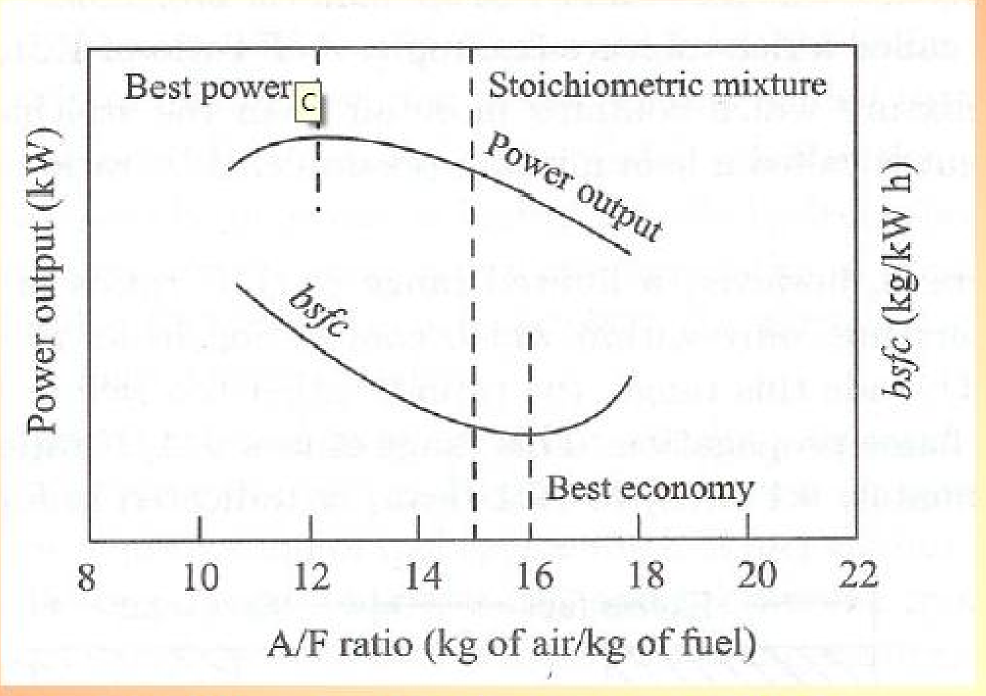
Variation of power output and sfc with A-F ratio in SI engine

(Full throttle and constant speed)



- Maximum Output = 12:1 (Best power mixture)
- Minimum Fuel Consumption = 16:1 (Best economy mixture)

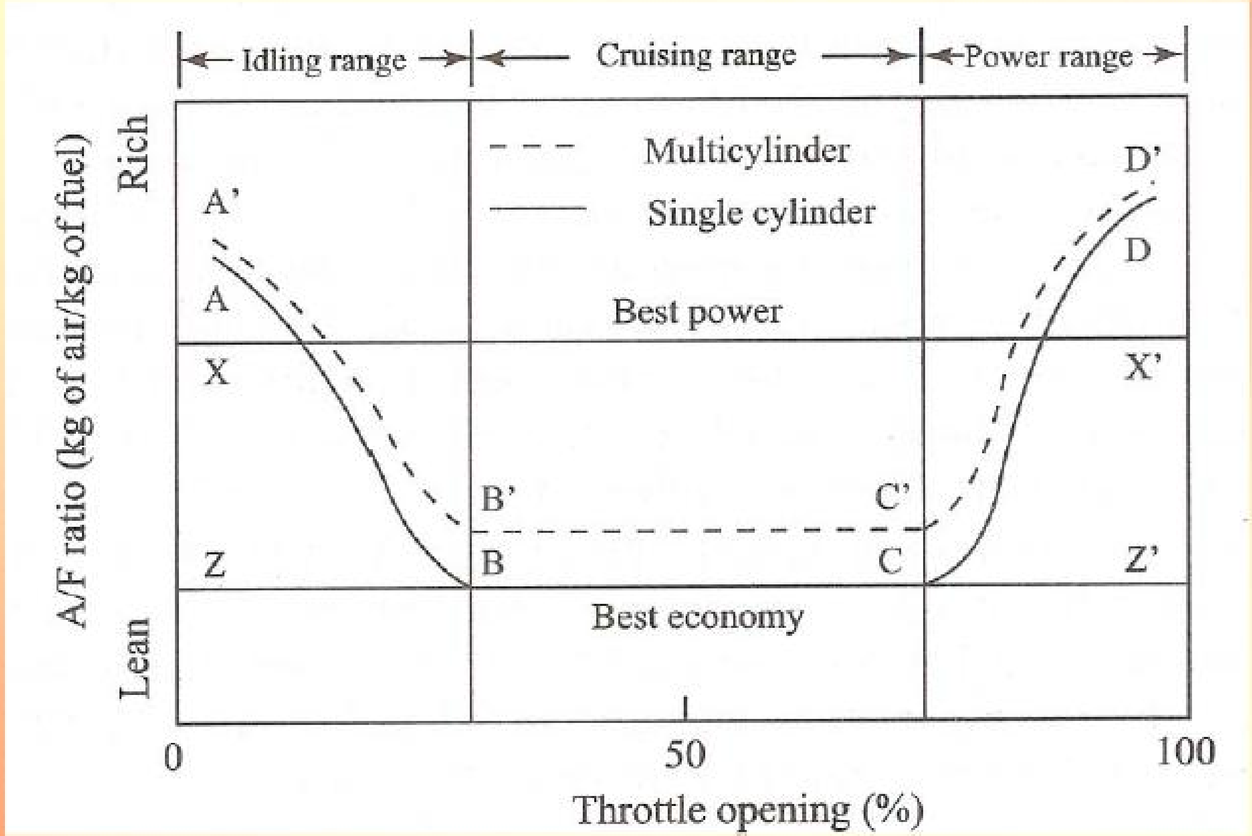
Various Loads

- **Idling/Starting:** Engine runs without load. Produces power only to overcome friction between the parts. Rich mixture‡ is required to sustain combustion.

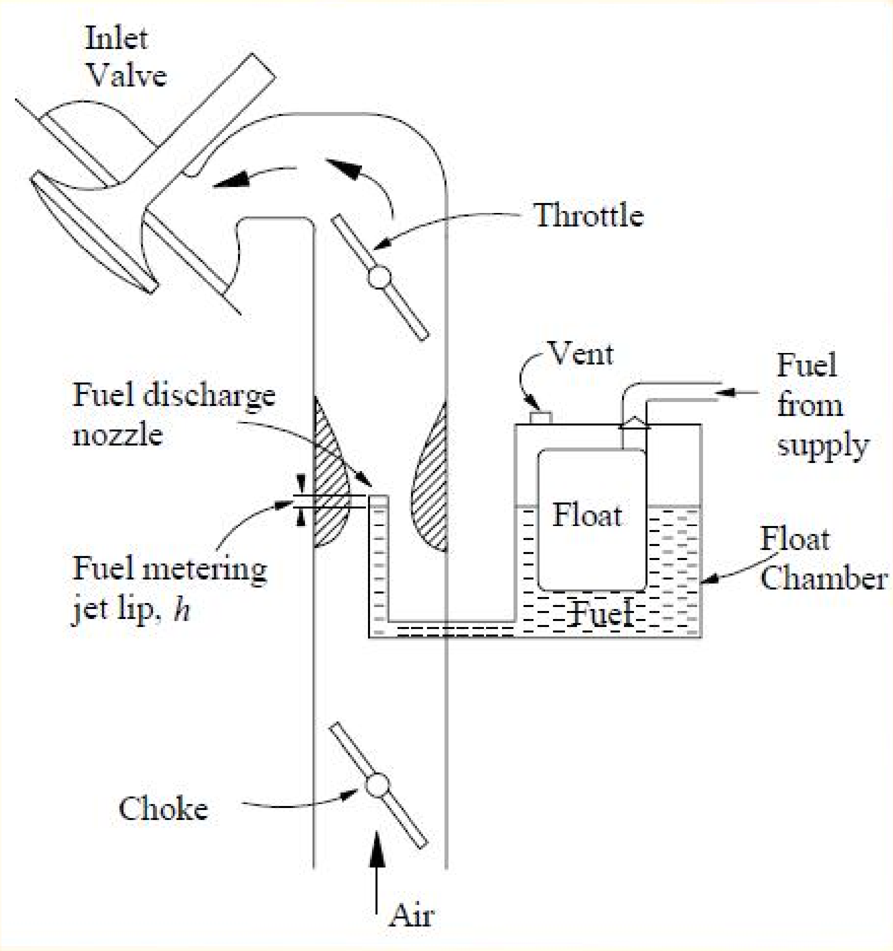
- **Normal Power/Cruising/Medium Load:** Engine runs for most of the period. Therefore, fuel economy is maintained. Low fuel consumption for maximum economy. Requires a lean mixture.

- **Maximum power/Acceleration:** Overtaking a vehicle (short period) or climbing up a hill (extra load). Requires a rich mixture.

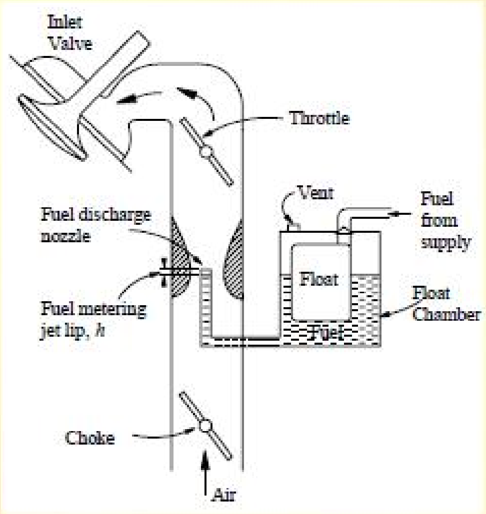
Carburetor Performance



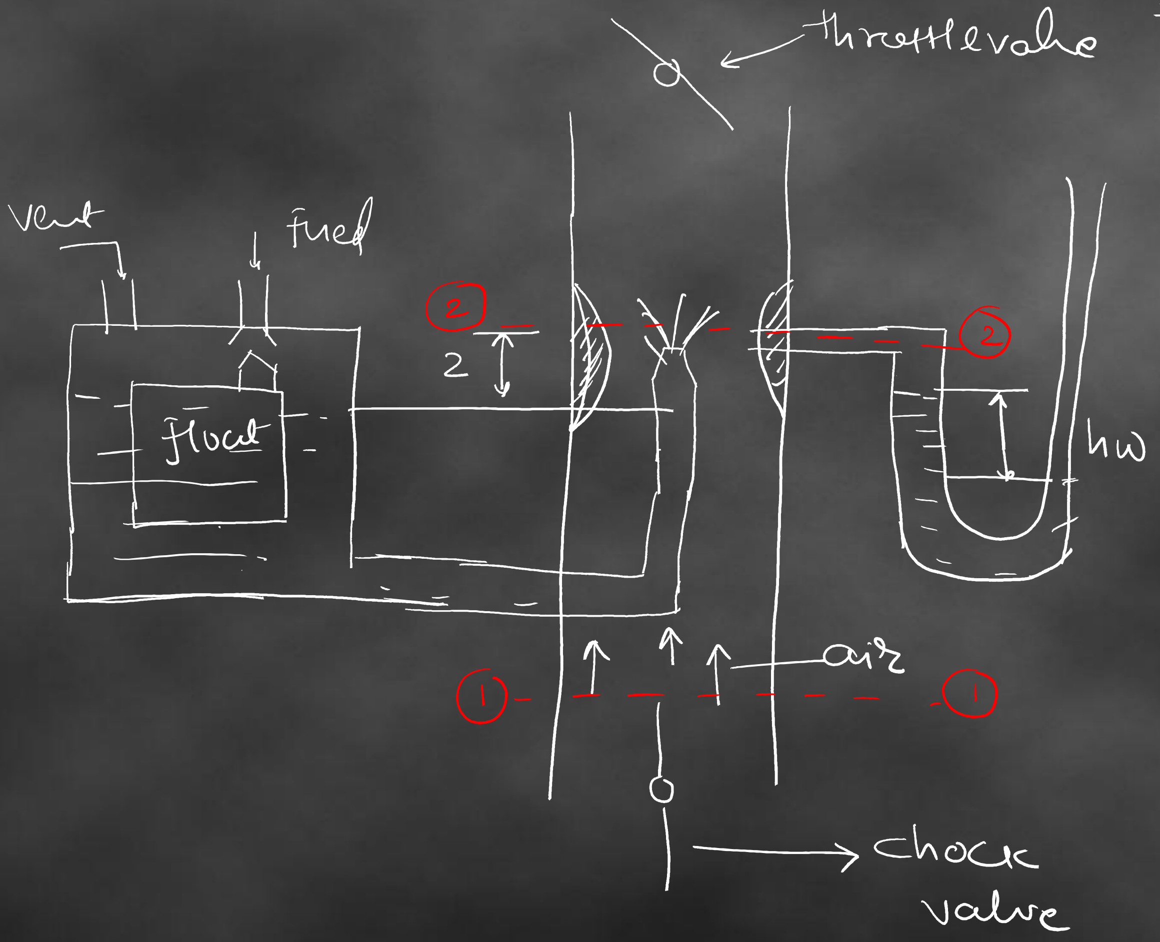
Simple Carburetor



Components of a Simple Carburetor



- ❑ A float chamber with a float to store fuel and to adjust its level
- ❑ A round cylinder with a venturi for atomization of fuel.
- ❑ A fuel nozzle to atomize and produce a spray of fuel
- ❑ A throttle valve to supply varying quantity of the mixture at different load conditions
- ❑ A choke valve to control the air supply in order to provide a rich or a lean mixture



⇒ Approximate Analysis

1. $\rho_a = C \quad \rho_{a_1} = \rho_{a_2} = \rho_a$
2. $V_1 = 0$

Let

z = height of nozzle tip

$V_1\ V_2$ = velocity at sec 1 & 2

$P_1\ P_2$ = Pressure at sec 1 & 2

m_a & m_f = mass flow rate of air & fuel

C_{da} & C_{df} =

A_f = c/s of fuel nozzle

A_2 = c/s of venturi throat

d =

g

Now Applying Bernoulli's eqn at 1-1 & 2-2 for air

$$\frac{P_1}{\rho_{a_1}} + \frac{V_1^2}{2} = \frac{P_2}{\rho_{a_2}} + V_2^2/2$$

$\rho_{a_1} = \rho_{a_2} = \rho_a$

$V_1 = 0$

$$\frac{P_1}{\rho_a} = \frac{P_2}{\rho_a} + \frac{V_2^2}{2}$$

$$V_2 = \sqrt{\frac{2(P_1 - P_2)}{\rho_a}}$$

mass flow Rate of air

$$m_a = \rho_a V_2 A_2 C_{da}$$

$$= A_2 C_{da} \rho_a \sqrt{\frac{2(P_1 - P_2)}{\rho_a}}$$

$$m_a = A_2 C_{da} \sqrt{2 \rho_a (P_1 - P_2)}$$

→ Apply Steady flow energy eqn for fuel

$$\frac{P_1}{\rho_F} = \frac{P_2}{\rho_F} + \frac{V_f^2}{2} + Zg$$

$$V_f = \sqrt{\frac{2(P_1 - P_2 - Zg\rho_F)}{\rho_F}}$$

mass flow Rate of fuel

$$m_f = A_f \rho_F V_f C_{df}$$

$$m_f = A_f C_{df} \sqrt{2 \rho_F (P_1 - P_2 - Zg \rho_F)}$$

Air fuel Ratio

$$\frac{m_a}{m_f} = \frac{A_2 C_{da} \sqrt{2 \rho_a (P_1 - P_2)}}{A_f C_{df} \sqrt{2 \rho_f (P_1 - P_2 - \rho_f z g)}}$$

$$= \frac{A_2}{A_f} \cdot \frac{C_{da}}{C_{df}} \sqrt{\frac{\rho_a}{\rho_f}} \sqrt{\frac{\Delta P}{\Delta P - z g \rho_f}}$$

$z = 0$

$$\boxed{\frac{m_a}{m_f} = \frac{A_2}{A_f} \cdot \frac{C_{da}}{C_{df}} \sqrt{\frac{\rho_a}{\rho_f}}}$$

Exact Analysis of simple carburettor

⇒ Compressibility of air is consider

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

$$V_1 = 0$$

$$h_1 = c_p T_1 \qquad h_2 = c_p T_2$$

$$V_2 = \sqrt{2 c_p (T_1 - T_2)}$$

$$= \sqrt{2 c_p T_1 (1 - T_2/T_1)}$$

$$V_2 = \sqrt{2 c_p T_1 \left(1 - (p_2/p_1)^{\gamma-1/\gamma}\right)}$$

$$m_a = \rho_1 A_1 V_1 C_{da} = \rho_2 A_2 V_2 C_{da}$$

$$m_a = \frac{A_1 V_1 C_{da}}{v_1} = \frac{A_2 V_2 C_{da}}{v_2}$$

$$p_1 v_1^\gamma = p_2 v_2^\gamma$$

$$v_2 = v_1 (p_1/p_2)^{1/\gamma}$$

$$= \frac{R T_1}{p_1} \left(\frac{p_1}{p_2}\right)^{1/\gamma}$$

$$m_a = \frac{A_2 C_{da} \cdot \sqrt{2 c_p T_1 \left(1 - (p_2/p_1)^{\gamma-1/\gamma}\right)}}{\frac{R T_1}{p_1} (p_1/p_2)^{1/\gamma}}$$

$$m_a = C_{da} \frac{A_2 P_1}{R T_1} \left(\frac{P_1}{P_2}\right)^{1/\gamma} \sqrt{2 c_p T_1 \left(1 - (P_2/P_1)^{\frac{\gamma-1}{\gamma}}\right)}$$

$$m_a = C_{da} \frac{A_2 P_1}{R \sqrt{T_1}} \sqrt{2 c_p \left[(P_1/P_2)^{2/\gamma} - (P_2/P_1)^{\frac{\gamma+1}{\gamma}}\right]}$$

$$\frac{m_a}{m_f} = \frac{C_{da} \frac{A_2 P_1}{R \sqrt{T_1}} \sqrt{2 c_p \left((P_2/P_1)^{2/\gamma} - (P_2/P_1)^{\frac{\gamma+1}{\gamma}}\right)}}{C_{df} \; A_f \sqrt{2 \rho_f (P_1 - P_2 - 2 g \rho_f)}}$$