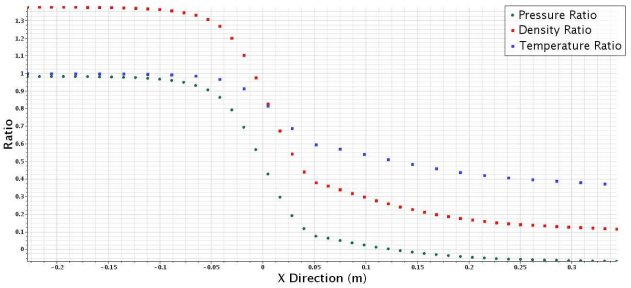
CFD ANALYSIS OF SUPERSONIC FLOW THROUGH CD NOZZLE

Objective

To study the supersonic flow with shock characteristics using CD Nozzle Analysis

Challenges

- To Locate the position of Shocks in divergent part
- To increase the overall efficiency of Nozzle under their operating condition
- Ensuring fine meshing at critical regions to capture the flow physics accurately



Graph 1: Computed Plots along Central Line

CFD Model

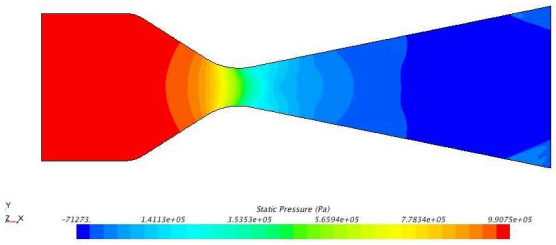


Fig.1: Static Pressure

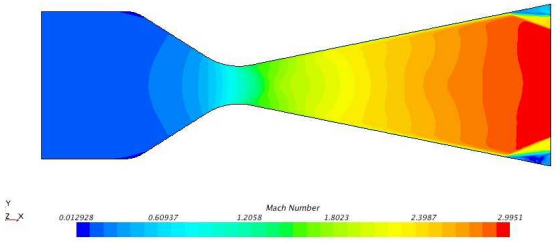


Fig.2: Mach Number

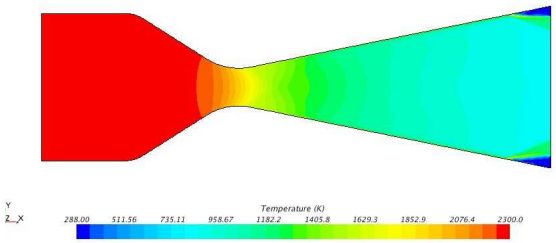


Fig.3: Temperature

Approach

The classical one-dimensional inviscid theory does not reveal the complex flow features in a choked CD nozzle accurately. The CFD has been used to compute supersonic flow in the CD nozzle for Nozzle Pressure Ratio (NPR) corresponding to presence of shock inside the diverging part of the nozzle. The computed solutions capable of locating the shock location, shock structure and after-shocks which cannot be predicted using the theoretical calculations.

Section	A_x/A_{th}	V (m/s)		T (K)		P (Pa) x 10^5		Mach	
		Theo	CFD	Theo	CFD	Theo	CFD	Theo	CFD
Position A	1.5	412	626	2217	2104	8.81	8.07	0.44	0.68
Position B	1.2	551.7	772	2150	2002	7.9	6.78	0.59	0.86
Throat	1	877.9	876	1918	1917	5.28	5.82	1	0.997
Position C	1.2	1221	1139	1559	1652	2.57	3.47	1.54	1.39
Position D	4	1710	1703	844	853	.293	.342	2.93	2.9

Table 1: Comparison of Theoretical Calculation with CFD

Conclusion

The one-dimension inviscid theory cannot reveal all the flow features correctly. One can capture such complex flows by employing a CFD code. The CFD code has been successfully used here to compute the real life flow features like lambda shock, location of shock and after-shocks in a CD nozzle.

The CFD use of convergent and convergent-divergent nozzles show that it is quite possible to understand how a convergent-divergent nozzle “works” and it has shown that useful calculations can be made to the point where an engineer can make a good start at designing a nozzle. However it makes sound sense to look at the nozzle in use to see what constraints the engineering imposes on the physics.

Benefits

- Predicting the effectiveness of modified Nozzle design without prototyping trials
- Improving the Efficiency of the Nozzle
- Modeling both co-axial nozzle and tangential-inlet swirl nozzle can meet the requirement of preparing nano-drugs in SEDS (Solution Enhanced Dispersion by Supercritical fluid) process

Applications

- Injection of Fuels into Combustion Chamber
- Optimization of Fire Extinguisher geometry and Discharge tubes
- Short Branch Nozzle, Fog Nozzle, Hand Control Nozzle
- Fuel and air interaction phenomena

COMPUTATIONAL FLUID DYNAMICS
TEFUGEN TECHNOLOGIES PRIVATE LIMITED
G Floor, L-2, Electrical & Electronics Industrial Estate, Thuvakudy, Tiruchirapalli – 620 015. Tamilnadu, India.
+91 431 2500322 +91 431 2501134 tefugen@tefugen.com www.tefugen.com