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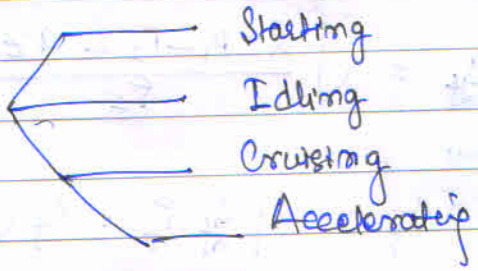
Carburetion :- The process of mixture preparation in an SI engine is called Carburetion. The device preparing the air-fuel mixture outside the cylinder is called Carburetor.

- It basically atomizes the fuel and mix with air in various proportions for different load conditions.



Functions of Carburetors :-

a) Atomize, Vaporize and mix the fuel homogeneously with air

b) Correct amount of air-fuel mixture supply for all load conditions and speed of the engine. So, that engine runs smoothly

Various factors affecting Carburetion

i) Time available for mixture preparation
ii) Temperature of incoming air
iii) Quality of fuel supplied
iv) Engine speed
v) Carburetor design

High temp air causes high rate of vaporization. & helps in Carburetion. However, there is a reduction in power output because of decrease in mass flow rate

- For an engine with rpm — 3000, the time available for mixture preparation is 0.02 sec.

Various Loads :—

- Idling/Starting → Engine runs without load. Produces power only to overcome friction between the parts. During Idling the throttle valve is nearly closed. Hence amount of fresh charge entering the Combustion chambers (Cylinder) is less while the exhaust gases amount lying in the Clearance Volume portion remains the same and hence mixing of fresh charge with exhaust gases is more

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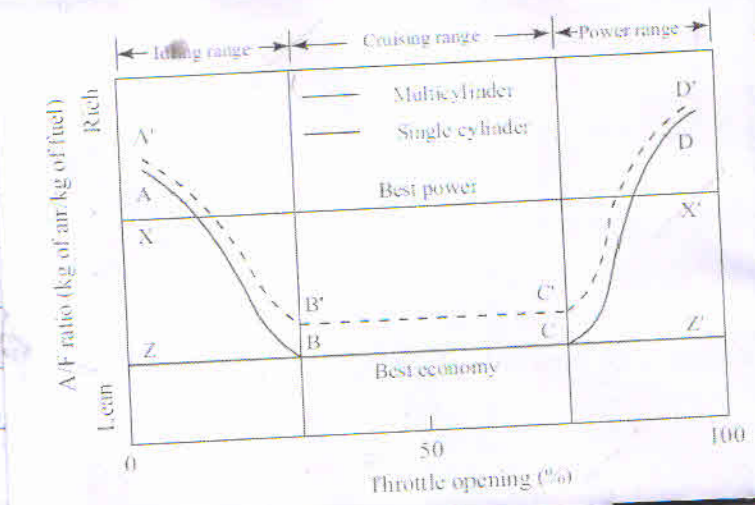
as Compared to full throttle opening. Hence more loss of fresh charge and indeed to Compensate this rich mixture supply is required. In order to sustain the Combustion.

Cruising Range :—
In this range the exhaust gas dilution is less and Carburetor provides the engine with the best economy mixture. Engine runs for most of this period and it requires lean mixture.

Power Range :— Overtaking a vehicle (Short period) or Climbing up a hill (extra load). During the range rich mixture is required → Reason of rich mixture is a) To provide best power
b) To prevent overheating of exhaust valve and area near it.



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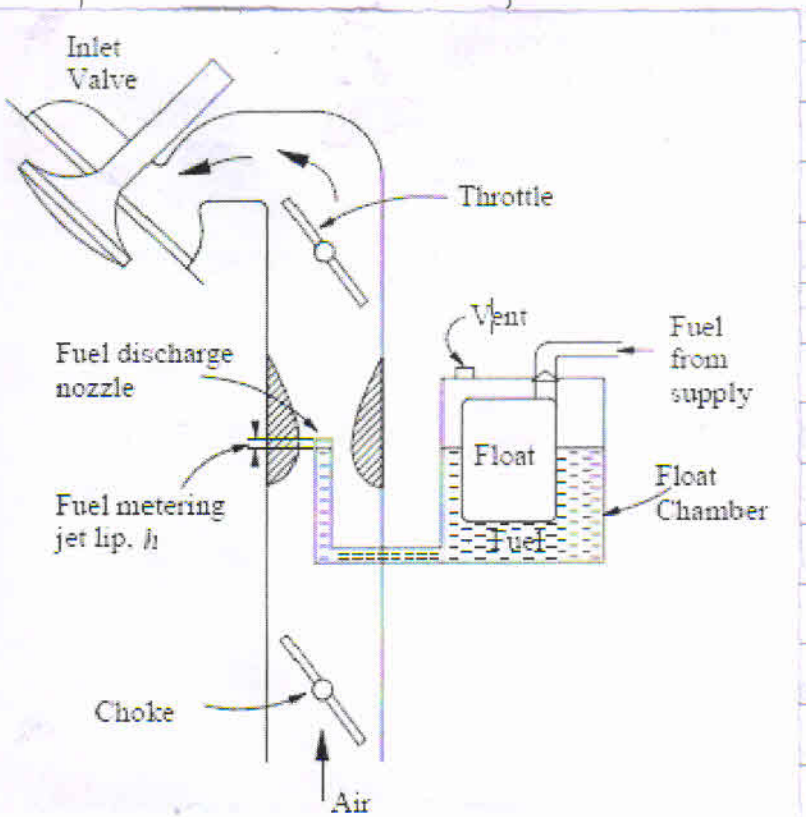
Starting a Cold engine :— (Why rich mixture is needed)

When engine is cold, a very small amount of fuel vaporizes. Also the fuel is cold with high viscosity causing lower flow rate. The engine & its parts are also cold & cause less vaporization. The cylinder walls and valves also absorbs more heat because of these reasons a rich mixture is required.

Components of Simple Carburetor :—

a) A float chamber with a float to store fuel and



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b) A ~~cylindrical body~~ cylindrical body with a venturi for atomization ~~of~~ purpose.

c) A fuel nozzle to atomize and produce a spray of fuel.

d) A throttle valve to supply varying quantity of the mixture at different load conditions.

e) A choke valve to control the air supply in order to provide a rich or a lean mixture.

Capable of supplying correct air-fuel mixture to the engine only at a particular load and speed.

Operation or Working of Simple Carburetor :—

- Carburetor depression.

Drawback of Simple Carburetor :—

a) Supply of required amount of air-fuel ratio is only at one throttle position.

b) For all other throttle position the mixture is either leaner or richer depending on whether the throttle is opened less or more.

Q. How throttle opening affects the regulation of fuel flow through the nozzle.

Calculation of Air-fuel ratio :—

$$A/F = \dot{m}_a/\dot{m}_f = ?$$

Let the tip of the fuel nozzle be at a height 'z' from fuel level in the float chamber

Applying SFEE b/w A-A (Point-1) and B-B (Point 2) Considering unit mass of air flow.

$$Q - W = h_2 - h_1 + \frac{1}{2}(C_2^2 - C_1^2)$$

For isentropic flow $Q = 0$
& no shaft work $W = 0$

Also $C_1 \simeq 0$

then $C_2 = \sqrt{2(h_1 - h_2)} = \sqrt{2C_p(T_1 - T_2)}$

Also mass flow is constant $\dot{m}_a = \rho_1 A_1 C_1 = \rho_2 A_2 C_2$

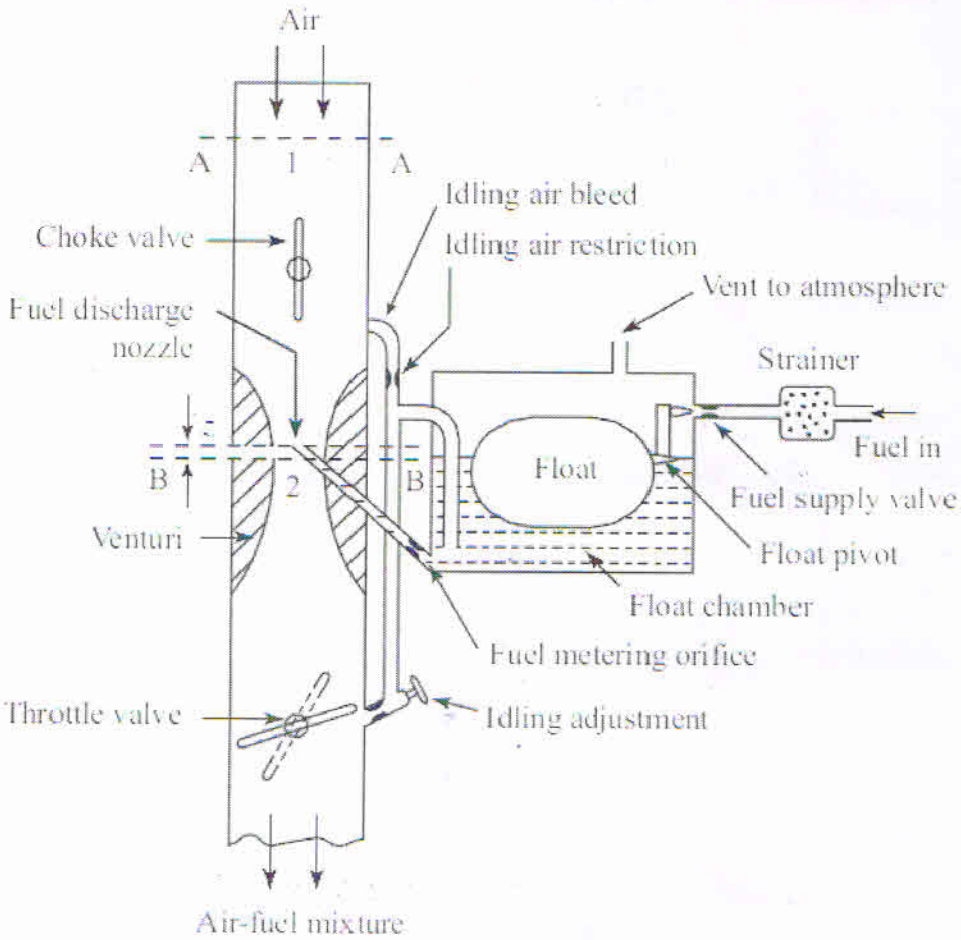
$$= \frac{A_1 C_1}{v_1} = \frac{A_2 C_2}{v_2}$$

Also $P_1 v_1^\gamma = P_2 v_2^\gamma$ or $v_2/v_1 = (P_1/P_2)^{1/\gamma}$

or $v_2 = \frac{RT_1}{P_1}\left(\frac{P_1}{P_2}\right)^{1/\gamma}$

Finally

$$(\dot{m}_a)_{\text{theoretical}} = \frac{A_2}{\frac{RT_1}{P_1}\left(\frac{P_1}{P_2}\right)^{1/\gamma}} \sqrt{2C_p T_1\left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}\right]}$$



$(\dot{m}_a)_{actual} = C_{d_t} (\dot{m}_a)_{theoretical}$

C_{d_t} ↙ Coefficient of discharge of Venturi throat.

Mass flow rate of fuel :—

let consider the incompressible flow and apply the Bernoulli's theorem.

$$\frac{P_1}{\gamma} = \frac{P_2}{\gamma} + \frac{C_2^2}{2g} + Z_1$$

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$$\frac{P_1}{\rho_f} - \frac{P_2}{\rho_f} = \frac{C_f^2}{2} + gz$$

$$C_f = \sqrt{2\left[\frac{P_1 - P_2}{\rho_f} - gz\right]}$$

ρ_f = fuel density C_f = fuel velocity at nozzle exit

z = nozzle lift

Also $(\dot{w}_f)_{theoretical} = \rho_f A_f C_f$

$$(\dot{w}_f)_{theoretical} = A_f \sqrt{2\rho_f (P_1 - P_2 - \rho_f g z)}$$

$$(\dot{w}_f)_{actual} = C_{d_f} (\dot{w}_f)_{theoretical}$$

C_{d_f} — Coefficient of discharge of fuel nozzle.

In order to overcome the drawback of Simple Carburetor

or

To supply the correct air-fuel mixture at different load conditions following arrangements are made —

a) Idling System
b) Auxiliary port system
c) Power enrichment by economizer system
d) Accelerating pump system
e) Choke

} from Book of Y. Gowrishankar

Also termed as compensating devices.

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Types of Carburetor :—

a) Based on direction of flow

- i) ~~Up~~ - draught (up draft)
- ii) ~~Down~~ - draught
- iii) ~~Cross~~ - draught / horizontal Carburetor

from (a) Book Ganeshan

Advantages & Disadvantages