

Lectures

8th Semester B. Tech. Mechanical Engineering

Subject: Internal Combustion Engines

I/C Prof M Marouf Wani

Topic: Engine Design And Operating Parameters

Engine Design Parameters Include:

1. **Bore** - diameter of each cylinder
2. **Stroke** - the maximum distance the piston travels to or fro in the cylinder
3. **Compression ratio** – the ratio of the maximum volume to the minimum volume available in the cylinder as per the position of piston at the entry of cylinder and inside the cylinder.
4. **Clearance volume** - the minimum volume available inside the cylinder as per the piston movement is defined as clearance volume.
The clearance volume helps in compression process of engine by allowing air-fuel mixture to be compressed from a maximum volume to a minimum volume.
The clearance volume helps in accommodating the spark plugs extruding into the cylinder.
Further the clearance volume helps the valve operating mechanism by allowing the valves to move inside the cylinder during its open period.
5. **Total volume** - the maximum volume available inside the cylinder as per the piston movement is defined as the total volume.
6. **Swept volume** - the difference between the maximum or total volume and the minimum or clearance volume available inside the cylinder as per piston movement is defined as swept volume of each cylinder.
7. **Displacement volume** – the displacement volume for engine is defined as the sum of the swept volumes of all cylinders in its engine block.
8. **Ratio of cylinder bore and piston stroke**
9. **Ratio of connecting rod length and crank radius**

The Engine Operating Parameters Include:

1. **Maximum rated power:** the highest power an engine is allowed to develop for short periods of operation.
The power developed by the engine varies with respect to both speed and speed.
For variable speed based automotive applications, maximum power is developed at the highest speed (say 5500 rpm) for which the engine has been designed.
For constant speed power generation based application, like DG sets, the maximum power is developed by the engine corresponding to maximum load on its alternator at the synchronous speed (say 1500 rpm or 1800 rpm) of the engine and the alternator.

2. **Normal rated power:** the highest power an engine is allowed to develop in continuous operation. This allowable power corresponding to the load and speed of the engine maintains a factor of safety for the engine operation. This also ensure the uninterrupted power generation and supply by the engine.
3. **Rated speed:** the crankshaft rotational speed (say 5500 rpm) at which rated power is developed is developed.
4. **Brake Torque:** The torque developed at the crankshaft of the internal combustion engine is defined as the brake torque of the engine. Since with earliest technology the torque at engine crankshaft was measured by using rope brake type of dynamometer so this torque was known as brake torque.

Torque developed by the engine varies both with respect to speed and load.

For variable speed applications like automotives, the speed (say 3000 rpm) at which the engine develops maximum torque is defined as the rated speed for the development of maximum torque. For constant speed applications like power generation (example DG sets) the engine develops both maximum torque and maximum torque at the same speed (say 1500 rpm or 1800 rpm). But in case of maximum power, the power developed internal to the engine corresponds to the maximum load applied on its alternator designed external to the engine.

Example: Maruti Suzuki 800cc Car Engine

Engine Design Parameters	
Bore, mm	68.5
Stroke, mm	72
Compression Ratio	8.7:1 A Spark Ignition engine
Clearance Volume, cc	34.54 For each cylinder
Total Volume, cc	300.54 For each cylinder
Swept Volume, cc	266 Volume available per cylinder
Number Of Cylinders	3 A multi-cylinder engine
Displacement Volume, cc	800 A displacement required to develop the rated power at the rated speed
Bore/Stroke Ratio	0.95 A medium size engine
Idle Speed, rpm	900±50 A speed required to overcome frictional loss or frictional power

Example: Maruti Suzuki 800cc Car Engine - Continued

Engine Operating Parameters	
Rated Power	39.5bhp at 5500 rpm Or
Rated Speed For Maximum Engine Power	5500 rpm A medium speed engine
Rated Torque	6 Kg-m at 3000 rpm Or
Rated Speed For Maximum Engine Torque	3000 rpm
Mean Piston Speed, m/sec	13.2 A medium speed automotive engine

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In charge Course:

Prof M Marouf Wani
Mechanical Engineering Department
National Institute of Technology
Srinagar, J&K
India – 190006

Text Book:
Internal Combustion Engine Fundamentals
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