POSTAL BOOK PACKAGE 2025

MECHANICAL ENGINEERING

CONVENTIONAL Practice Sets

CONTENTS

INTERNAL COMBUSTION ENGINES

5 CHAPTER
Engine Components, Friction Cooling and Lubrication

Practice Questions : Level-I

Q.1 What is the function of the condenser and the contact breaker in the battery-ignition system of an S.I. engine?

Solution:

Contact breaker: This is a mechanical device for making and breaking the primary circuit of the ignition coil. It consists of a fixed metal point against which, another metal point bears which is mounted on a spring loaded pivoted arm. The metal used is one of the hardest metals, usually tungsten and each point has a circular flat face of about 3 mm diameter. The fixed contact point is earthed by mounting it on the base of the contact breaker assembly whereas the arm to which the movable contact point is attached, is electrically insulated. When the points are closed the current flows and when they are open, the circuit is broken and the flow of current stops.

Condenser: The function of condenser in a coil ignition circuit is to reduce the spark at the contact points as they open in the distributor and thus minimize the burning and pitting of the points. Its construction is the same as that of every electrical capacitor, which is simple: Two metal plates separated by an insulating material are placed face to face. The insulation is often only air, but for particular technical requirement some high quality insulating material is also used.

Q.2 Explain Air Cooling System for I.C. Engine.

Solution:

In the air-cooled system, a current of air is made to flow past the outside of the cylinder barrel, outer surface area of which has been considerably increased by providing cooling fins. This method will increase the rate of cooling. This method is mainly applicable to engines in motor cycles, small cars, airplanes and combat tanks where motion of vehicles gives a good velocity to cool the engine. The cooling fins provided are either cast integral with the cylinder and cylinders head or can be fixed with the cylinder block separately. The rate of heat transfer from the cylinder walls can be substantially increased by using baffles which force the air through the space between the fins.

Advantages:

1. Absence of cooling pipes, radiator, etc. makes the cooling system simpler and thus has minimum maintenance problems.
2. No danger of coolant leakage.
3. Installation of air-cooled engines is easier.
4. The weight of air-cooled engine is less than that of water-cooled engine.

Limitations:

1. Cooling is not uniform.
2. Produces more aerodynamic noise.
3. Specific fuel consumption is slightly higher.

Practice Questions : Level-II

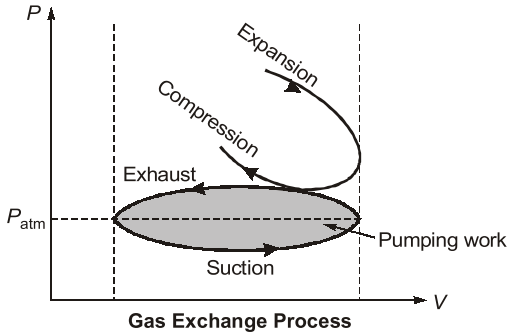
Q3 State various losses considered by actual cycle analysis of IC engines. Discuss any one of them in detail.

Solution:

The various losses considered by actual cycle analysis of IC engine are:

1. Leakage
2. Imperfect mixing of fuel and air
3. Progressive burning
4. Burning time losses due to the motion of the piston during combustion.
5. Heat losses to the cylinder walls.
6. Exhaust blow down losses.
7. Fluid friction
8. **Pumping loss:** The purpose of the gas exchanger process is to admit the fresh charge during the suction stroke and remove the burnt gases at the end of the expansion stroke. During the induction process, pressure losses occur as the charge passes through the air filter, the carburettor and the intake manifold. There is an additional pressure drop across the inlet valve. The drop in pressure along the intake system also depends on the engine speed. The pressure during the suction stroke is below atmospheric. The exhaust system consists of an exhaust manifold, an exhaust pipe, and often a catalytic converter for emission control, and a muffler or silencer. The burned cylinder gases get expelled because of the pressure difference between the cylinder and the exhaust system. The difference during the exhaust stroke is much higher than the atmospheric.

   Figure shows the gas exchanger processes in a conventional SI engine. The difference of work done in discharging the exhaust gases and the work done by the fresh charge during the suction stroke is called the pumping loop. The area of the pumping loop indicates negative work and it represents pumping losses. The term pumping is used as the gas from the lower inlet pressure is pumped to the higher exhaust pressure.



Gas Exchange Process

Q4 (i) Briefly explain 'Evaporative Cooling System' which is generally used for big-capacity stationary IC engines, with a schematic diagram.

(ii) List four advantages and disadvantages each of a water-cooled system in a CI engine.

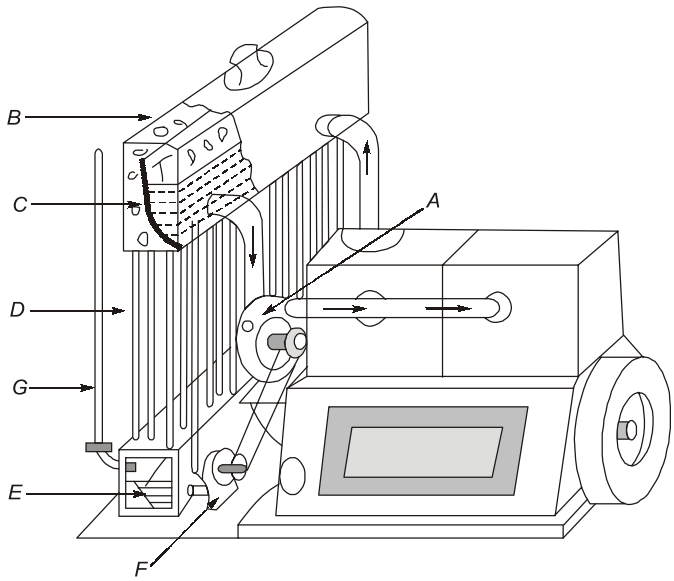
Solution:

Evaporative Cooling System: In this system, the engine is cooled because of the evaporation of the water in the cylinder jackets into steam. The high latent heat of vaporization of water is used to achieve cooling by allowing it to evaporate in the cylinder jackets.

This system is used predominantly in stationary engines and big capacity IC engines.

Evaporative Cooling with air cooled condenser: The figure above illustrates evaporative cooling with air-cooled condenser.

1. Water is circulated by pump *A* and when delivered to the overhead tank *B*, part of it boils out.



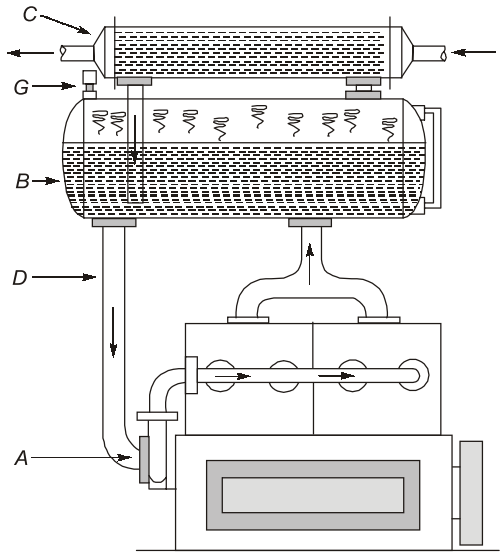
A partition *C* is provided in the tank.

The vapour rises above the partition *C* and the condensing action of the radiator tubes *D* makes the condensate flow into the lower tank *E* from which it is picked up and returned to the tank *B* by the small pump *F*.

The vertical pipe *G* is in communication with the outside atmosphere to prevent collapsing of the tanks *B* and *E* when the pressure inside them due to condensation falls below atmospheric.

Evaporative cooling with water-cooled condenser:

This type of cooling system is illustrated by the following figure:



In this case, condensation of the vapour formed in the overhead tank *B* occurs in the heat exchanger *C* cooled by a secondary water circuit and the water returns to *B* by gravity.

The pump *A* circulates the cooling water to the engine and heated water from the engine is delivered to tank *B* thereby maintaining circulation.

Advantages of water cooled system in CI engine are:

1. Compact design of engines with appreciably smaller frontal area is possible.
2. The fuel consumption of high compression liquid-cooled engines are rather lower than for air cooled ones.
3. Because of the even cooling of cylinder barrel and head due to jacketing makes it possible to reduce the cylinder head and valve seat temperatures.
4. In case of water cooled engines, installation is not necessarily at the front of the mobile vehicles, aircraft etc. as cooling system can be conveniently located wherever required.

Disadvantages:

1. This is a dependent system in which water circulation in jackets is to be ensured by additional means.
2. Power absorbed by the pump for water circulation is considerable and affects the power output of engine.
3. Cost of the cooling system is considerably high.
4. System requires considerable maintenance of its various parts.

■■■■

$$P = \frac{2\pi NT}{60000}\ \text{kW}$$

Full load torque, $$T = \frac{P \times 60000}{2\pi N} = \frac{8 \times 60000}{2 \times \pi \times 475} = 160.8\ \text{Nm}$$

Torque at half load, $T_{1/2} = 80.4$ Nm

From the graph, time for the fall of 100 rpm at no load, $t_2 = 8.3$ s and time for the fall of same 100 rpm at half load, $t_3 = 3.4$ s.

$$T_f = \frac{t_3}{t_2 - t_3} T_{1/2} = \left(\frac{3.4}{8.3 - 3.4}\right) \times 80.4 = 55.8\ \text{Nm}$$

$$fp = \frac{2 \times \pi \times 475 \times 55.8}{60000} = 2.77\ \text{kW}$$

$$\eta_m = \frac{bp}{bp + fp} = \frac{8}{8 + 2.77} \times 100 = 74.28\%$$

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