Ex.1 A simple Carburetor has the ventury of throat diameter 8 cm and the coefficient of discharge is 0.94. the fuel orifice has diameter of 0.5 cm and it's coefficient of discharge is 0.7. find air-fuel ratio if the pressure drop amount to 0.14 bar when (a) nozzle tip is neglected (b) Nozzle tip is taken into account and it is equal to 0.5 cm. Assume density of fuel as 780 kg/m3 and density of air as 1.293 kg/m3 Neglect compressibility of air

(Approximate)

⇒ given Data

$d_a = 8 cm = 8 \times 10^{-2} m$

$C_{da} = 0.94$

$d_f = 0.5 cm = 0.5 \times 10^{-2} m$

$C_{df} = 0.7$

$\Delta P = 0.14 bar = 0.14 \times 10^{5} N/m^2$

$\rho_a = 1.293 kg/m^3$

$\rho_f = 780 kg/m^3$

Case -(a) Nozzle tip is Neglected

Air - fuel Ratio

$$\frac{m_a}{m_f} = \frac{C_{da}}{C_{df}} \times \frac{A_a}{A_f} \times \sqrt{\rho_a / \rho_f}$$

$$= \frac{C_{da}}{C_{df}} \times \frac{\pi/4 \, d_a^2}{\pi/4 \, d_f^2} \times \sqrt{\rho_a / \rho_f}$$

$$= \frac{0.94}{0.7} \times \frac{(8 \times 10^{-2})^2}{(0.5 \times 10^{-2})^2} \times \sqrt{\frac{1.293}{780}}$$

$$\boxed{m_a / m_f = 13.99}$$

Case-(b) when Nozzle tip is Considered

$$\frac{m_a}{m_f} = \frac{C_{da}}{C_{df}} \times \frac{A_a}{A_f} \times \sqrt{\frac{\rho_a}{\rho_f}} \times \sqrt{\frac{\Delta P}{\Delta P - zg\rho_f}}$$

where $\frac{C_{da}}{C_{df}} \times \frac{A_a}{A_f} \times \sqrt{\frac{\rho_a}{\rho_f}} = 13.99$

$$\frac{m_a}{m_f} = 13.99 \times \sqrt{\frac{0.14 \times 10^5}{0.14 \times 10^5 - 0.005 \times 9.81 \times 780}}$$

$$= 13.99 \times 1.0013692$$

$$\boxed{\frac{m_a}{m_f} = 14.009}$$

Ex.2 A:F ratio of mixture supplied to an engine by carburetor is 15:1. The fuel consumption of engine is 7.5 kg/hour. The diameter of venture is 2.2 cm find the diameter of fuel nozzle if tip of nozzle is 4 mm. Take the following specification for calculation. Density of fuel used = 750 kg/m3 Cd of air = 0.82 Cd of fuel= 0.7 atmospheric pressure = 1.013 bar and atmospheric temperature = 25 c

→ given Data

$\frac{m_a}{m_f} = 15/1$

$m_f = 7.5$ kg/hr

$d_a = 2.2$ cm $= 2.2 \times 10^{-2}$ m

$d_f = ?$

$z = 4$ mm $= 4 \times 10^{-3}$ m

$\rho_f = 750$ kg/m^3

$C_{da} = 0.82$

$C_{df} = 0.7$

$P_{atm} = 1.013$ bar

$= 1.013 \times 10^5$ N/m^2

$T_{atm} = 25°C$

$= 25 + 273$

$= 298$ K

Air-fuel Ratio

$$\frac{m_a}{m_f} = \frac{C_{da}}{C_{df}} \times \frac{A_a}{A_f} \times \sqrt{\frac{\rho_a}{\rho_f}} \times \sqrt{\frac{\Delta P}{\Delta P - 2g\rho_f}}$$

$$\frac{15}{1} = \frac{0.82}{0.7} \times \frac{(2.2\times10^{-2})^2}{d_f^2} \times \sqrt{\frac{1.29}{750}} \times \sqrt{\frac{1.013\times10^5}{1.013\times10^5 - 4\times10^{-3}\times9.81\times750}}$$

$$d_f^2 = 1.566\times10^{-6}\ m^2$$

$$d_f = 1.25\times10^{-3}\ m$$

$$\boxed{d_f = 0.125\,cm}$$

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Ex.3 A simple jet carburetor is required to supply 6 kg of air per minute and 0.45 kg of fuel of density 740 kg/m3. The air is initially at 1.013 bar and 27°C. Calculate the throat diameter of the choke for a flow velocity of 92 m/s, velocity coefficient of 0.8. If the pressure drop across the fuel metering orifice is 0.75 of that at the choke, calculate orifice diameter assuming Cd=0.60.

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$m_a = 6 \ kg/min$

$m_f = 0.45 \ kg/min$

$\rho_f = 740 \ kg/m^3$

$\rho_a = 1.29 \ kg/m^3$

$P_1 = 1.013 \ bar = 1.013 \times 10^5 \ N/m^2$

$T_1 = 27 + 273 = 300 \ K$

$V_2 = 92 \ m/s$

$(\Delta P)_f = 0.75 (\Delta P)_a$

$C_{da} = 0.8$

$C_{df} = 0.60$

⇒ Applying SFEE

$$h_1 + \frac{V_1^2}{2} = h_2 + V_2^2/2$$

$h_1 = C_p T_1$ $h_2 = c_p T_2$ $V_1 = 0$ $C_p = 1.005\ kJ/kg\,K$

$$C_p T_1 = C_p T_2 + V_2^2/2$$ $= 1005\ J/kg\,K$

$$1005 \times 300 = 1005 \times T_2 + (92)^2/2$$

$$T_2 = 295.79\ K$$

$$\frac{P_2}{P_1} = (T_2/T_1)^{\gamma/\gamma-1} = \left(\frac{295.79}{300}\right)^{1.4/1.4-1} \times 1.013$$

$$P_2 = 0.9642$$

$$\Delta P_a = P_1 - P_2 = 1.013 - 0.9642$$

$$= 0.04889 \text{ bar}$$

$$= 4889 \text{ N/m}^2$$

$$P_2 = \rho_a R T_2$$

$$0.9642 \times 10^5 = \rho_a \times 287 \times 295.79 \Rightarrow \rho_a = 1.1357 \text{ kg/m}^3$$

$$m_a = C_{da} A_a \sqrt{2 \rho_a (\Delta P)_a}$$

$$\frac{6}{60} = 0.8 \times \pi/4 \, d_a^2 \times \sqrt{2 \times 1.1357 \times 4889}$$

$$d_a = 0.03886 \text{ m}$$

$$\boxed{d_a = 3.88 \text{ cm}}$$

$$\dot{m}_f = C_{df} \times A_f \times \sqrt{2 \rho_f (\Delta P)_f}$$

$$(\Delta P)_f = 0.75 (\Delta P)_a$$

$$= 0.75 \times 4889$$

$$= 3666.75 \ N/m^2$$

$$\frac{0.45}{60} = 0.75 \times \pi/4 \times d_f^2 \times \sqrt{2 \times 740 \times 3666.75}$$

$$d_f = 0.2338 \ cm$$

$$\boxed{d_f = 2.388 \ mm}$$