Analysis of Flow of Nozzles by Using Computational Fluid Dynamics

N. Lenin Rakesh and K. Rambalaji

Abstract--- *Introduction Control of high-speed jets, with passive control in the form of tabs of various shapes has been reported by large number of researchers in open literature. A tab is essentially a small solid strip kept normal to the flow, usually at the nozzle exit.*

Keywords--- *Flow of Nozzles, Fluid Dynamics, Flow Channel.*

I. INTRODUCTION

Introduction Control of high-speed jets, with passive control in the form of tabs of various shapes has been reported by large number of researchers in open literature. A tab is essentially a small solid strip kept normal to the flow, usually at the nozzle exit. A tab (placed normal to the flow) generates a pair of counter rotating transverse vortices (with the axis of rotation along the tab length), which become stream wise soon after shedding, that can influence the jet flow development significantly. From the vortex theory, it is well known that, the smaller the vortex size the better is its mixing promotion efficiency. Also, small vortices are stable and can travel longer distances compared to large vortices, which are unstable [1]. In the subsonic and sonic jet studies reported so far, tabs of straight edges only have been studied

II. LITERATURE SURVEY

Rathakrishnan E et al (2009), The efficiency of corrugated tabs in promoting the mixing of Mach 1.8 axi-symmetric free jet has been investigated experimentally. Two rectangular tabs of 4.2% blockage, with corrugations at the edges, located diametrically opposite at the exit of a Mach 1.8 convergent-divergent nozzle were found to be better mixing promoters than identical rectangular tabs without corrugations, at over expanded, correctly expanded and under expanded states of the jet. Furthermore, the corrugated tabs were found to be more efficient in weakening the shocks in jet core compared to the plain tabs. As high as 78% of reduction in core length was achieved with corrugated tabs for the jet operated at nozzle pressure ratio (NPR) of 7, the corresponding reduction with the plain tabs is only 54%. The mixing effectiveness of corrugated tabs increases progressively with increase of NPR whereas, the maximum mixing effectiveness of the plain tabs is found to be at the correctly expanded state. Shadowgraph pictures of the uncontrolled and controlled jets clearly demonstrate the effectiveness of corrugated tabs in weakening the waves in the jet core. The speculation of smaller vortices generated by the corrugated tab is supported by a preliminary visualization with water flow channel.

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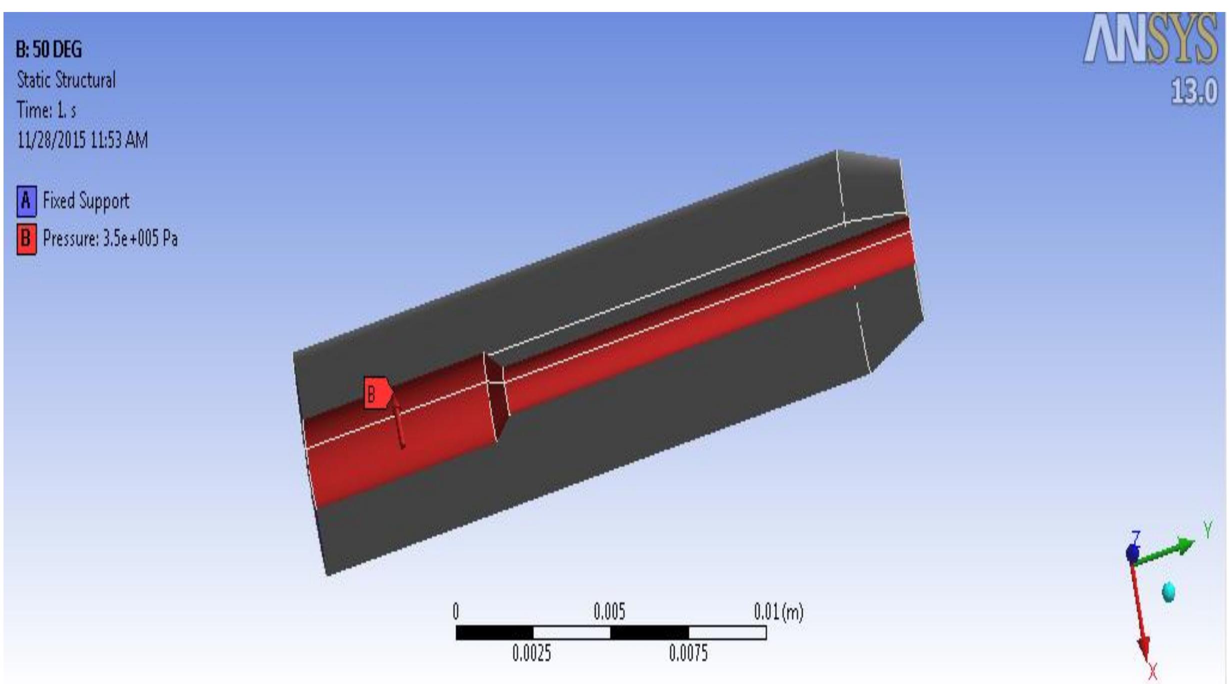
PiyushVijayan et al (2014), Numerical Simulation of a circular, square and rectangular jet is being carried out at subsonic Mach number and various flow properties and turbulence characteristics are being obtained. Simulations are performed in a three dimensional computational domain using steady RANS equations and SST k-_ turbulence model. The computational domain is discretized using hexahedral mesh .The velocity decay of all the three nozzles are being analyzed with the main aim of attaining better mixing characteristic. Results show that the rectangular jet due to its better entrainment and small scale mixing property is more efficient when it comes to mixing enhancement characteristic due to its non axi-symmetric geometry. Furthermore, the importance of Urms and Vrms in mixing enhancement is also analyzed. Shortening of potential core and velocity decay in rectangular jet ultimately also result in reduction of sound from the jet exit.

III. ANSYS: AN OVERVIEW

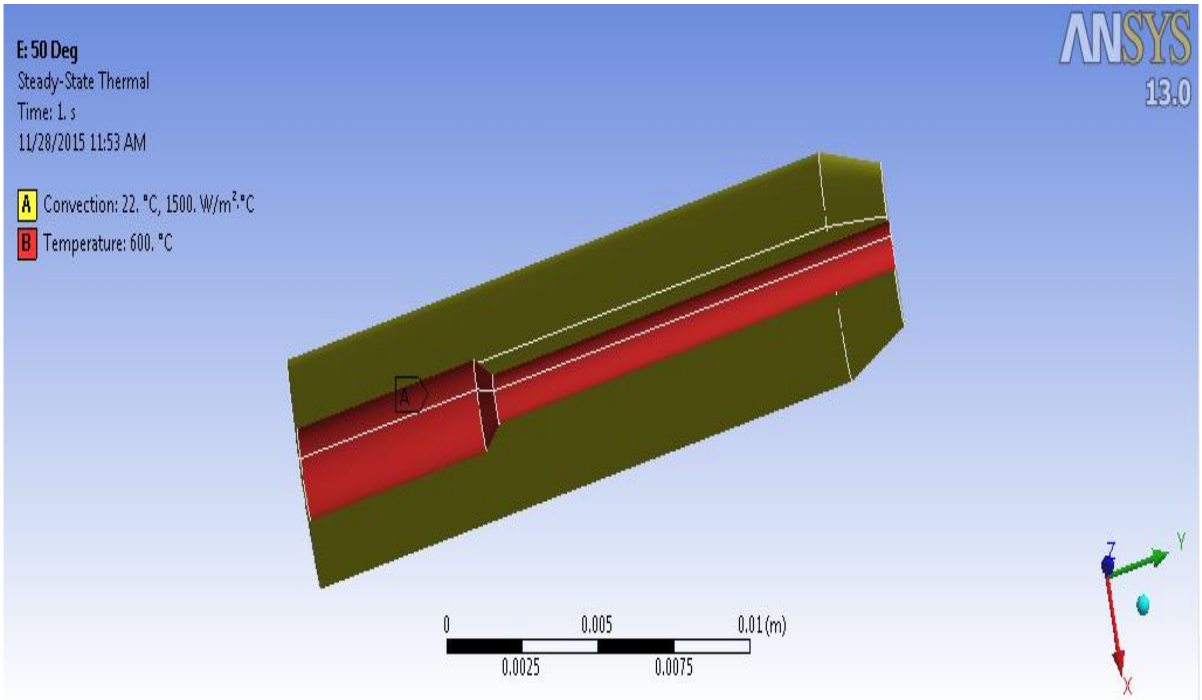
ANSYS has evolved into a multipurpose design analysis software program, recognized around the world for its many capabilities. The first release of the ANSYS program looked much different than it does today; offering only heat transfer and linear structural analysis. It was a batch program, like most in its day, and ran only on a mainframe computer. The early 1970s brought many changes to the program as the ANSYS staff incorporated new technology and user requests.

IV. PARAMETERS

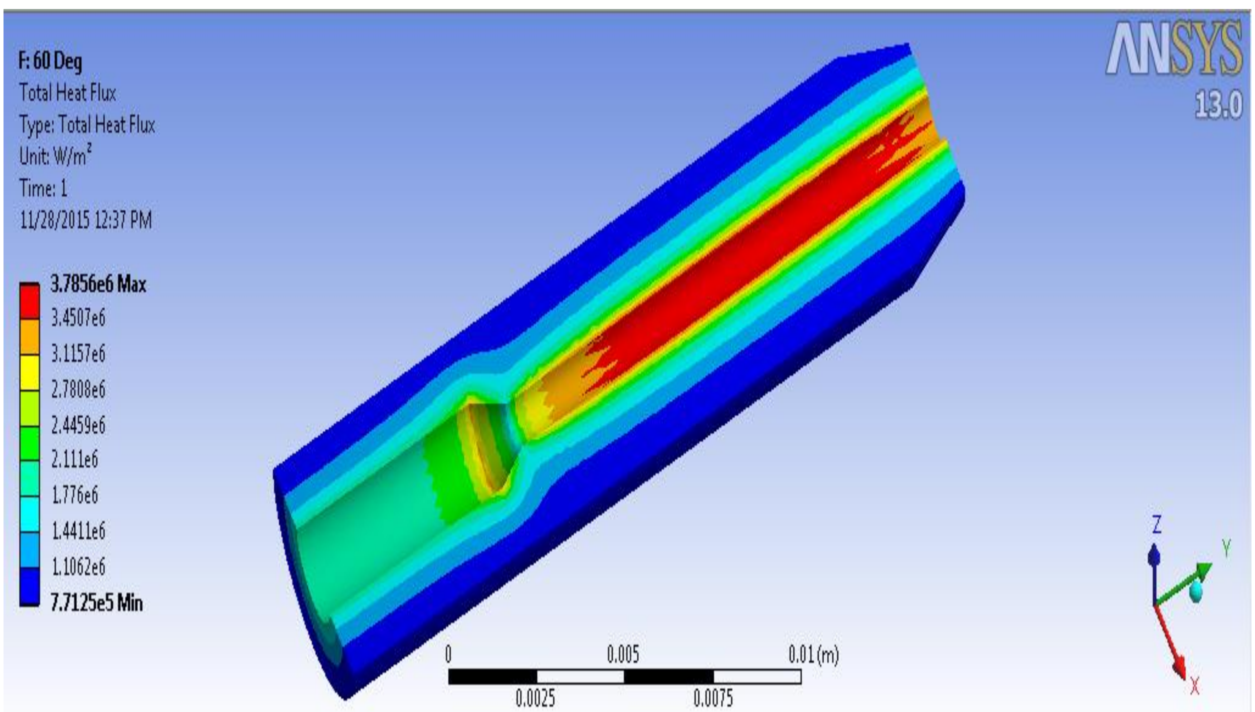
Structural Load



Thermal Load



V. ANALYSIS RESULTS



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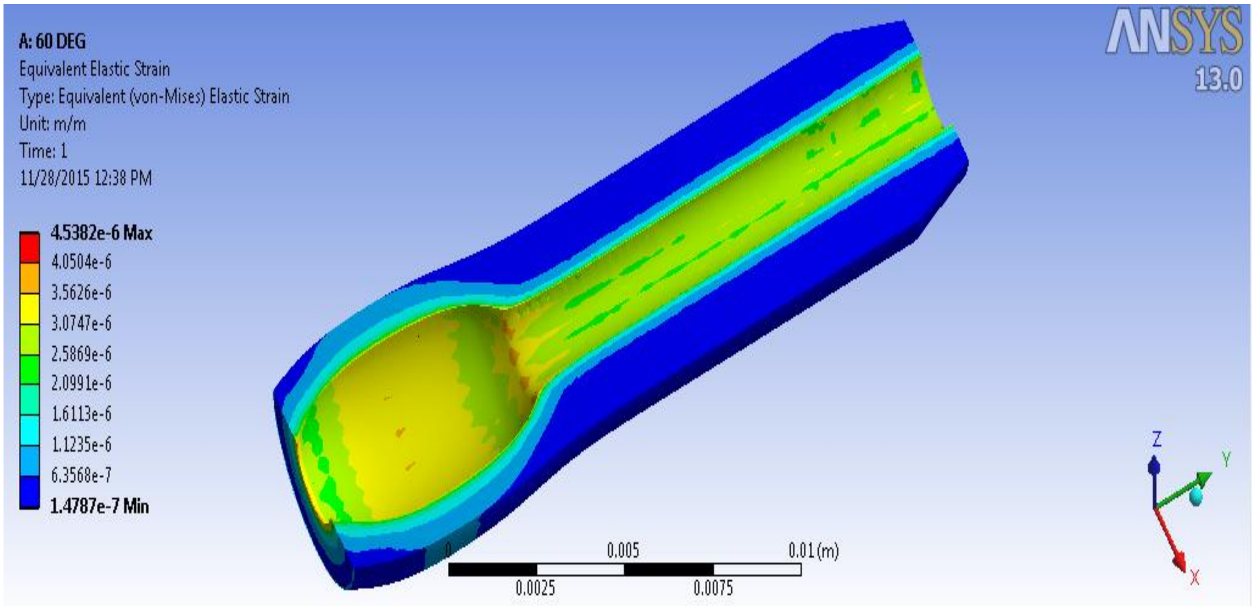
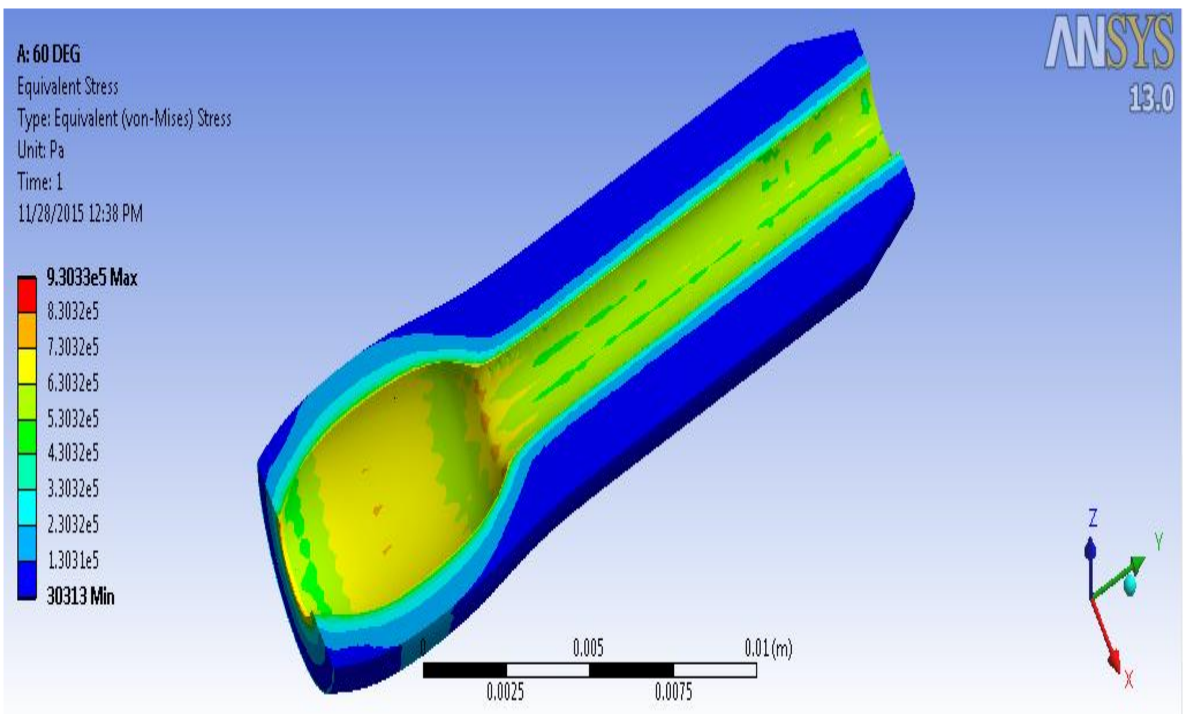
Von mises Strain in 60 deg Angle



Von Mises Stress in 60 deg Angle



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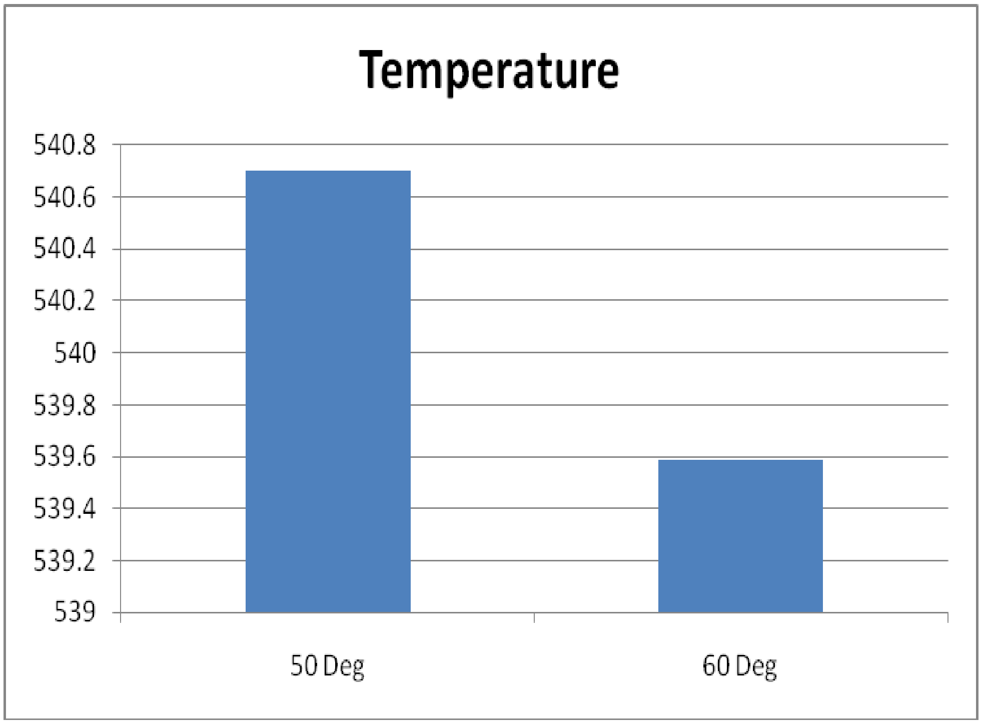
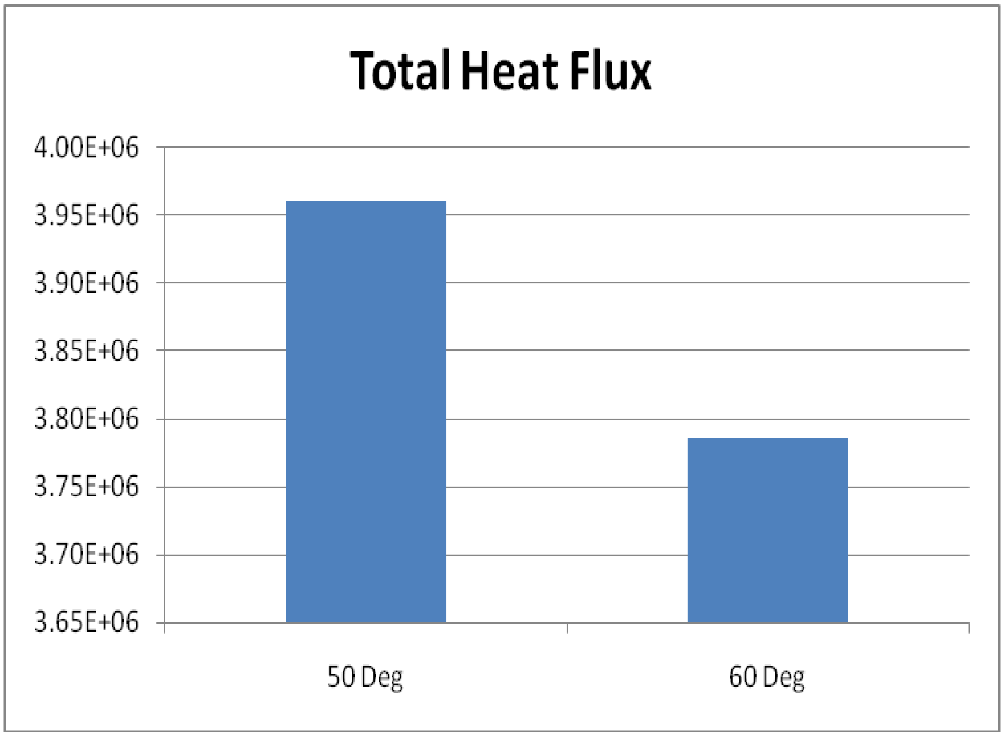
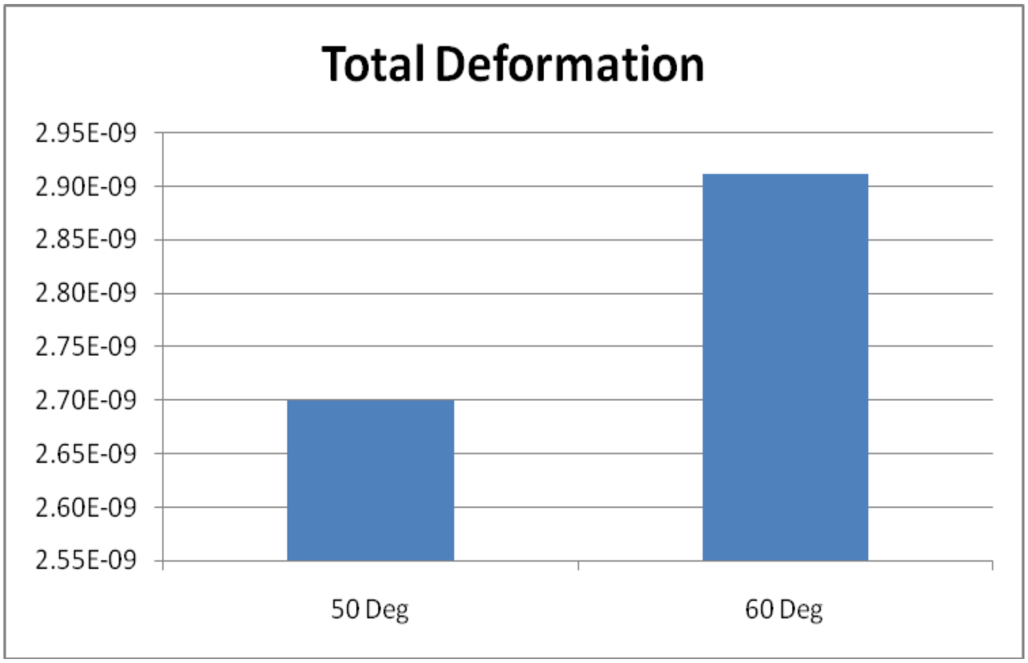
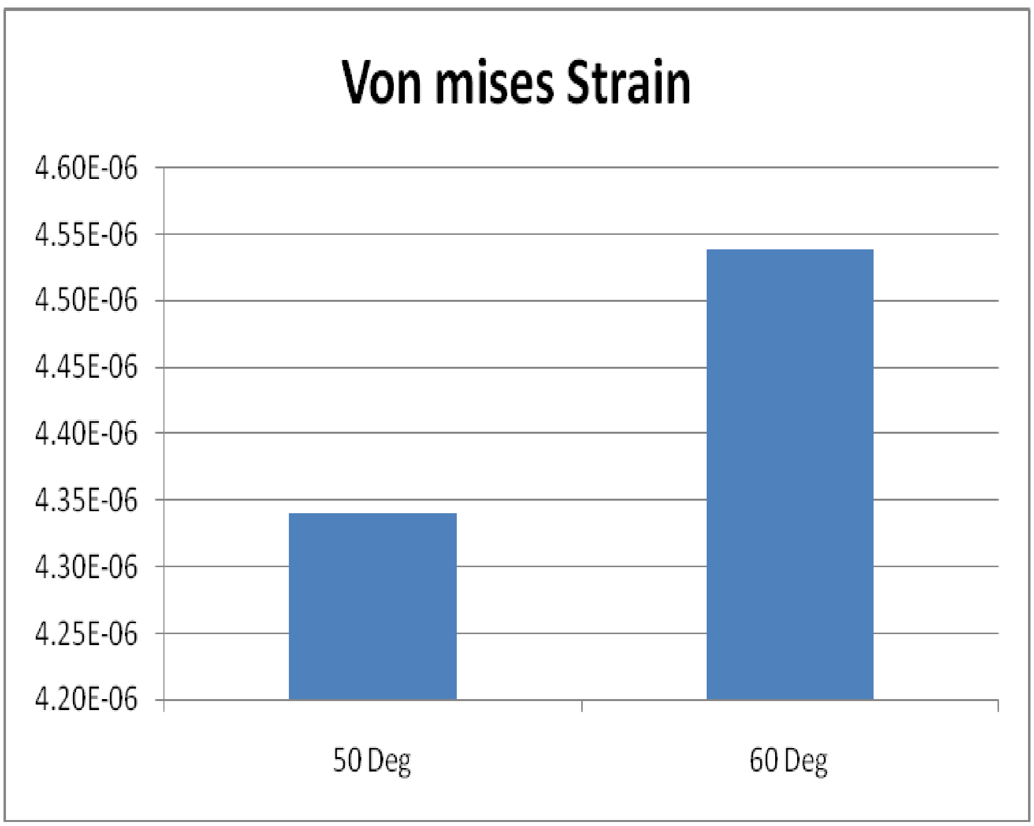
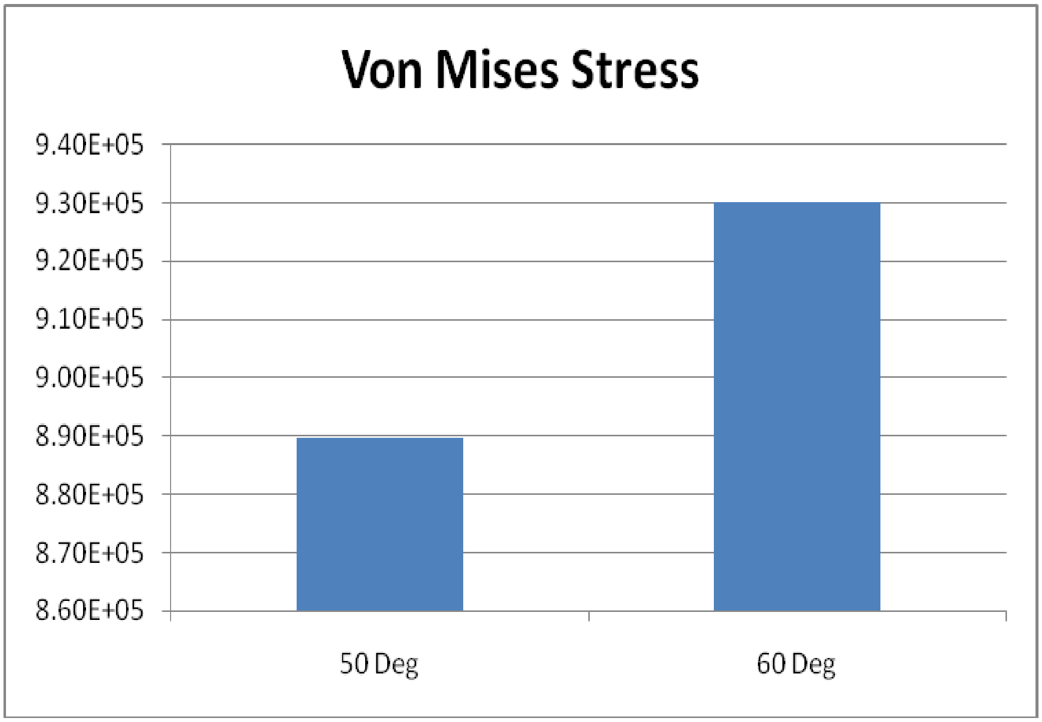
VI. COMPARISON OF RESULTS






Total Deformation
2.95E-09
2.90E-09
2.85E-09
2.80E-09
2.75E-09
2.70E-09
2.65E-09
2.60E-09
2.55E-09
50 Deg
60 Deg


Von mises Strain
4.60E-06
4.55E-06
4.50E-06
4.45E-06
4.40E-06
4.35E-06
4.30E-06
4.25E-06
4.20E-06
50 Deg
60 Deg



VII. CONCLUSION

From the obtained numerical results it was concluded followings.

At the throat section also, the Mach number goes on increasing with increase in divergent angle.

The static pressure decreases with increased divergent angle.

It was observed that oblique shocks are formed during flow through the nozzle. When the divergent angle was 50 °, the first shock occurred at 1m from the inlet and this wave reflected from the walls of the nozzle. It was found that the decrease in divergent angle displaces the shock towards the exit of the nozzle. The strengthen of nozzle was increased with the reduced angle. When the angle was reduced the strengthen of the nozzle was reduced.

FUTURE SCOPE

In future the fluid dynamic analysis will be conducted in the Nozzle. By using COMPUTIONAL FLUID DYNAMICS the dynamic analysis are going to be conducted.

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