Engine Types

General comparison between petrol (SI) and compression ignition engines (CI)

	(SI) engines:	(CI) engines:
* Control type:	* Quantity control	* Quality control unit
* Fuel:	* Gasoline	* Diesel
* Ignition:	* Spark ignition (SI)	* Compression ignition (CI)
* Compression ratio:	* 6-9 : 1	* 11-21 : 1
* Thermal efficiency:	* 12% to 25%	* 25% to 36%
* Volumetric efficiency:	* Low, at part load and high speed	* High
* Fuel consumption (kW/h):	* High	* Lower 35% to 45% (full load)
	* High	* Lower 50% (1/3 load)
* Weight (same capacity):	* Lighter	* Heavier
* Power to weight ratio:	* High	* Low
* Max. Torque and Power:	* High	* Low
* Fire risk:	*Yes	* No
* Noise:	* Low	* High
* Maintenance:	* More	* Less
* Initial Cost (price):	* Low	* High
* Fuel price per litre:	* High	* Low
* Use:	* Passenger cars	* Trucks, busses, tanks.....

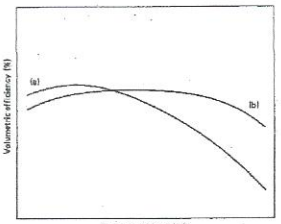

Fig. 3.11 Volumetric efficiency and engine speed. (a) petrol engine, normally aspirated with carburettor. (b) compression ignition engine, normally aspirated.

* Maximum engine pressure:	* 30:40 bar	* 60:80 bar
* bmep:	* 7:10 atm	* 5:6 atm
* Maximum engine speed:	* 3500 : 7000 rpm	* 2000 : 3500 rpm
* Exhaust temperature:	* 700 :1000° C	* 500 : 600° C

General comparison between 2-stroke and 4-stroke engines

	Tow-stroke engine	Four-stroke engine
* Power stoke:	* One every one rev.	* One every two rev.
* Specific fuel consumption:	* High (at low speeds)	* Low
* Power (same capacity) :	* High (poor power at low speeds)	* Low
* Cost:	* Low	* High
* Noise:	* High	* Low
* Pollution:	* High	* Low

* It might be expected that the two-stroke engine would develop twice the power of a four-stroke engine of the same size, but experience does not confirm that. The operation is less effectively carried out (loss of fresh mixture and incomplete scavenging).

Single- and multi-cylinder engines

Power/weight ratio:

The engine power varies as the square of the bore (that is, with the piston area) but the mass varies as the cube of the bore (that is, with the volume of metal used). Increasing power by using

a large cylinder therefore results in a low power/weight ratio, whereas increasing the number of cylinders maintains power and weight in the same proportions.

Firing interval and torque fluctuation:
Since all the cylinders must fire in two revolutions of he four-stroke crankshaft, the firing interval is 720° divided by the number of cylinders. The effective power stroke occupies about 135°. With a single cylinder the mass of a large flywheel is required to absorb torque fluctuations and provide energy for the crankshaft. As the number of cylinders increases, torque is smoother and less flywheel mass is needed, aiding acceleration

Cooling
Large cylinders have long heat paths, such as from the piston center. Multi-cylinder units are necessary for large power to avoid lubrication and detonation problems due to overheating.

Balance and inertia loads
The single-cylinder unit can only be imperfectly balanced and vibration will occur at certain engine speeds. Four-cylinder in-line units have small secondary out-of-balance forces, while horizontally opposed; six and eight-cylinder units can have entirely satisfactory balance. The reduced reciprocating mass of the multi-cylinder engine permits higher crankshaft speeds without inertia force problems.

Conventional car engine
A part from the benefits of traditional experience in this type of unit, the four-stroke, four-cylinder, in-line, water-cooled petrol engine has inherent advantages.

The two-stroke unit has unacceptable fuel consumption. The economy of the compression-ignition (CI) is offset by the lower power and acceleration, with increased cost, noise, weight and (to some) more objectionable fuel.

Twin-Cylinder engines have greater torque fluctuations, and six cylinder units are an unnecessary expense under 2-2.5 L capacity. The in-line layout is cheaper; fewer components are needed than for the V4 or the horizontally opposed four (HO4). The usually requires a balance shaft, and HO4 has complicated manifolds and cooling arrangements.

Air cooling is not suited to four-cylinder in-line units; it is noisier, requires power to drive the large cooling fan, and complicates interior heating.