MECHANICAL ENGINEERING SCIENCE

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COMPARISON OF PETROL AND DIESEL ENGINES

Description	Petrol Engine (SI Engine)	Diesel Engine (CI Engine)
Basic cycle	Works on **Otto cycle** or constant volume heat addition cycle.	Works on **Diesel cycle** or constant pressure heat addition cycle.
Fuel	Petrol, a highly volatile fuel. Self-ignition temperature is high.	Diesel oil, a non-volatile fuel. Self-ignition temperature is comparatively low.
Introduction of fuel	A gaseous mixture of fuel-air is introduced during the suction stroke. A carburettor and an ignition system are necessary. Modern engines have petrol injection	Fuel is injected directly into the combustion chamber at high pressure at the end of the compression stroke. A fuel pump and injector are necessary.

Description	Petrol Engine (SI Engine)	Diesel Engine (CI Engine)
Ignition	Requires an ignition system with spark plug in the combustion chamber.	Self-ignition occurs due to high temperature of air because of the high compression.
Compression ratio	6 to 10. Upper limit is fixed by antiknock quality of the fuel.	16 to 20. Upper limit is limited by weight increase of the engine.
Speed	Due to light weight they are high speed engines.	Due to heavy weight they are low speed engines.
Thermal efficiency	Because of the lower CR, the maximum value of thermal efficiency that can be obtained is lower.	Because of higher CR, the maximum value of thermal efficiency that can be obtained is higher.

COMPARISON OF PETROL AND DIESEL ENGINES

Description	Petrol Engine (SI Engine)	Diesel Engine (CI Engine)
Weight	Lighter due to comparatively lower peak pressures.	Heavier due to comparatively higher peak pressures.

APPLICATIONS OF IC ENGINES

- The most important application of IC engines is in transport on land, sea and air. Other applications include industrial power plants and as prime movers for electric generators.

4S Petrol Engines:

- The most important application of small four-stroke petrol engines is in automobiles. A typical automobile is powered by a four-stroke four-cylinder engine developing an output in the range of 30-60 kW at a speed of about 4500 rpm.

- Another application of four-stroke petrol engine is in small pumping sets and mobile electric generating sets.

- Smaller aircrafts normally employ four-stroke gasoline (SI) radial engines.

APPLICATIONS OF IC ENGINES

4S Diesel Engines:

- The four-stroke diesel engine is one of the most efficient and versatile prime movers. It is manufactured in sizes from 50 mm to more than 1000 mm of cylinder diameter and with engine speeds ranging from 100 to 4500 rpm while delivering outputs from 1 to 35000 kW.

- Small diesel engines are used in construction machinery, air compressors, drilling rigs and many miscellaneous applications.

- Tractors for agricultural application use about 30 kW diesel engines whereas jeeps, buses and trucks use 40 to 100 kW diesel engines.

- Diesel engines are used both for mobile and stationary electric generating plants of varying capacities.

PERFORMANCE PARAMETERS OF IC ENGINES

- The following factors are to be considered in evaluating the performance of an engine:

  (i) **Maximum power or torque**

  (ii) **Specific fuel consumption**

  (iii) **Reliability and durability**

- Engine performance characteristics can be determined by the following two methods.

  (i) By using **experimental results** obtained from engine tests.

  (ii) By **analytical calculation** based on theoretical data.

PERFORMANCE PARAMETERS OF IC ENGINES

Engine Power

- The energy flow through the engine is expressed in three distinct terms.
- They are
  - Indicated Power, IP,
  - Friction Power FP
  - Brake Power, BP.

- Indicated power can be computed from the measurement of forces in the cylinder and brake power may be computed from the measurement of forces at the crankshaft of the engine. Friction power can be calculated with the above two values.

PERFORMANCE PARAMETERS OF IC ENGINES

ii) Indicated Power - The power developed inside the cylinder of the engine is called the indicated power (IP).

$$IP = \frac{np_mLANK}{60 \times 1000}$$

Were,

n= Number of cylinders

Pm = *Indicated mean effective pressure in Pa or* N/m^2

L= *Length of stroke in m*

A= *Area of piston* m^2

N= *Speed of the engine on rpm*

For 4-stroke engine: K= ½
For 2-stroke engine: K = 1

PERFORMANCE PARAMETERS OF IC ENGINES

iii) Brake Power – It is the net power available at the crank shaft of the engine for performing useful work (BP).

- It is always less than indicated power since a part of the power developed in the engine cylinder is used to overcome the frictional losses at different moving parts of the engine.

- Brake power of an engine can be determined by a brake of some kind applied to the brake pulley of the engine. The arrangement used for determination of BP of the engine is known as dynamometer. Usually, **rope brake dynamometer** is used for this purpose.

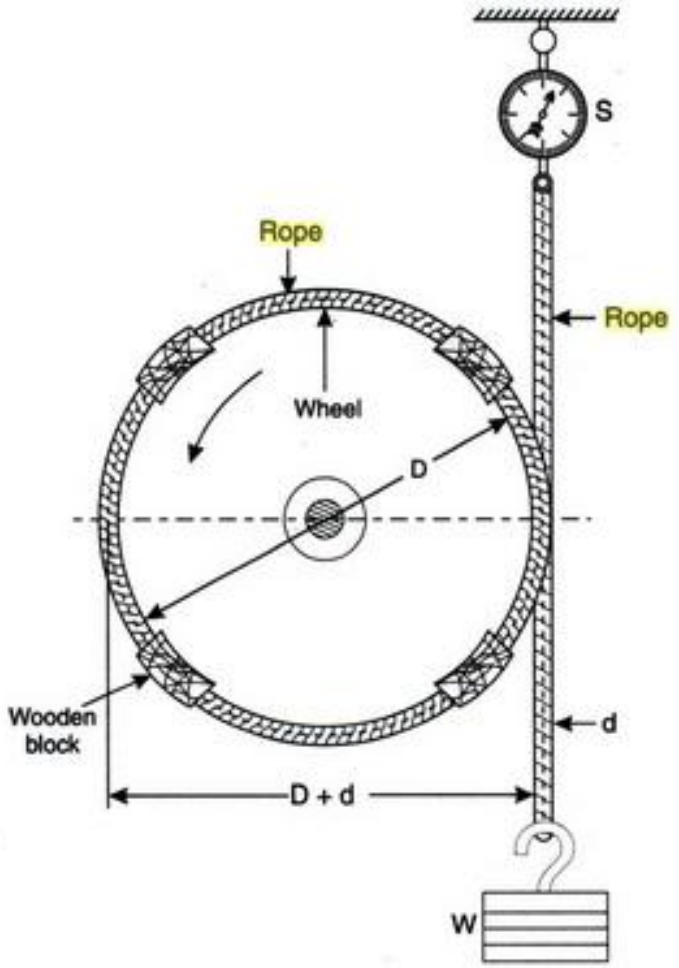
BP is given by,

$$BP = \frac{2\pi NT}{60\times1000} \quad (expressed\ in\ kW)$$

where
N = Crank speed in rpm; T = Torque in N-m

PERFORMANCE PARAMETERS OF IC ENGINES

- The rope brake dynamometer consists of rope wrapped round the brake drum or flywheel keyed to crankshaft of an engine whose BP is to be determined.
- One end of the rope is connected to the spring balance (with reading 'S') while at the other end is hung a weight W.
- Wooden blocks are incorporated to check the rope slipping off the brake drum/flywheel.
- It is evident from the figure that the net brake load which opposes the rotation is (W-S) and the effective radius at which the net load acts = (D+d)/2, where D is the diameter of the brake drum and d is the diameter of the rope.



PERFORMANCE PARAMETERS OF IC ENGINES

Therefore,

$\therefore$ **Braking torque,**

$$T = \text{Frictional force} \times \text{radius} = (W - S)\left(\frac{D+d}{2}\right) \text{ Nm.}$$

$$\therefore \text{ Brake power, B.P.} = \frac{(W-S)\pi(D+d)N}{60\times10^3} \text{ kW}$$

PERFORMANCE PARAMETERS OF IC ENGINES

iv) Friction Power – It is the difference between the indicated power and brake power.

$$FP = IP - BP$$

- Apart from expressing engine performance in terms of power, it is also essential to express in terms of efficiencies.

v) Mechanical efficiency - Mechanical efficiency takes into account the mechanical losses in an engine like friction losses in case of pistons, bearings, gears, valve mechanisms, losses due to absorption of power by fuel pump, oil pump, radiator etc. In general, mechanical efficiency of engines varies from 65 to 85%.

It is defined as the ratio of brake power to indicated power.

$$\eta_{mech} = \frac{Brake\ power\ (BP)}{Indicated\ power\ (IP)}$$

PERFORMANCE PARAMETERS OF IC ENGINES

vi) Thermal efficiency – It gives an idea of the output generated by the engine with respect to heat supplied in the form of fuel.

- Thermal efficiency is expressed in two ways, viz., **indicated thermal efficiency** and **brake thermal efficiency.**
- **Indicated thermal efficiency =** $\eta_{ith} = \frac{IP}{CV \times m_f}$
- **Brake thermal efficiency** = $\eta_{bth} = \frac{BP}{CV \times m_f} \times 100$

CV is the calorific value of the fuel in KJ/kg and mf is mass flow rate of the fuel in *kg/s*. *IP and BP are in kW*.

PERFORMANCE PARAMETERS OF IC ENGINES

vii) Specific fuel consumption – It is the mass of fuel consumed per kW of power developed per hour and is a criterion of economical power production.

- Specific fuel consumption is expressed in two ways, viz., **indicated specific fuel consumption (ISFC)** and **brake specific fuel consumption (BSFC).**

- **ISFC** = $\frac{Mass\ of\ fuel\ consumed\ in\ kg/hr}{Indicated\ Power\ in\ kW}$

- **BSFC** = $\frac{Mass\ of\ fuel\ consumed\ in\ kg/hr}{Brake\ Power\ in\ kW}$

THANK YOU

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