

Compressible Flow in a Convergent Divergent Nozzle.

Experiment	Velocity (m/s)	T ₁ (°C)	T ₂ (°C)	T ₃ (°C)	T ₄ (°C)	Bar		
						P ₁	P ₂	P ₃
1	5.4	15	7	6	14	5.5	2.8	-0.3
2	3.5	16	8	11	15	3.5	1.8	-0.1
3	1.1	15	10	16	15	0.2	-0.2	0

Ambient Temp - 13°C

D₁ = 15.83mm

Ambient Press - 1015mBar

D₂ = 4.31mm

Air Constant - 287.058

D₃ = 15.83mm

D₄ = 80.00mm.

Example Calc

Mass Flow rate = $\frac{P}{\text{density}} \times \frac{A}{\text{surface area}} \times \frac{V}{\text{velocity}}$

Temp 1 = 15°C (288.15 kelvin)

Pressure 1 = 5.5Bar (550000 Pascals)

Diameter 1 = 15.83mm

Velocity = 5.4 m/s

$$P = \rho RT \rightarrow \frac{P}{RT} = \rho \rightarrow \frac{550000}{287.058 \times 288.15 \text{ kelvin}} = 6.649 \text{ kg/m}^3$$

$$A = \frac{\pi d^2}{4} \rightarrow \frac{\pi \times 15.83^2}{4} \rightarrow 196.8121 \text{ mm}^2$$

$$V = 5.4 \text{ m/s}$$

$$m = \rho AV = 6.649 \times 196.8121 \times 5.4 = 7066.75 \text{ kg/s}$$

Velocity

$$p_1 A_1 V_1 = p_2 A_2 V_2$$

$$\frac{6.649 \times 196.81 \times 5.4}{3.469 \times 14.589} = V_2$$

$$V_2 = 139.6128$$

Speed of Sound

$$a = \sqrt{\gamma G_c R T}$$

$$\sqrt{\gamma \times 6.673 \times 287.058 \times 13^\circ\text{C (Ambient Temp)}}$$