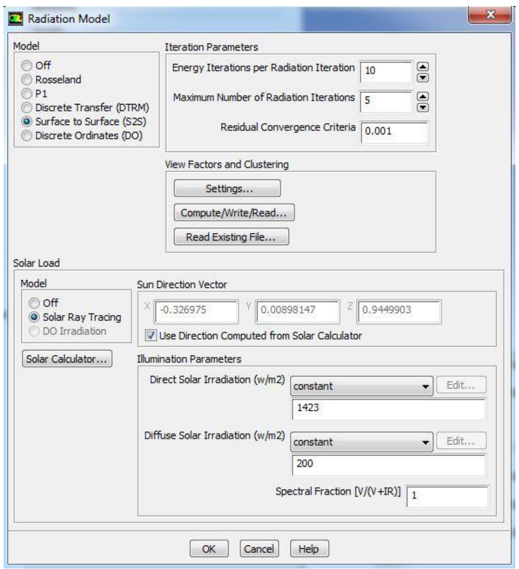

Fig.6. Selection of solar ray tracking and parameter values

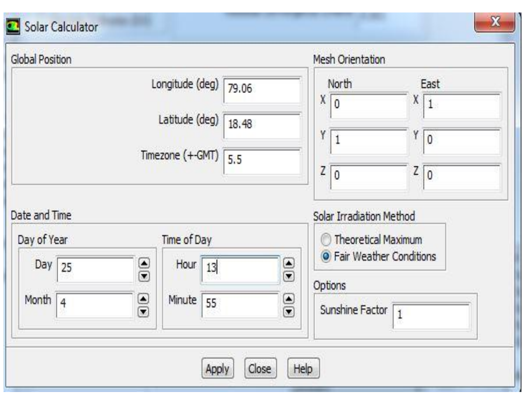

Fig.7. Solar calculator along with time, date and time zone

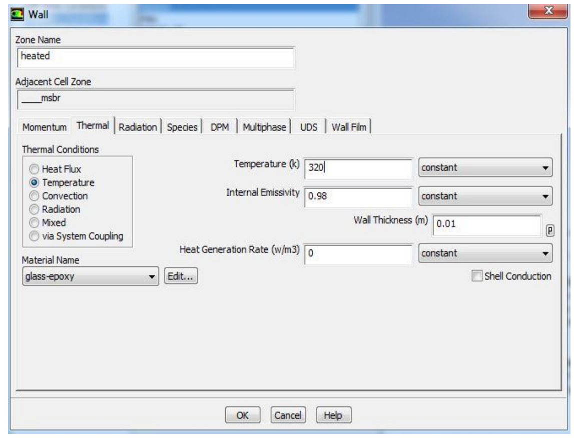

Fig.8. Temperature acted on solar plate

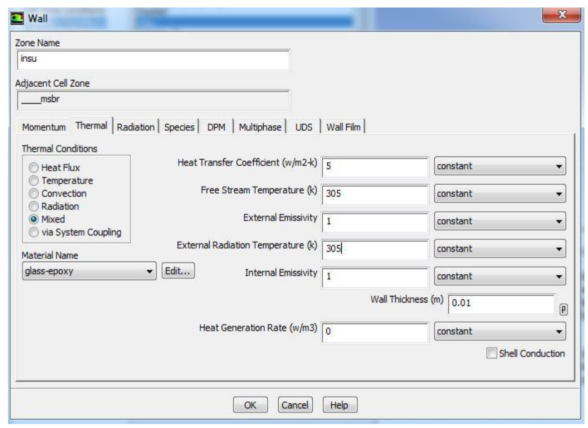

Fig.9. Insulation conditions

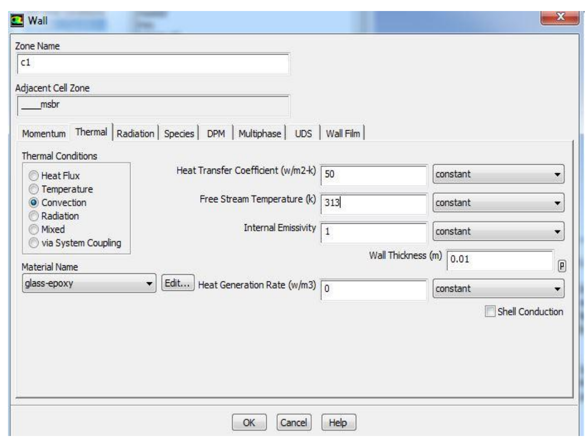

Fig.10. Convection conditions

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Results

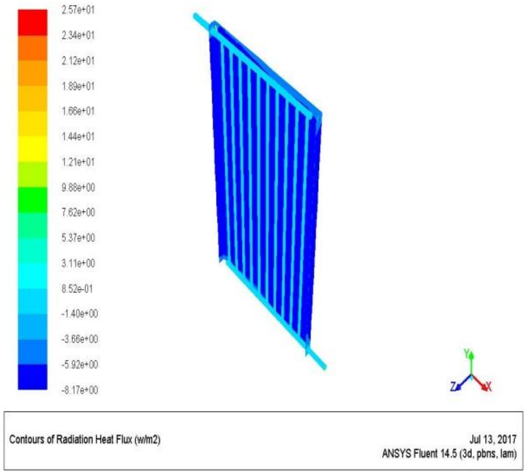


Fig.11. Contours of Radiation Heat Flux

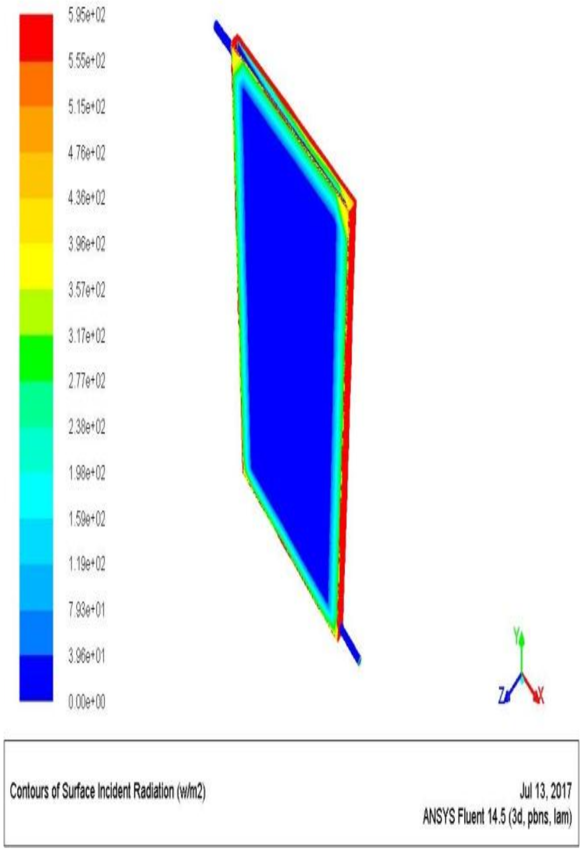


Fig.12. Contours of surface incident radiation

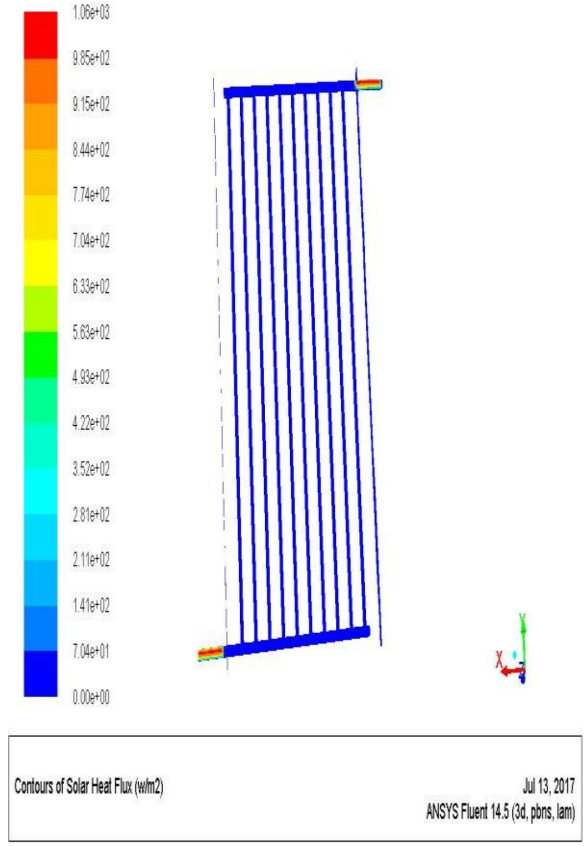


Fig.13. Contours of solar heat flux

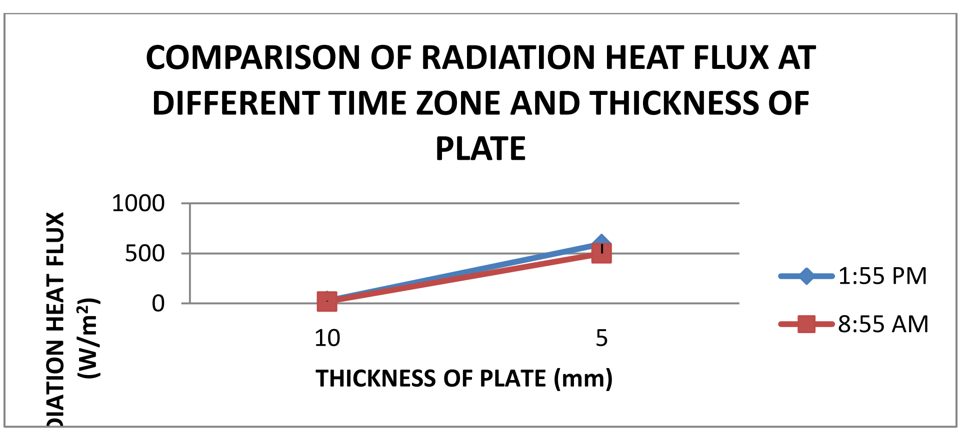
Radiation Heat Transfer Rate (w)

c1	-0.0060082576
c2	-0.0045782756
heated	0.00040227032
insu	-0.1174429
wall-____msbr	0.00027169354
Net	**-0.12735547**

V. RESULT TABLE

	10mm thickness of plate		5mm thickness of plate	
	1:55 PM	8:55 AM	1:55 PM	8:55 AM
Radiation residuals	2436	2021.02	2560	2131.2
Temperature (k)	324.72	312.725	321.7	306.956
Total surface heat flux (w/m^2)	-154.361	-138.9	573	208.76
Radiation heat flux (w/m^2)	25.67	19.526	594	499
Surface incident radiation (w/m^2)	594.5	510.22	752.6	612.3
Solar heat flux (w/m^2)	1055.586	935.025	1220	1020.67
Wall func .heat. trans. coeff. (w/m^2k)	1906.69	1723.69	2813.23	2811.17
Total heat transfer rate (w)	-1.819	-1.04289	-2.3571565	-1.2996124
Radiation heat transfer rate (w)	-0.1273	-0.0651	0.71089156	0.59747258

Graphs



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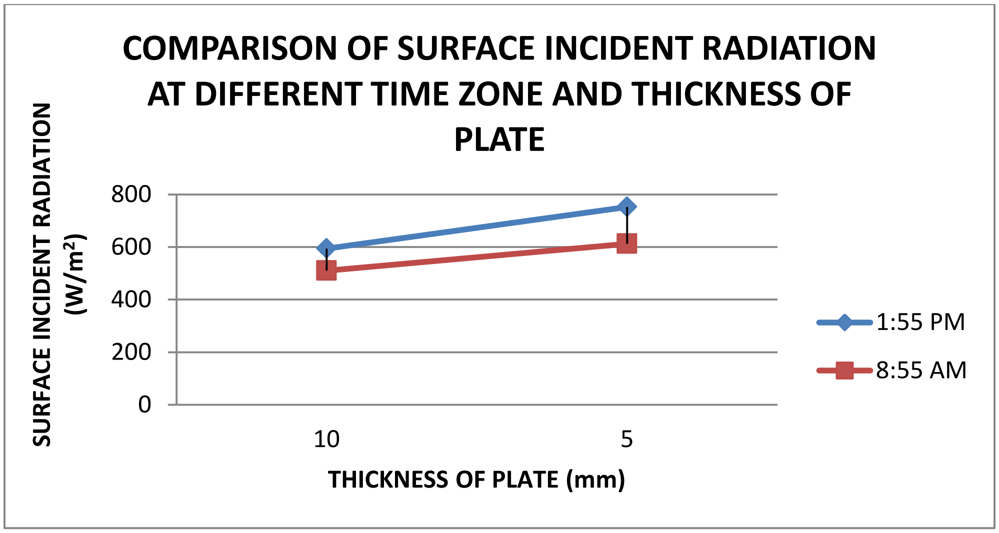
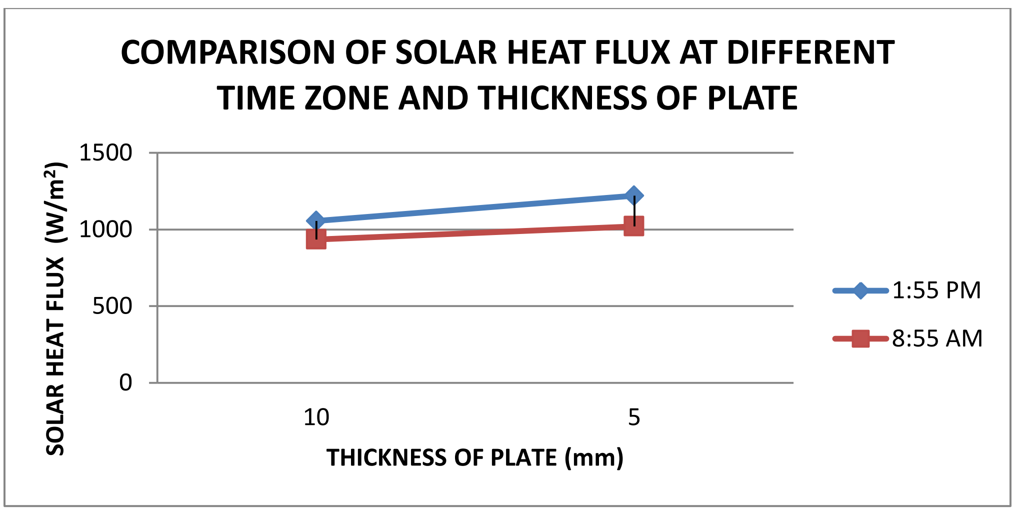
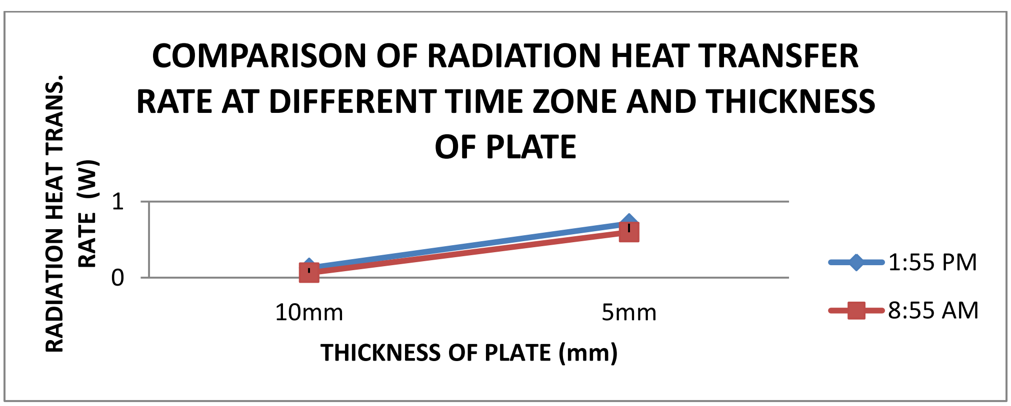






THERMAL ANALYSIS

THICKNESS OF PLATE – 10mm

TIME - 1:55 PM

All the values are taken from the above CFD calculations.

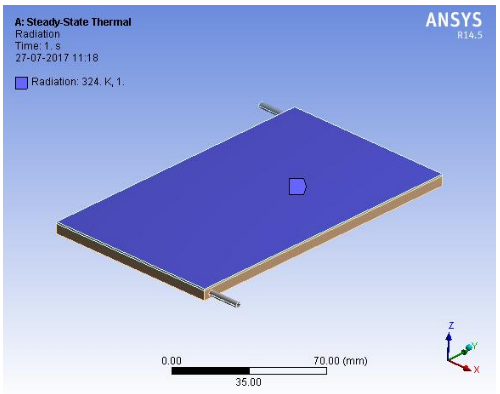


Fig.14. Radiation

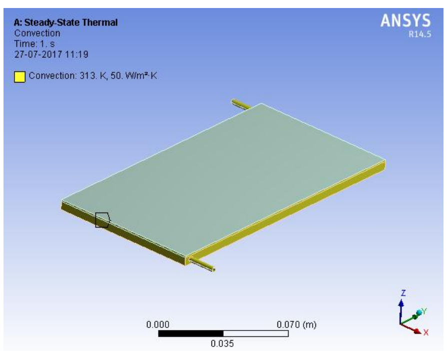


Fig.15. Convection

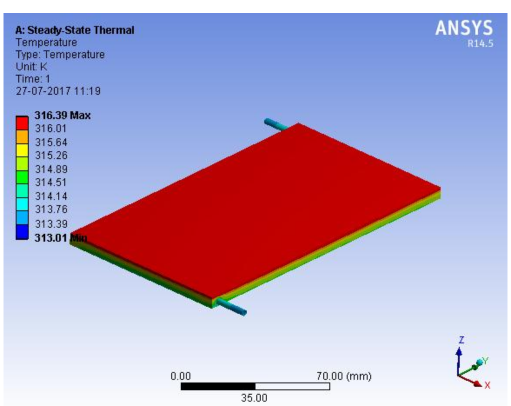


Fig.16. Temperature Distribution on 10mm thickness plate at 1.55PM using Aluminum as pipe material

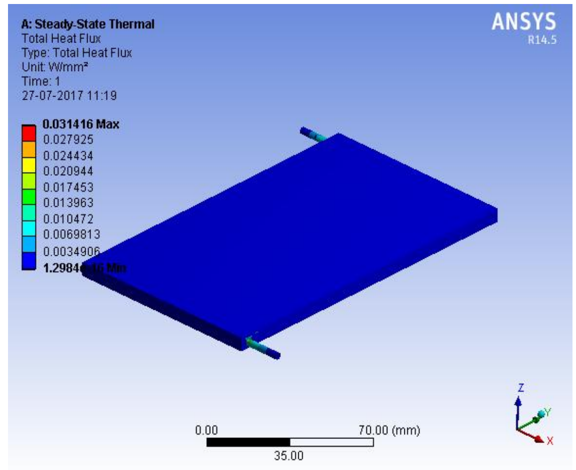
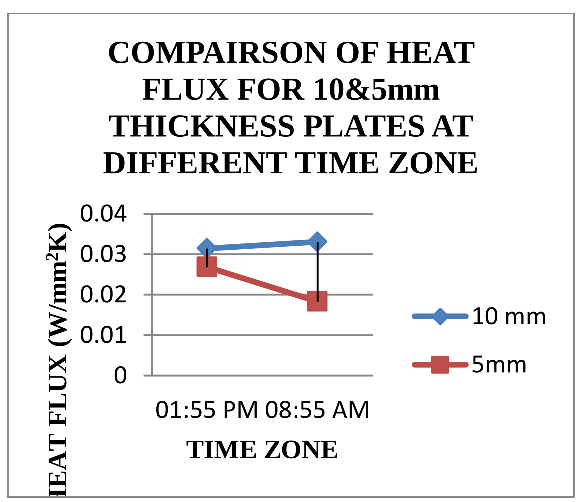


Fig.17. Heat flux on 10mm thickness plate at 1.55PM using Aluminum as pipe material

RESULTS TABLE

	10mm thickness		5mm thickness	
	1:55 PM	**8:55 AM**	**1:55 PM**	**8:55 AM**
Temperature (K)	316.39	303.61	316.57	302.46
Heat flux (W/mm^2)	0.031416	0.033044	0.026855	0.018284



VI. Conclusion

By observing CFD analysis results, Radiation heat flux is more for 5mm thickness plate at time zone of 1.55PM. The atmosphere temperature is increases then radiation is also increases. With respect to this the rate of heat transfer from the body is increases and transfers the heat to all bodies. Solar heat flux is also more for 5mm thickness plate at time zone of 1.55PM. Incident solar radiation is the amount of solar radiation energy received on a given surface during a given time and the value is more for 5mm thickness plate at time zone of 1.55PM. As well radiation Heat transfer rate is also more for 5mm thickness plate at time zone of 1.55PM.By observing thermal analysis results, the heat flux is more for 10mm thickness plate at time zone of 1.55PM.

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