Design And Optimization Of Combustor In Scram-Jet Engine

Ms.M. Gunasarami[1], Mr.M. Sanjay[2], Mr.M.G. Rajagopal[3]
[1]Dept of Aeronautical Engineering
[2, 3]Assistant Professor, Dept of Aeronautical Engineering
[1, 2, 3] Excel Engineering College

Abstract- *Optimization of combustor in scramjet engine This undertaking was especially a continuation of work performed in the T3 free cylinder stun burrow. Its points were twofold. To display the stream inside the model Scramjet motor utilizing the Computational Fluid Dynamics (CFD) program, CFD, the streamlining was performed by utilizing CFD. Weight estimations on the dividers of both the physical and calculation models were then looked at. In a succinct frame, the general objective of this task was to pick up certainty with the utilization of a CFD program for displaying supersonic stream and to apply this program to improve the Scramjet for most extreme push.*

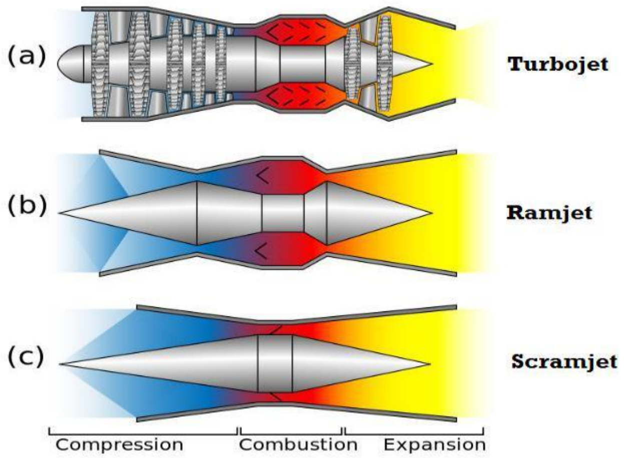
Keywords- Scramjet engine–Design&Analysis-Thrust Check -Modified thrust-software used etc.

I. INTRODUCTION

A specific end goal to give the meaning of a scramjet motor, the meaning of a ramjet motor is first vital, as a scramjet motor is an immediate relative of a ramjet motor. Ramjet motors have no moving parts, rather working on pressure to ease back free stream supersonic air to subsonic paces, in this way expanding temperature and weight, and afterward combusting the packed air with fuel. Finally, a spout quickens the fumes to supersonic paces, bringing about push. Because of the deceleration of the free stream air, the weight, temperature and thickness of the stream entering the burner are "impressively higher than in the free stream". At flight Mach quantities of around Mach 6, these builds make it wasteful to keep on slowing the stream to subsonic velocities. In this manner, if the stream is never again eased back to subsonic velocities, yet rather just eased back to worthy supersonic paces, the ramjet is then named a 'supersonic ignition ramjet,' bringing about the acronym scramjet. Keeping in mind the end goal to give the meaning of a scramjet motor, the meaning of a ramjet motor is first essential, as a scramjet motor is an immediate relative of a ramjet engine. Ramjet motors have no moving parts, rather working on pressure to ease back freestream supersonic air to subsonic paces, in this manner expanding temperature and weight, and afterward combusting the compacted air with fuel. In conclusion, a spout quickens the fumes to supersonic rates, bringing about push.

Jet Engine: A stream motor is a response motor releasing a quick moving plane that creates push by fly impetus. This expansive definition incorporates air breathing plane engines (turbojets, turbofans, ramjets, and pulsejet) and non-air breathing plane engines (such a rocket engines) in general, motor and warmed inside, utilizing motor put away as fuel, and rocket motor powers gives both the motor and mass stream to make push. All fractional air-breathing plane motors inner ignition motors that straightforwardly the air by consuming fuel, with the resultant hot gases utilized drive by means of a propulsive spout, albeit different strategies for warming the air have been exploratory with, (for example, atomic stream motors) most the model fly motors are turbofans which have to a great extent supplanted turbojets. The cutting edge motors utilize a gas turbine motors center with high finished all weight proportion (around 40 is to 1 out of 1995) and high turbine section temperature (about 1800 k in 1995) and the give a lot of the push with turbine control us straightforward slam impact (ramjet) or heartbeat ignition (beat fly) to give pressure.

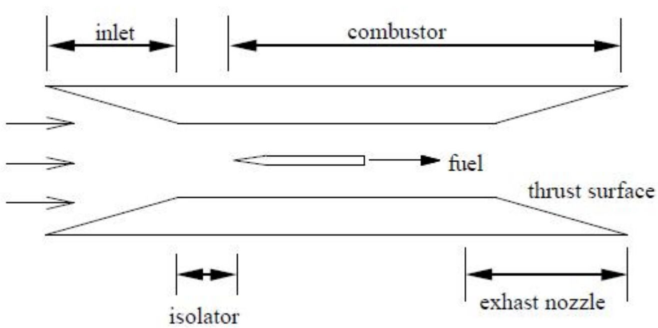
Scramjet Engine: Scramjets are mechanically very similar to ramjets. Like a ramjet, they consist of an inlet, a combustor, and a nozzle. They primary difference between scramjet and ramjet is that scramjet do not slow the oncoming airflow to the subsonic speed for combustion, they use supersonic combustion instead the name scramjet comes from supersonic combusting ramjet. In order to provide the definition of a scramjet engine, the definition of a ramjet engine is first necessary, as a scramjet engine is a direct descendant of a ramjet engine. Ramjet engines have no moving parts, instead operating on compression to slow free stream supersonic air to subsonic speeds, thereby increasing temperature and pressure, and then combusting the compressed air with fuel. Lastly, a nozzle accelerates the exhaust to supersonic speeds, resulting in thrust.



Comparative diagram of scramjet engine

Due to the deceleration of the free stream air, the pressure, temperature and density of the flow entering the burner are "considerably higher than in the free stream". At flight Mach numbers of around Mach 6, these increases make it inefficient to continue to slow the flow to subsonic speeds. Thus, if the flow is no longer slowed to subsonic speeds, but rather only slowed to acceptable supersonic speeds, the ramjet is then termed a 'supersonic combustion ramjet,' resulting in the acronym scramjet.

The advancement was performed by utilizing CFD. Weight estimations on the dividers of both the physical and calculation models were then looked at.

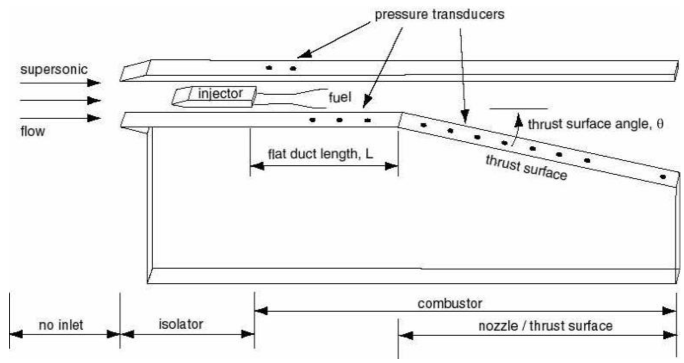


Generic scramjet engine

In a succinct frame, the general objective of this venture was to pick up certainty with the utilization of a CFD program for demonstrating supersonic stream and to apply this program to streamline the Scramjet for greatest push.

II. SCRAMJET MODEL

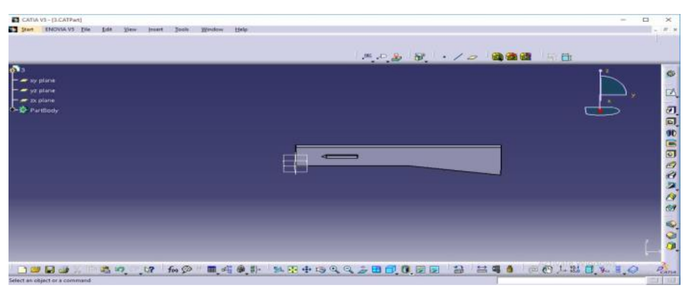
The Scramjet is intended to be utilized as a part of the T3 Free Piston Shock Tunnel4. This stun burrow is fit for delivering supersonic stream at a high temperature, the conditions that would be common at the bay of a genuine Scramjet. The Scramjet is a channel roughly 500mm long, 25 mm high and 52 mm wide. It has a plane base injector (level finished) infusing fuel parallel to the stream and push surface on the base side. The two geometric parameters, level channel length, L and push surface edge, q ought to be noted. For the motivations behind this postulation the level conduit length is characterized as the separation between the finish of the injector and the beginning of the push surface. Twelve weight transducers are mounted on the floor of the Scramjet. Figure 2 demonstrates a schematic of the Scramjet. A few alterations were made to the Scramjet amid this task. These are layout in area.

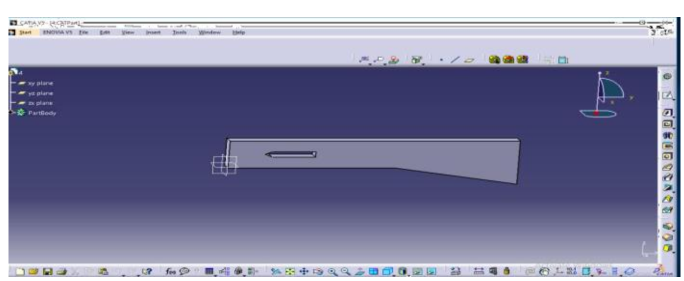


Schematic of Scramjet showing flat duct length, L and thrust surface angle

III. CATIA MODELLING

CATIA is a multi-stage programming suite for PC helped design(CAD) , PC supported manufacturing(CAM),computer-helped engineering(CAE), PLM and 3D created by the French organization Dassault framework.





Three graphs have been drawn with various pushed surface point and level channel length. The principal graph speaks to 50mm level conduit length with 4 push surface point.

SOLUTION METHODOLOGY AND GOVERNING EQUATION

It utilizes a control volume approach in computing stream parameters. The locale of enthusiasm for the stream is partitioned into a lattice. Every network component is considered as a control volume with the properties consistent over its volume. For each control volume, liquid stream is reenacted by numerically unraveling incomplete differential conditions that administer the vehicle of stream amounts, otherwise called stream factors. The factors incorporate mass, force, vitality, turbulence amounts, blend portions and species focuses The three conditions normal to every single liquid dynamic issues are the protection of mass, force and vitality conditions. In differential shape these are:

Conservation of mass:

$$\frac{\partial \rho}{\partial t}+\frac{\partial}{\partial x_j}(\rho u_j)=0$$

Where *uj*is the jth Cartesian component of the instantaneous velocity and *r* is the fluid density.

Conservation of momentum:

$$\frac{\partial}{\partial t}(\rho u_i)+\frac{\partial}{\partial x_j}(\rho u_i u_j)=-\frac{\partial p}{\partial x_k}+\frac{\partial \tau_{ij}}{\partial x_j}+\rho f_i$$

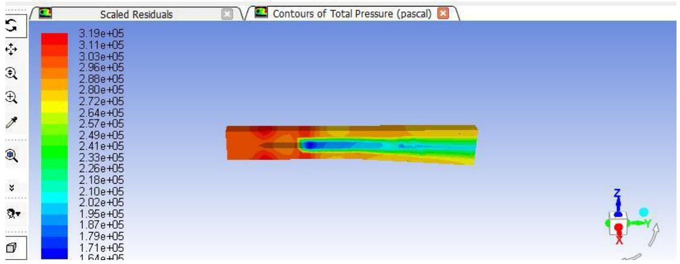
Where *p* is the static pressure, *tij* is the viscous stress tensor and *fi* is the body force.

IV. ANSYS ANALYSIS

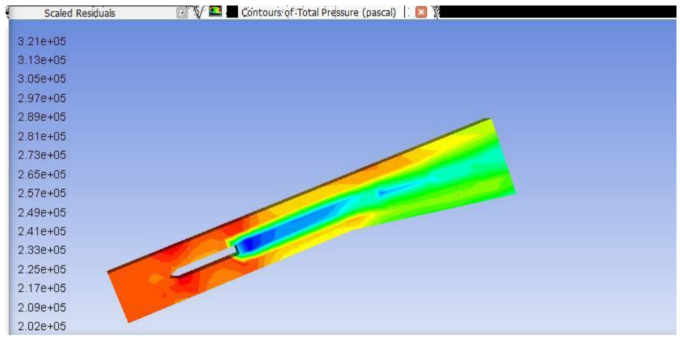
ANSYS develops and mark its finite element analysis software used to simulate engineering problems. The software creates simulated computer models of structures, electronics or machine components to simulate strength, toughness,electricity,temperaturedistribution,electromagnetim, fueled flow and other attributes. ANSYS is used to determine how a product will function with different specification, without building test product and connecting crash testers. Finally, the ANSYS software simulate and analysis, moment, fatigue, fractures, fluid flow, temperature distribution, electromagnetic efficiency and other effects over time.

1. Pressure Analysis:

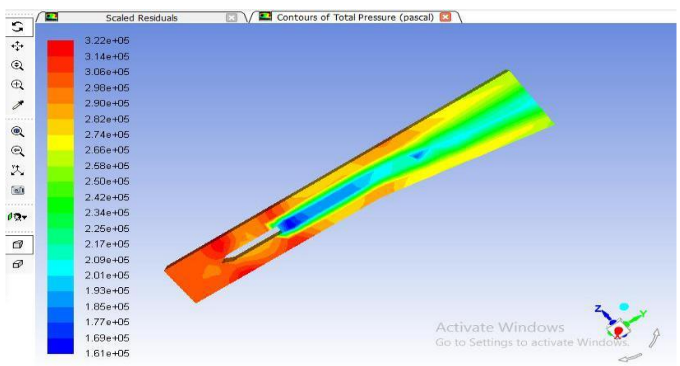
The below analysis work is the pressure contour for the given free stream conditions mentioned. The pressure is seen to be constant after reaching the inlet and slowly varies but remains same till the end of the injector exit



Pressure Analysis for model 1



Pressure Analysis for model 2



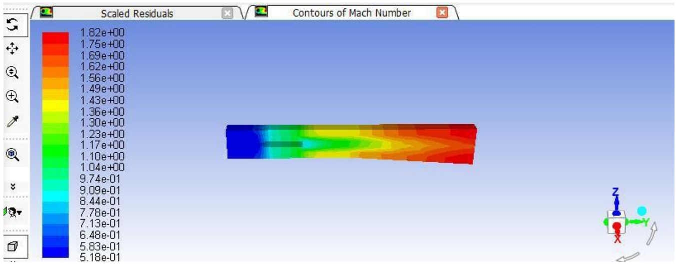
Pressure Analysis for model 3

Comparative Data

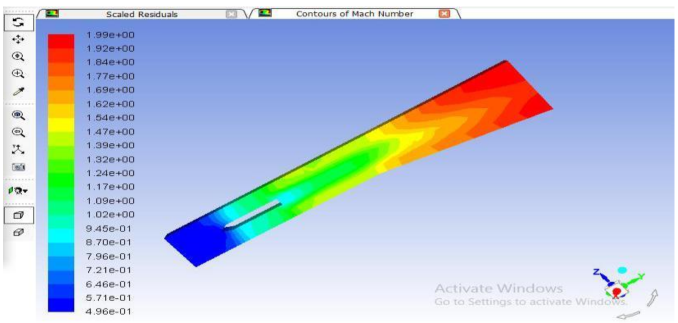
Models	Pressure values min(pa)	Pressure value max(pa)
Model 1	1.64e5	3.19e5
Model 2	1.61e5	3.22e5
Model 3	2.02e5	3.21e5

2. Velocity-Mach Number Analysis:

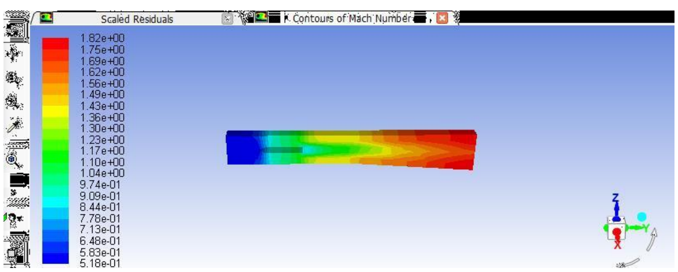
The above analysis result is the velocity contour for the configuration. This shows that there is very high velocity flow over the sides of injector wall and slowly decreases when it passes out the exit area



Velocity Analysis for model 1



Velocity Analysis for model 2



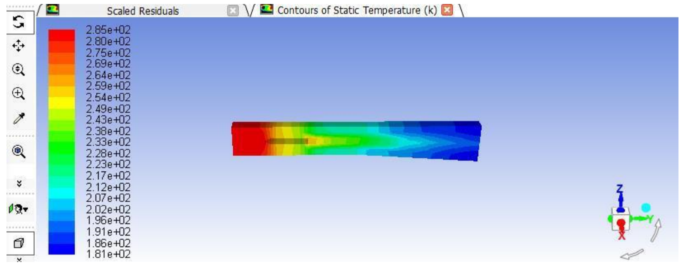
Velocity Analysis for model 3

The free stream conditions used were as follows:

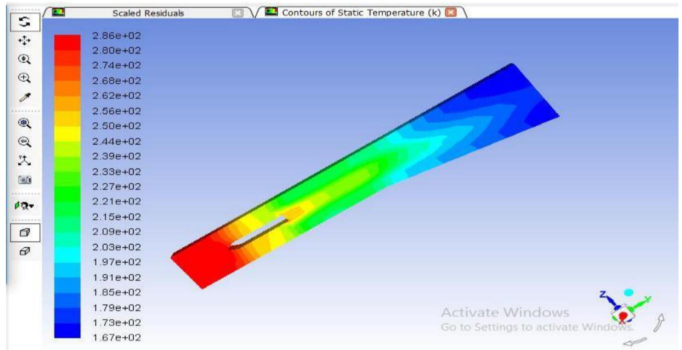
a) Mach number-3.0
b) Pressure-100 kpa
c) Temperature- 1000 K
d) Equivalent Ratio- 0.5

3. Temperature Analysis

This temperature result shows the heat which is acting on the surface



Temperature Analysis for model 1



Temperature Analysis for model 2

V. CONCLUSIONS

Overall, CFD-FLUENT was found to be a useful and accurate tool for modelling the supersonic, Combusting flow in a Scramjet engine. While the initial development of a CFD model was time consuming, once an accurate model was determined, modifications of flow conditions and geometric parameters could be easily and quickly made. It is interesting to note that obtaining experimental pressure measurements was a quicker process than CFD modelling in terms of both overall time taken and the time to investigate each configuration. However, CFD generates a much larger number of flow parameters than can be experimentally determined and is significantly less expensive, in terms of both personnel and equipment, than performing experiments in the shock tunnel. Also, once a model has been developed and verified subsequent modelling is significantly quicker and easier than experiments. Hopefully this project provides a basis for subsequent CFD modelling of the Scramjet engine.

REFERENCES

[1] Yu, G., J.G. Li, X.Y. Chang, L.H.Chen, and C.J. Sung. "Investigation of Kerosene Combustion Characteristics with Pilot Hydrogen in Model Supersonic
[2] Combustors." Journal of Propulsion and Power, Volume 17, No. 6, NovemberDecember 2001: 1263-1272.
[3] National Research Council, Committee on the National Aerospace Initiative, Air Force Science and Technology Board, Division on Engineering and Physical Sciences.

Evaluation of the National Aerospace Initiative. Washington, DC: The National Academies Press, 2004.

[4] Wickham, D.T., J.R. Engel, B.D. Hitch, and M.E. Karpuk. "Initiators for Endothermic Fuels." Journal of Propulsion and Power, Volume 17, No. 6, November-December 2001: 1253-1257.SR-71 Flight Manual. 2 June 2008 <http://www.sr-71.org/blackbird/manual/>.

[5] Heiser, William H., David T. Pratt, Daniel H. Daley, and Unmeel B. Mehta.Aeronautics and Astronautics, 1994.