Experimental Investigation And Analysis Of Heat Transfer In Rectangular Channel With Elongated Hole

AUTHOR 1

Egalapati Aravind received the B.Tech degree in mechanical engineering from Kakinada Institute of Engineering and Technology Campus, JNTU, Kakinada, Andhra Pradesh, India, in 2018 year and perusing M.Tech in Thermal Engineering from BonamVenkataChalamayya Engineering College (AUTONOMOUS), Odalarevu, Andhra Pradesh, India.

AUTHOR 2

Mr. Giddi Venkateswara Rao M.Tech. Asst. Prof. Department of Mechanical engineering from Bonam Venkata Chalamayya Engineering college (AUTONOMOUS), Odalarevu, Andhra Pradesh, India.

ABSTRACT

Gas turbine vanes and blades are exposed to high air temperature. And increasing turbine rotor inlet temperature directly leads to a rise in thermal efficiency and output power of gas turbines. The rotor inlet temperature is far higher than the melting point of the blade and vane material. Hence, cooling technology of turbine blades has become one of the most important key factors for improvement of gas turbine engine efficiency.

In this thesis, a model of rectangular channel with blockage will be designed and fabricated. The rectangular channel has a width-to-height ratio of 11:1. The blockages will be subdivided into two different cases using two different aspect ratios (hole-width-to-height ratio) which are determined by the number of holes with four and six holes per blockage. Experiments are conducted to determine the heat transfer. CFD analysis will be done to validate with that of experimental data.

INTRODUCTION

The fins are lengthy surfaces which unsure the heat transfer rates by cumulative the area of heat transfer. Fins are used in car engines, heat exchangers, refrigerators, transformers, electronic devices etc. In numerous manufacturing requests the free convection refrigeration by air is most extensively used since they are cheap, more dependable, light in heaviness and easy to production. Though the involuntary convection has advanced heat transfer constant as compared to the usual convection but the industrial and working cost will upsurge meaningfully and the heaviness and sound will also upsurge. So, usual convection is healthier for greatest of the requests. Natural convection heat transfer rate can be augmented by cumulative the fin part but at the cost of augmented heaviness, better size and advanced cost of flippers. Presentation of the flippers in footings of warmth transmission rate with discount in size, cost and heaviness of fins can be reached by formation sure changes in the geometry. Finished the use of pierced fins the heat broadcast continuous can be better with discount in mass and price of fins. In the past few ages numerous studies were did in order to control the best fin shape which delivers heat transfer improvement finished the four-sided fins by if the holes of dissimilar forms and sizes below natural convection.

In the study of heat transfer, flippers are exteriors that spread from an thing to upsurge the rate of heat transfer to or after the setting by cumulative convection. The quantity of transmission, convection, or energy of an thing controls the quantity of heat it transfers. Cumulative the fever gradient amid the thing and the setting, cumulative the convection heat transfer constant or cumulative the superficial area of the thing upsurges the heat transfer. Occasionally it is not possible or inexpensive to alteration the first two options. Thus, addition a fin to an thing upsurges the superficial area and can occasionally be an inexpensive answer to heat transfer glitches.

LITERATURE REVIEW

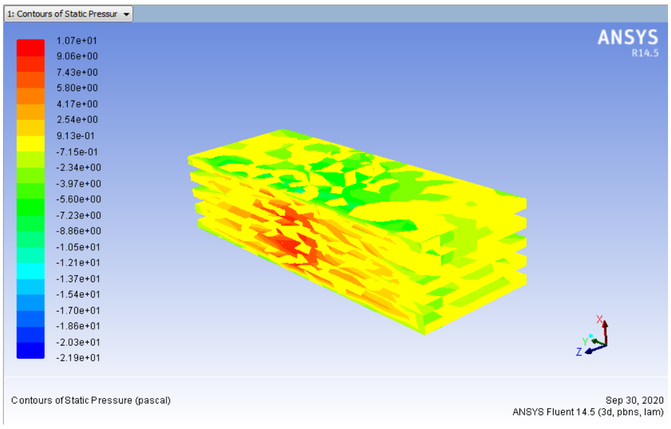
Heat conduction is the mode of heat transfer accomplished via two mechanisms, by molecular interaction where energy exchange takes place by kinetic motion or by direct impact of molecule, or by the drift of free electrons as in case of metallic solids. Convection is the mode of heat transfer between a surface and a fluid moving over it. A large number of studies have been conducted on shape modifications by cutting some material from fins to make holes, cavities, slots, grooves or channels through the fin body to increase the heat transfer area and/or the heat transfer coefficient.

Santosh Bhosle and Kishor Kulkarni [1] conducted various experimental studies to quantify and compare the natural convection heat transfer enhancement fin array with various fin spacing, perforation angle, and perforation diameter, pitch of perforation and heater inputs. The variables for this natural convection cooling with the help of finned surfaces are orientation and geometry. In this study, the steady state heat transfer from the solid fin and perforated fin arrays are measured. The present study establishes optimized fin setup for various parameters of fin geometry and its effect on heat transfer results. The results obtained are matched well and showed similar trend and satisfactory agreement for heat transfer under natural convection. From all results it is concluded that the heat transfer rate for the fins of perforation with constant pitch and 4 mm diameter with 45^{o} geometry of perforation is optimum fin and the array of this fin with 10 mm spacing is best suited horizontal rectangular fin array.

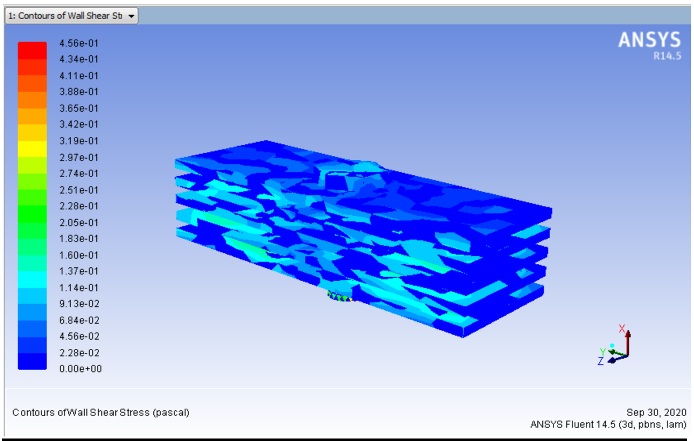
CFD ANALYSIS

ORIGINAL MODEL

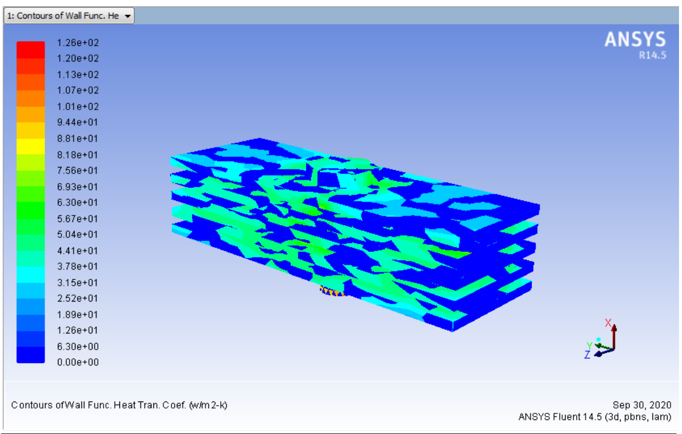
PRESSURE



SHEAR STRESS



HEAT TRANSFER COEFFICIENT



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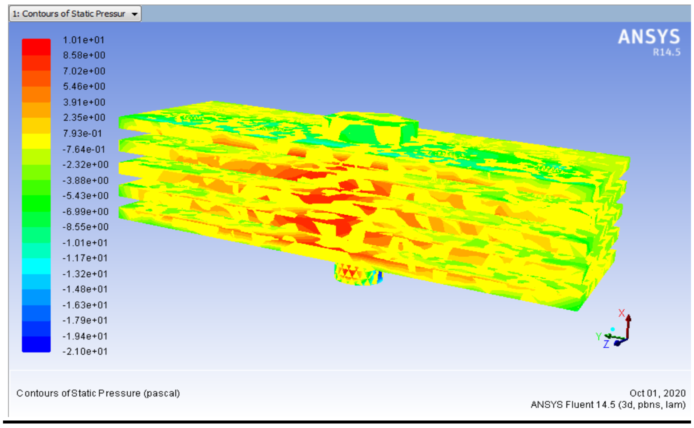
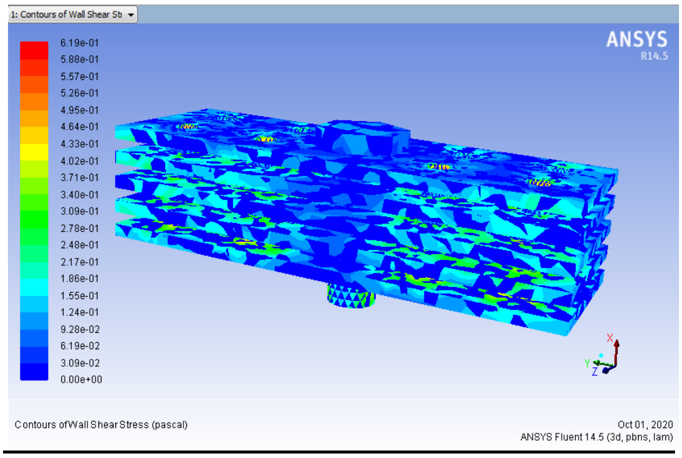
MODIFIED MODEL 1

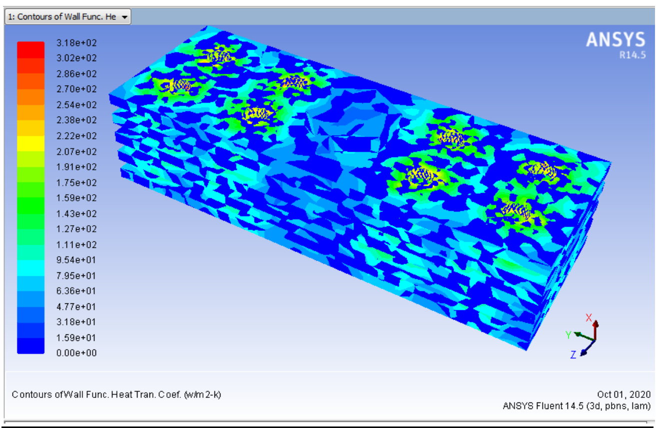
PRESSURE



SHEAR STRESS



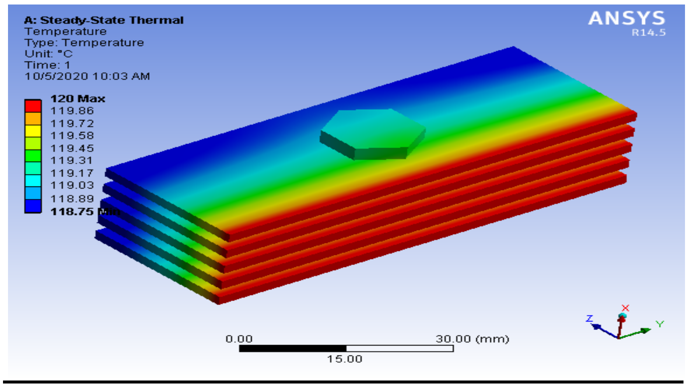
HEAT TRANSFER COEFFICIENT



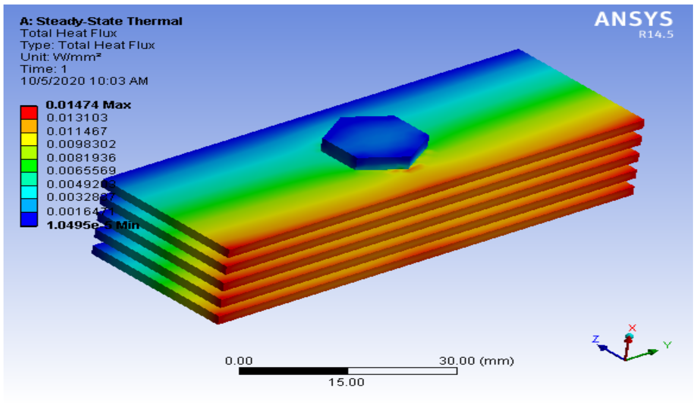
THERMAL ANALYSIS

ORIGINAL MODEL- AL 2024

TEMPERATURE

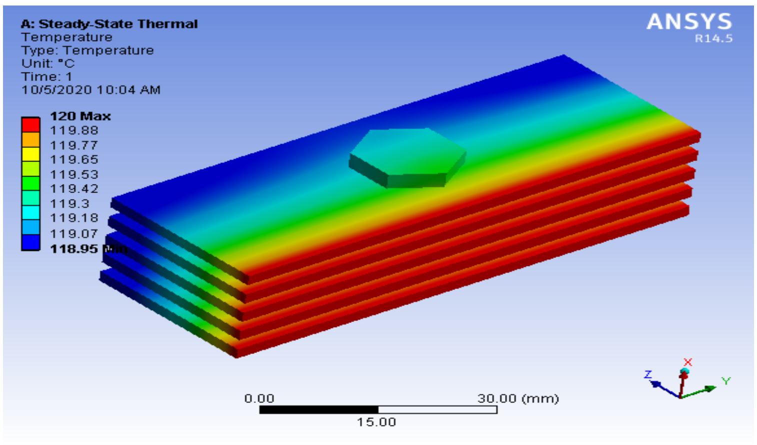


HEAT FLUX



AL 6061

TEMPERATURE



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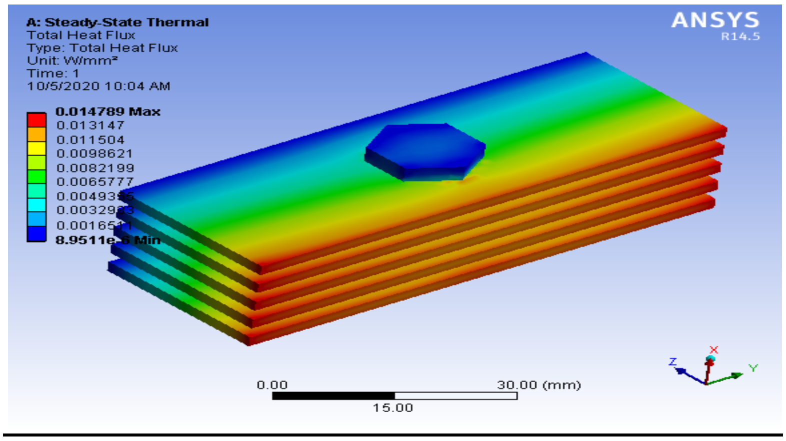
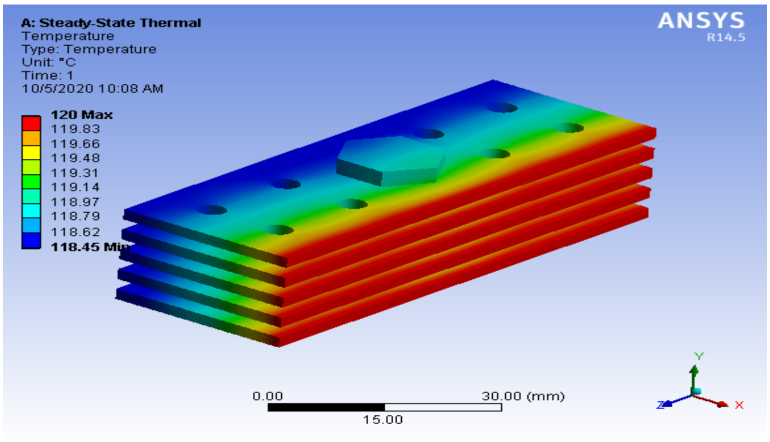
HEAT FLUX

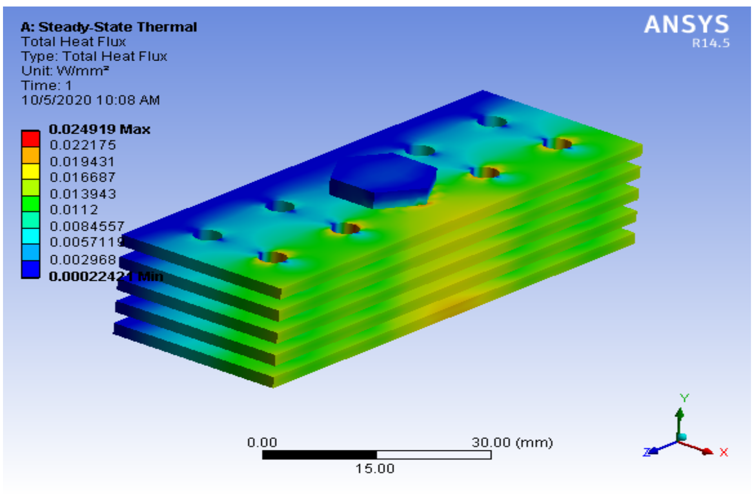


MODIFIED MODEL 1 - AL 2024

TEMPERATURE

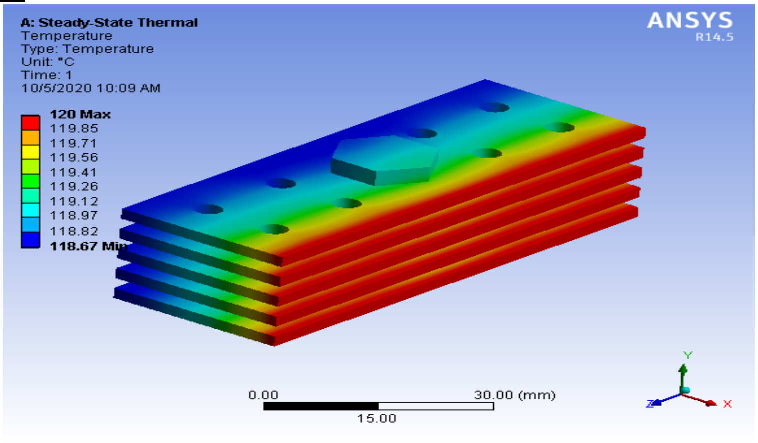


HEAT FLUX



AL6061

TEMPERATURE



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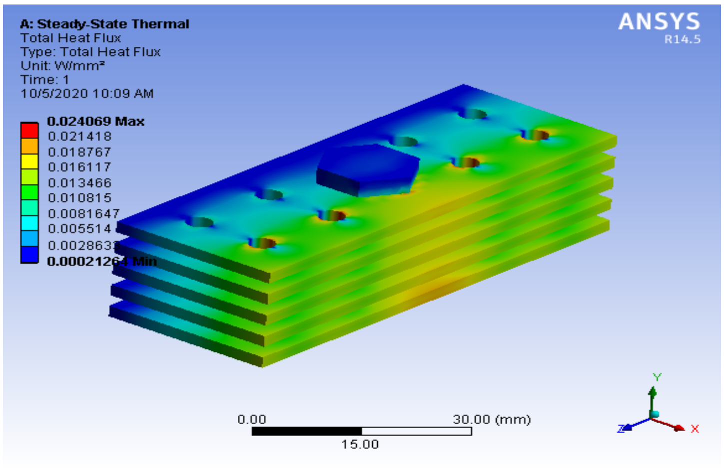

TABLES

CFD

MODELS	PRESSURE	SHEAR STRESS	HEAT TRANSFER COEFFICIENT
ORIGINAL	1.07E+01	4.56E-01	1.26E+02
MODIFIED 1	1.01E+01	6.19E-01	3.18E+02
MODIFIED 2	1.09E+01	6.60E-01	3.40E+02
MODIFIED 3	1.16E+01	7.53E-01	3.31E+02

THERMAL

MODELS	MATERIALS	TEMPERATURE	HEAT FLUX
ORIGINAL	AL 2024	120	0.01474
	AL 6061	120	0.014789
MODIFIED 1	AL 2024	120	0.024919
	AL 6061	120	0.024069

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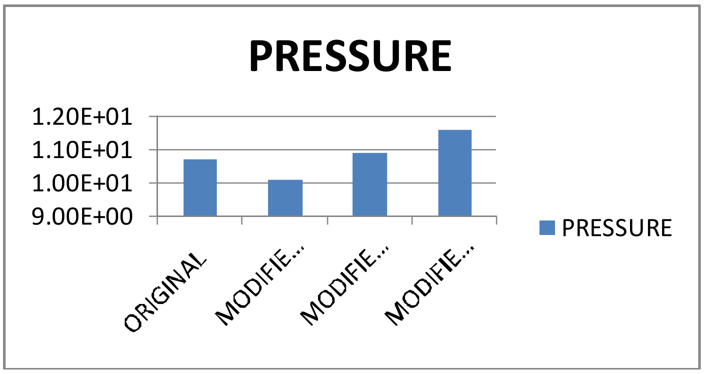
MODIFIED 2	AL 2024	120	0.024651
	AL 6061	120	0.024526
MODIFIED 3	AL 2024	120	0.029666
	AL 6061	120	0.029815

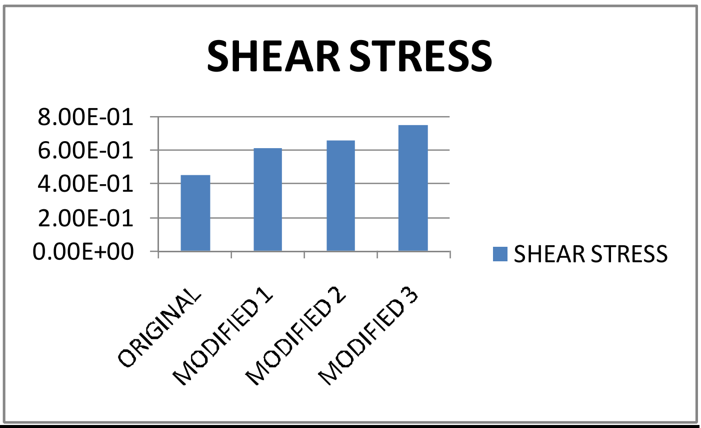
GRAPHS

CFD

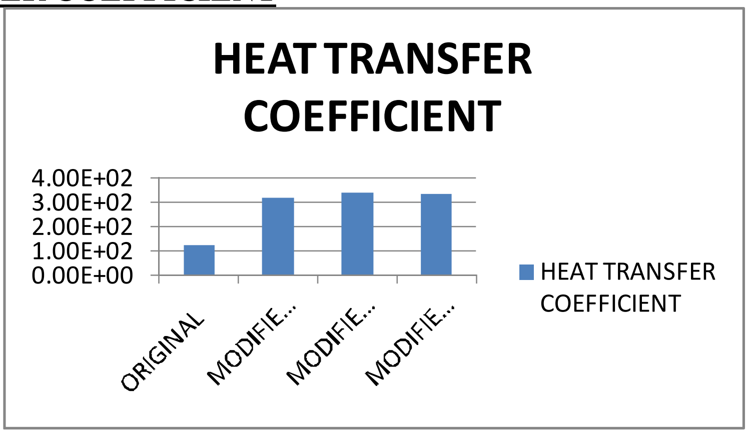
PRESSURE



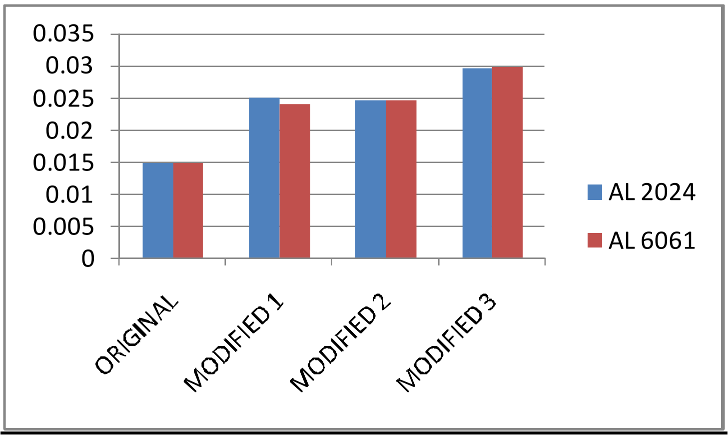
SHEAR STRESS



HEAT TRANSFER COEFFICIENT



THERMAL HEAT FLUX



CONCLUSION

In this thesis, a model of rectangular channel with blockage will be designed and fabricated. The rectangular channel has a width-to-height ratio of 11:1. The blockages will be subdivided into two different cases using two different aspect ratios (hole-width-to-height ratio) which are determined by the number of holes with four and six holes per blockage. Experiments are conducted to determine the heat transfer. CFD analysis and thermal analysis is done.

As if we verify the results here we can clearly observe that the modified model 1 best result when compared in the CFD analysis. As the shear stress below the maximum point, the pressure should be low. As here this obtains the better output.

As if we verify the results obtained in the thermal analysis, here the heat flux is best for the modified model 3 with the al 6061 material. As we can suggest the al 6061 material for its better conductivity of the material.

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