ME 3455

CFD Lab

Assignment 5

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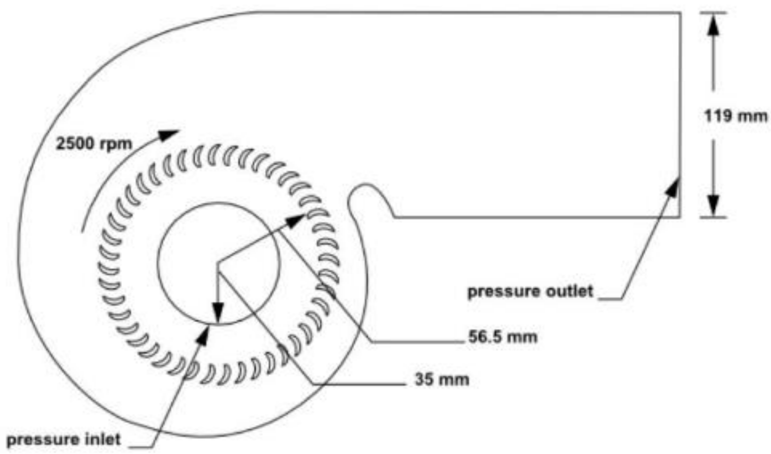
ME21BTECH11001

Question: The performance curve for a centrifugal pump working at 2500 rpm is to be determined using CFD. Use the mesh file provided on Google classroom and tutorial no. 10 from the Ansys tutorial guide. To simplify the problem, use multiple reference frames. A small portion of the domain around the rotating blades is considered to be rotating while the other two portions are stationary. Run the simulations for different pressure heads 0 Pa, 25 Pa, 50 Pa, 75 Pa, etc. until roughly 225 Pa. The simulation is unlikely to converge for larger pressure heads. Prepare a short report including the following figures and with brief comments on them.



a) Plot contours of pressure for 4 selected pressure heads (say for pressure heads of 0 Pa, 50 Pa, 150 Pa and 200 Pa).

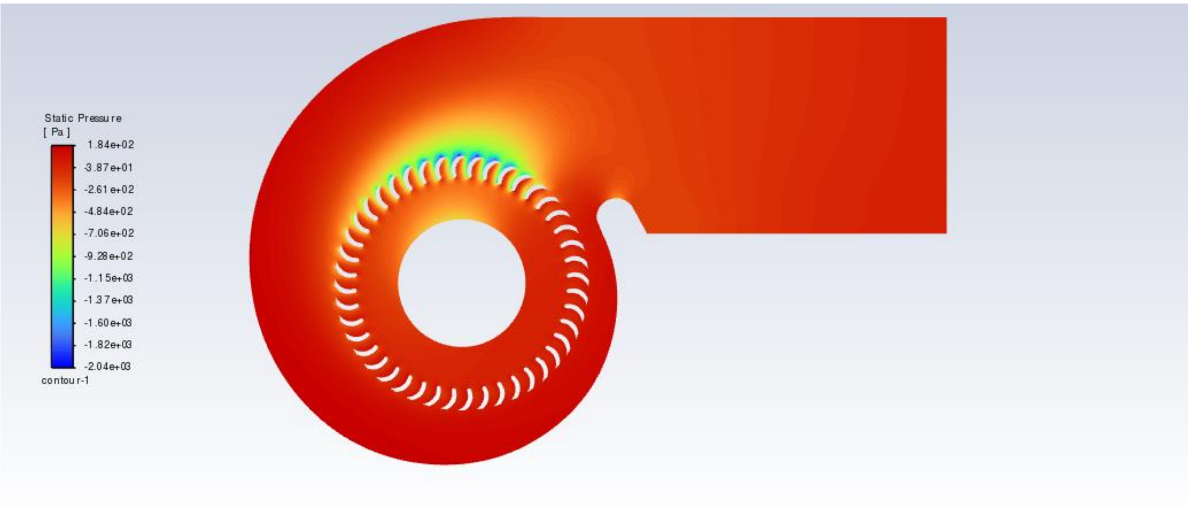


Fig: Pressure Contour of 0 Pa

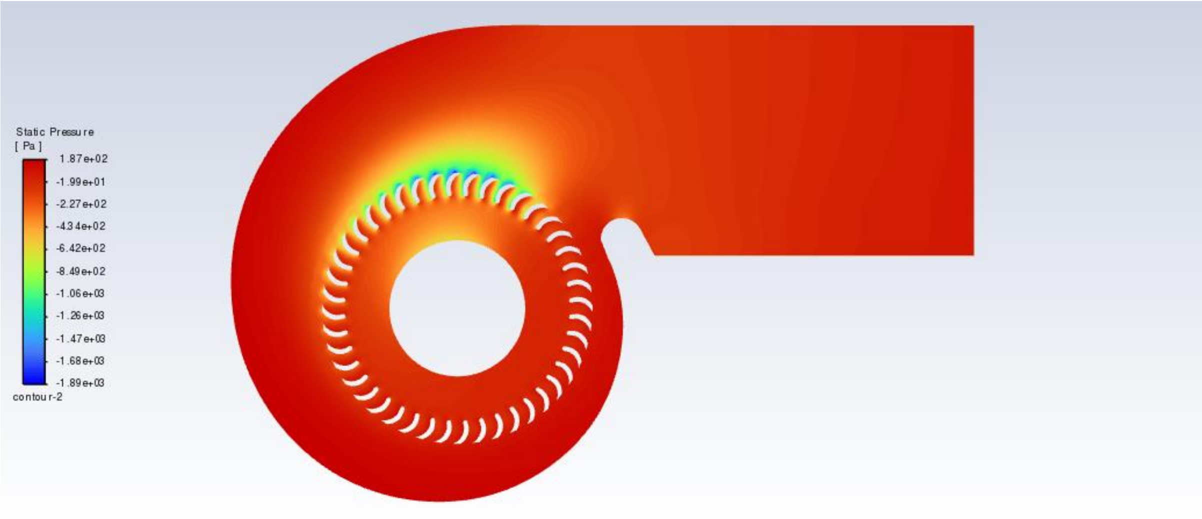


Fig: Pressure Contour of 50 Pa

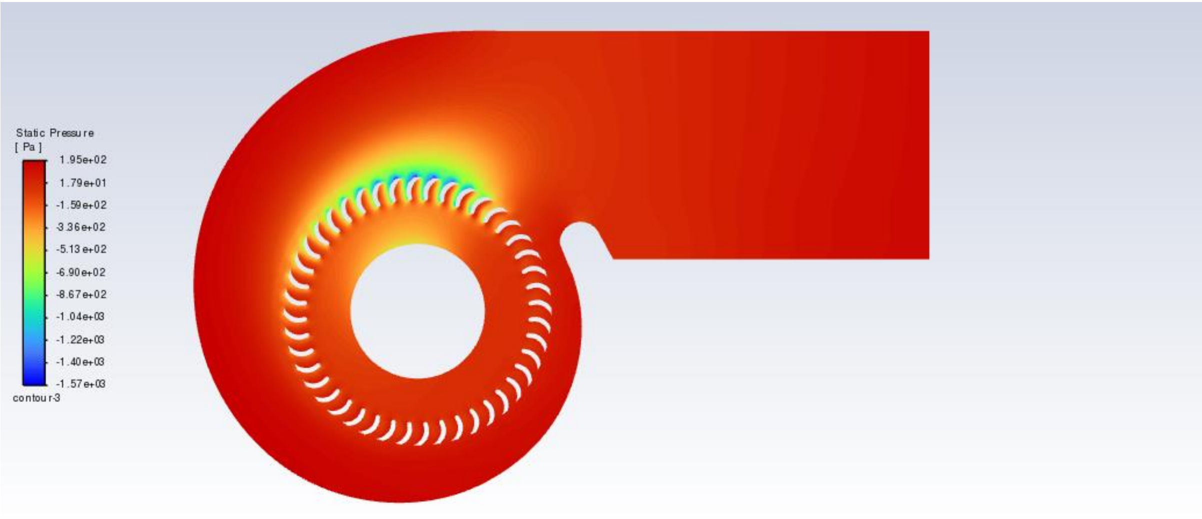


Fig: Pressure contour of 150 Pa

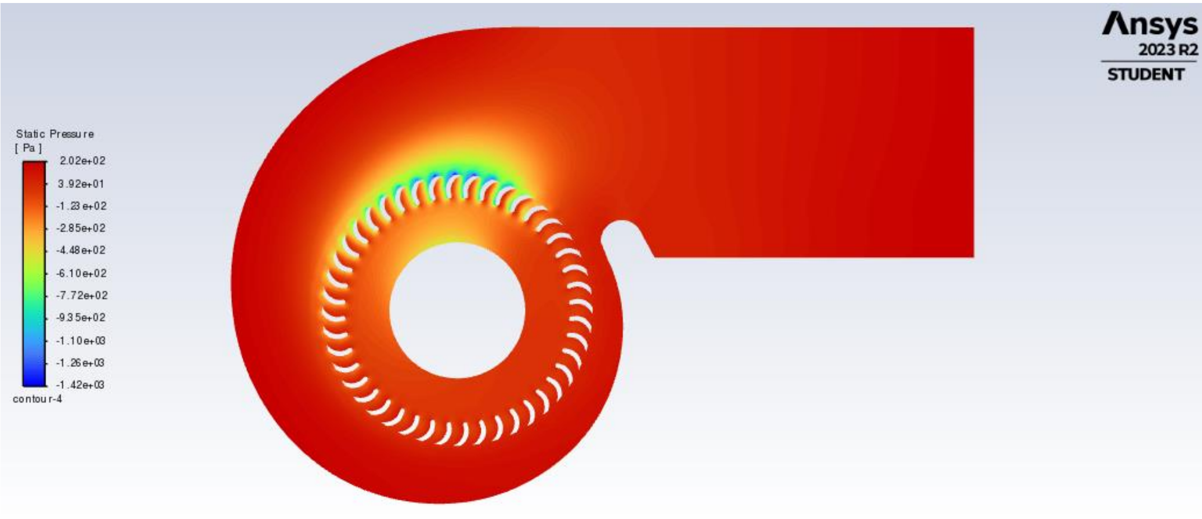


Fig: Pressure contour of 200 Pa

- By keeping the blower's rotation speed constant (fixed RPM), you are isolating the effect of outlet pressure on the performance.
- You are varying the outlet pressure in steps of 25 and observing the resulting volumetric flow rate (Q) after each run has converged. This helps in understanding how the blower responds to changes in outlet pressure.
- With increase in o/p pressure the static pressure increases.

b) Plot contours of velocity magnitude for the same 4 cases.

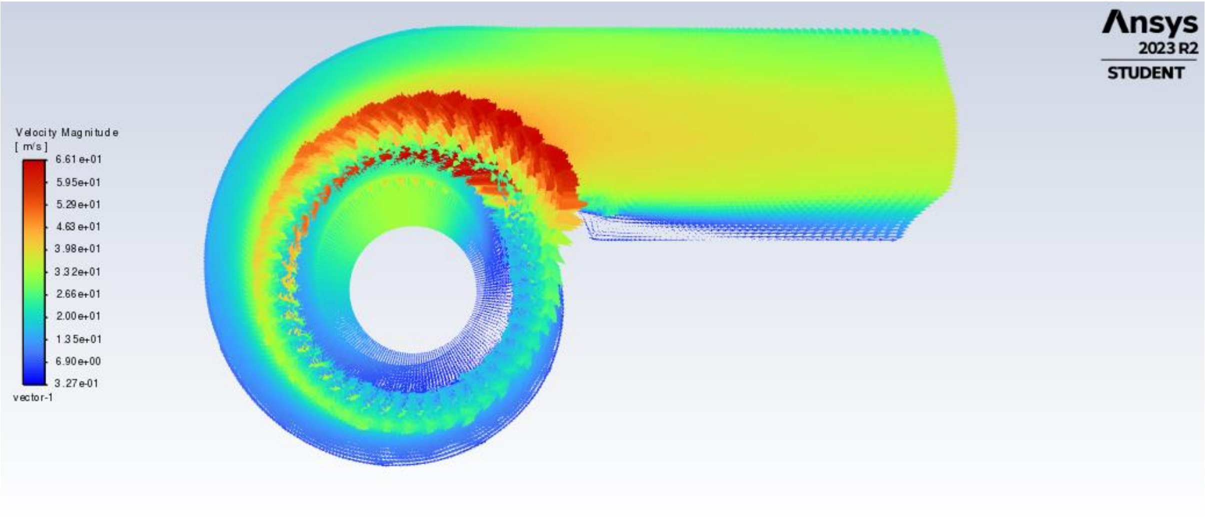


Fig: Velocity Magnitude contour of 0 Pa

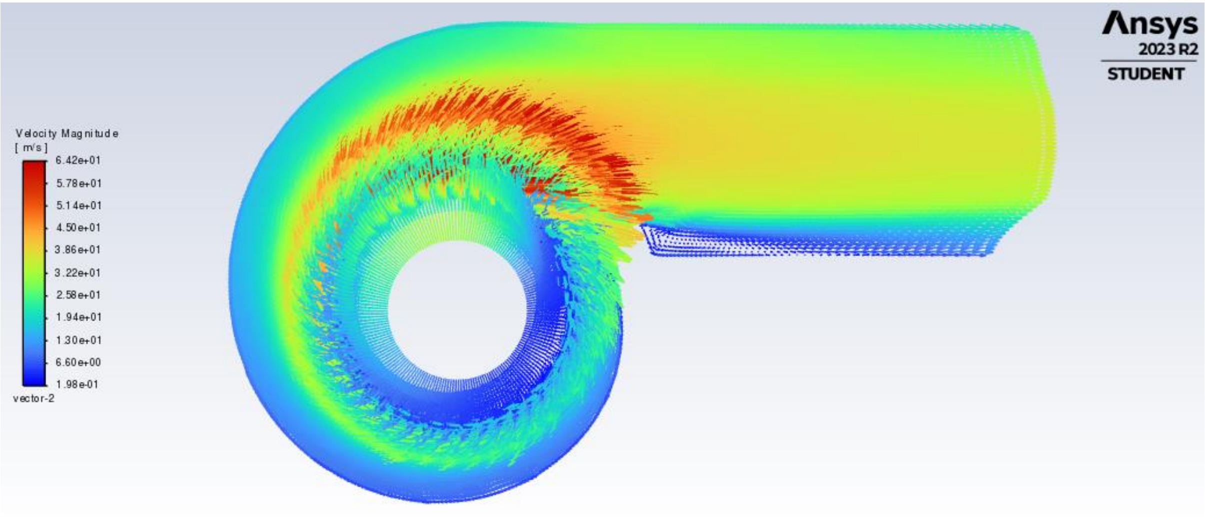


Fig: Velocity Magnitude contour of 50 Pa

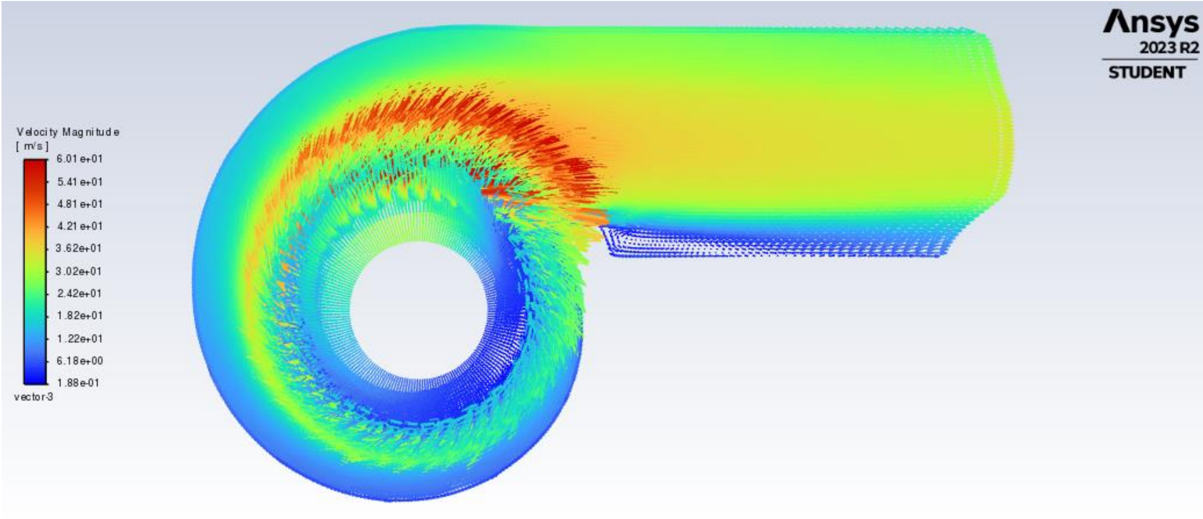


Fig: Velocity Magnitude contour of 150 Pa

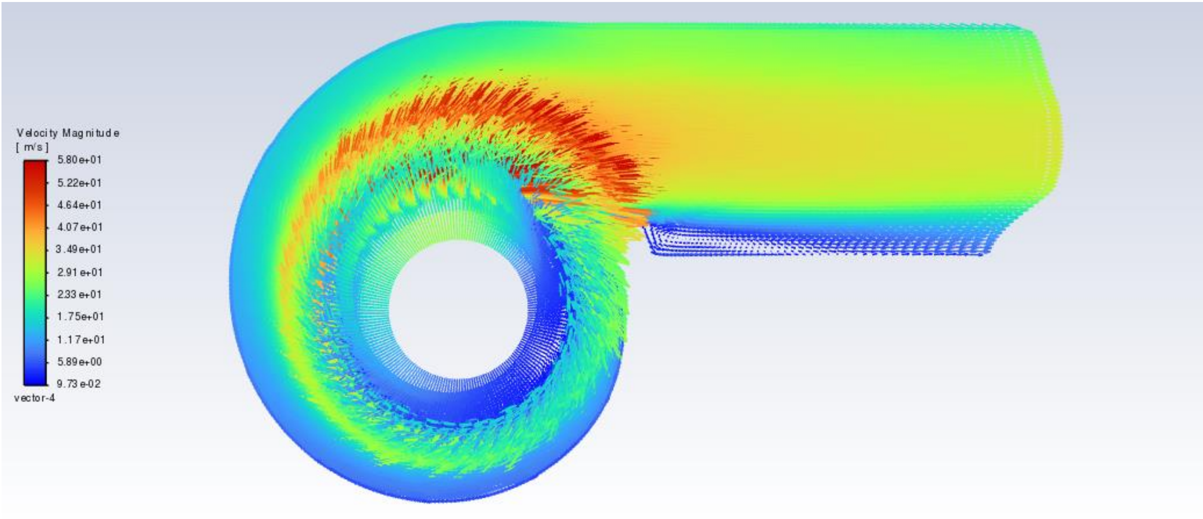


Fig: Velocity Magnitude contour of 200 Pa

d) Plot the pressure head (H) vs mass flow rate (Q) using all the 8 or 9 cases that you simulate.

Pressure Head (Pa)	o/p flow rate (kg/s)	i/p flow rate (kg/s)
0	4.4448158	4.4446928
25	4.3619402	4.3618237
50	4.277428	4.2773331
75	4.1913836	4.191288
100	4.1031563	4.1029861
125	4.0130751	4.012906
150	3.9210686	3.920873
175	3.8276569	3.8274687
200	3.7319088	3.7316175
225	3.634459	3.6341596
250	3.5342253	3.5338477

Fig: Table for Pressure Head and Mass Flow Rate

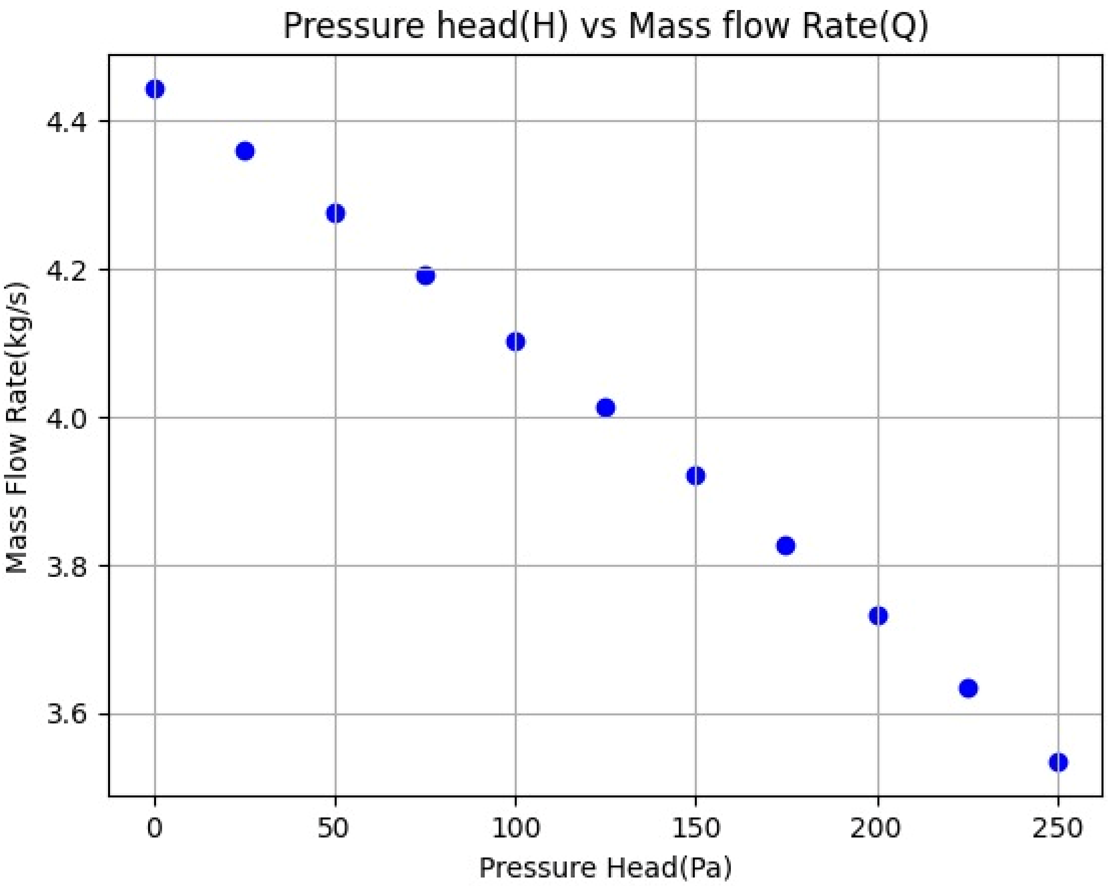


Fig: Plot for Pressure Head vs Mass Flow

e) Fit a parabola through the H − Q data and extend the parabola until it hits the Q = 0 line.

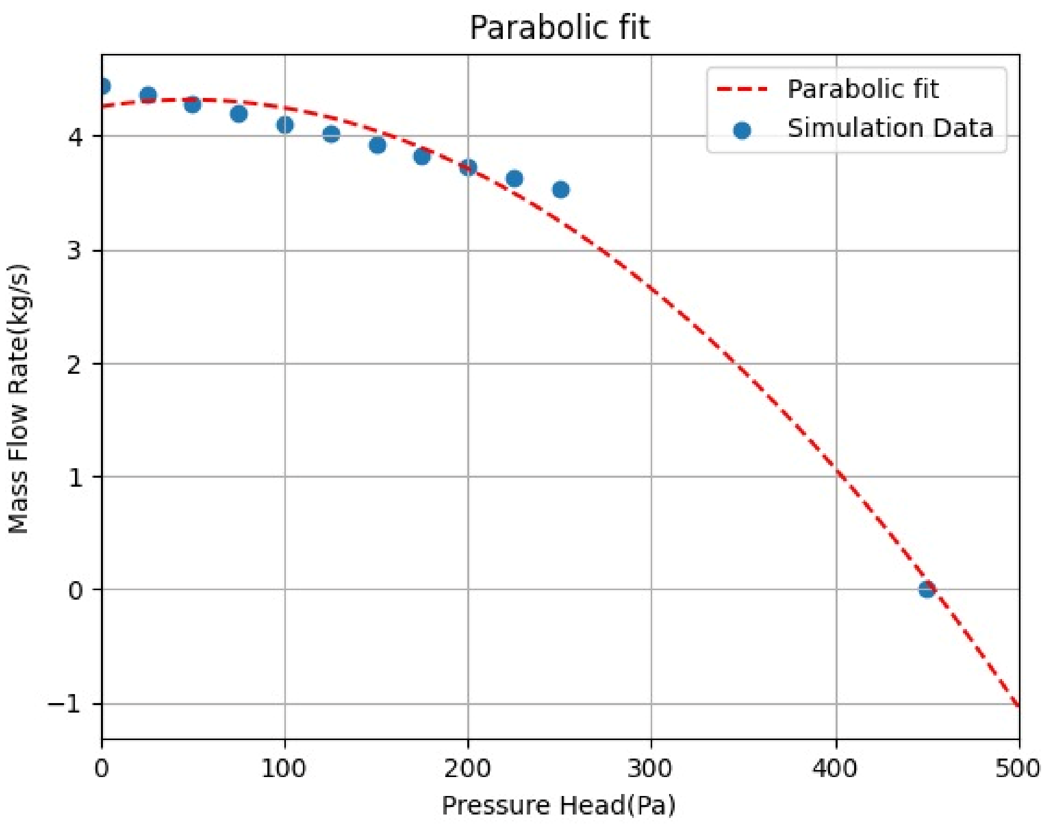


Fig: Parabolic fir for above data

- The expectation of a parabolic relation between H and Q is based on theoretical considerations. In fluid dynamics, the H-Q curve for a blower often exhibits a parabolic shape.

f) Determine the maximum discharge and the shutoff pressure head from the parabolic fit.

➔ At 0 Pa, mass flow rate = Q = 4.5 kg/s (approx.)

➔ At 0 kg/s, Pressure Head = H = 450 Pa (approx.)

➔ Maximum Discharge = 4.5 kg/s & Shutoff Head = 450 Pa (approx.)

- After obtaining the data points (H, Q) from the simulations, we will fit a parabola to the data.
- The point where the H-Q curve intersects the Q-axis represents the maximum discharge point, and the point where it intersects the H-axis represents the shutoff head. These points provide critical information about the blower's capabilities and limitations.