**REPORT**

**Title :** Studies of SI Engine models (4-stroke and 2-stroke)

**Introduction :** An internal combustion engine (ICE or IC engine) is a [heat engine](https://en.wikipedia.org/wiki/Heat_engine) in which the [combustion](https://en.wikipedia.org/wiki/Combustion) of a [fuel](https://en.wikipedia.org/wiki/Fuel) occurs with an [oxidizer](https://en.wikipedia.org/wiki/Oxidizer) (usually air) in a [combustion chamber](https://en.wikipedia.org/wiki/Combustion_chamber) that is an integral part of the [working fluid](https://en.wikipedia.org/wiki/Working_fluid) flow circuit. In an internal combustion engine, the expansion of the high-[temperature](https://en.wikipedia.org/wiki/Temperature) and high-[pressure](https://en.wikipedia.org/wiki/Pressure) gases produced by combustion applies direct [force](https://en.wikipedia.org/wiki/Force) to some component of the engine. The force is applied typically to [pistons](https://en.wikipedia.org/wiki/Piston), [turbine blades](https://en.wikipedia.org/wiki/Turbine_blade), a [rotor](https://en.wikipedia.org/wiki/Pistonless_rotary_engine), or a [nozzle](https://en.wikipedia.org/wiki/Propulsive_nozzle). This force moves the component over a distance, transforming [chemical energy](https://en.wikipedia.org/wiki/Chemical_energy) into useful [kinetic energy](https://en.wikipedia.org/wiki/Kinetic_energy) and is used to propel, move or power whatever the engine is attached to. This replaced the [external combustion engine](https://en.wikipedia.org/wiki/External_combustion_engine) for applications where weight or size of the engine is important.

**Classification :**

1.Based on type of ignition -

A) SI engine :- A spark-ignition engine [(SI engine](https://en.m.wikipedia.org/wiki/Spark-ignition_engine)) is an internal combustion engine, usually a petrol engine, where the combustion cycle of an air-fuel mixture is ignited by a spark plug.

B) CI engine :- A **CI** engine is type of an internal combustion engine in which the fuel charge is ignited by the heat of compression.

2. Based on Types of fuel used

A) petrol engine - The [petrol engine](https://en.m.wikipedia.org/wiki/Petrol_engine) (British English) or the gasoline engine (American English) is a spark-ignition internal combustion engine designed to run on petrol ( gasoline) and similar volatile fuels.

B) Diesel engine - The [diesel engine](https://en.m.wikipedia.org/wiki/Diesel_engine) (also known as the compression-ignition or CI engine), named after Rudolf Diesel, is an internal combustion engine in which the ignition of the fuel is caused by the high temperature of the air in the cylinder due to mechanical compression (adiabatic compression)

C) Gas engine -The gas engine is an internal combustion engine operating on gaseous fuel, such as coal gas, producer gas, biogas, landfill gas or natural gas.

D) Dual fuel engine - Dual-fuel engine is a diesel engine designed to operate on both gaseous and liquid fuels.

3. Based on number of strokes

A) 2 stroke engine :- A two-stroke (or two-cycle) engine is a type of internal combustion engine that completes a two-stroke (up and down) power cycle of the piston during a single rotation of the crankshaft.

B) 4 stroke engine :- The four-stroke (also four-cycle) engine is an internal combustion (IC) engine in which the piston completes four separate strokes while rotating the crankshaft.

## **Applications of IC Engines**

## Following are the application of ic engine:

## 1. IC engines are used in Road vehicles like scooters, motorcycles, buses etc.

## 2. It is also used in Aircraft.

## 3. IC engine is commonly used in Motorboats.

## 4. IC engine has great application in small machines, such as lawnmowers, chainsaws, and portable engine-generators.

### **Ideal cycle analysis**

Ideal cycles are simplified thermodynamic closed cycles to analyze the compression, combustion, and expansion process in an engine with a focus on extraction of work from combustion of the fuel–air mixture. Since the [thermodynamic system](https://www.sciencedirect.com/topics/engineering/thermodynamic-system) is modeled as a closed system in these ideal cases, the combustion process is modeled as a heat addition to the working gases. There are three different ideal heat addition methods modeled:

1. *constant volume (CV)*

2. *constant pressure (CP),* and

3. *limited pressure (LP).*

The three heat addition methods are illustrated in terms of the pressure-versus-engine position and log of pressure versus log of volume . The analysis requires definition of thermodynamic properties for the working fluid (trapped gases in the cylinder = fuel + air) and application of thermodynamic conservation laws including [conservation of energy](https://www.sciencedirect.com/topics/engineering/conservation-of-energy) and assumption of [isentropic processes](https://www.sciencedirect.com/topics/engineering/isentropic-process) for compression and expansion.

## **Working Principle of Internal Combustion Engines**

In IC engines (internal combustion engines) the combustion of takes place inside the cylinder, therefore the thermal energy of the fuel is directly converted into mechanical work.

the IC engine has a higher thermal efficiency than the thermal efficiency of EC engines. In internal combustion engines, when the IC engine is working continuously, we may consider a cycle starting from any strokes.

We know that when the engine returns back to the stroke where it starts we say that one cycle has been completed. The IC engine has four steps to complete one cycle as follows:

***Suction Stroke*** In this stroke the fuel vapour, in the correct proportion, is supplied to the engine cylinder.

***Compression Stroke*** In this stroke, the fuel vapour is compressed in the engine cylinder.

***Expansion Stroke*** In this stroke, the fuel vapour burn by the [spark plug](https://www.theengineerspost.com/types-of-spark-plugs/) is provided on the top of the engine cylinder. when the fuel is burned suddenly raise the pressure, due to the expansion of the combustion products in the engine cylinder. The rise of the pressure pushes the piston with a high force and rotates the crankshaft. The crankshaft, in turn, drives the machine connected to it.

***Exhaust Stroke*** In this stroke, the burnt gases are exhausted from the engine cylinder, so as to make space available for the fresh fuel vapour.

**Components :**

**4-Stroke Engine**

1. **Intake**, **induction** or **suction**: The intake valves are open as a result of the cam lobe pressing down on the valve stem. The piston moves downward increasing the volume of the combustion chamber and allowing air to enter in the case of a CI engine or an air-fuel mix in the case of SI engines that do not use [direct injection](https://en.wikipedia.org/wiki/Gasoline_direct_injection). The air or air-fuel mixture is called the *charge* in any case.
2. **Compression**: In this stroke, both valves are closed and the piston moves upward reducing the combustion chamber volume which reaches its minimum when the piston is at TDC. The piston performs [work](https://en.wikipedia.org/wiki/Work_(physics)) on the charge as it is being compressed; as a result, its pressure, temperature and density increase; an approximation to this behavior is provided by the [ideal gas law](https://en.wikipedia.org/wiki/Ideal_gas_law). Just before the piston reaches TDC, ignition begins. In the case of a SI engine, the spark plug receives a high voltage pulse that generates the spark which gives it its name and ignites the charge. In the case of a CI engine, the fuel injector quickly injects fuel into the combustion chamber as a spray; the fuel ignites due to the high temperature.
3. **Power** or **working stroke**: The pressure of the combustion gases pushes the piston downward, generating more [kinetic energy](https://en.wikipedia.org/wiki/Kinetic_energy) than is required to compress the charge. Complementary to the compression stroke, the combustion gases expand and as a result their temperature, pressure and density decreases. When the piston is near to BDC the exhaust valve opens. The combustion gases expand [irreversibly](https://en.wikipedia.org/wiki/Irreversible_process) due to the leftover pressure—in excess of [back pressure](https://en.wikipedia.org/wiki/Back_pressure), the gauge pressure on the exhaust port—; this is called the *blowdown*.
4. **Exhaust**: The exhaust valve remains open while the piston moves upward expelling the combustion gases. For naturally aspirated engines a small part of the combustion gases may remain in the cylinder during normal operation because the piston does not close the combustion chamber completely; these gases dissolve in the next charge. At the end of this stroke, the exhaust valve closes, the intake valve opens, and the sequence repeats in the next cycle. The intake valve may open before the exhaust valve closes to allow better scavenging.

**2-Stroke Engine**

1. **Power**: While the piston is descending the combustion gases perform work on it, as in a 4-stroke engine. The same [thermodynamic](https://en.wikipedia.org/wiki/Thermodynamics) considerations about the expansion apply.
2. **Scavenging**: Around 75° of crankshaft rotation before BDC the exhaust valve or port opens, and blowdown occurs. Shortly thereafter the intake valve or transfer port opens. The incoming charge displaces the remaining combustion gases to the exhaust system and a part of the charge may enter the exhaust system as well. The piston reaches BDC and reverses direction. After the piston has traveled a short distance upwards into the cylinder the exhaust valve or port closes; shortly the intake valve or transfer port closes as well.
3. **Compression**: With both intake and exhaust closed the piston continues moving upwards compressing the charge and performing a work on it. As in the case of a 4-stroke engine, ignition starts just before the piston reaches TDC and the same consideration on the thermodynamics of the compression on the charge.