Vaughn College of Aeronautics and Technology

MEE440

Heat Transfer

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Final Project

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Introduction

Heat transfer is the transfer of thermal energy between physical systems. As an engineer we work with many mechanical and electrical systems that generate heat. With the use of heat transfer we can understand and improve our model by taking in consideration of the heat being applied. There are many concepts such as thermal conductivity and heat coefficient that pertain to many systems and materials. In this project we had to solve for the heat coefficient of a system with different configurations of an aluminium model.

For our project, we had to recreate three models given to us to test in COMSOL. We used solidworks to recreate the models being: a series of solid aluminum cylinders which were pipes standing on its face perpendicular to the plate they were on. The second model had a series of flat plates which were fins parallel to each other that were perpendicular to the plate they were on, and the third was just a flat plate. For this lab, we have to find the heat coefficient. The heat coefficient is a quantitative characteristic of convective heat transfer that refers to how well heat is conducted through over a series of resistant mediums.

Problem Statement

The problem given to us was: three "electronic chips" with initial heat needed to be cooled down given an initial material, and temperature. In addition, we were to create an ambient temperature using a block of air, with an initial velocity. Using the COMSOL program, we were to calculate the temperature to find the heat convection coefficient for the flat plate, pipe bundle, and straight fins. We can then compare and contrast the results between the pipe bundle, the fins and the flat plate and see which one is more efficient, and compare our results with our peers to see their results with varying free-flow velocity, Q, or initial temperature drastically change the results of the cooling of said chips. By observing the various values for the conditions put on each model we can see how to improve on the system in order to get a desired outcome.

COMSOL/SolidWorks Design

First we constructed the models using SolidWorks

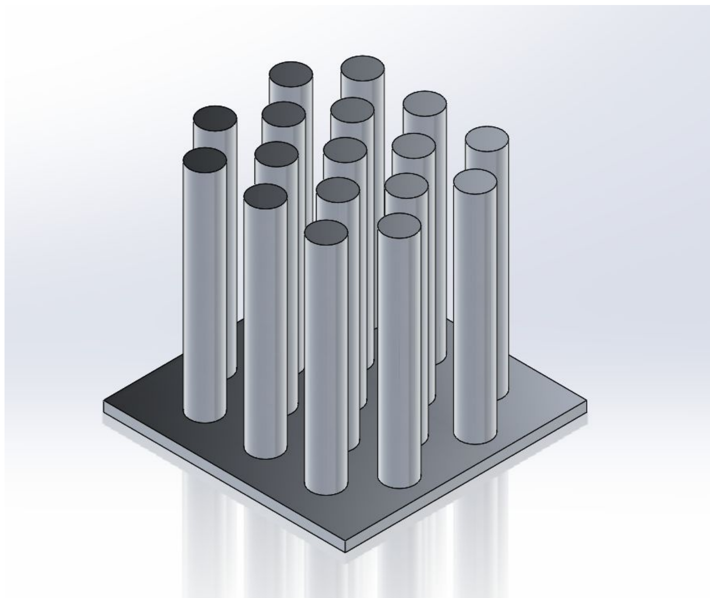


Image 1: Pipe bundle as model in SolidWorks

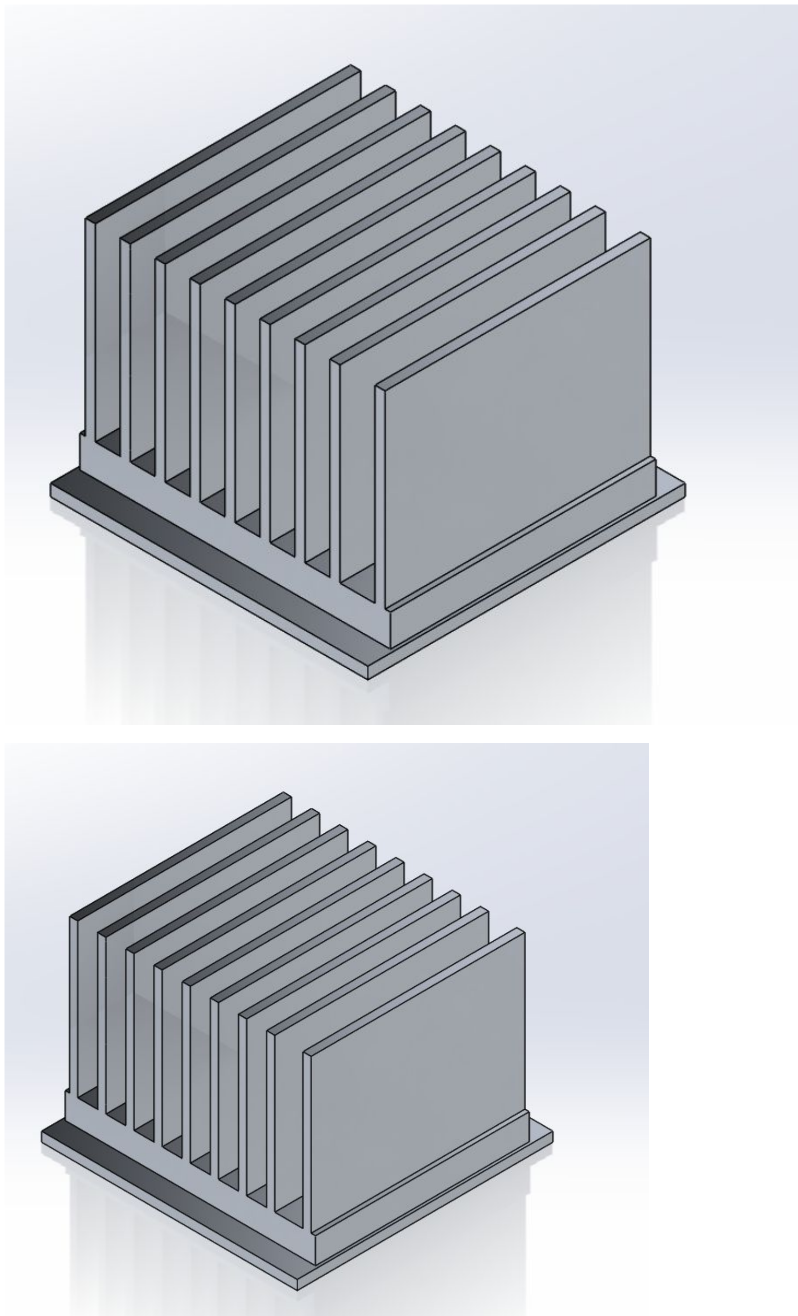


Image 1: Fins as modelled in SolidWorks

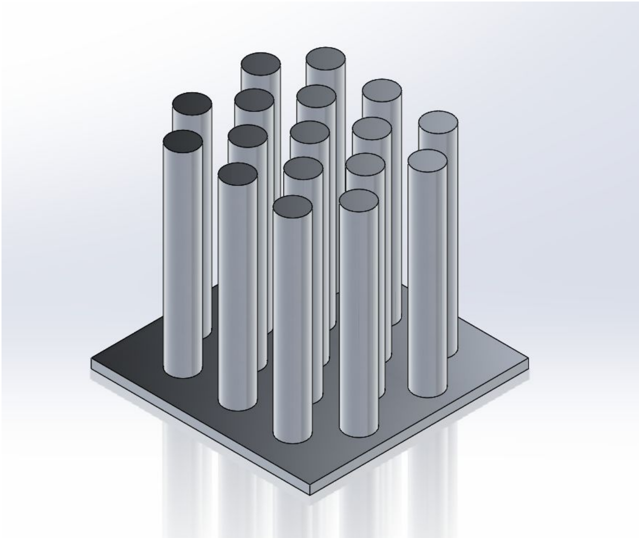


Image 2: Pipe Bundle as modelled in Solidworks

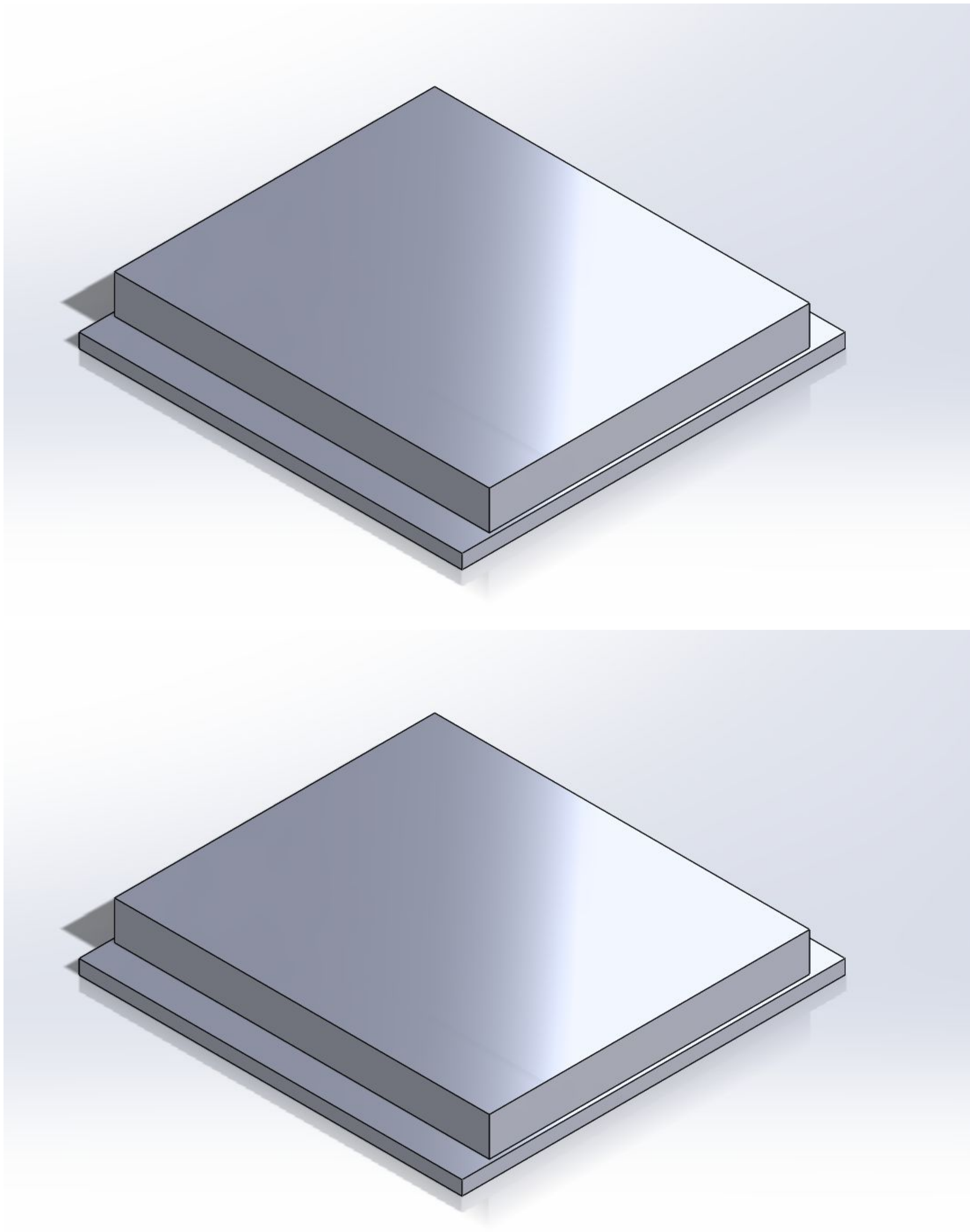


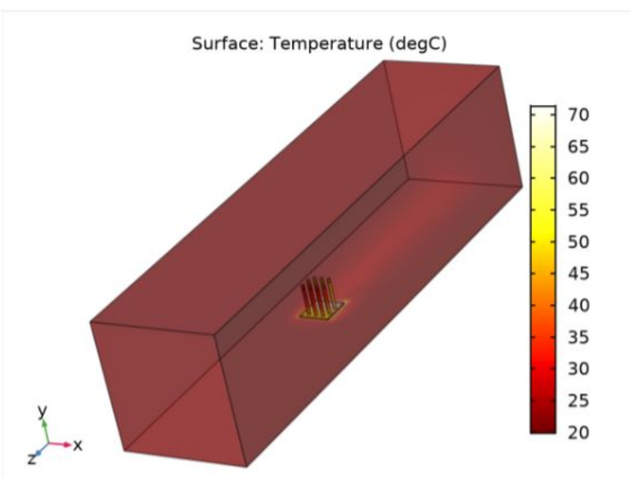
Image 3: Flat Plate as modelled in SolidWorks

After the models were constructed, we had placed them in COMSOL to apply the heat at the base of 150 W, an ambient temperature of 20 degrees Celsius, and air flow speed of 2.0 m/s. Within COMSOL program we used a convective heat flux boundary condition which is the assumption that the heat conduction at the surface of the material is equal to the heat convection in the same direction. We then placed them in a block of air around the heatsink, and applied an initial Velocity being 2.0 m/s and an initial temperature to the block which would be the Ambient temperature.

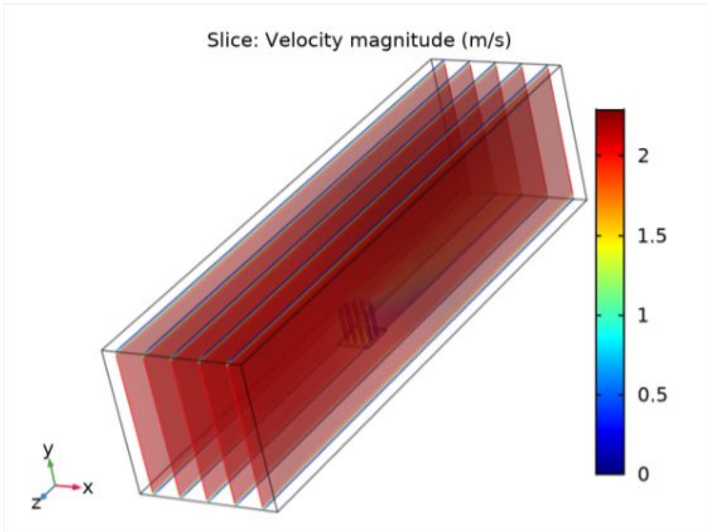
In the COMSOL Program, we applied free and forced convection. The free convection was the heat being applied to the model while the forced convection was the air flow being applied to the model. Free convection is the transfer of heat in which fluid motion is not generated because of external forces. Forced Convection is the transfer of heat due to an external force such as a pump.

Results in Comsol

Model 1- Cylinders

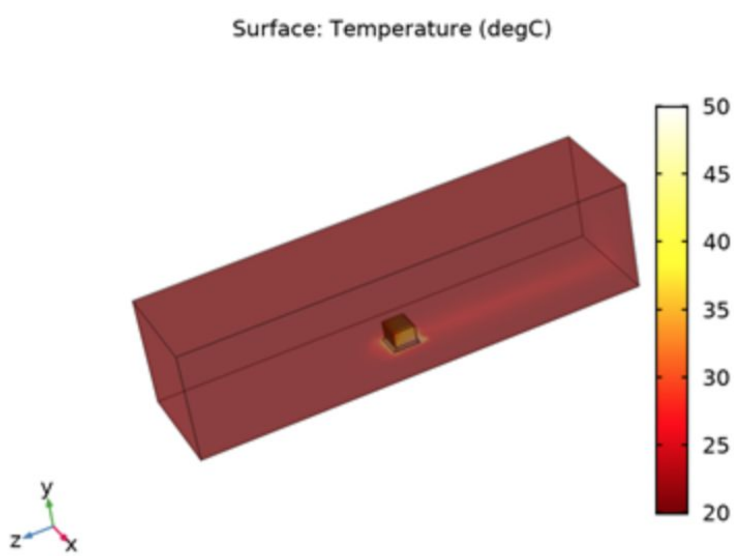


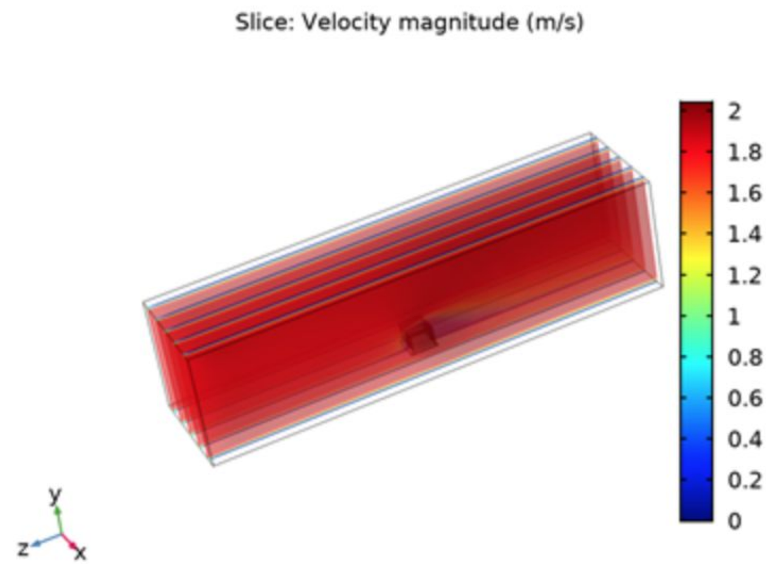
Surface: Temperature (degC)



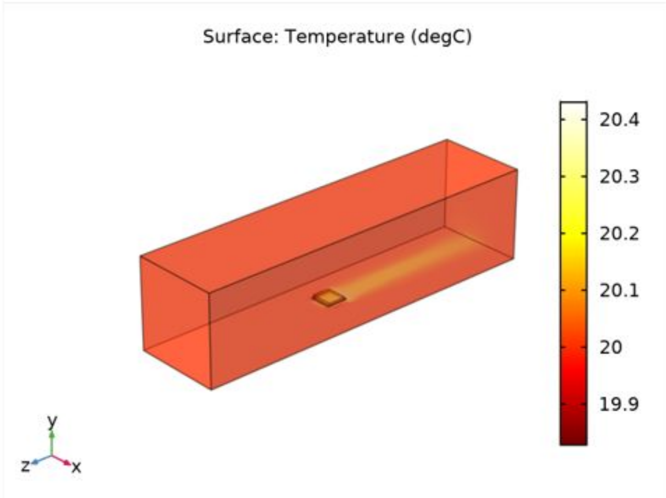
Slice: Velocity magnitude (m/s)

Model 2- Fins

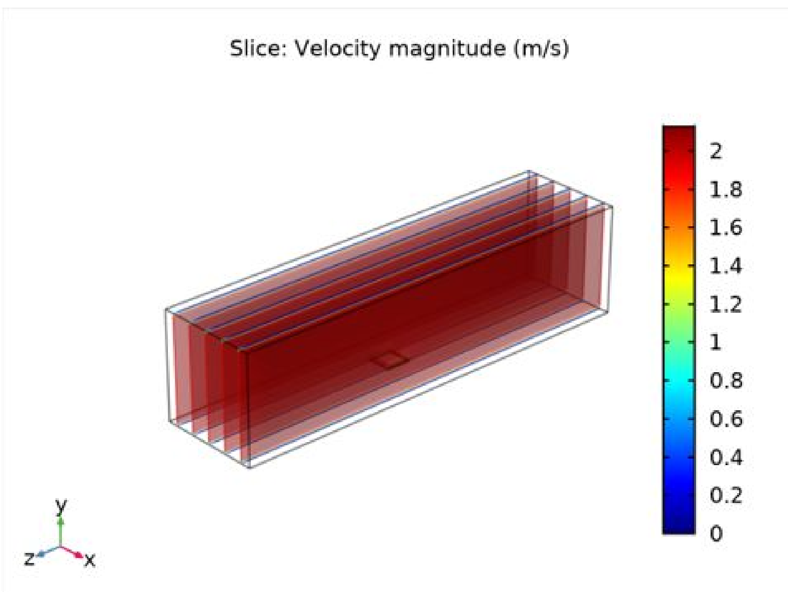




Model 3-Plate



Surface: Temperature (degC)



Slice: Velocity magnitude (m/s)

Model	Surface area(m^2)	Q(W)	Initial (℃) Temperature (Ti)	Final (℃) Temperature (Tf)	Heat coefficient (W/(m^{2}K))

Flat plate	0.014	150	20	20.552	19409.9379
Pipe Bundle	0.098	150	20	48.145	54.3831
Fins	0.14	150	20	50.1996	34.61

Conclusion

We determined the heat coefficient for each of these components requested utilizing the conditions that the heat at the base is 150W, the ambient temperature of 20 degrees celsius, and air flow speed of 1.5 m/s . We observed how the shape and dimensions changed the result of the heat coefficient for each model despite the same conditions were being applied to each of them. For the heat coefficient it seems that the smaller the surface area the ambient temperature is being applied on the the higher the heat coefficient will be. We notice that the final temperature seems to increase as the smaller the surface area is being applied by the ambient temperature. This observation align to what we had expected because from the formula h=q/(A*(Tf-Ti)) we can conclude the larger the area or larger the final temperature will result in a smaller heat coefficient.