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Exploration of Heat Transfer in a Single Tube -Fin Arrangement of an Automotive Radiator

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***Abstract* — Radiators are heat exchangers used to reassign thermal energy from one medium to another for the reason of cooling and heating. The radiators are commonly used in automobiles for the purpose of cooling the engine. The radiator design at hand depends on the empirical manner. In this current work, investigation of radiator with fins (tube fin arrangement) is done for an existing radiator through SOLID WORKS for modelling and ANSYS 14.0 for analyzing.**

***Keywords* — ANSYS, Fins, Convection, Finite Element Analysis, Radiator.**

I. INTRODUCTION

A radiator absorbs heat from the engine with the help of coolant. This hot coolant is then fed into the inlet tank of the radiator either on the top or along one side from which it is distributed across the radiator core through tubes to another tank on the opposite end of the radiator. As the coolant passes through the radiator tubes on its way to the opposite tank, it transfers much of its heat to the tubes which, in turn, transfer the heat to the fins that are lodged between each row of tubes. The fins then release the heat to the ambient air. Fins are used to greatly increase the contact surface of the tubes to the air, thus increasing the exchange efficiency. In the study of heat transfer, fins are surfaces that extend from an object to increase the rate of heat transfer to or from the environment by increasing convection. Increasing the temperature gradient between the object and the environment, increasing the convection heat transfer coefficient, or increasing the surface area of the object increases the heat transfer. Thus, adding a fin to an object increases the surface area and can sometimes be an economical solution to heat transfer problems. Use of aluminium increased, eventually taking over the vast majority of vehicular radiator applications. The main inducements for aluminium are reduced weight and cost. The most common heat sink materials are aluminium alloys. Aluminium alloys 6061 and 6063 are commonly used, with thermal conductivity values of 166 and 201 W/m-K, respectively. The values depend on the temper of the alloy.

Magarajan et al [1] calculated heat release of an IC engine cylinder cooling fins with six numbers of fins having pitch are determined numerically using commercially available CFD tool Ansys Fluent. The heat release from the cylinder which is calculated numerically is validated with the experimental results. Mirapalli et al [2] provided rectangular and triangular fins on the periphery of engine cylinder. Heat transfer analysis is carried out by placing rectangular and then triangular fins. Analysis is carried out by varying temperatures on the surface of the cylinder from 200 ºC to 600ºC and varying length from 6 cm to 14 cm. Input parameters such as density, heat transfer coefficient, thermal conductivity and thickness of fin are taken and output parameters such as rate of heat flow, heat flow per unit mass, efficiency and effectiveness are determined.

Jassem et al [3] In this work five fins were used, a rectangular non-perforated and four perforated fins of shapes like circle, square, triangle, and hexagon having same cross section area. These Perforations are distributed on 3 columns and 6 rows and analyzed. Shaikh et al [4] dealt with performance of various available fins profiles namely Rectangular, Triangular, Trapezoidal, Circular, Rhombic, and Elliptical. The result were tabulated and studied for comparison of different fin profiles. The best performing fin was then selected on the basis of maximum heat dissipation. From the study circular fin model showed the performance of different profiles under similar conditions and finally compared it with fin profiles on the basis of heat dissipation and thermal stresses.

II. EXPERIMENTAL METHOD

FEA is a method of piecewise approximation, and a computer aided mathematical technique for obtaining approximate numerical solution to predict the response of the physical systems subjected to external influence. The need of FEA is to reduce hard calculations, many experiments and time consumption. Solid Works a 3D mechanical CAD (computer-aided design) is used for 3D model the radiator with and without fins with parameters shown in table 1 and the material selected for the radiator is AA 6061.

Table 2.1 shows the Design parameters of fin.

1.	**Number of fins**	**Top**	**Bottom**	**Middle**
		42	42	74
2.	**Height of fins**	370		
3.	**Number of tubes**	56		
4.	**Inlet and outlet diameter**	25		
5.	**Fin size top**	60x55x1		
6.	**Fin size middle**	406x28x1		

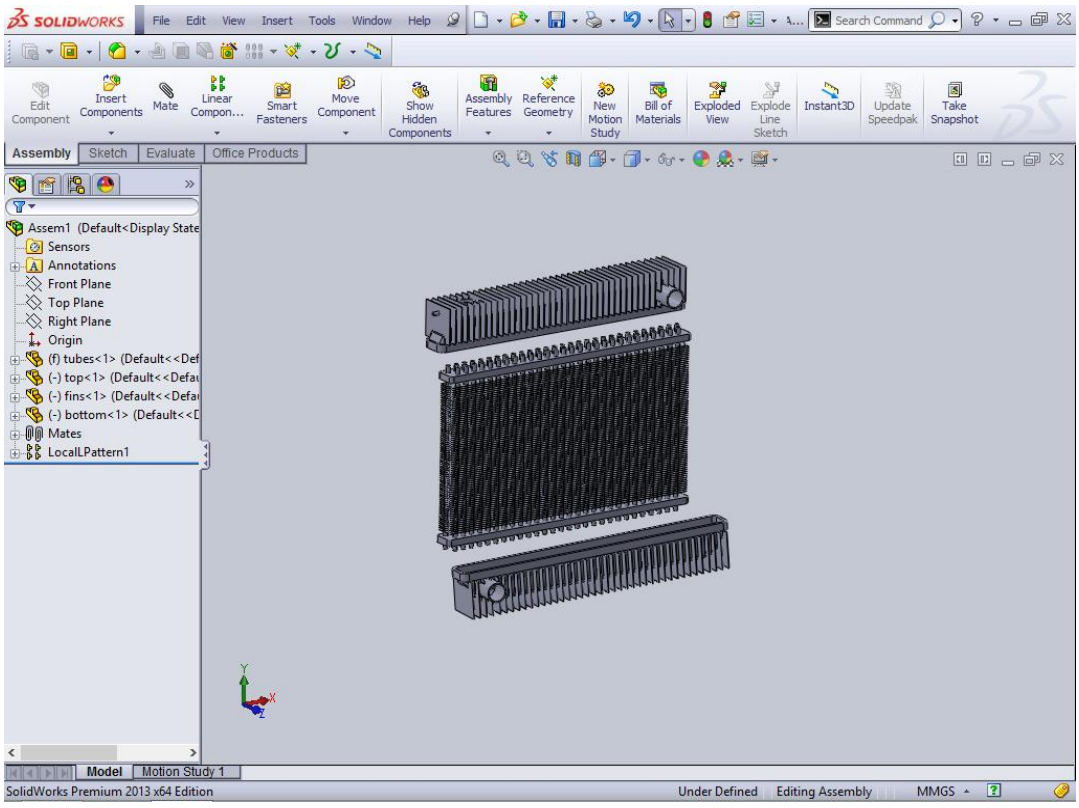


Figure 1: Exploded view of the Radiator with fins.

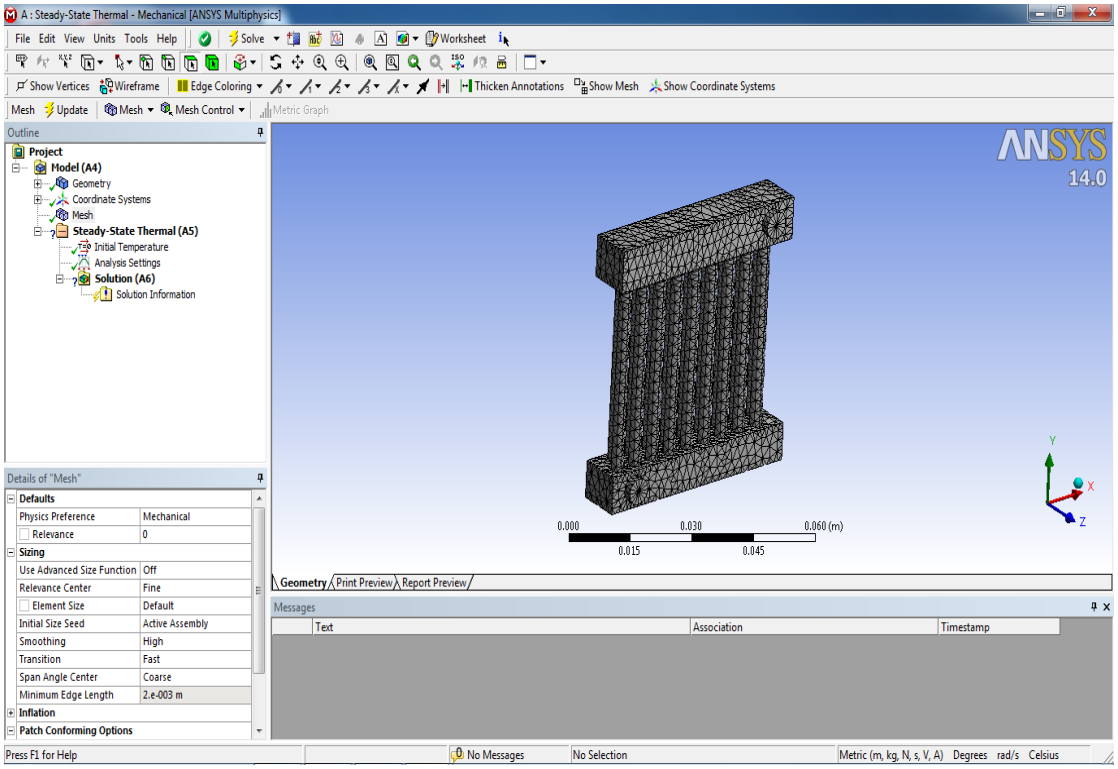


Figure 2: Meshed model for Unfinned radiator.

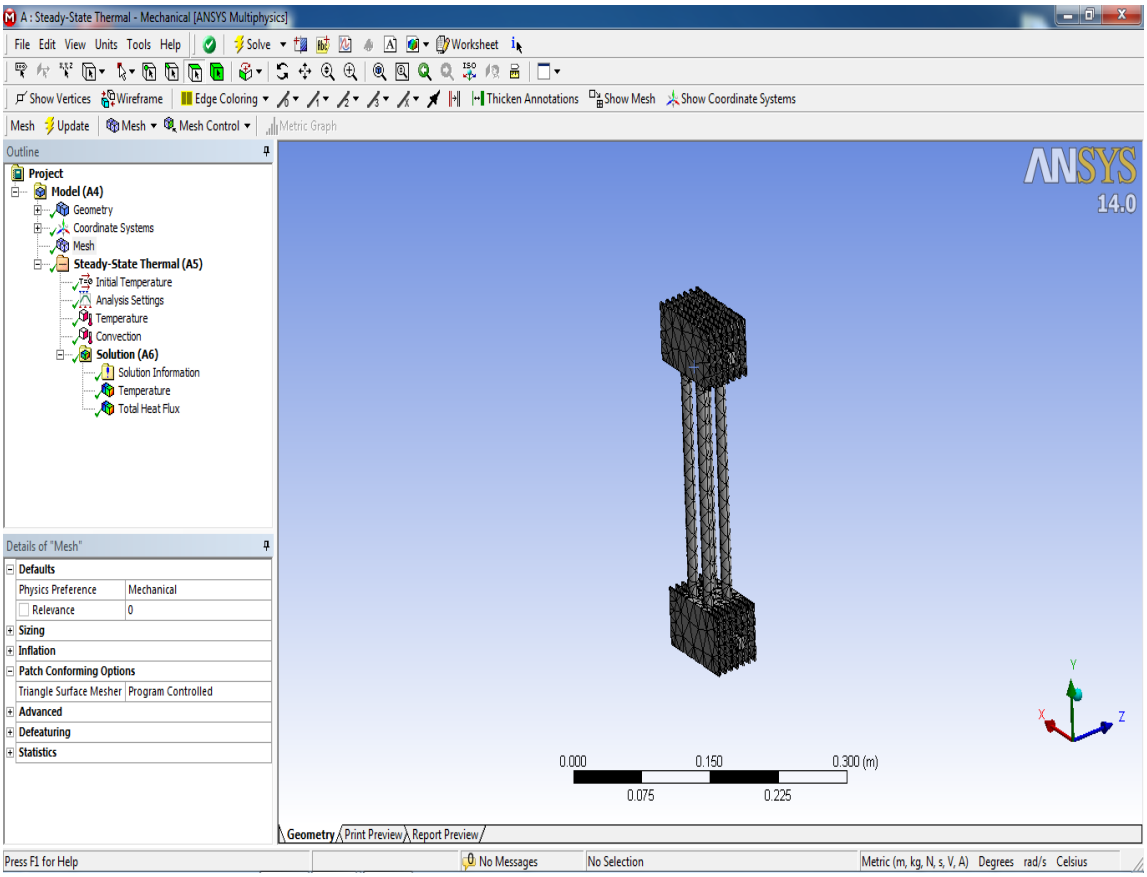
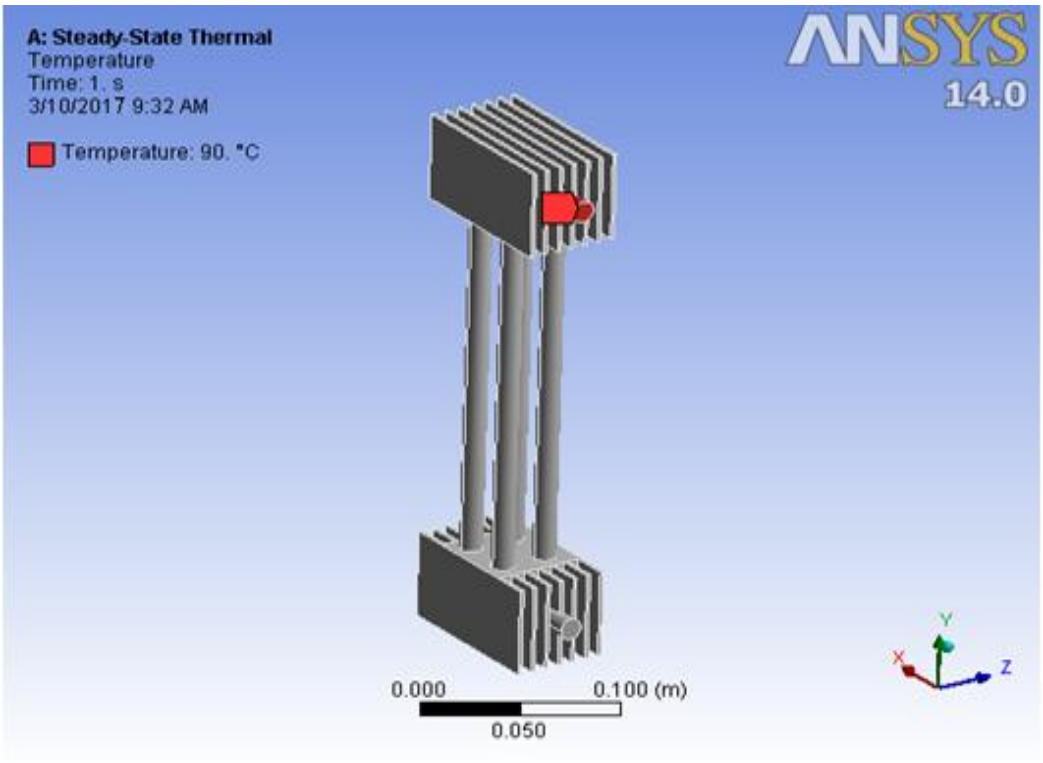


Figure 3: Meshed model for Finned radiator.



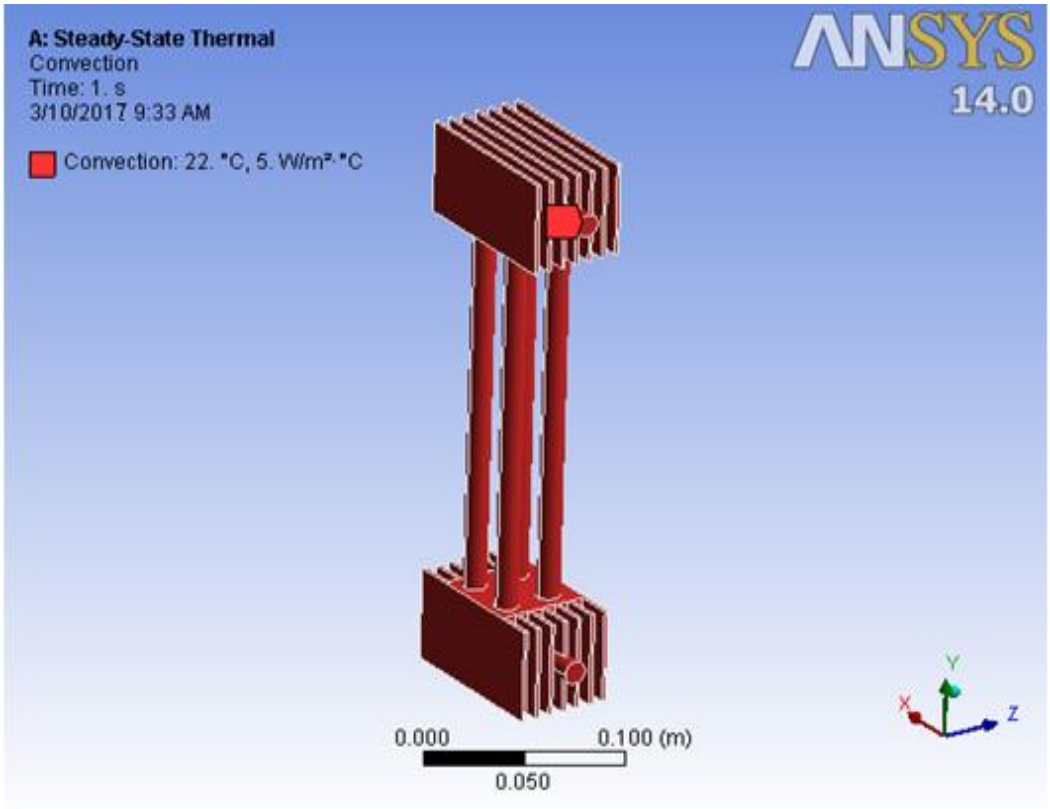
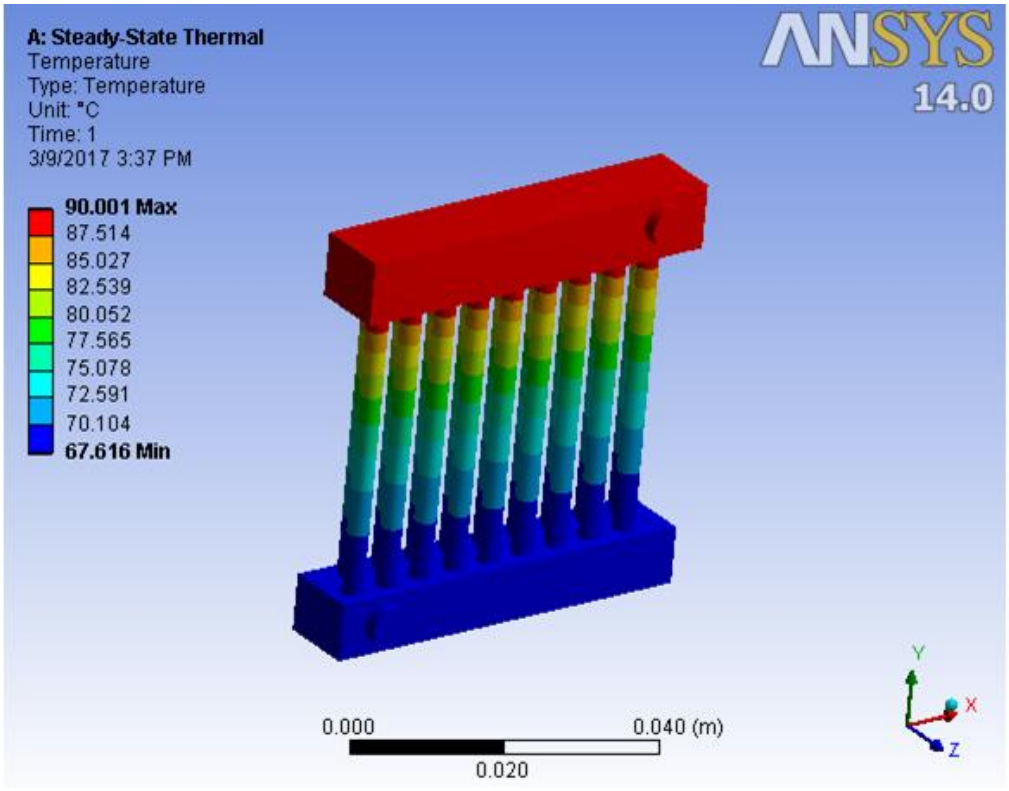


Figure 4a & 4b: Constraints of the Radiator.

III. RESULTS AND DISCUSSION



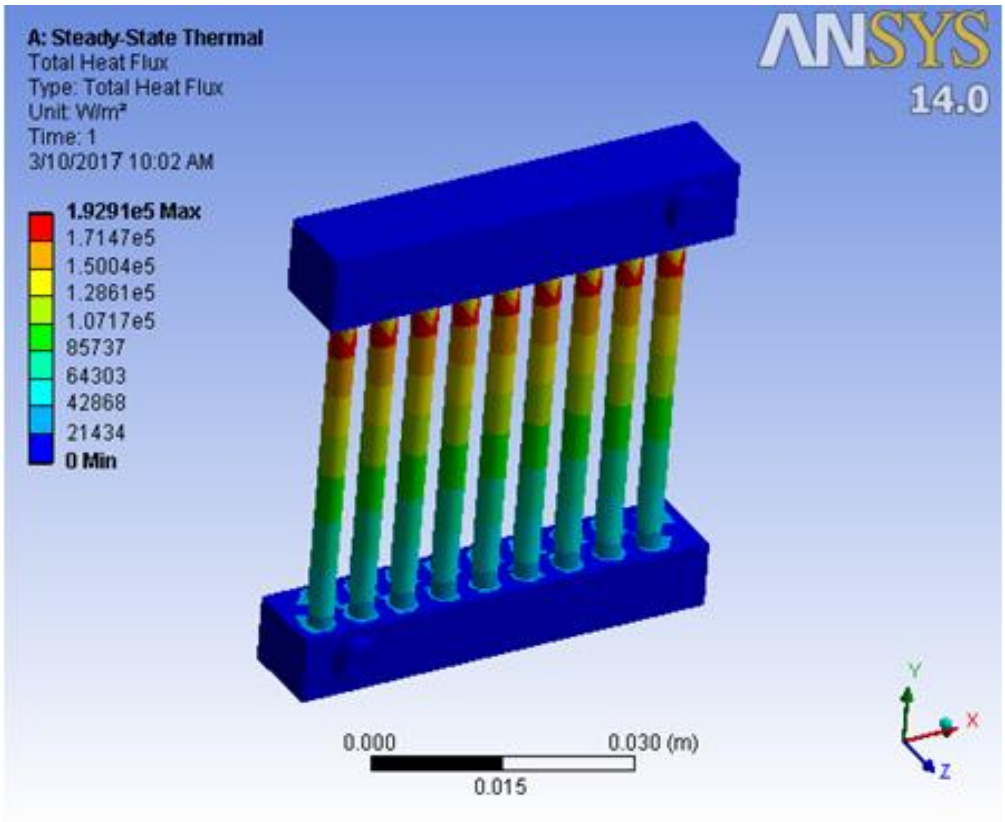
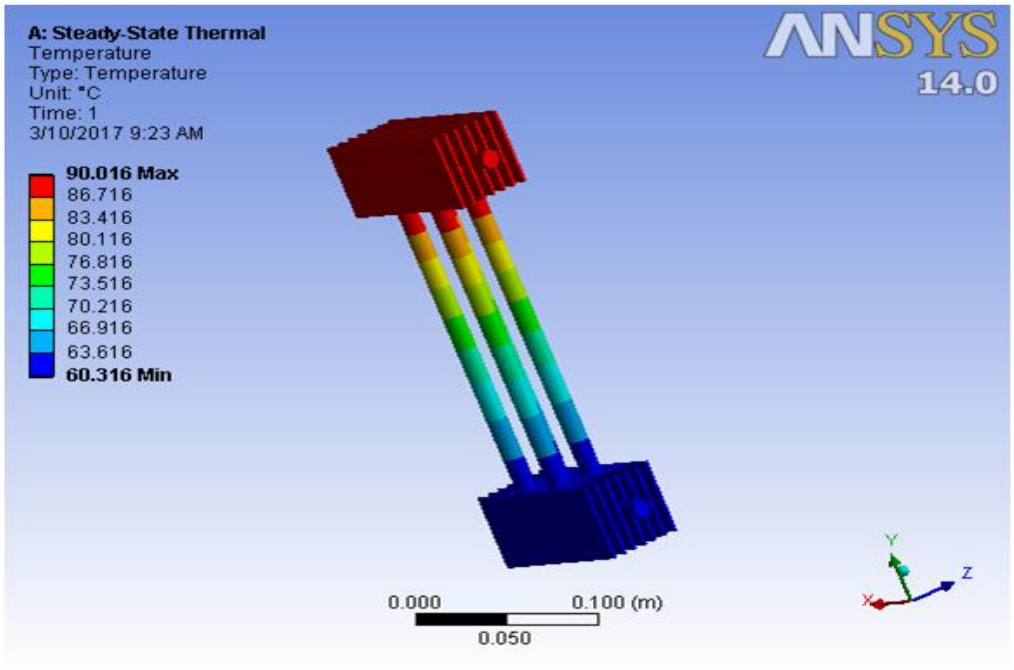


Figure 5a & 5b: Temperature Distribution and Heat Flux of Unfinned Radiator.



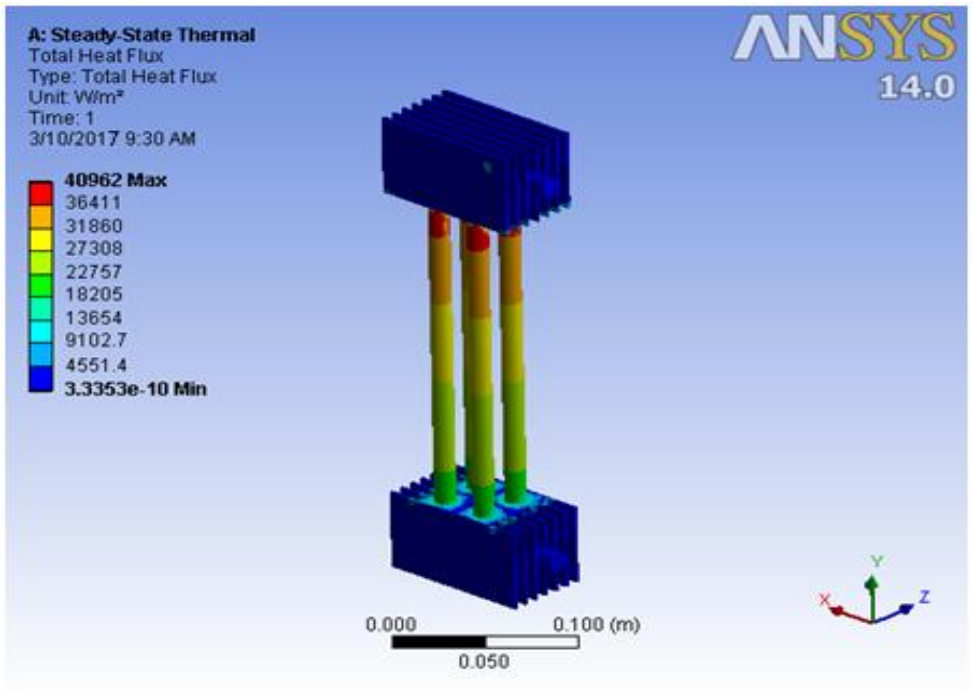


Figure 6a & 6b: Temperature Distribution and Heat Flux of Finned Radiator.

IV. CONCLUSION

This study is aimed to analyze the temperature characteristics simulation in a commercially existing radiator to establish better design by using a commercial software ANSYS FLUENT. In this project a radiator is designed with and without fins. The analysis tool ANSYS is used to perform thermal analysis on radiator at different temperature rates. From the results it is clear that thermal flux is increased for the modified model. So it can be concluded that modifying the radiator model with fins yielded better results.

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