MODEL AND PERFORMANCE ANALYSIS OF CONVERGENT-DIVERGENT JET WITH DIFFERENT MACH NUMBERS

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Abstract

The model of exhaust jet system for aircraft having a supersonic cruise mission is often optimized for a cruise condition and conjointly should offer sufficient thrust performance at alternative vital operational points like takeoff and transonic conditions. In distinction, the exhaust jet system for a vehicle with accelerating mission should offer best performance across the flight en-wrap as there's not a hard and fast cruise purpose wherever the craft operates the bulk of the time.

The aerodynamic model and performance analysis of exhaust jet convergent – divergent models by changing the lengths of the jet under subsonic (0.4), transonic (0.9) and supersonic (3.0) flow conditions. The lengths considered for convergent – divergent jet is 152.19mm, 188.02mm. The comparisons are made for pressure distribution, velocity.

3D models are done in CREO 2.0 and CFD analysis is done in ANSYS.

Keywords:

Convergent-divergent(C-D) Jet

Mach number

Static pressure

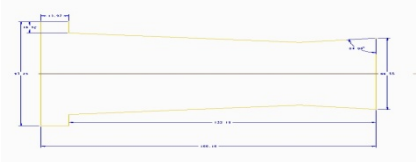
Velocity

1. Introduction

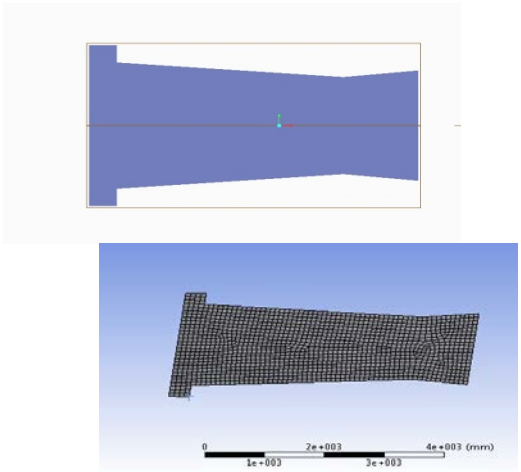
A jet is a device modeled to control the direction or characteristics of a fluid flow (especially to increase velocity) as it exits (or enters) an enclosed chamber or pipe. A jet is usually a pipe or tube of variable cross sectional space and it is accustomed direct or modify the flow of a fluid (liquid or gas). Jets are often accustomed to control the speed of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them. In jet speed of fluid will increase on the expense of its pressure energy.

For model modeling reference is taken from "An experiment on aerodynamic jets at M= 2 by J. REID, Communicated by the Deputy Controller Aircraft (Research and Development), Ministry of Aviation Reports and Memoranda No. 3382, November, 1962.

2. Models of Convergent-Divergent Jet with Different Lengths

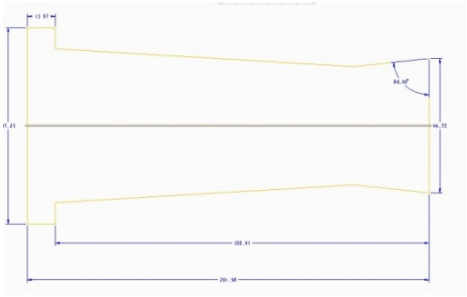


2D Model of C-D jetWith Length 152.19mm

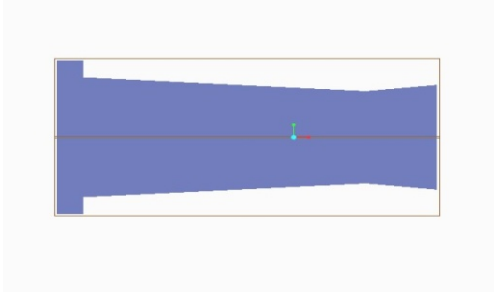


3D Surface Model of C-Djet with Length 152.19mm **3.Subsonic Flow (Mach number =0.4)**

Materials Properties



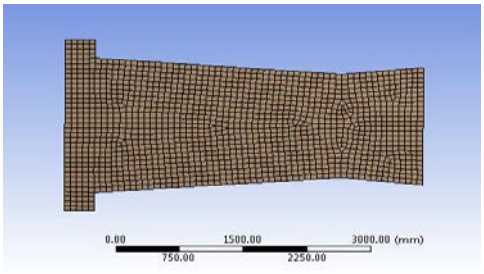
2D Model of C-Djet with Length 188.02mm



Inlet Velocity= 137.29

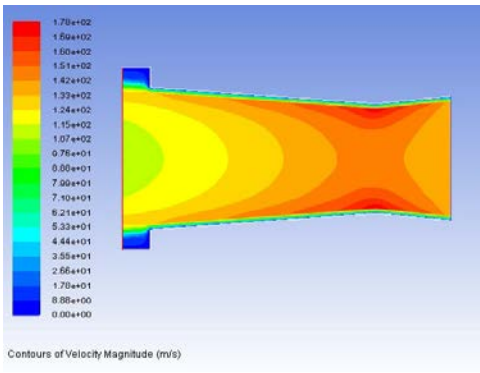
3D Surface Model of C-D jet with Length 188.02mm

Pressure of C-D Jet with Length 152.19mm for M= 0.4



Meshed Model of C-D Jet with Length 152.19mm

Meshed Model of C-D Jet with Length 188.02mm



Velocity of C-D Jet with Length 152.19mm for M= 0.4 Pressure of C-D Jet with Length 152.19mm for M= 0.9

Pressure of C-D Jet with Length 188.02mm for M= 0.4

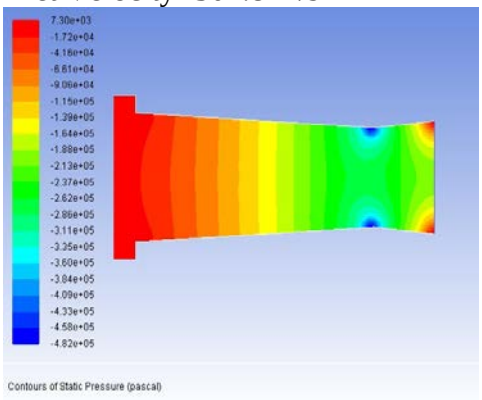
Velocity of C-D Jet with Length 152.19mm for M= 0.9

Material name	Nitrogen fluid
Material type	Fluid
Density	1.138(kg/m^3)
Thermal conductivity	0.0242m/m K
Viscosity	1.663e^{-5}(kg/m s)

Velocity of C-D Jet with Length 188.02mm for M= 0.4 Pressure of C-D Jet with Length 188.02mm for M= 0.9

4. Transonic Flow (Mach number= 0.9)

Inlet Velocity=307.8 m/s



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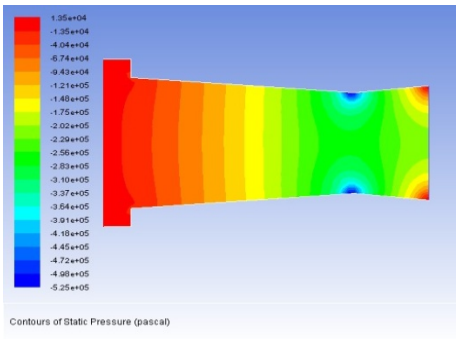
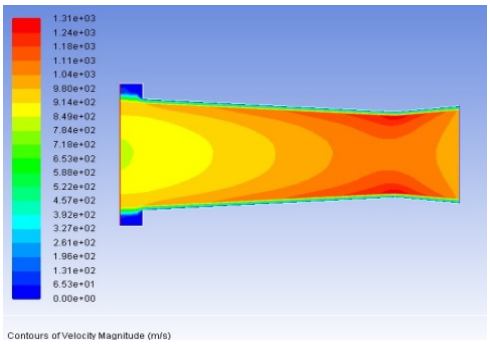
Velocity of C-D Jet with Length 188.02mm for M= 0.9 Pressure of C-D Jet with Length 188.02mm for M= 3

5. Supersonic Flow (Mach number = 3)





Pressure of C-D Jet with Length 152.19mm for M= 3 Velocity of C-D Jet with Length 188.02mm for M= 3

TRANSONIC FLOW (Mach number=0.9):

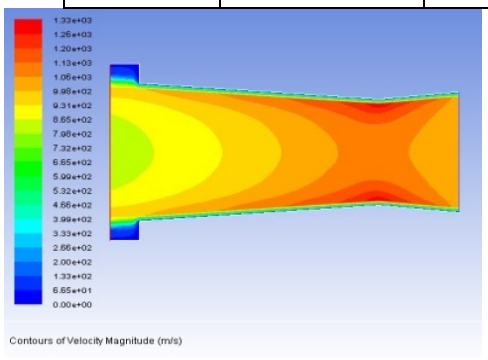
Length (mm)	Pressure (Pa)	Velocity (m/s)
152.19	1.35e+04	1.33e+03
188.02	7.30e+03	1.31e+03

SUPERSONIC FLOW (Mach number=3):

6. Results Of C-D Jet With Different Mach Numbers

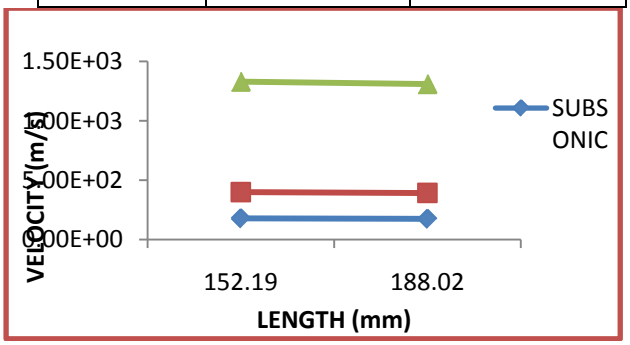
SUBSONIC FLOW (Mach number=0.4):

Length (mm)	Pressure (Pa)	Velocity (m/s)
152.19	2.41e+02	1.78e+02
188.02	1.30e+02	1.74e+02



Velocity of C-D Jet with Length 152.19mm for M= 3

Length (mm)	Pressure (Pa)	Velocity (m/s)
152.19	1.22e+02	3.99e+02
188.02	6.58e+02	3.92e+02



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Comparison Of Pressure Values For Different Flows And Lengths of C-D Jet

Comparison Of Velocity Values For Different Flows And Lengths of C-D Jet

CONCLUSION

The aerodynamic modeland performance analysis of exhaust jetconvergent-divergent models by changing the lengths of the jet under subsonic (0.4), transonic (0.9) and supersonic (3.0) flow conditions. The lengths considered for convergent-divergent jet are 152.19mm, 188.02mm. The comparisons are made for pressure distribution, velocity.

By observing the results, the pressure is increasing from inlet to the outlet and it is more at the intersection of convergent and divergent jet. The velocity is decreasing from inlet to outlet.

The pressure distribution, velocities are more under supersonic flow conditions due to high inlet velocities. The values are increasing by increasing the length of the jet. This is due to fact that by increasing the lengths the fluid is compressed inside the jet.

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