Calculations For Volume:-

(i) Calculation For Volume :-

(a) 2 stroke Engine - one cycle - one rotation - one suction

Vol. of air taken in $= V_s$

For N rotation, Vol of air $= V_s \times N$

(b) 4 stroke Engine - one cycle - Two rotation - one suction

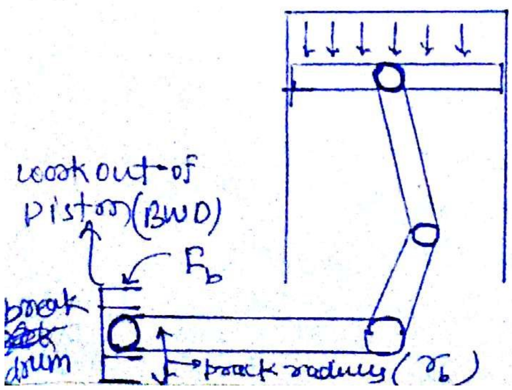
~~For N rotation~~ Vol. of air $= V_s$

Avg. Vol/rotation $= \frac{V_s}{2}$

For N rotation, Vol. of air $= \frac{V_s}{2} \times N = V_s \times \frac{N}{2}$.

(2) Mechanical Efficiency:- (Motion efficiency)

The input to the piston is found by the expansion of the gas. Volume will increase and pressure decrease hence the input to the piston is found from P-V diagram which is also know as the indicator daigram. Thus the input to the piston is called the indicated work done (iwd).



F_b - break force

shaft से एक break drum connected होता है जिससे ~~out~~ bwD मिलता है।

The energy output of piston is the energy available at the shaft of engine and is found by a break mechanism. (Dynamometer). Thus the work output of engine is know as the break work done (BWD)

The ratio of BWD to IWD is defined as the mechanical efficiency of engine and is given by

$$\eta_m = \frac{\text{Break work done}}{\text{Indicated work done}}$$

$$\boxed{\eta_m = \frac{BWD}{IWD}} = \frac{bmep \times V_s}{imep \times V_s}$$

$$\boxed{\eta_m = \frac{bmep}{Imep}}$$

bmep - break mean effective pressure
imep - indicated mean effective pressure.

(3) Power (P) [Rate of doing work]

$$\therefore \; P = \frac{\text{work done}}{\text{time}} \quad or \quad P = \frac{WD}{sec.} \left[watt = J/sec. \right]$$

4) Calculation for Break Power.

$$\text{Break power} = \frac{BWD}{Sec.} = F_b \times 2\pi r_b \times \frac{N}{60}$$

$$\boxed{B.\ Power = \frac{F_b (2\pi r_b) N}{60}} \quad \text{watts}$$

यहाँ N का same value रखना है।

5) Heat added (HA) & thermal efficiency (η)

$$\text{Calorific Value} = \frac{HA}{kg\ fuel}$$

$$HA/sec. = (\text{Calorific Value}) \times m_f/sec.$$

$$\boxed{HA/Sec. = HA/kg\ fuel \times m_f/Sec.}$$

Indicated thermal efficiency

$$\boxed{\eta_{IT} = \frac{IWD}{HA}}$$

$$\boxed{\eta_{BT} = \frac{BWD}{HA}}$$

⑥ Vol/sec. (volume per sec.)

$$\boxed{Vol/sec = \frac{Vol.}{Cycle} \times \frac{N}{60}}$$ → rpm (No. of Cycle)

2 stroke − N

4 stroke − N/2

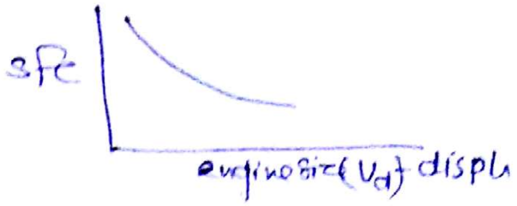
⑦ Specific Gravity (Relative density)

$$\boxed{\text{Specific Gravity} = \frac{\text{Density of substance}}{\text{Density of water}}}$$

$$\rho_w = 1\ \frac{gm}{cc} = 1000\ \frac{kg}{(100)^3 m^3} = 1000\ kg/m^3$$

⑧ Specific fuel consumption (sfc): it is defined as the fuel flow rate per unit power output

$$sfc = \frac{m_f / hr}{Power (kW)}$$



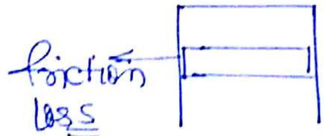
if power - break power, Indicated power
sfc - break sfc, indicated sfc.

⑨ Friction Power

It is a one type of loss

IWD = BWD + FWD

↓ friction work done.



⑩ Ave. piston speed.

L - meter
N - rev/min

☆ avg. piston speed = 2LN

* where N is the speed of the engine in rev/min

Chap 4
Q.5
WB
Pg. 12

$\eta_m = 0.8$ IP = ?
B.P = 60 kW FP = ?

$$\eta_m = \frac{BP}{IP} \Rightarrow IP = \frac{60}{0.8} = 75\ kW\ \text{Ans}$$

$$FP = 75 - 60$$

$$FP = 15\ kW\ \text{Ans}$$

Ques 9 2 cyc, 4 stroke

B.P. = 15 kW (develope means output B.P.)

B.P./cyl. = 7.5 kW /cyl.

N = 2400 rpm

break specific fuel consumption =

bsfc = 0.268 kg/kWh

ρ_f = 850 kg/m³

$Vol_f / cycle$ (m³) = ?

$$bsfc = \frac{m_f/hr}{B.\ Power} \Rightarrow 0.268 \frac{kg}{kWh} = \frac{m_f}{7.5\ kW}$$

$$m_f = 0.268 \times 7.5 \ kg/hr$$

$$\rho_f = \frac{m_f}{V_f} \quad \therefore \quad V_f = \frac{m_f}{\rho_f} = \frac{0.268 \times 7.5}{3600 \times 850} \ m^3/sec.$$

$$\frac{Vol.}{Sec.} = \frac{Vol.}{Cycle} \times \frac{N}{2}$$

$$\frac{0.268 \times 7.5}{3600 \times 850} = \frac{Vol.}{Cycle} \times \frac{2400}{2 \times 60}$$

$$Vol/cycle = 0.033 \times 10^{-6} \ m^3 \quad \text{Ans}$$

Q.14

$m_f = 10\ gm/sec.$

Power output BP = 160 kW

$\eta_m = 0.75$

Isfc = ?

$$IP = \frac{160}{0.75}$$

$$isfc = \frac{m_f/hr}{I.P.} = \frac{10 \times 3600 \times 0.75}{1000 \times 160}$$

ISFC = 0.1687 kg/kWhr

Q.15

$\frac{m_f}{m_a} = 0.05$ Imep = 6 bar

$\eta_v = 0.90$ $HV/kg\ fuel = 45000\ KJ/kg$

$\eta_{ith} = ?$ $\rho_{air} = 1\ kg/m^3$

$$m_a = \frac{m_f}{0.05} = \frac{kg}{0.05\ kg\ fuel} = 20\ \frac{kg}{kg\ fuel}$$

$$\rho_a = \frac{m_a}{Vol_a} \therefore V_a = \frac{m_a}{\rho_a} = 20\ m^3/kg\ fuel$$

$$\eta_{vol} = \frac{V_a}{V_s} \therefore V_s = \frac{20}{0.9}\ m^3/kg\ fuel$$

$IWD = imep \times V_s / kg\,fuel$

$IWD = 6\times10^5 \times \frac{20}{0.9}$ J/kg fuel

$$\eta_{IT} = \frac{IWD/kg\,fuel}{HA/kg\,fuel} = \frac{6\times10^5 \times 20/0.9}{45000 \times 1000}$$

$= 0.2962$

$= 29.62\%$

(T1) $r = 5.5$ $\quad \frac{V_s}{V_c} = r - 1 \Rightarrow V_s = 4.5\,V_c$

$WD = 23.625\times10^5\,V_c$ J $\qquad imep = ?$

$WD = imep \times V_s$

$$V_s = \frac{23.625\times10^5\,V_c\ J}{4.5\,V_c}$$

$V_2 = 5.250$ bar.

☆

(T3) $r = 10$ $\qquad HR = 1500$ KJ/kg

$P_1 = 100$ kPa $\qquad HA = 700$ KJ/kg.

$T_1 = 300$ K $\qquad R = 0.287$ KJ/kgK

$P_1 = 1$ bar

$$mep = \frac{WD}{V_s} = \frac{1500-700}{0.77} = \frac{800\times10^3}{0.77\times10^5}$$

~~mep = 1.032 bar~~.

$mep = 10.32$ bar

~~$\frac{V_s}{V_2} = r - 1$~~

~~$\frac{V_s}{V_2} = 9$~~

~~$V_s = 9V_2$~~

$$V_1 = \frac{RT_1}{P_1} = \frac{287\times300}{10^5}$$

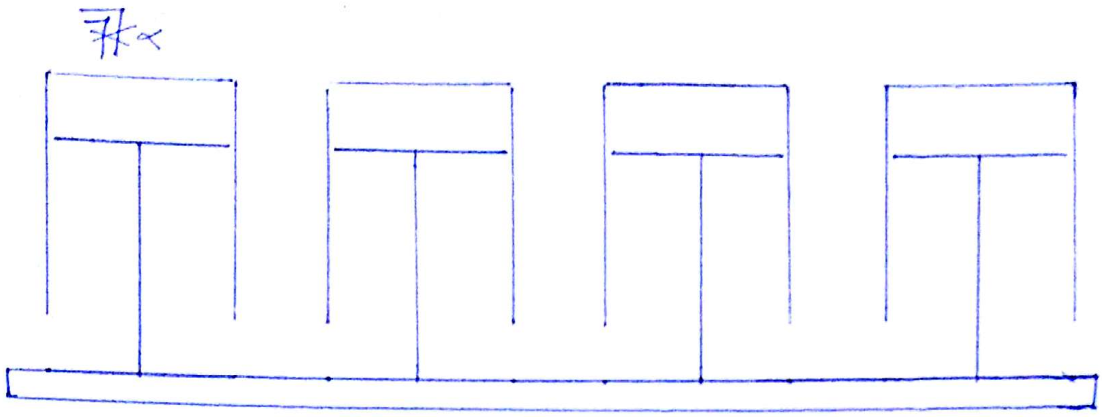
$V_c + V_s = 0.86$

$V_1 = 0.86\ m^3/s$

$\frac{V_s}{9} + V_s = 0.86$

$V_s = 0.77\ m^3/s$

* Testing of I.C. Engine (Morse key Test)



$IP/cycle = I$

$BP/cycle = B$

$F.P/cycle = F$

For 4 cylinder working

$$4I = 4B + 4F \quad -①$$

if 3 cylinder working (one by one) { एक एक करके engine का flow रोक देंगे और BP निकालेंगे }

$$3I = 3B + 4F \quad -②$$

(eq.) → $4F$: Friction for all cylinder because it also connected to shaft

(पहले cyl को cut होने के बाद) 1st cylinder $3B_1$

— " — 2nd — " — $3B_2$

— " — 3rd — " — $3B_3$

— " — 4th — " — $3B_4$

Now $$3B = \frac{3B_1 + 3B_2 + 3B_3 + 3B_4}{4}$$

Now $$3I = 3B + 4F \quad -②$$

$$I = 4B - 3B$$

$$4I = 4(4B - 3B)$$

$$\boxed{\eta_m = \frac{4B}{4I}}$$

$$4B \neq 4 \times B$$

$$4B - 3B \neq B$$

$$4B - 3B \neq 3B - 2B$$

⇒

let us consider a four cylinder engine
Also let

$$I.P./cycle = I$$

$$B.P./cycle = B$$

Initial the engine is test with a dynamomenter for all 4 working cylinder. The B.P. will be obtain for 4 working cylinder.

we have 4 cylinder

$$4I = 4B + 4F \quad -①$$

later the engine is tested by ~~diff~~ cutting of different single cylinder at a time. four different reading will be obtain for three working cylinder. if these reading are $3B_1$, $3B_2$, $3B_3$, $3B_3$ then avg. of these ~~redc~~ reading will be

$$3B = \frac{3B_1 + 3B_2 + 3B_3 + 3B_4}{4}$$

we than have for three working cylinder

$3I = 3B + 4F$ — ②

① − ② it gives

$I = 4B - 3B$

then indicated power of entire engine (4 cylinder)

$I.P. = 4(I) = 4(4B - 3B)$

therefor mechanical efficiency

$$\therefore \boxed{\eta_m = \frac{4B}{4I}}$$

Depanding on Given data, Any other unknow value can be determine

The following point are to be noted

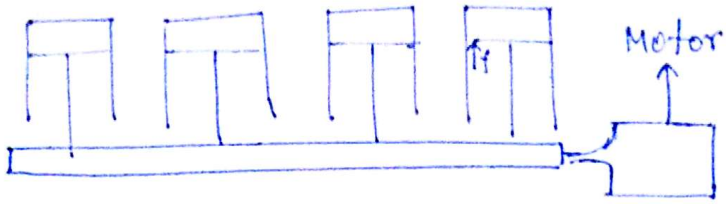
$4B \neq 4 \times B$

$4B - 3B \neq B$

$(4B - 3B) \neq (3B - 2B)$

☆ Imp-

Motoring Test :-



Friction

$F_f = A + BV^2$

frictional power equal to motor power

*The following point must be noted

① Speed of the engine recorded during morse key test.

② The engine must be put off before starting morting test:-

③ Motor is then attached to the engine shaft

④ On starting the motor the speed of Motor must be same and the speed of engine during ~~Mot~~ morse key test

⑤ The power input to the Motor will then be equal to the ~~f~~ frictional power of engine.

⑥ If the mechanical efficiency of Motor is given

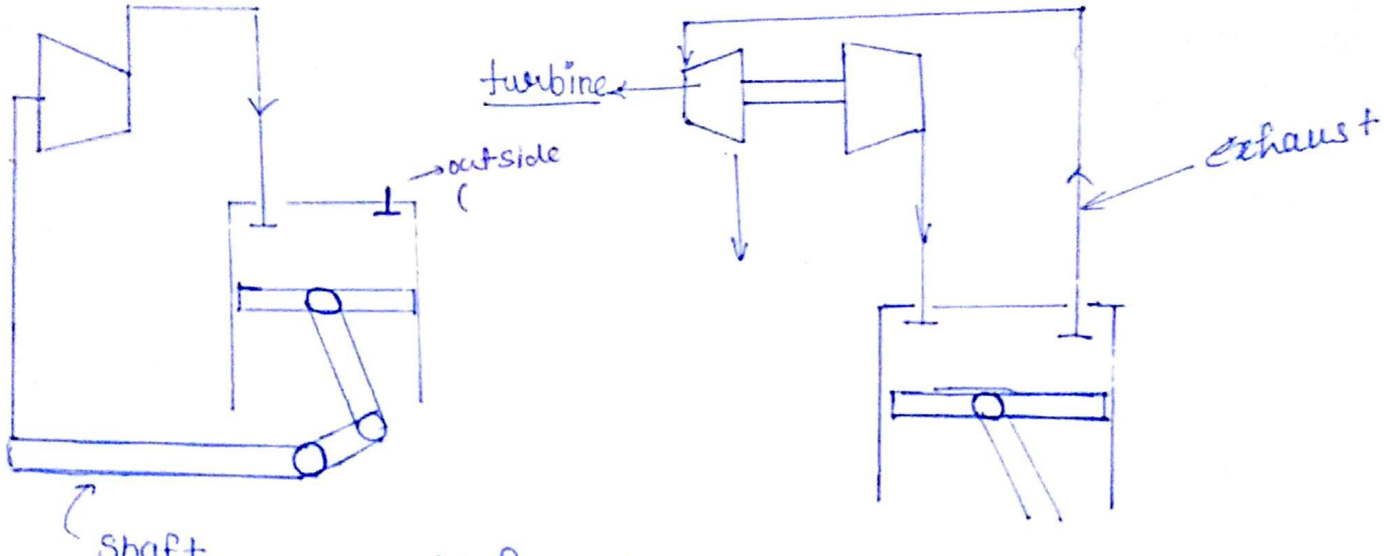
$$\boxed{P_f = P_m \times \eta_m}$$

P_f → Friction Power

P_m → Motor power

η_m → efficiency of motor.

Supercharger:- (Rotary compressor / Centrifugal compressor)



Air fuel Ratio

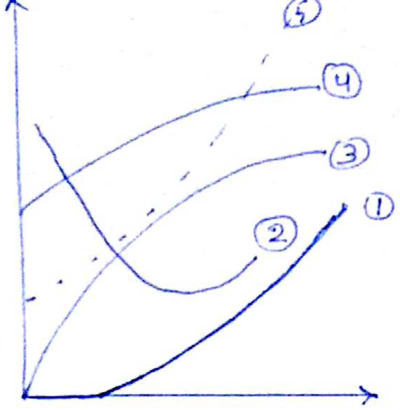
$$AF = \frac{m_a}{m_f}$$

supercharger is a rotary compressor it attched before the cylinder in diesel engine and before the carborator in petrol engine. On using a supercharger, the mass of air circulator is more. The final pressure after super charging is 1.5 times to 2 times the entry pressure.

Super charger is of two diff. types.

In one super charger the engine shaft drive's the super-charger. In another Supercharger, the exhaust gas from engine drives a turbine and the turbine drive the super charger. Such a super charger is known as turbo charger.

Q.2



B.H.P. (Break power)

A - 5
B - ~~4~~ 3
C - 4
D - 2

(A) Total fuel consumption.

in starting m_f = a const.

if we need to increase B.P.

$m_f \propto (B.P.) \Rightarrow m_f = b(B.P.)$

to total fuel consumption $mf_1 + mf_2$

$m_f = a + b \times (B.P.)$ Graph (5)

→ willians line.

(B) $\eta_m = \frac{B.P.}{I.P.}$ At starting B.P. = 0

$\eta_m = 0$

only 3rd Graph passing through origion

if after some time B.P. increase, more friction is there

So η_m will less. (कम हो जायेगा ज्यादा speed में)

(C) Indicated power $\frac{B.P.}{\eta_m} = I.P.$ 4th Graph

(D) Brake specific fuel Consumption

when B.P. less friction is more so more fuel Consumption

(1st Gear में Power ज्यादा होता है so more fuel consumption)

More the torque in 1st Gear so more fuel consumption

For 2nd Gear friction less

for 3rd Gear more ~~power~~ B.P. More fuel Consumption

2

Differance between the 2 stroke and 4 stroke Petrol Engine :—

1) In a 2 stroke engine, one cycle is complated in one rotation of the shaft. For 4 stroke engine two rotation are needed for the complition of the cycle.

2) The two valve of the 4 stroke engine are replaced by three different port in a 2 stroke engine.

3) In 2 stroke engine, The lubricating oil mix with petrol before entering into the fuel tank.
For 4-stroke engine, the lubrication oil takeing sepratelly and not mixed with fuel

3) for a single cylinder engine, the Flywheel for a two stroke Engine is smaller than that of a four stroke engine. It is reverse when there are four cylinder for the 2 stroke & 4 stroke engine.
{continious power मिलती जाएगी 4 cylind 4 stroke मे so energy store करने के small small needed)
(Flywheel - to store energy)

4) The transfer port and the exhaust port open at the same time in a 2 stroke engine thus the some AFM will escape out of the exhaust port from a 2 stroke engine due to which the milage of a 2 stroke engine is much less than that of a 4 stroke engine.

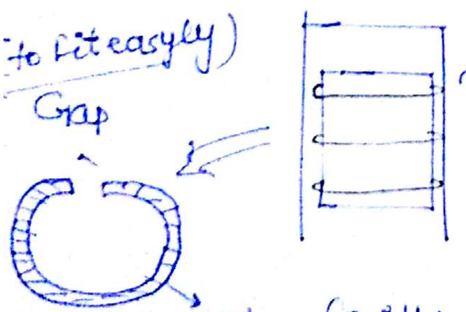
⑤ Due to larger surface area the radiation heat loss is more in a 2 stroke engine than that of a 4 stroke engine.

⑥ In 2-stroke engine the lubrication oil enters the combustion chamber along with fuel. Some of these lubricating particle undergoes combustion hence less lubricating oil will be available for the piston stroke after compustion friction will be more hence the output will be reduce.

⑦ Due to varies disadvantages all the 2 stroke engine on the roads are being replace by 4 stroke engine.

Ex 50cc engine वाली गाड़िया 2 stroke eg. Luna, TVS)

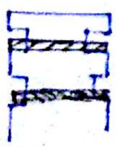
(Brittle Material)



three piston ring on piston
Made of silica cast iron }
cast iron is rough so we use Silica Cast iron

Ring (Brittle Material)

For Cylinder – Allumian Alloy by Casting



Connecting rod & Crank – strong Material
it is called Forge steel
made by only forging

For shaft – High speed steel (HSS)

Following Point should be remember:-

① The piston rings are made of silicon cast iron. The ~~silicon and~~ cylinder & piston material is cast Al Alloy.

② The connecting rod & crank rod is manufactured from forged steel. The engine shaft is made from High speed steel (CHSS).

Difference between Petrol (SI) & Diesel (CI) Engine:-

1) Ignition ~~to~~ should takes place at lesser temp for petrol engine for this purpose a spark plug is necessary.

2) For Diesel engine low temprature will result in knocking. Thus high temp. are necessary for the ignition of fuel in diesel engine. The Diesel engine do not have spark plug. [The high temp required for diesel engine to ignite the fuel is called self ignition temp.]

The minimum temp needed for the ignition of the fuel in presence of a burner is known as the flash point temp. The minimum temp. needed for the ~~engine~~ ignition to continue even after removing the burner is know as fire point temp. It is thus clear that sparking in SI engine should take place continue from

-Flash point to fire point temp.

→ The self ignition temp. is much above the Fire point temp

2) For a carborated petrol engine, The Air and Fuel get mix inside the carborator and then enter into the engine cylinder. There is no carborator for a Diesel engine and also for petrol engine fitted with a microprocessor

(such an engine is know as an electronic fuel injection engine.) EFI engine)

* For the seprate entry of fuel, in the case of a diesel engine and an EFI engine a nozzle (Also known as an injector) is provided.

* The fuel enters in diesel engine at the end of compression stroke and during last stage of suction in an EFI engine

* Electronic fuel injection is introduced for petrol engine to regulate the fuel immediately according to changing load condition This will result in a good saving in fuel.

3) Heat addition takes place at constant Pressure in case of diesel engine and at constant volume in case of petrol engine.

(4) For the same comp. ratio, the efficiency of a petrol engine is higher than that of the diesel engine but this is theoritical.

(5) In practice the η of a diesel engine is 1.5 to 2 times more than that of a petrol engine

Hence the η of a diesel engine only is higher

(6) For a diesel engine, the compression ratio is between 16 to 20 and for petrol engine ~~~~ it is between 6 to 10.

(7) At ~~for~~ cruising speed

AFR 16 - petrol engine.

A/F 25 to 35 - diesel engine.

~~The~~ ~~O/P~~

operations	A/F Ratio
Idling	12-12.5
Cruising/Normal	16-16.5
max. power range	12-13
transient operation /starting	3-5