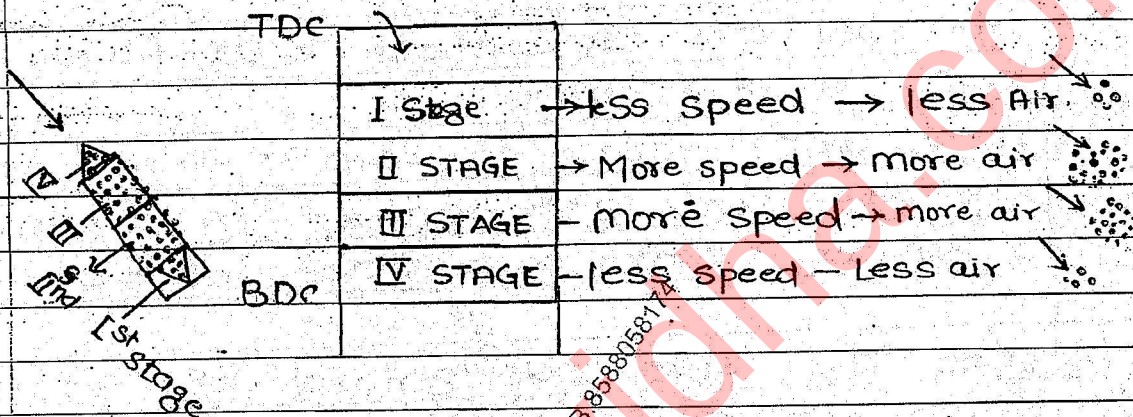


Combustion In CI Engine:-

- If small impurities are available in Cyl. and Fuel then engine does not start.
- Finding the mass at various point in Suction stroke in CI Engine is more important.

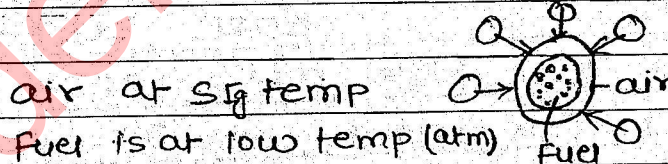
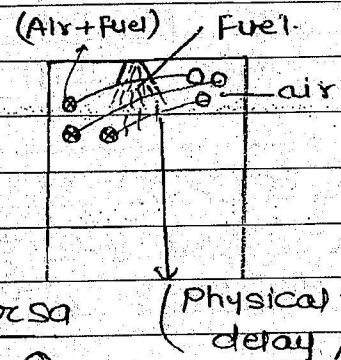
FOUR STAGES OF SUCTION :-



Ist stage of combustion :-

@ - After compression 1st stage of comb. takes place.

@ - chemical lag is more when temp. is more above the self-ignition temp. & vice versa



So temp of fuel air is decreases.

@ - so more air comes with contact to fuel & temp inc. so the temp is again increases and become comes at self-ign temp.

1) The temp. of the Comb. chamber at the start of 1st stage of comb. is close to the self ign. temp.

ii) less mass of air is circulated, hence the fuel supply is in the form of fuel spray is also less.

iii) During the fuel spray, the air will be physically in contact with the fuel for some time. This time taken is called the "physical Delay".

Thus For Diesel engine Ignition Delay.

i.e. $\text{ignition delay} = \text{physical delay} + \text{chemical delay}$.

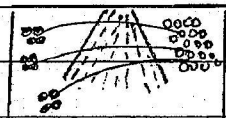
Since the temp of the charge is close to the self ignition temp, the chemical delay will be long.

5. The 1st stage of Comb. is known as the delay period.

6. At the end of the 1st stage of comb. the temp. of the comb temp will be above the self ign. temp.

2nd stage of Combustion :-

@ - any batch take a small quantity of fuel (occur at 1 time within the lakhs of batch) and temp of that batch is also less. (close to self ign temp) & more chemical lag. & more time required in comb.)



@ - To knock the piston to cyl. is called knocking.

If knocking is occur then no body can control it

In second stage of Comb, more fuel is supply & more heat is produce & in this way piston will uncontrollable & knocking happen so this 2nd stage is called uncontrollable stage.

In 1st stage knocking is not possible, but in second stage knocking may occur 1 times out of lakhs of cycle.

i) The temp at the start of 2nd stage comb. is about at self ign temp.

ii) More mass of air is circulated hence the fuel sprayed is also in large quantity.

iii) Due to the circulation of large mass of air, the air particles cross the fuel spray in different batches. The chemical lag is short for all the batches of AF mixture. If the comb. takes place for all the batches of AFM, one after another until the last batch of AFM, then comb. is said to be normal or smooth.

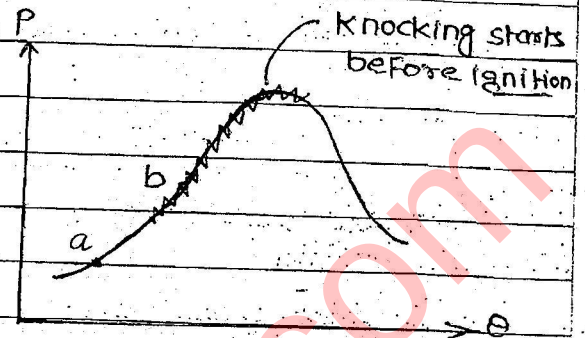
4) On the otherhand if a particular batch of air carry less fuel with it, then less heat will be produce during the chemical action due to which the temp rise of this charge will be less (close to self ignition temp), the chemical delay will be longer for this batch. In the mean time more batches of AFM will get collected with this batch resulting in the comb. taking place for all the batches of AFM will be at same time, liberating abnormal

amount of heat which a piston unable to handle & knocking occurs.

5. a : Injection of fuel
(20° before end of comp)
b : Ignition of fuel.

- In diesel engine as much as high possible temp will be kept.

- In petrol engine before 20° of end of comp. Sparking start. Similarly, in Diesel engine before 20° end of comp. fuel is injected.



i) The second stage of comb. is known as uncontrol comb.

ii) At the end of 2nd stage of comb, the temp of the charge will be very high above self ignition temp.

3rd stage of comb.

i. The temp. of the comb. chamber at the start of 3rd stage comb. is ab

ii) More mass of air is circulated. Hence mass of fuel sprayed is also large.

iii) The air crosses the fuel spray in different batches since the temp. of comb. chamber is very high hence the comb of AFM takes place immediately after crossing fuel sprayed.

- Bevel gear is used to change the gears

Date : / /

Page No.

iii) Knocking does not take place during the IIIrd stage of comb. (called controlled combustion)

4th - stage of combustion :-

i. Comb. during the 4th stage takes place due to the heat transfer after burning of fuel particle.

ii) Very less air will be left for comb in the 4th - stage. Hence the fuel available is also less.

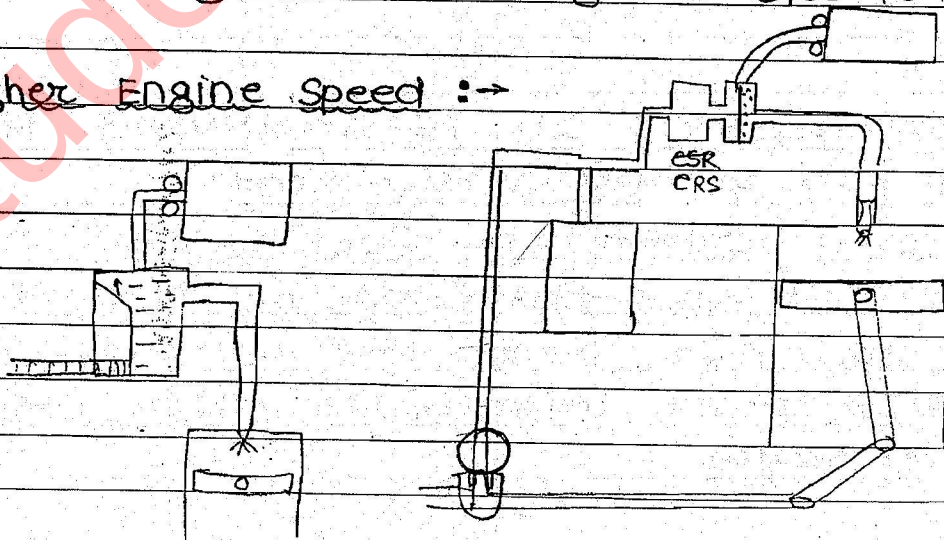
iii) The 4th - stage of comb. is known as after burning.

Factors affecting knocking in CI Engine :-

1. Higher compression Ratio (C.R)

- Higher CR results in higher temp of charge tendency to knock decreases. It is for this reason that the CR of Diesel engine is as high as b/w 16 to 20.

2. Higher Engine Speed :->



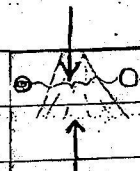
** - Higher Engine speed is result in more supply of fuel during the 1st of comb. (Delay period). Hence the fuel available for 2nd-stage of comb will be less. tendency to knock will increase. Thus diesel engine must be run at low speed.

3. Increasing the load :-

Higher engine load will result in higher-work output and power. More fuel will be supplied. More energy will be released during the 2nd-stage of comb. tendency to knock is less. Hence ideal combination for minimum knocking is less speed & more load.

4. Atomisation :-

For atomisation, cyl. press must be less. (Atomisation)



For a better atomisation during the fuel spray the fuel will spray at more space. Air will be in the contact for more time. physical delay will be more. Air will carry more fuel with it. After crossing the fuel spray. Knocking during the second stage of comb. will reduce.

It is to be denoted that for a good atomisation, the engine injection press. should be as high as possible & cyl. press (after comp) should be as low as possible in the range of comp ratio 16 to 20.

5. Advancing the fuel injection :-

- Advancing the fuel injection will result in less comp. temp of the charge will be less. Knocking will be higher. Hence the fuel injection should not be advanced. Retardation can take place.

6. Quality of fuel :-

Standard Fuel.

1. Normal Cetane (ZERO knock)

ii) α -methyl naphthalene (Readily knock).

Higher the cetane no. better is the antiknock quality of the Diesel engine

- In India the cetane no. of Diesel fuel is b/w 40 to 50.

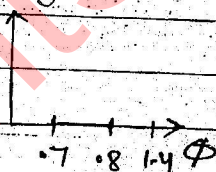
Ques:-

ch. 2 (7)

i) x

2) $\checkmark$

iii) $\checkmark$



(2)

(a)

(3)

c

(4)

(6)

i) $\checkmark$

ii) $\checkmark$

iii) x

iv) $\checkmark$

7)

c

8)



$$\eta = 1 - \left(\frac{1}{r}\right)^{\gamma-1}$$

$$= 1 - \left(\frac{V_2}{V_1}\right)^{\gamma-1}$$

$\rightarrow$ No Relatⁿ with temp
beac γ is ind of temp
const for a engine

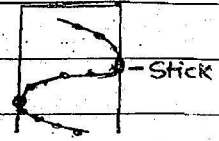
→ only in petrol engine.
not in SI engine

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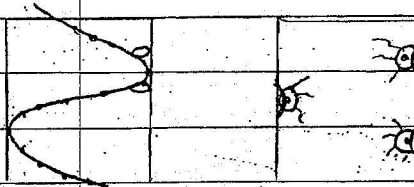
Page No. 133

PRE-IGNITION OR MISFIRING:

I. - After comb. Some of the unburnt hydrocarbon (UBHC) particle stick to the inner wall of cylinder.

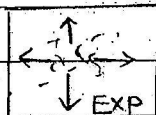
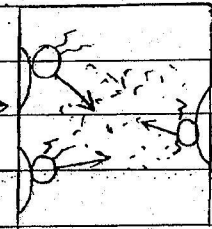


II) →

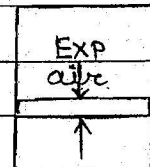


During next cycle some fresh fuel particles @ ~~with~~ contain the UBHC on the cyl. wall. Heat flows from UBHC to fresh fuel particles, some of the fuel particles gets ignited. This ignition is known as pre-ignition or mis-firing.

III) The heat coming out of pre-ignited fuel will be taken by the surrounding air. This air will expand in all dirn.



The expanding air will oppose piston motion & there is loss of work



→ pre-ignition takes place in SI engine only.

→ under worst circumstances, the engine ceases due to mis firing & work output of the cycle will be lost completely.

THEORIES OF ABNORMAL COMBN:-

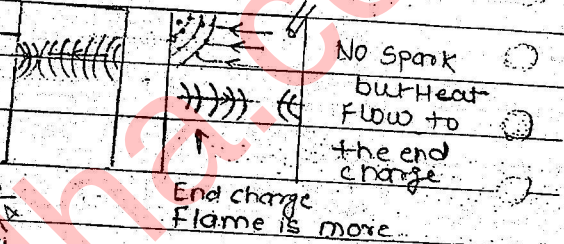
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Page No.

1. DETONATION THEORY :-

- The flame front travel towards the end charge in a uniform manner.
- All these fuel particle in end charge get ignited simultaneously.

2. PRE - IGNITION THEORY :-

- The heat liberated for the fuel particle during Sparking (at the time of chemical action) flows towards the end charge and is the reason for the formation of flame front in the end charge.
- The heat travels towards the end charge at a speed of twice of sonic velocity.



@# At the time of Deceleration, the fuel does not burnt completely and emission of fuel is directly to the atm so maxm pollution occurs at Deceleration

(14) $CR \downarrow$ $T \downarrow$ $NO_x \downarrow$

(15) $EGR = \text{Exhaust gas recirculation}$
→ used to control NO_x

-
-
-
-

S/. Lean mixture means temp decreases.

POLLUTANTS :-

1. CO :- poisonous.

— will cause giddiness, when inhaled in small quantity.

2. HC : (UBHC) : causes photochemical smog when it contain with moisture in air.

— It causes Skin cancer & affect the lungs.
— also affects plant and animal.

*** 3. NOx : Same as HC, also affect underwater creatures.

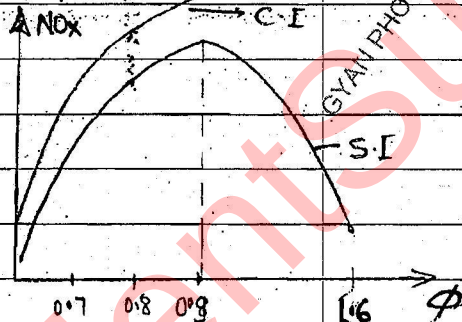
— For deformation of NOx,

a) temp. of the charge should be very high.

b) Excess of oxygen is available

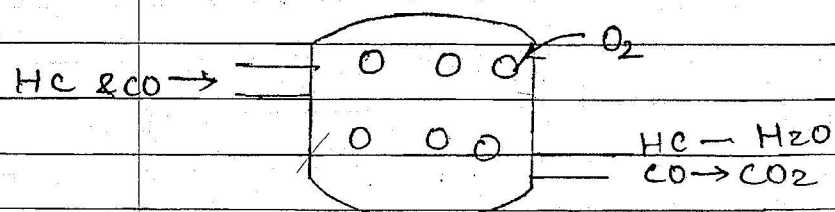
c) Incomplete comb. of the fuel.

Graph of NOx for petrol & Diesel engine.



The graph is always increase for CI engine.

Two-way Converter (Thermal converter)



Two-way converter absorb O_2 from outside & converts into CO_2 .

It also convert HC to H_2O & CO_2 .