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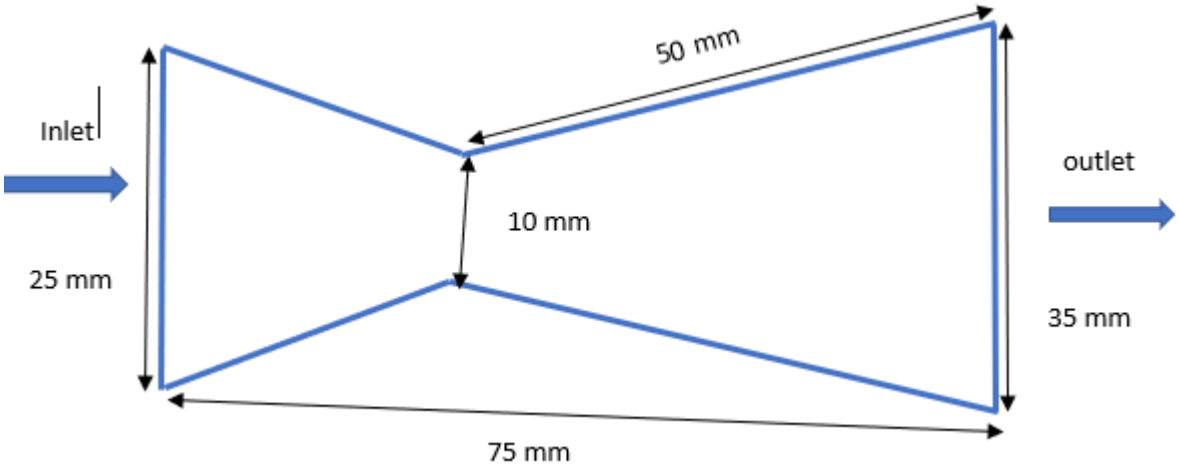
Project Title: Simulation of Convergent Divergent Nozzle

1.0. **Problem Specification**: Compute the C-D nozzle flow using fluent and plot the velocity, pressure at inlet and outlet of the nozzle. Also Plot the Contour map and residual plots.



2.0. **Boundary Condition**:

2.1. Inlet: Total gauge pressure = 3 bar
2.2. Outlet: Total gauge pressure = 0 bar
2.3. Wall: stationary wall, no slip boundary condition, roughness constant = 0.5

3.0. **Meshing:**

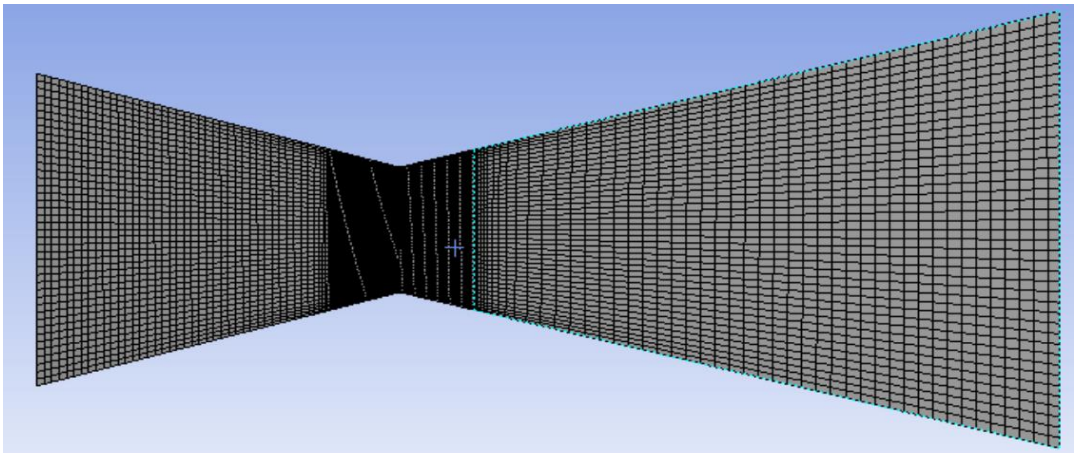


Fig.1.Streched Meshing of C-D Nozzle.

A structured grid is generated where sizing is 40 in both horizontal and vertical direction. At distance of 5 mm in both left and right side from center or junction, the grid is stretched since, those are the critical portions and changes are supposed to takes place there. The stretching is done to obtain the solution with low residual.

4.0. Problem Setup:

4.1. Fluent Launcher: 2D and No double precision. Only single iteration.

4.2. Solver: Density based i.e. Compressible. Absolute Velocity, steady time, Space-2D, Velocity Formulation.

4.3. Models: Energy Equation, Viscous and Laminar.

4.4. Materials: Air, density = ideal gas

4.5. Viscosity: Sutherland, 3 coefficient method,

- 4.5.1. Reference Viscosity = 1.716 x 10^{-5} kg/ms
- 4.5.2. Reference Temperature (T_0) = 273.11 K
- 4.5.3. Effective Temperature S(K) = 110.56 K

4.6. Monitor: Iteration to plot = 500 (Since convergence taking place at 342) and iteration to store = 500.

4.7. Initialization: standard (not hybrid)

5.0. Grid Independence: It contain grid size in both directions and Mesh nodes & elements. It is observed that there is no significant in the output result if grid size variation is less.

#
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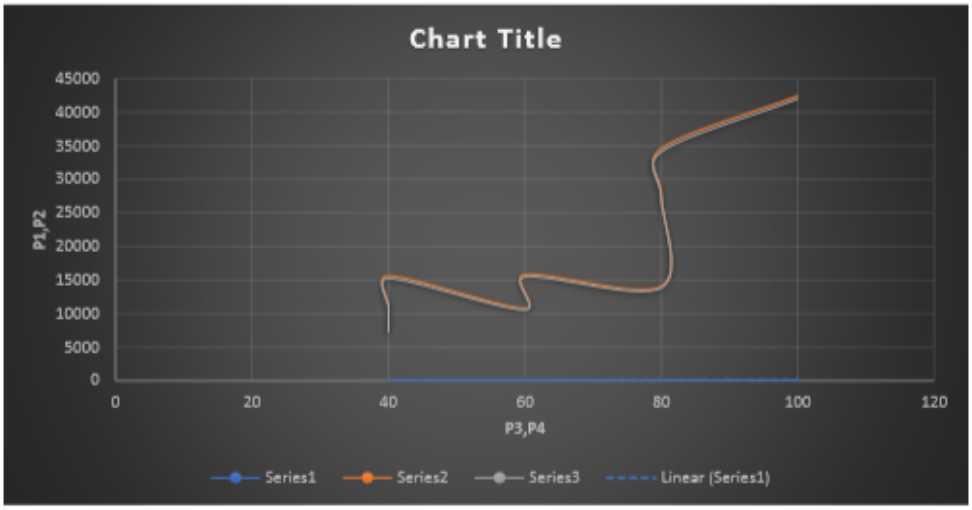
The parameters defined in the project are:
P3 - Edge S P4 - Edge S P1 - Mesh Nodes P2 - Mesh Elements
#
The following header line defines the name of the columns by reference to the parameters.

Name	P3	P4	P1 (mesh node)	P2(mesh element)
DP 0	40	40	7439	7224
DP 1	40	60	11295	11000
DP 2	40	80	15651	15272
DP 3	60	40	10788	10553
DP 4	60	60	15813	15500
DP 5	80	40	14080	13825
DP 6	80	80	27639	27224
DP 7	80	100	34608	34113
DP 8	100	100	42436	41992



Legends:
P1 = Mesh Node (Orange Color - series 2)
P2 = Mesh Element (white color - series 3)
P3 = X grid (main x-axis)
P4 = Y grid (blue color - linear series 1)

6.0. **Contour Plots**: This session contains the output results which is obtained after doing simulation.

6.0.1. Pressure: High at inlet = 2.933 bar and low at outlet = 0 bar.

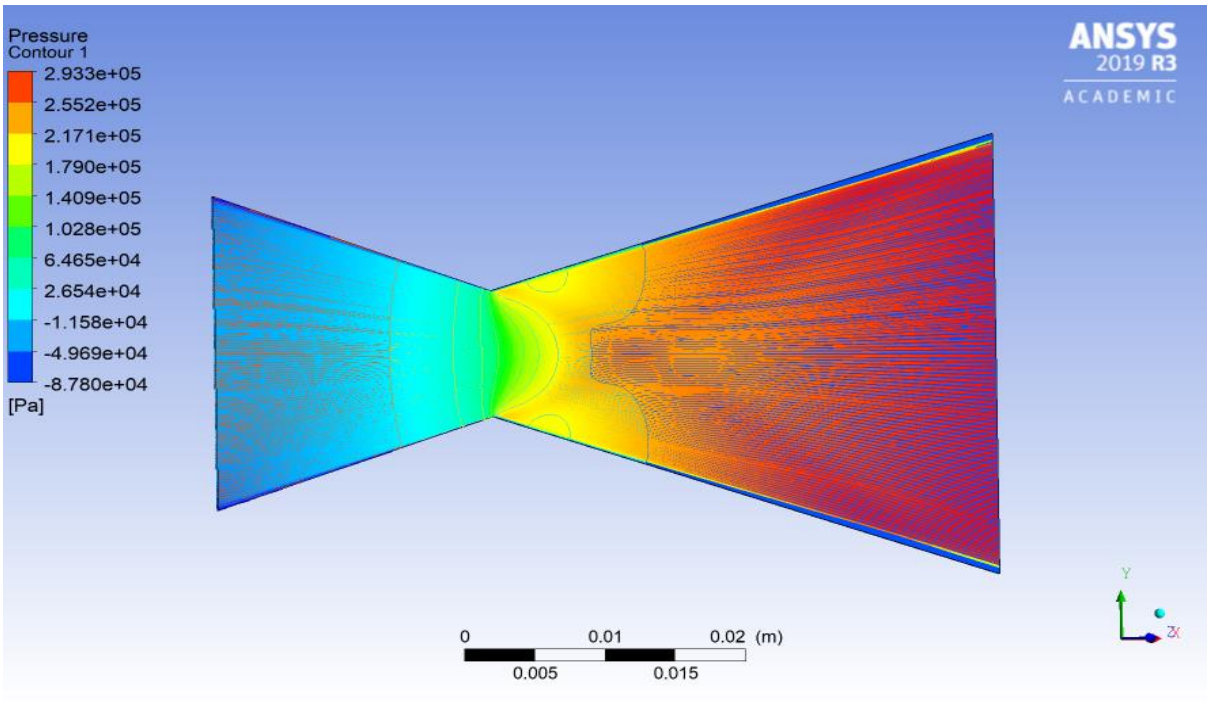


Fig.2. Contour plot of Pressure.

6.0.2. Velocity: High at outlet = 611 m/s and low at inlet = 0 m/s.

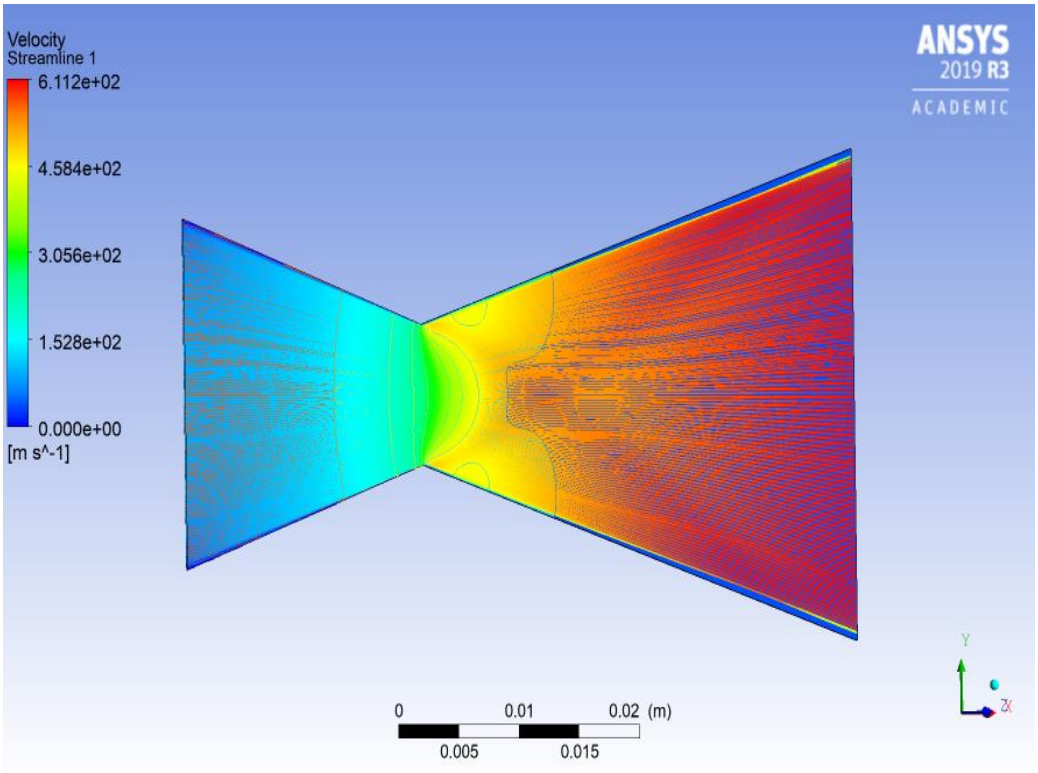


Fig.3. Contour plot of velocity streamline.

6.0.3. Wall Shear: maximum at inlet side = 9.883 pa and minimum at outlet side = 3.90 pas

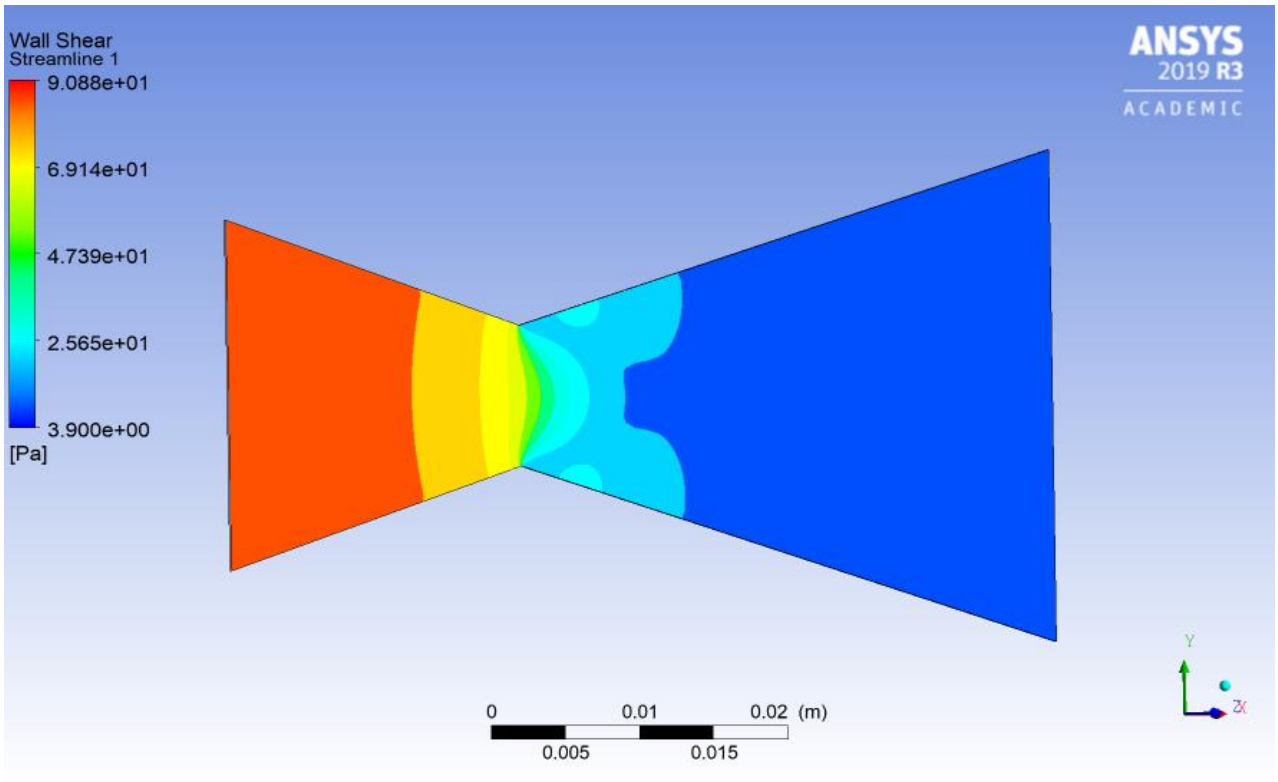


Fig.4. Contour plot of wall shear.

7.0. Residual Plots at inlet, outlet, wall at interior and wall:

7.0.1. Velocities, Continuity and Energy:

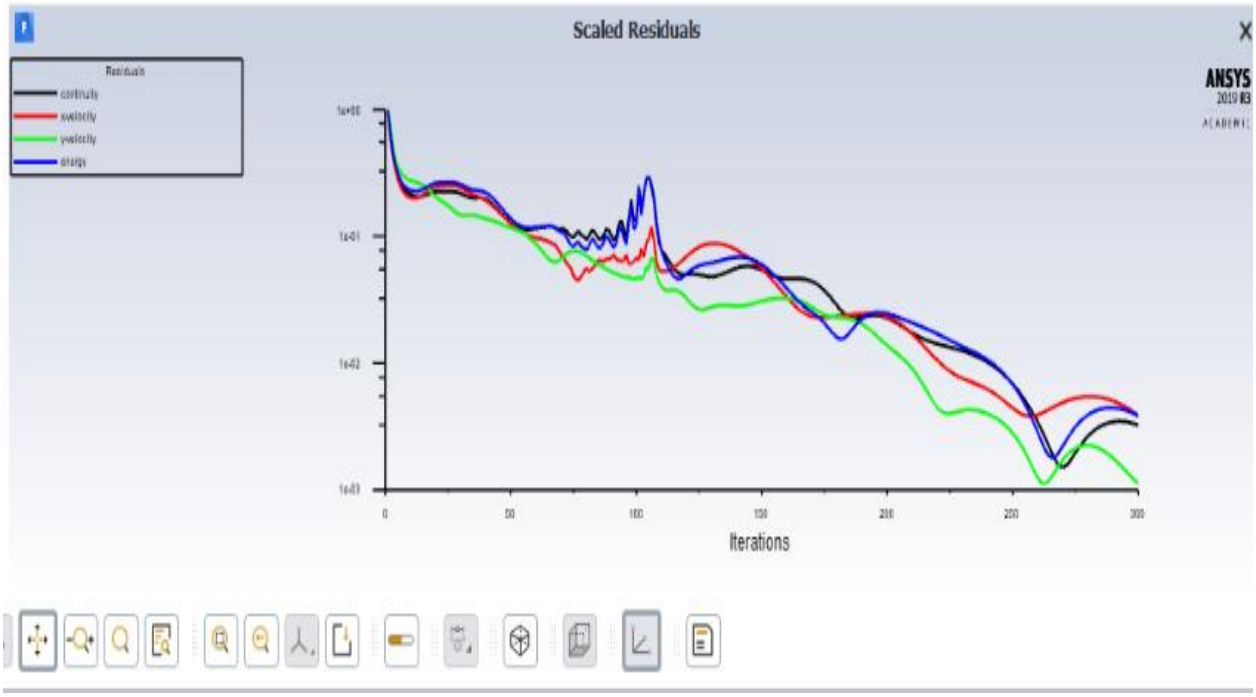


Fig.5. Residual Plot.

7.0.2. Pressure Residual: At inlet, outlet, wall of interior and wall.

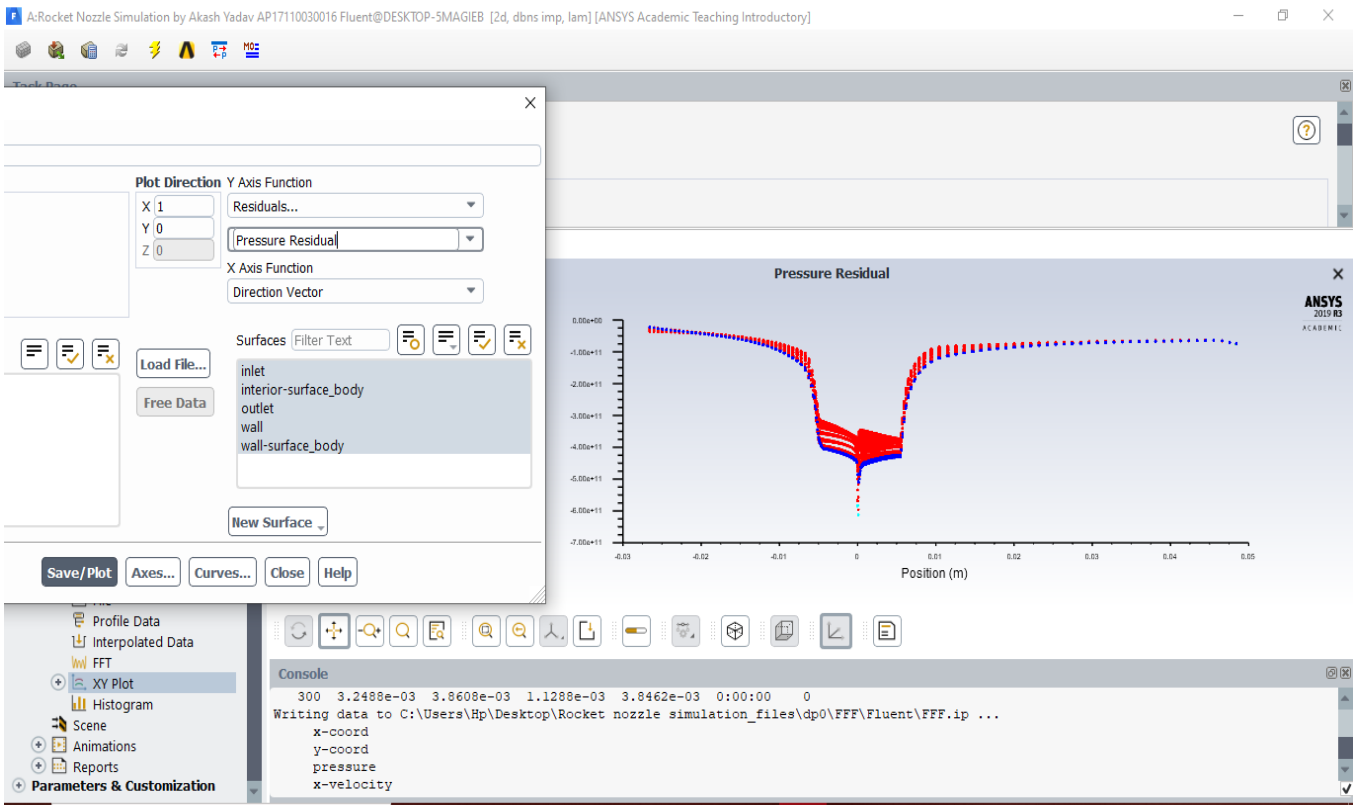


Fig.6. Pressure Residual

7.0.3. Velocity Residual: At inlet, outlet, wall of interior and wall.

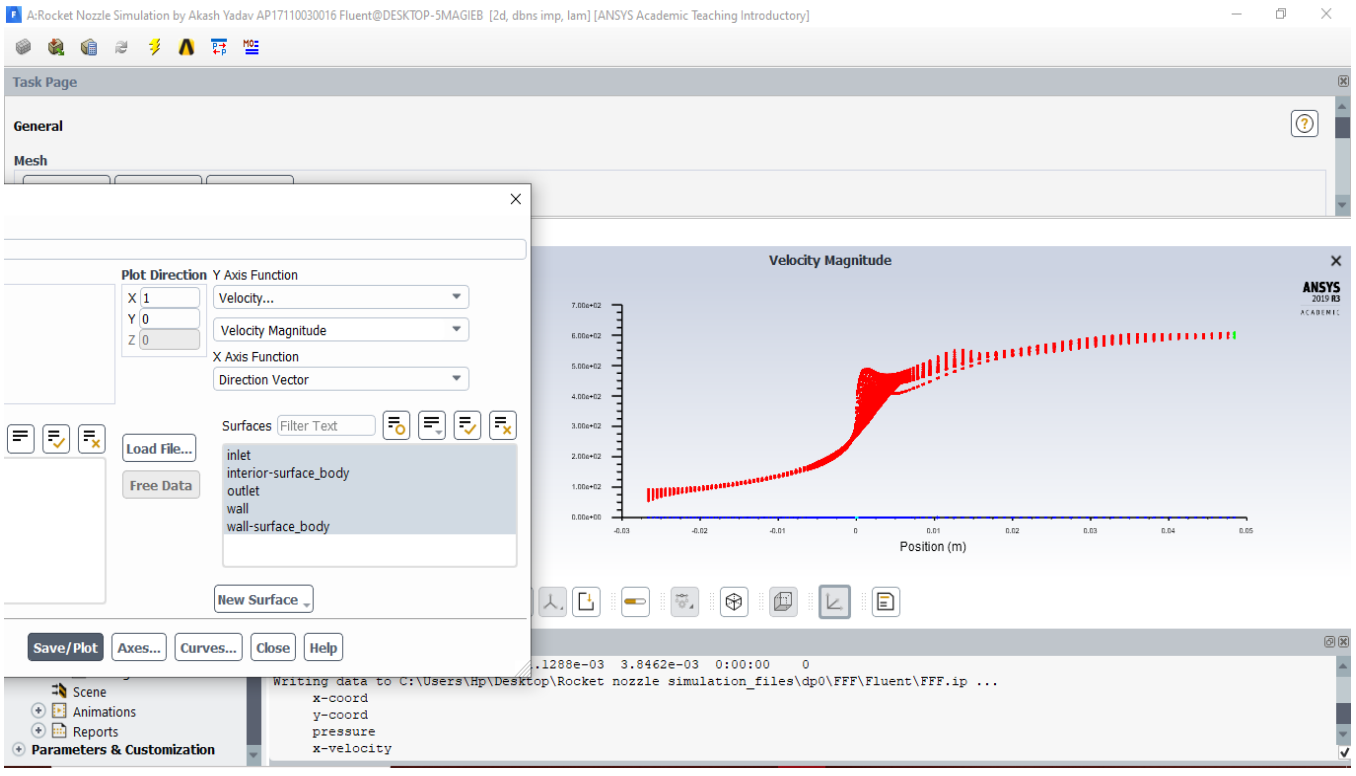


Fig.7. Velocity Residual.

7.0.4. Skin Friction Coefficient: At inlet, outlet, wall of interior and wall.

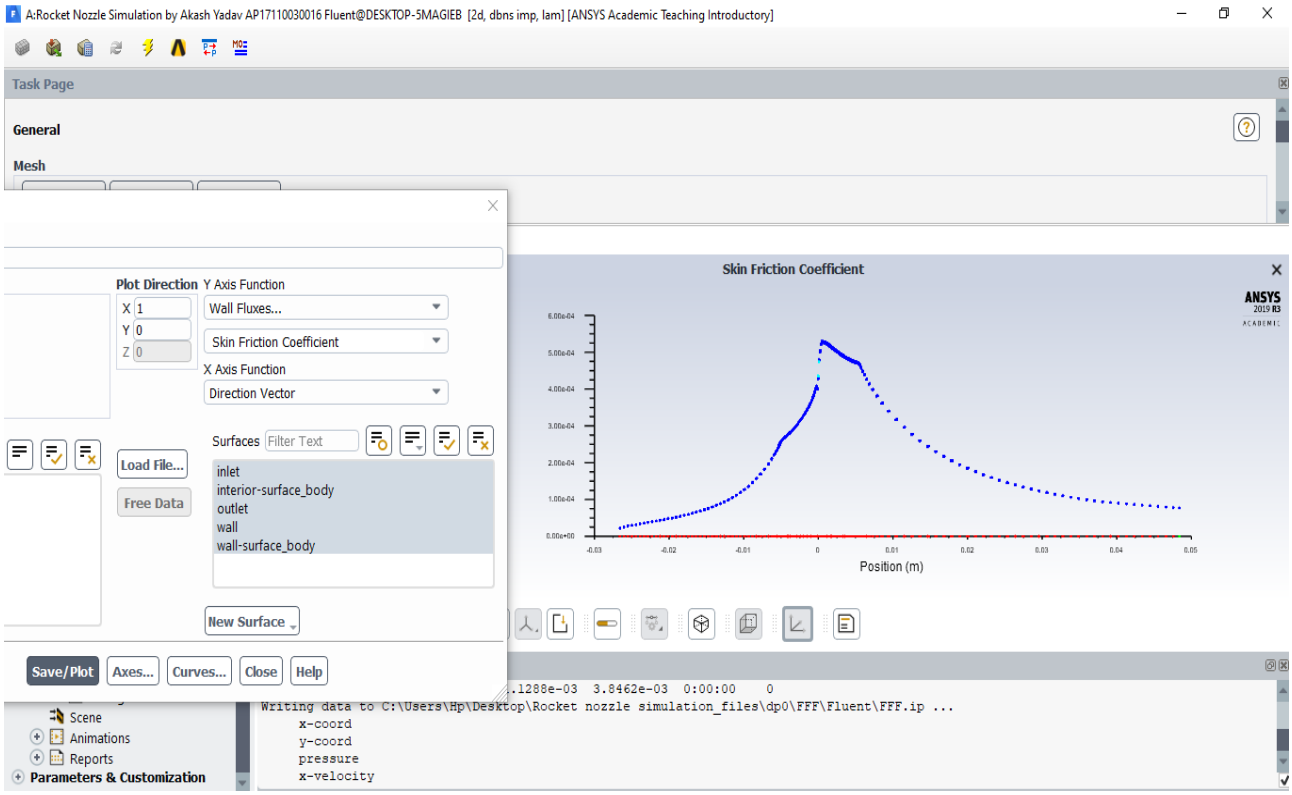
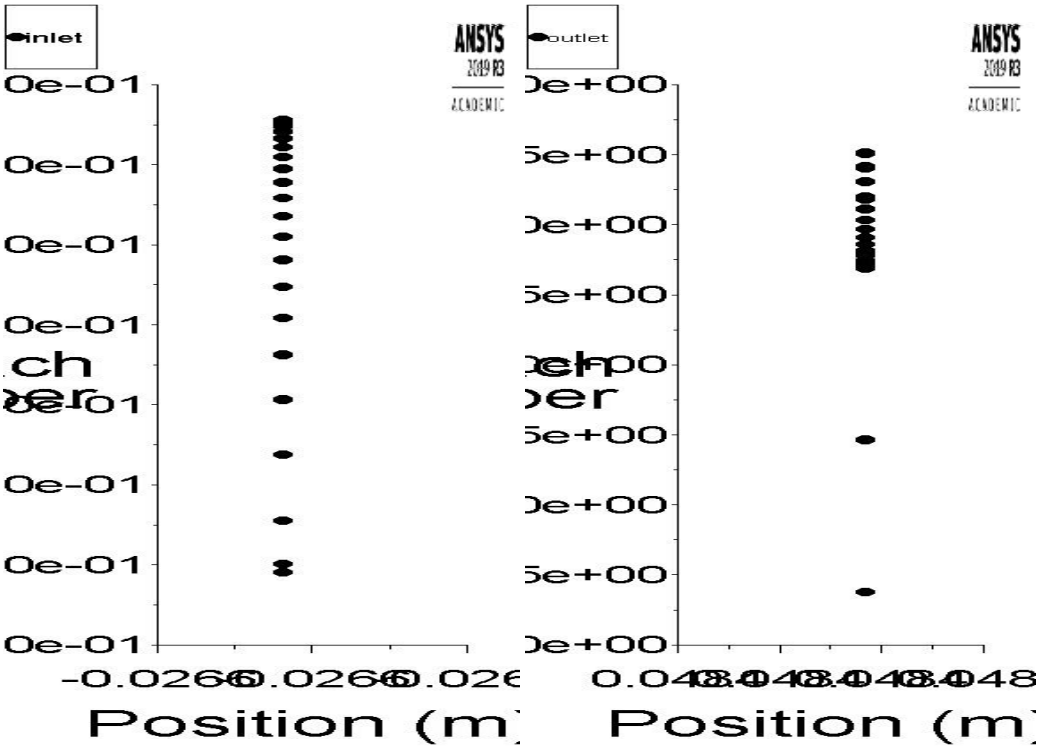


Fig.8. Skin Friction Coefficient.

7.0.5. Mach Number Plot:



8.0. Conclusion:

It is observed that the pressure at inlet is high whereas velocity is low and pressure at outlet is low whereas velocity is high for ideal gas with no slip boundary condition. It is also noted that the solution is converges at 342 iteration. In grid independence, it is observed there is no significant variation in grid nodes and grid elements. Both curves approach towards each other.