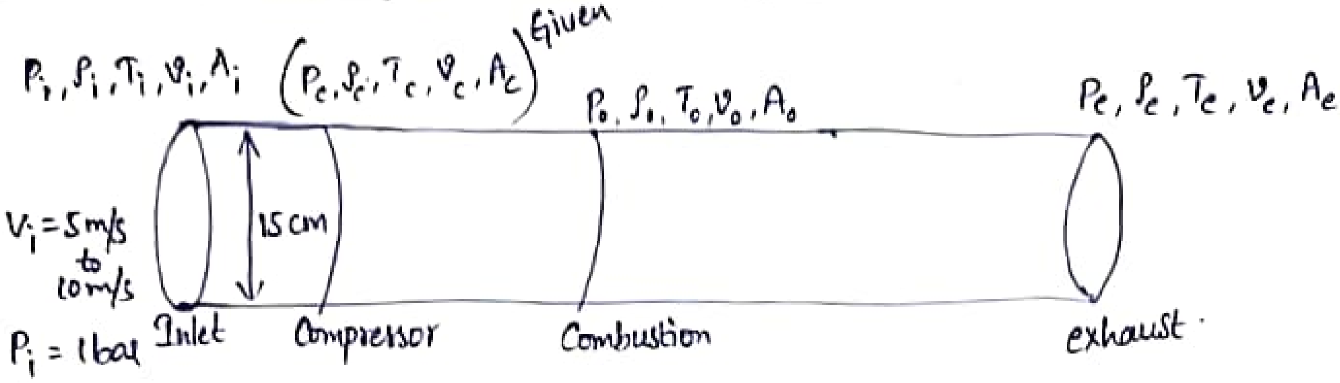


$P_i = 1\,bar$

$T = 300\,K$ (or) $27^\circ C$

Assumptions: $A_0 = A_c$

Isobaric process in combustion chamber i.e, $P_0 = P_c$

Inlet: $P_c, T_c, V_c, \rho_c, A_c$ (These values we will get from compressor outlet)

Exit: $P_0 = P_c$, $A_0 = A_c$

Heat added $(q) = \eta_c \cdot \underbrace{LHV}_{\text{latent heat of vapourisation}} \cdot FAR$ ↳ Fuel-Air ratio

By using conservation of mass

$$\dot{m}_{in} = \dot{m}_{out}$$

$$\rho_c V_c A_c = \rho_0 V_0 A_0 \qquad [A_0 = A_c]$$

$$\rho_c V_c = \rho_0 V_0$$

$$\boxed{V_0 = \frac{\rho_c V_c}{\rho_0}} \rightarrow (1)$$

$$\cancel{V_0 = \rho_c V_c}$$

$$\rho_c A_c V_c = \rho_0 A_0 V_0$$

$$\rho_c A_c V_c = \left(\frac{P_c}{R T_0}\right) A_0 V_0$$

$$\rho_c \times \frac{A_c}{A_0} \times V_c \times \frac{R T_0}{P_c} = V_0$$

$$\frac{A_c}{A_0} \times V_c \times \frac{\rho_c R_i T_0}{P_c} = V_0$$

$$\boxed{\frac{A_c}{A_0} \times V_c \times \frac{T_0}{T_c} = V_0} \rightarrow (2)$$

Ideal Gas law:

$$P_c = \rho_c R T_c$$

$$P_0 = \rho_0 R T_0$$

R = specific gas constant.

$R_{air} = 287.7$

$R_{fuel} = 350$

$R_{fuel\ mixture} = 288.1$

$P_c = \rho_c R T_c$

$$P_c = P_0 \Rightarrow \rho_c \cancel{R} T_c = \rho_0 \cancel{R} T_0$$

$$\rho_0 = \frac{\rho_c T_c}{T_0}$$

$$\boxed{\rho_0 = \frac{P_c}{R T_0}} \rightarrow 3$$

from eq 2 $\Rightarrow \frac{A_c}{A_0} \times V_c \times \frac{T_0}{T_c} = V_0$

we know $\frac{A_c}{A_0} = 1$

So, $\boxed{V_0 = V_c \times \frac{T_0}{T_c}} \rightarrow 4$

from 1st law of Thermodynamics:

$$\Delta U = \dot{Q} - \dot{W} = \dot{m}\left(h_2 - h_1 + \frac{V_2^2}{2} - \frac{V_1^2}{2} + g(z_2 - z_1)\right)$$

$$\dot{Q} = \dot{m} C_p (T_0 - T_c) + \left(\frac{V_0^2 - V_c^2}{2}\right)$$ (work done by turbine = 0)

$$q = C_p (T_0 - T_c) + \left(\frac{V_0^2 - V_c^2}{2}\right)$$

By substituting eq-4 $\left(V_0 = V_c \times \frac{T_0}{T_c}\right)$

$$q = C_p (T_0 - T_c) + \frac{V_c^2}{2}\left(\frac{T_0^2}{T_c^2} - 1\right)$$

$$q = C_p T_c (\theta - 1) + \frac{V_c^2}{2}(\theta^2 - 1)$$

$\left[\theta = \frac{T_0}{T_c}\right)$

$$q = C_p T_c \theta - C_p T_c + \frac{V_c^2}{2}\theta^2 - \frac{V_c^2}{2}$$

$$\frac{V_c^2}{2}\theta^2 + C_p T_c \theta - \left( C_p T_c + \frac{V_c^2}{2} + q \right) = 0$$

$$\theta = \frac{-C_p T_c \pm \sqrt{(C_p T_c)^2 + 4\left(\frac{V_c^2}{2}\right)\left(C_p T_c + \frac{V_c^2}{2} + q\right)}}{V_c^2}$$

Conservation of momentum:

$$P_c A_c + \rho_c V_c^2 A_c = P_o A_o + \rho_o V_o^2 A_o$$

Exit Temperature : $T_o = \theta T_c$

Exit velocity : $V_o = V_c \theta$

Exit Density : $\rho_o = \rho_c \frac{T_c}{T_o} = \frac{\rho_c}{\theta}$