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Cfd And Thermal Investigation Of A Hypersonic Scramjet Engine Using Various Ramp Angles

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ABSTRACT

A scramjet engine is a supersonic combustion ramjet engine which doesn't have moving parts in the engine. The major differences between ramjet and scramjet engine is flow of air in the combustion chamber. Hypersonic Scramjet engines generally starts at free stream Mach number of 5 to 6 is released from turbojet engines or rockets.

Hypersonic Scramjet engines generally starts at free stream Mach number of 5 to 6 is released from turbojet engines or rockets. Although the scramjet starting with Mach no 4.0 is possible with today's technology, initially in this project we are going to analyses directly on the supersonic flight to get the velocity of the air passing through it and then later the CFD analysis is carried out at different ramp angles with a starting Mach number of 4.00 and the variation is compared. The model is designed using ANSYS Design Modeler, meshing is done using ANSYS Mesh and CFD analysis is done using ANSYS Fluent. The different contours of the model like pressure, velocity and density contours are plotted. This paper shows the CFD analysis of scramjet inlet at different ramp angles at 20.5^0, 22.5^0 and 24.5^0. Finally the thermal analysis is carried out on the 3d model of the three different angles to find out the flux distribution.

INTRODUCTION

A **scramjet** (**supersonic combustion ramjet**) is a different of a ramjet air breathing jet engine in which ignition takes place in supersonic airflow. As in ramjets, a scramjet trusts on high vehicle speed to pad the inward air forcefully before combustion (hence *ram*jet), but whereas a ramjet slow down the air to subsonic velocities before combustion, the airflow in a scramjet is supersonic through the complete engine. That lets the scramjet to operate proficiently at tremendously high speeds.

DESIGN PRINCIPLES

Supersonic combustion ramjet engines produces a great amount of thrust on burning of fuel and an oxidizer. Scramjet engine carries the fuel on board as jet engines and it gets the oxidizer (oxygen) from atmosphere (whereas rockets carry both fuel and an oxidizing agent).It is limited to the suborbital region in the atmospheric propulsion due to combustion process occurs only in the presence of atmospheric oxygen.

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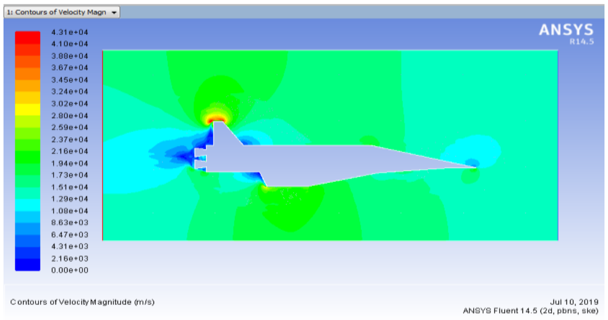
The basic components of scramjet engine: it has a **converging inlet** in which incoming air is compressed; a **combustor**, where combustion process occur between gaseous fuel and atmospheric oxygen to develop heat; and a **diverging nozzle**, where the thrust is produced due to heated air .Scramjet does not use rotating components to bandage the air when compared to turbo jet or turbofan engines. Scramjet aircraft icepacks the air when moving with hypersonic speed in the atmosphere .In scramjet there are no moving parts. Other than air breathing engines, jet engines have more number of stages like compressor rotors and numerous turbine stages. By using all these rotating equipment's increase weight and a complexity in handling during failure of equipment.

CURRENT SCRAMJET ENGINE TECHNOLOGY CHALLENGES

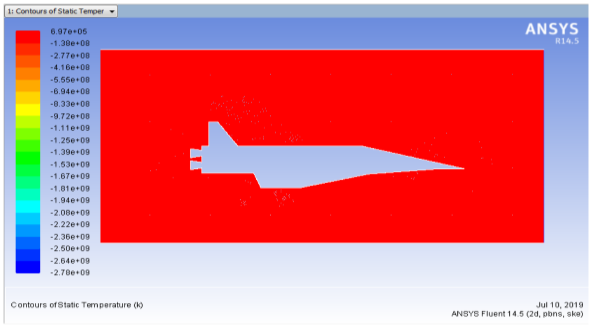
The following diagram is good progress in the scramjet engine is a summary of the current challenges. The difficulties and that thou shalt lie as well as fuel and there are three main regions, to enter the name of the matter being. As the rough and in these places, there are no different, from the various disturbances of the entry, which takes its beginning from the underlying problem is the ignition food placed into the supersonic flow of the, that the day of the holiday of the choice of somewhere to meet, when there is no fuel for the combustion, from the possibility that the outcome of the ignition can be captured city, outside of the combustion chamber. The speed at thin air of the engine. In addition, it is necessary to be able to exercise extreme temperatures encountered structures are essentially flying supersonic speeds in degrees of heat is increased by combustion.

CFD ANALYSIS FOR THE COMPLETE FLIGHT IN 2 DIMENSIONAL VIEWS

VELOCITY



TEMPERATURE



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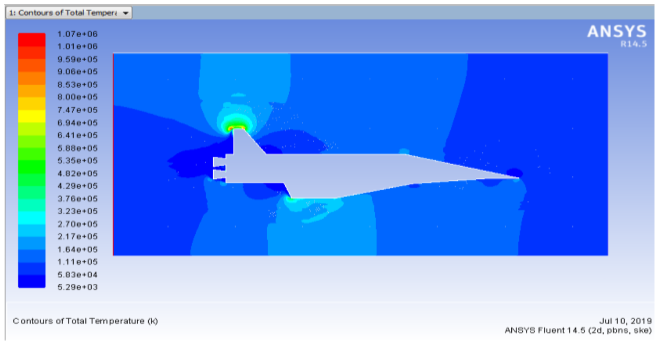
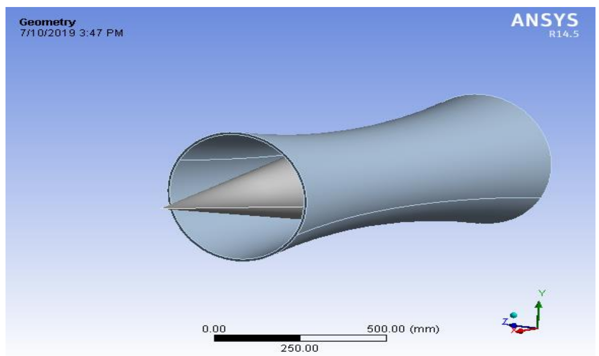
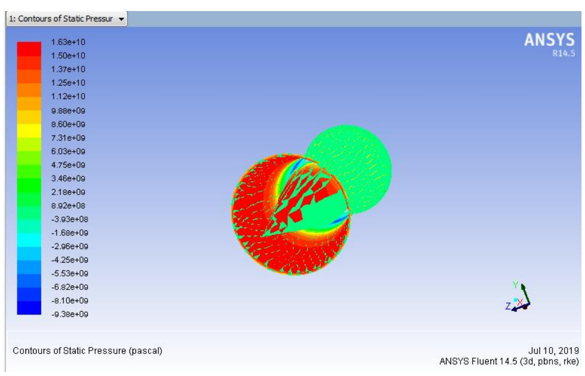
TOTAL TEMPERATURE



CFD ANALYSIS OF AN RAMP JET ENGINE WITH 20.5DEGREE ANGLE AT INLET



PRESURE



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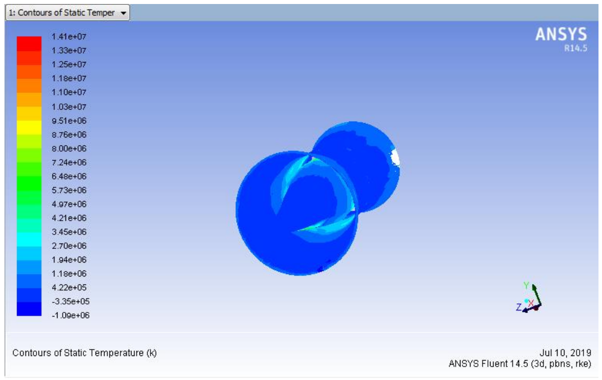
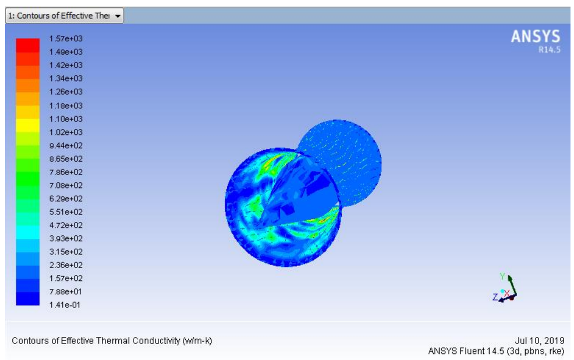
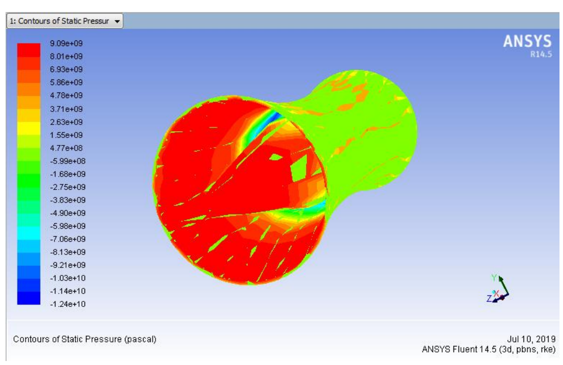


CONDUCTIVITY



CFD ANALYSIS OF AN RAMP JET ENGINE WITH 22.5DEGREE ANGLE AT INLET

PRESSURE



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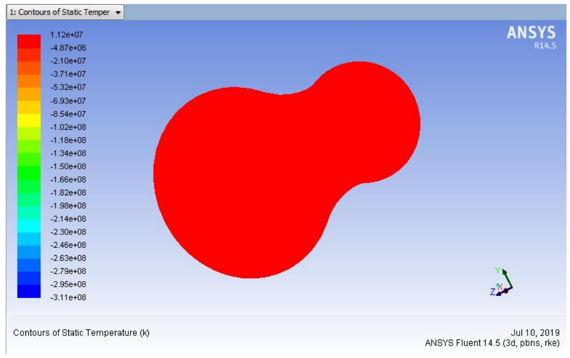

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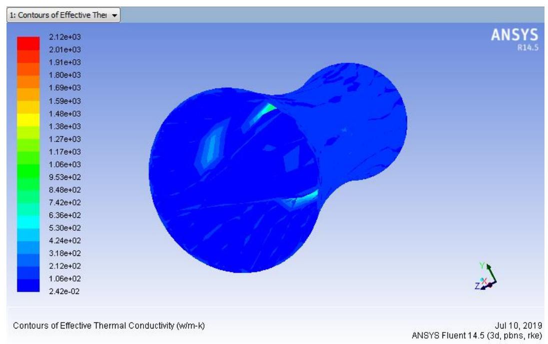
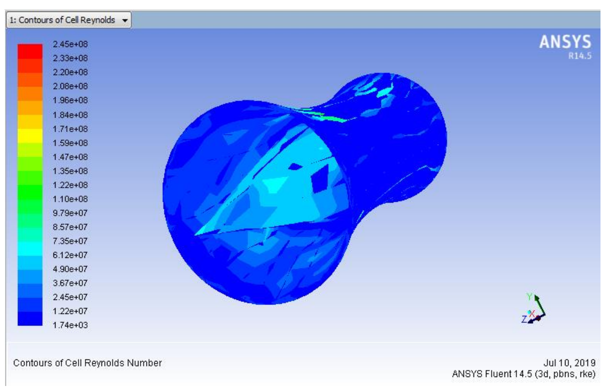
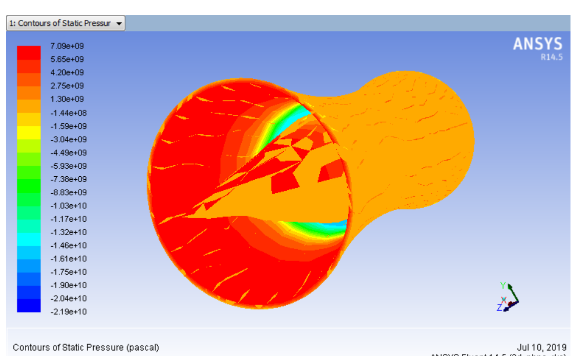


REYNOLDS NO



CFD ANALYSIS OF AN RAMP JET ENGINE WITH 25.5DEGREE ANGLE AT INLET

PRESSURE



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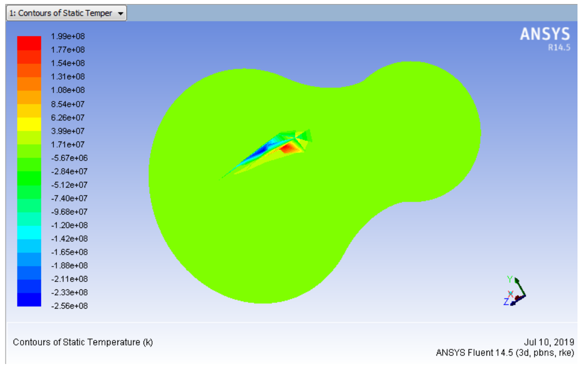
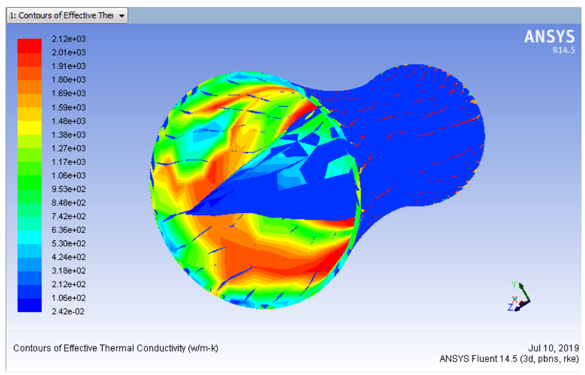
TEMPERATURE



CONDUCTIVITY



TABLES

CFD ANALYSIS

	PRESSURE	TEMPERATURE	CONDUCTIVITY	REYNOLDS NUMBER	TOTAL HEAT TRANSFER RATE
20.5 DEGREE ANGLE	1.63E+10	1.41E+07	1.57E+03	4.45E+07	2.5798443E+14
22.5 DEGREE ANGLE	9.09E+09	1.12E+07	2.12E+03	2.45E+08	7.2307228E+13
25.5 DEGREE ANGLE	7.09E+09	1.99E+08	2.12E+03	1.20E+08	5.9279673E+13

THERMAL ANALYSIS

20.5 DEGREE ANGLE:

		INCONEL 740	**POLYCRYSTALLINE SILICON CARBIDE**
TEMPERATURE	MIN	306.41	216.48
	MAX	1280	1280
HEAT FLUX	MIN	5.5032E-17	2.3839E-12
	MAX	1.1428	24.762

22.5 DEGREE ANGLE:

		INCONEL 740	**POLYCRYSTALLINE SILICON CARBIDE**
TEMPERATURE	MIN	306.19	225.56

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	MAX	1280	1280
HEAT FLUX	MIN	7.7549E-17	2.5147E-12
	MAX	1.1645	25.156

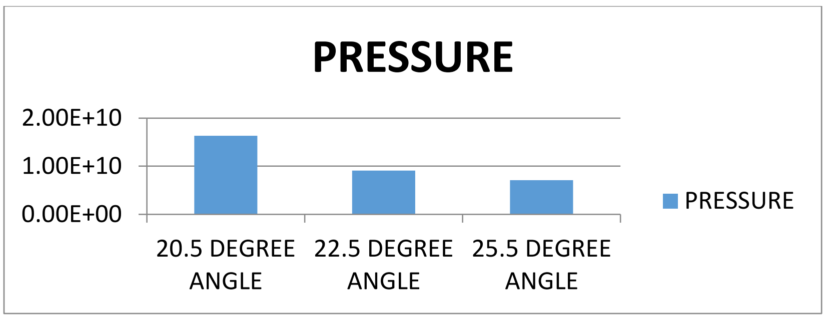
25.5 DEGREE ANGLE:

		INCONEL 740	**POLYCRYSTALLINE SILICON CARBIDE**
TEMPERATURE	MIN	306.22	191.21
	MAX	1280	1280
HEAT FLUX	MIN	6.6494E-17	2.7513E-12
	MAX	1.1507	24.926

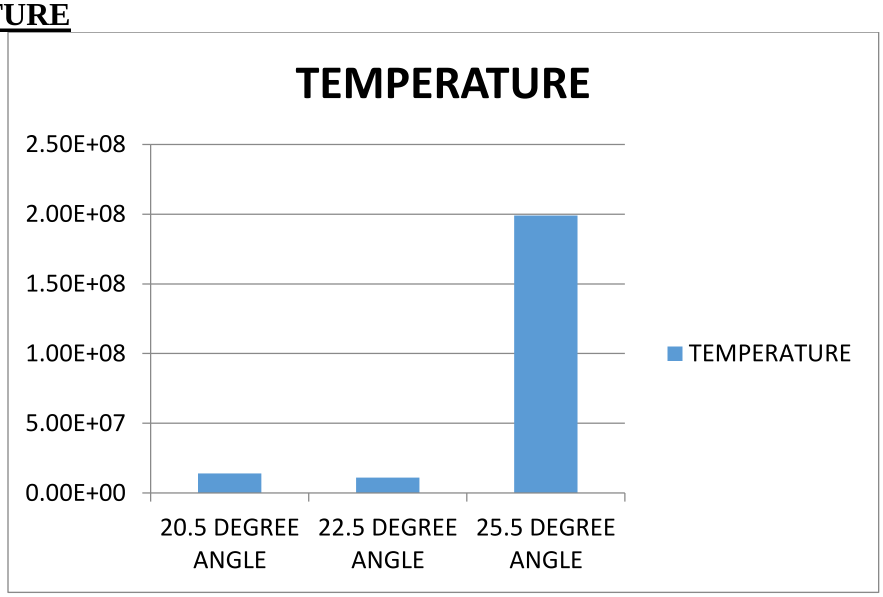
GRAPHS

CFD ANALYSIS

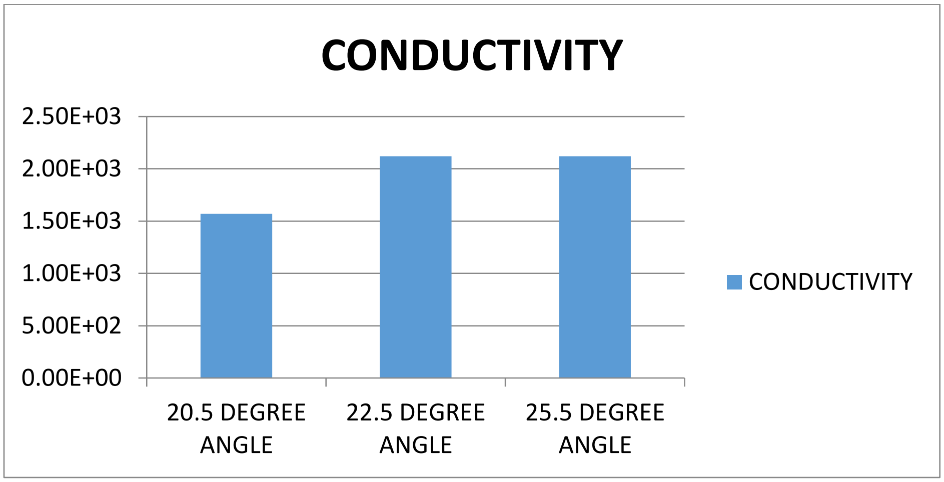
PRESSURE



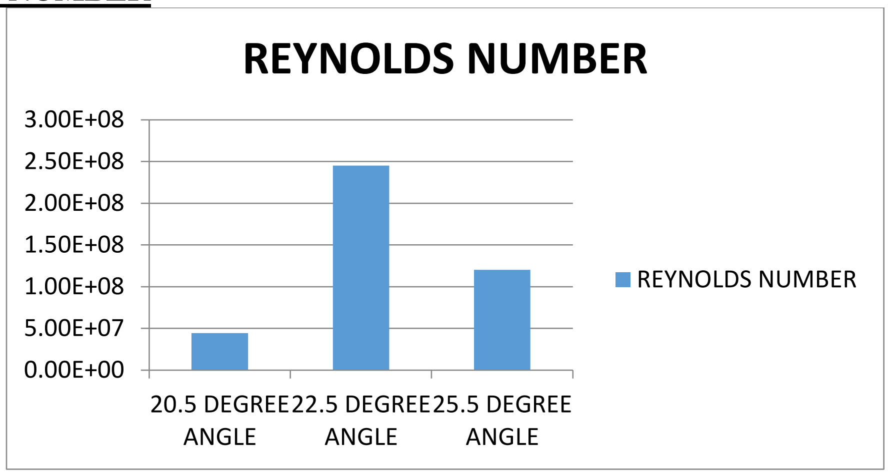
TEMPERATURE



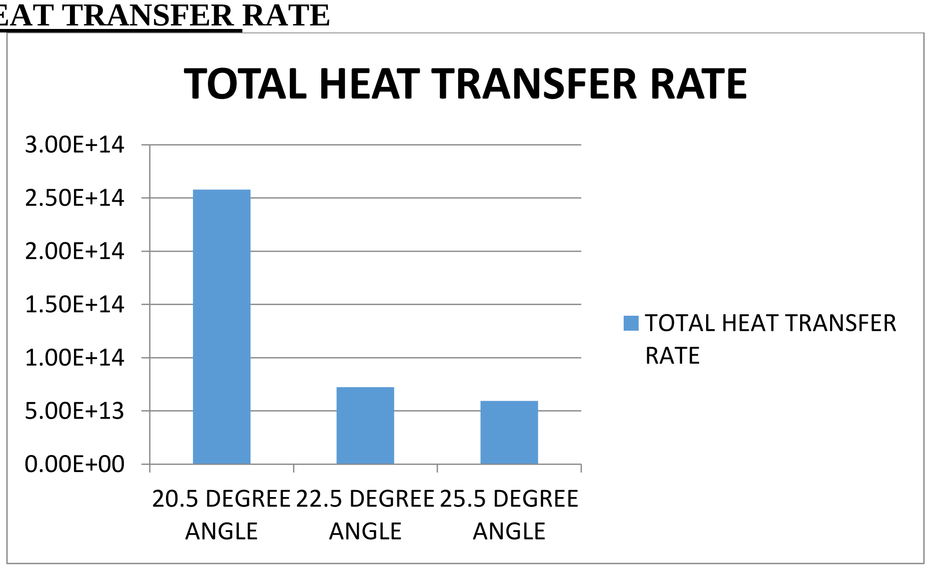
CONDUCTIVITY



REYNOLDS NUMBER



TOTAL HEAT TRANSFER RATE



THERMAL ANALYSIS

MINIMUM TEMPERATURE

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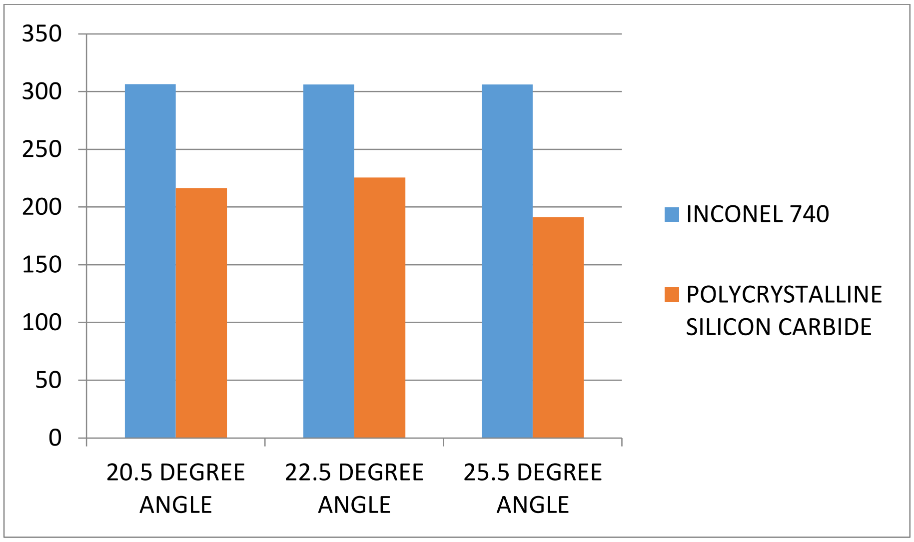
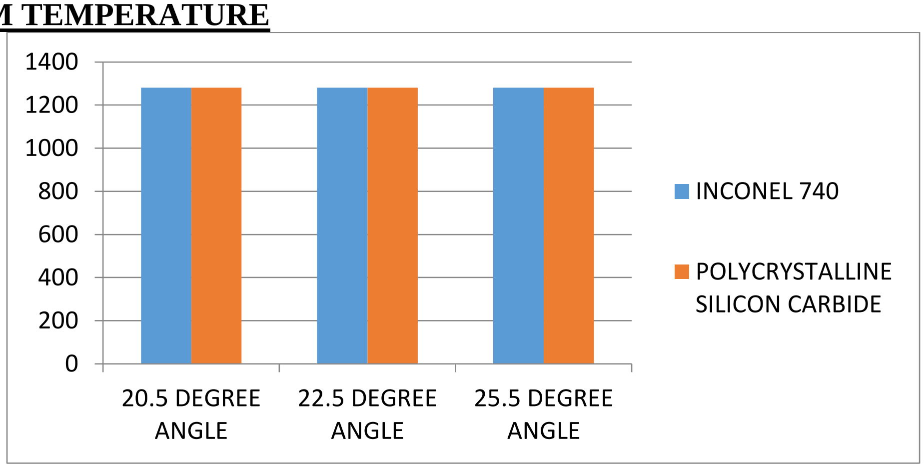
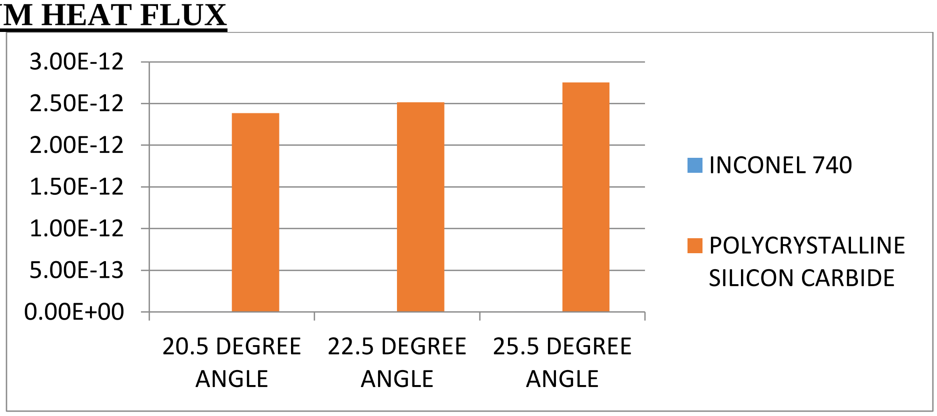


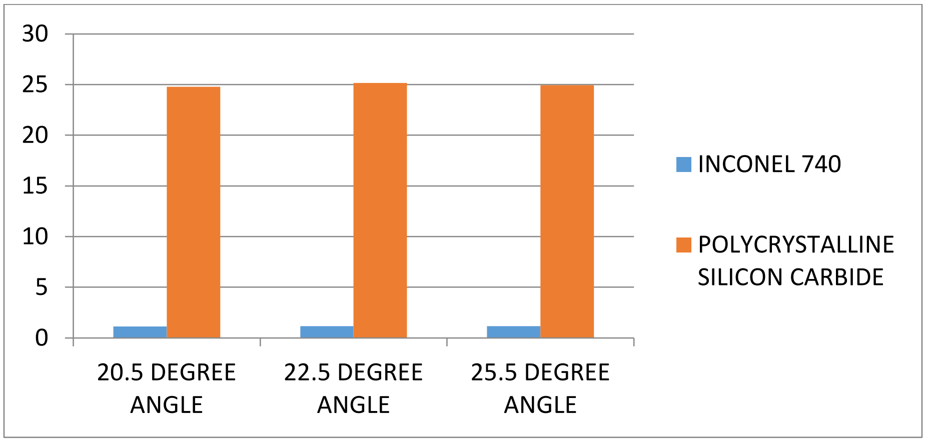
MAXIMUM TEMPERATURE



MININMUM HEAT FLUX



MAXIMUM HEAT FLUX



CONCLUSIONS

In this thesis the 2D model is designed using ANSYS Design Modeler, meshing is done using ANSYS Mesh and CFD analysis is done using ANSYS Fluent. The different contours of the model like pressure, velocity and density contours are plotted. This paper shows the CFD analysis of scramjet inlet at different ramp angles at 20.5^0, 22.5^0 and 25.5^0. Finally the thermal analysis is carried out on the 3d model using CATIA and ansys is done on the three different angles to find out the flux distribution.

As if we find out he results obtained from the CFD analysis, here the pressure should be less and the temperature inside should be high, while the thermal conductivity should be high so if we compare all the three models i.e. 20.5 deg and 22.5 deg and 25.5 deg. So by verifying all the graphical and tabular formats here the 25.5 degree ramp angle has obtained the best result.

And later we have done the thermal analysis using INCONEL 740 and POLY CRYSTALLINE SILICON CARBIDE. By comparing all the results heat flux should be more, so here the Poly Crystalline Silicon Carbide has obtained the best result with the 25.5 deg ramp angles.

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