UNIT II –INTERNAL COMBUSTIONENGINES

1. List the various components of engine.

(i)Cylinder block
(ii)Cylinder head
(iii)Crankcase
(iv) Cylinder liners
(v) Piston& piston rings

2. Name the basic thermodynamic cycles of the two types of internal combustion reciprocating engines.

Otto cycle in S.I engines and diesel cycle in C.I engines.

3. Define compression ratio of an IC engine?

It is the ratio of volume when the piston is at BDC to the volume when the piston is at TDC.

4. Define the terms Mean effective pressure?

It is defined as the algebraic sum of the mean pressure acting on the during one complete cycle.

5. What is meant by highest useful compression ratio?

The compression ratio which gives maximum efficiency is known as highest useful compression ratio.

6. Why compression ratio of petrol engines is low while diesel engines have high compression ratio?

Since fire point of petrol is less as compared to diesel, petrol engine has low compression ratio.

7. Compare the thermal efficiency of petrol engines with diesel engines. Give reasons.

Thermal efficiency of diesel engine is greater than petrol engine this is due to high compression ratio.

8. What do you mean by scavenging in I.C.Engines?

The process of removing the burnt gases from the combustion chamber of engine cylinder by using fresh air fuel mixture is known as Scavenging.

9. Define Cetane number?

The property that quantities the ignition delay is called as Cetane number.

10. Which is better efficient two stroke or four stroke engines?

Two-stroke engine give always lesser efficiency than four-stroke engine due to incomplete combustion and poor scavenging.

11. Why a choke is used in carburetor and what is meant by automatic chocking?

Initially, more fuel is required to reduce high starting torque which is done by using supply unit will be cut off by a choke called automatic choking.

12. What are the important requirements of fuel injection system?

* The beginning as well as end of injection should take place sharply
* Inject the fuel at correct time in the cycle throughout the speed range of the engine.
* The injection of fuel should occur at the correct rate and in correct quantity as required by the varying engine load.
* Atomize the fuel to the required degree.
* Distribute the fuel throughout the combustion chamber for better mixing.

13. Mention different types of fuel injection systems in C. I engines.

a) Air injection system
b) Airless or Solid injection
(i) Common rail system
(ii) Individual pump system.

14. Define delay period with respect to a CI engine.

The physical delay period is the time between the beginning of injection and the attainment of chemical reaction reaction conditions. During this period fuel is atomized, mixed with air and raised to its self-ignition temperature.

During the chemical delay reactions start slowly ad then accelerate until ignition takes place.

15. What is the purpose of providing spark plug in SI engine?

The function of a spark plug is to produce an electric spark for the ignition of compressed air-fuel mixture inside the engine cylinder.

16. What is the purpose of a thermostat in an engine cooling system?

A Thermostat valve is used in the water-cooling system to regulate the circulation of water in system to maintain the normal working temperature of the engine parts during the different operating conditions.

17. State any three functions of lubrication?

a) It reduces friction between moving parts.
b) It reduces wear and tear of the moving parts.
c) It minimizes power boss due to friction.

SRI VIDYA COLLEGE OF ENGINEERING & TECHNOLOGY
VIRUDHUNAGAR

DEPARTMENT OF MECHANICAL ENGINEERING

THERMAL ENGINEERING QUESTION BANK FOR 16MARKS

Q.No	UNIT II	In Notes / Answer Key
1	Explain full pressure lubrication system I.C Engine.	ANSWER KEY
2	Explain the water cooling system in I.C Engine	ANSWER KEY
3	Explain the 2 types of Ignition system In S.I Engine	ANSWER KEY
4	Draw and explain the valve timing diagram of 4 strokes Diesel Engine.	NOTES
5	Draw and explain the port timing diagram of 2stroke Petrol Engine	NOTES
6	Explain with neat sketch the exhaust gas analysis	ANSWER KEY
7	The following observations are recorded during a test on a four-stroke petrol engine, F.C = 3000 of fuel in 12sec, speed of the engine is 2500rpm, B.P = 20KW, Air intake orifice diameter = 35mm,Pressure across the orifice = 140mm of water coefficient of discharge of orifice = 0.6, piston diameter = 150mm, stroke length = 100mm, Density of the fuel = 0.85gm/cc , r=6.5, Cv of fuel = 42000KJ/Kg, Barometric pressure = 760mm of Hg , Room temperature = 24^{o}c	ANSWER KEY
8	Explain Basic components of Engines.	NOTES

UNIT-II-IC ENGINES-ANSWER KEY FOR 16MARK

Q.NO:1 **lubrication system**

1. The job of the lubrication system is to distribute oil to the moving parts to reduce friction between surfaces which rub against each other.
2. An oil pump is located on the bottom of the engine.
3. The pump is driven by a worm gear off the main exhaust valve cam shaft.
4. The oil is pumped to the top of the engine inside a feed line.
5. Small holes in the feed line allow the oil to drip inside the crankcase.
6. The oil drips onto the pistons as they move in the cylinders, lubricating the surface between the piston and cylinder.
7. The oil then runs down inside the crankcase to the main bearings holding the crankshaft.
8. Oil is picked up and splashed onto the bearings to lubricate these surfaces.
9. Along the outside of the bottom of the crankcase is a collection tube which gathers up the used oil and returns it to the oil pump to be circulated again.

cooling system for an engine.

1. Although gasoline engines have improved a lot, they are still not very efficient at turning chemical energy into mechanical power.
2. Most of the energy in the gasoline (perhaps 70%) is converted into heat, and it is the job of the cooling system to take care of that heat. In fact, the cooling system on a car driving down the freeway dissipates enough heat to heat two average-sized houses!
3. The primary job of the cooling system is to keep the engine from overheating by transferring this heat to the air, but the cooling system also has several other important jobs.
4. The engine in your car runs best at a fairly high temperature.
5. When the engine is cold, components wear out faster, and the engine is less efficient and emits more pollution.
6. So another important job of the cooling system is to allow the engine to heat up as quickly as possible, and then to keep the engine at a constant temperature.

Splash:

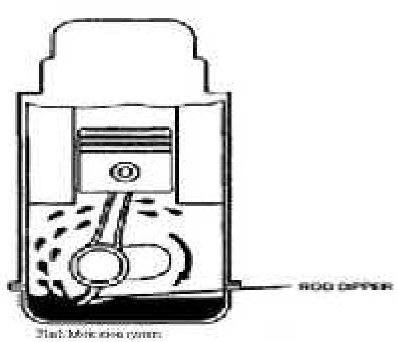

Fig 2.10 Splash

The splash system is no longer used in automotive engines. It is widely used in small four-cycle engines for lawn mowers, outboard marine operation, and so on. In the splash lubricating system , oil is splashed up from the oil pan or oil trays in the lower part of the crankcase. The oil is thrown upward as droplets or fine mist and provides adequate lubrication to valve mechanisms, piston pins, cylinder walls, and piston rings.

In the engine, dippers on the connecting-rod bearing caps enter the oil pan with each crankshaft revolution to produce the oil splash. A passage is drilled in each connecting rod from the dipper to the bearing to ensure lubrication. This system is too uncertain for automotive applications. One reason is that the level of oil in the crankcase will vary greatly the amount of lubrication received by the engine. A high level results in excess lubrication and oil consumption and a slightly low level results in inadequate lubrication and failure of the engine.

Combination of Splash and Force Feed:

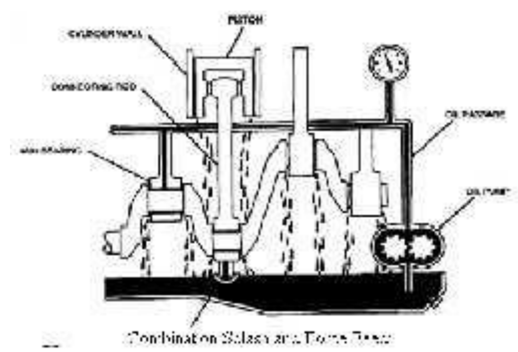

Fig 2.11: Combination Splash and Force Feed

In a combination splash and force feed , oil is delivered to some parts by means of splashing and other parts through oil passages under pressure from the oil pump. The oil from the pump enters the oil galleries.

From the oil galleries, it flows to the main bearings and camshaft bearings. The main bearings have oil-feed holes or grooves that feed oil into drilled passages in the crankshaft. The oil flows through these passages to the connecting rod bearings. From there, on some engines, it flows through holes drilled in the connecting rods to the piston- pin bearings. Cylinder walls are lubricated by splashing oil thrown off from the connecting-rod bearings. Some engines use small troughs under each connecting rod that are kept full by small nozzles which deliver oil under pressure from the oil pump. These oil nozzles deliver an increasingly heavy stream as speed increases.

At very high speeds these oil streams are powerful enough to strike the dippers directly. This causes a much heavier splash so that adequate lubrication of the pistons and the connecting-rod bearings is provided at higher speeds. If a combination system is used on an overhead valve engine, the upper valve train is lubricated by pressure from the pump.

Force Feed :

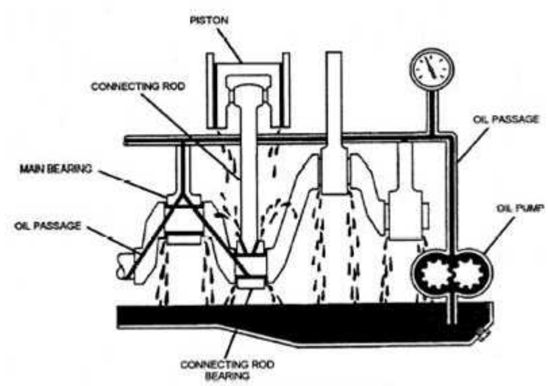

Fig 2.12 Force Feed

A somewhat more complete pressurization of lubrication is achieved in the force-feed lubrication system. Oil is forced by the oil pump from the crankcase to the main bearings and the camshaft bearings. Unlike the combination system the connecting-rod bearings are also fed oil under pressure from the pump. Oil passages are drilled in the crankshaft to lead oil to the connecting-rod bearings.

The passages deliver oil from the main bearing journals to the rod bearing journals. In some engines, these opening are holes that line up once for every crankshaft revolution. In other engines, there are annular grooves in the main bearings through which oil can feed constantly into the hole in the crankshaft. The pressurized oil that lubricates the connecting-rod bearings goes on to lubricate the pistons and walls by squirting out through strategically drilled holes. This lubrication system is used in virtually all engines that are equipped with semi floating piston pins.

Q.No:2 **Water Cooling System**:

In this method, cooling water jackets are provided around the cylinder, cylinder head, valve seats etc. The water when circulated through the jackets, it absorbs heat of combustion. This hot water will then be cooling in the radiator partially by a fan and partially by the flow developed by the forward motion of the vehicle. The cooled water is again recirculated through the water jackets

Thermo Syphon System:

In this system the circulation of water is due to difference in temperature (i.e. difference in densities) of water. So in this system pump is not required but water is circulated because of density difference only.

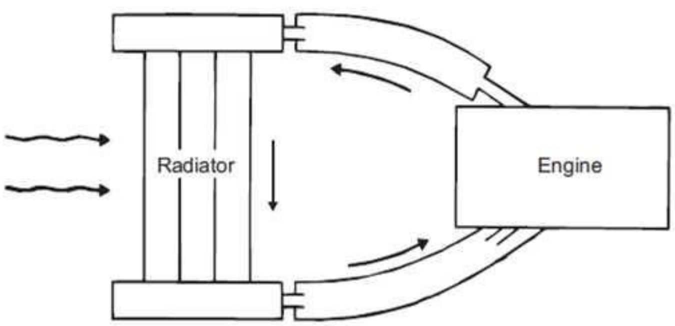

Fig 2.14 Thermo Siphon System

Pump Circulation System: In this system circulation of water is obtained by a pump. This pump is driven by means of engine output shaft through V-belts.

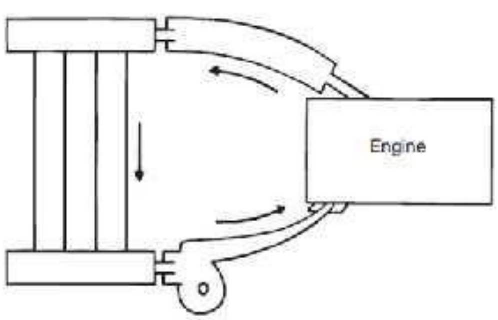

Fig 2.15 Pump Circulation System

Q.No:3 IGNITION SYSTEM

Basically Convectional Ignition systems are of 2 types : (a) Battery or Coil Ignition System, and (b) Magneto Ignition System. Both these conventional, ignition systems work on mutual electromagnetic induction principle. Battery ignition system was generally used in 4-wheelers, but now-a-days it is more commonly used in 2-wheelers also (i.e. Button start, 2- wheelers like Pulsar, Kinetic Honda; Honda-Activa, Scooty, Fiero, etc.). In this case 6 V or 12 V batteries will supply necessary current in the primary winding. Magneto ignition system is mainly used in 2-wheelers, kick start engines. (Example, Bajaj Scooters, Boxer, Victor, Splendor, Passion, etc.). In this case magneto will produce and supply current to the primary winding. So in magneto ignition system magneto replaces the battery. **Battery or Coil Ignition System** Figure shows line diagram of battery ignition system for a 4-cylinder petrol engine.

It mainly consists of a 6 or 12 volt battery, ammeter, ignition switch, auto-transformer (step up transformer), contact breaker, capacitor, distributor rotor, distributor contact points, spark plugs, etc. Note that the Figure 4.1 shows the ignition system for 4-cylinder petrol engine, here there are 4-spark plugs and contact breaker cam has 4-corners. (If it is for 6-cylinder engine it will have 6-spark plugs and contact breaker cam will be a hexagon).

The ignition system is divided into 2-circuits:

i. **Primary Circuit :**

It consists of 6 or 12 V battery, ammeter, ignition switch, primary winding it has 200-300 turns of 20 SWG (Sharps Wire Gauge) gauge wire, contact breaker, capacitor.

(ii) Secondary Circuit:

It consists of secondary winding. Secondary **Ignition Systems** winding consists of about 21000 turns of 40 (S WG) gauge wire. Bottom end of which is connected to bottom end of primary and top end of secondary winding is connected to centre of distributor rotor. Distributor rotors rotate and make contacts with contact points and are connected to spark plugs which are fitted in cylinder heads (engine earth).

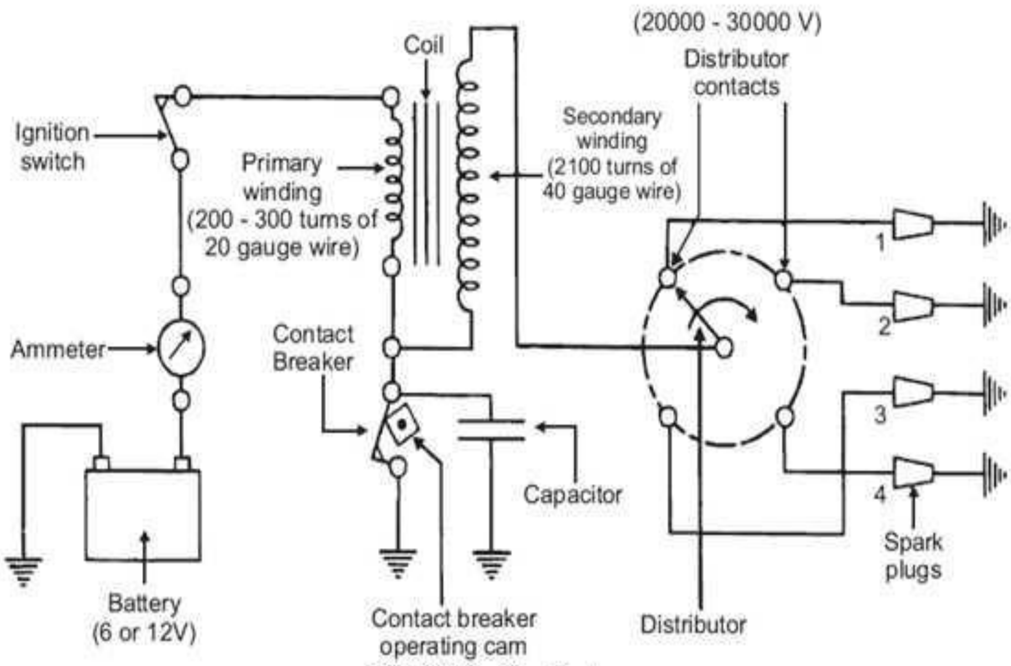

Fig 2.8 Ignition System

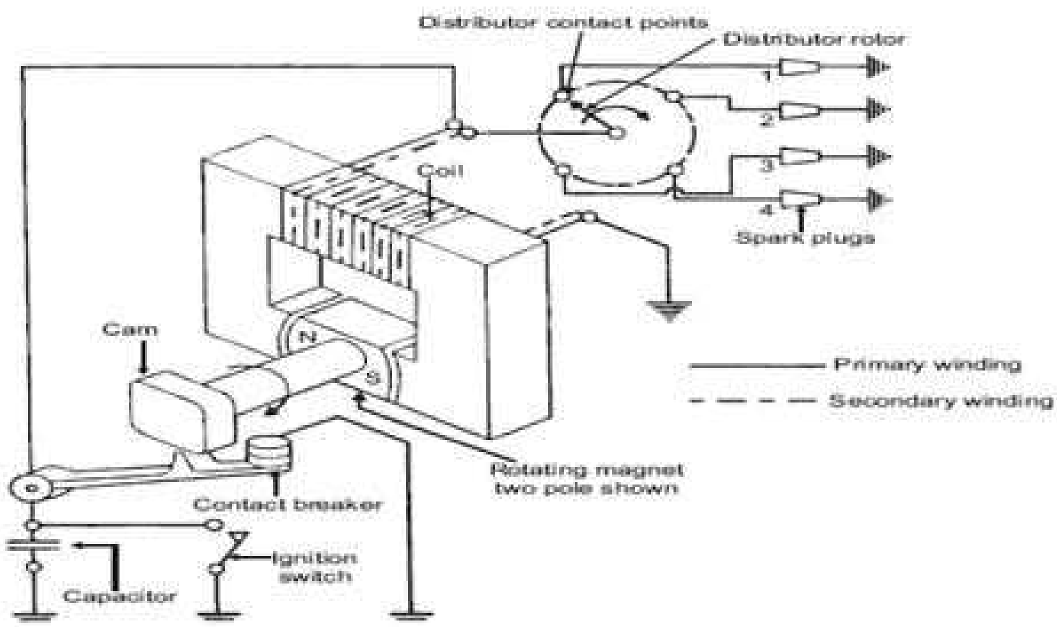

Fig 2.9 Ignition System Secondary Circuit

Working : When the ignition switch is closed and engine in cranked, as soon as the contact breaker closes, a low voltage current will flow through the primary winding. It is also to be noted that the contact beaker cam opens and closes the circuit 4-times (for 4 cylinders) in one revolution. When the contact breaker opens the contact, the magnetic field begins to collapse. Because of this collapsing magnetic field, current will be induced in the secondary winding. And because of more turns (@ 21000 turns) of secondary, voltage goes unto 28000-30000 volts. This high voltage current is brought to centre of the distributor rotor. Distributor rotor rotates and supplies this high voltage current to proper stark plug depending upon the engine firing order. When the high voltage current jumps the spark plug gap, it produces the spark and the charge is ignited-combustion starts-products of combustion expand and produce power. **Magneto Ignition System** In this case magneto will produce and supply the required current to the primary winding. In this case as shown, we can have rotating magneto with fixed coil or rotating coil with fixed magneto for producing and supplying current to primary, remaining arrangement is same as that of a battery ignition system.

Q.No 6 **Exhaust Smoke and Other Emissions:**

Smoke and other exhaust emissions such as oxides of nitrogen, unburned hydrocarbons, etc. are nuisance for the public environment. With increasing emphasis on air pollution control all efforts are being made to keep them as minimum as it could be. Smoke is an indication of incomplete combustion. It limits the output of an engine if air pollution control is the consideration.

Emission Formation Mechanisms: (S.I) This section discusses the formation of HC, CO, Nox, CO2, and aldehydes and explains the effects of design parameters.

Hydrocarbon Emissions:

HC emissions are various compounds of hydrogen, carbon, and sometimes oxygen. They are burned or partially burned fuel and/or oil. HC emissions contribute to photochemical smog, ozone, and eye irritation.

There are several formation mechanisms for HC, and it is convenient to think about ways HC can avoid combustion and ways HC can be removed; we will discuss each below. Of course, most of the HC input is fuel, and most of it is burned during “normal” combustion. However, some HC avoids oxidation during this process. The processes by which fuel compounds escape burning during normal S.I. combustion are:

1. Fuel vapor-air mixture is compressed into the combustion chamber crevice volumes. 2. Fuel compounds are absorbed into oil layers on the cylinder liner. 3. Fuel is absorbed by and/or contained within deposits on the piston head and piston crown. 4. Quench layers on the combustion chamber wall are left as the flame extinguishes close to the walls. 5. Fuel vapor-air mixture can be left unburned if the flame extinguishes before reaching the walls. 6. Liquid fuel within the cylinder may not evaporate and mix with sufficient air to burn prior to the end of combustion. 7. The mixture may leak through the exhaust valve seat. **(ii) Carbon Monoxide** Formation of CO is well established. Under some conditions, there is not enough O2 available for complete oxidation and some of the carbon in the fuel ends up as CO. The amount of CO, for a range of fuel composition and C/H ratios, is a function of the relative air-fuel ratio. Even when enough oxygen is present, high peak temperatures can cause dissociation – chemical combustion reactions in which carbon dioxide and water vapor separate into CO, H2, and O2. Conversion of CO to CO2 is governed by reaction $CO + OH \leftrightarrow CO_2 + H$ Dissociated CO may freeze during the expansion stroke. **(iii) Oxides of Nitrogen** Nox is a generic term for the compounds NO and NO2. Both are present to some degree in the exhaust, and NO oxidizes to NO2 in the atmosphere. Nox contributes to acid rain and photochemical smog; it is also thought to cause respiratory health problems at atmospheric concentrations found in some parts of the world. To understand Nox formation, we must recognize several factors that affect Nox equilibrium. Remember that all chemical reactions proceed toward equilibrium at some reaction rate. Equilibrium NO (which comprises most of the Nox formation) is formed at a rate that varies strongly with temperature and equivalence ratio. **(iv) Carbon Dioxide** While not normally considered a pollutant, CO2 may contribute to the greenhouse effect. Proposals to reduce CO2 emissions have been made. CO2 controls strongly influence fuel economy requirements. **(v) Aldehydes** Aldehydes are the result of partial oxidation of alcohols. They are not usually present in significant quantities in gasoline-fueled engines, but they are an issue when alcohol fuels are used. Aldehydes are thought to cause lung problems. So far, little information of engine calibration effects on aldehyde formation is available.

Emission Formation in C.I. Engine:

For many years, diesel engines have had a reputation of giving poor performance and producing black smoke, an unpleasant odor, and considerable noise. However, it would find it difficult to distinguish today‟ s modern diesel car from its gasoline counterpart. For diesel engines the emphasis is to reduce emissions of Nox and particulates, where these emissions are typically higher than those from equivalent port injected gasoline engines equipped with three-way catalysts. Catalyst of diesel

Exhaust remains a problem insofar as research has not yet been able to come up with an effective converter that eliminates both particulate matter (PM) and oxide of nitrogen.

Q.No:7

Given data:

Fuel consumption = 30cc in 12sec $= \frac{30}{12} \times 3600 \left(\frac{cc}{hr}\right)$

Speed (N) = 2500/60 rps

Brake power = 20KW

Orifice diameter (d_o) = 0.035m

Pressure across the orifice (P_o) = 140mm of water

Coefficient of discharge (C_d) = 0.6

Piston diameter (d) = 150mm = 0.15m

Stroke length (l) = 0.1m

Density of fuel (ρ) = 0.85gm/cc

Compression ratio (r) = 6.5

Room temperature (Ta) = 297K

Barometric pressure = 760mm of Hg = 101.325KK/m^2= 10.34m of water

To Find:

(i) Volumetric efficiency on the air basis alone

(ii) Air-fuel ratio

(iii) The brake mean effective pressure

(iv) The relative efficiency on the brake thermal efficiency

Solution:

10.34m of water = 101.325KN/m^2

Pressure head $= \frac{P_o}{\rho \times g}$

P_o = 0.14m of water

$= \frac{101.325}{10.34} \times 0.14$

P_o = 1372N/m^2

Density of gas (ρ) = P/RT

$= \frac{101.325}{0.287 \times 297}$

ρ = 1.1887Kg/m^3

Pressure head (h) $= \frac{1372}{1.1887 \times 9.81}$

h = 117.6557m

Qair = $C_d \times a \times \sqrt{2gh}$

$= 0.6 \times \frac{\pi}{4} (0.035)^2 \sqrt{2 \times 9.81 \times 117.6557}$

= 0.02774 m^3/sec

No. of. Suction strokes per second $= \frac{N}{2} = \frac{2500}{60 \times 2} = 20.833$

Air consumptions per stroke $= \frac{0.02774}{20.833}$

= 0.001332m^3

Stroke volume (Vs) $= \frac{\pi}{4} \times (0.15)^2 \times 0.1 = 0.001767$ m^3

Volumetric efficiency (η_{vol}) $= \frac{0.001332}{0.001767} \times 100\%$

η_{vol} =

75.382% volume of air consumed $V_{air} = Q_{air}$ = 0.02774m^3/sec

= 0.02774 $\times$ 3600 m^3/hr

Mass of air consumed (m_a) = $V_a \times \rho_a$ = 99.864 $\times$ 1.1887

$= 118.71 Kg/hr$

Fuel consumption = 9000cc/hr

Mass of the fuel consumed (m_f) = 9000×0.85 =

7.65Kg/hr

Air fuel ratio $= \frac{m_a}{m_f} = \frac{118.71}{7.65} = 15.518$

Brake power (B.P) = 20KW = $P_{mb} \times l \times a \times n \times k$

$$P_{mb} = \frac{20}{0.001767 \times 20.833 \times 1}$$

$$= 543.294 KN/m^2$$

Air standard efficiency (η_{air}) = $1 - \frac{1}{(r)^{\gamma-1}}$

$$= 1 - \frac{1}{(6.5)^{1.4-1}}$$

$$= 52.703\%$$

Brake thermal efficiency (η_{BT}) $= \frac{BP \times 3600}{F.C \times C.V} = 22.4\%$

Relative efficiency on brake thermal efficiency basis (η_{rel}) = η_{BT} / η_{air}

$$= 0.22409/0.52703$$

$$\eta_{rel} = 42.52\%$$