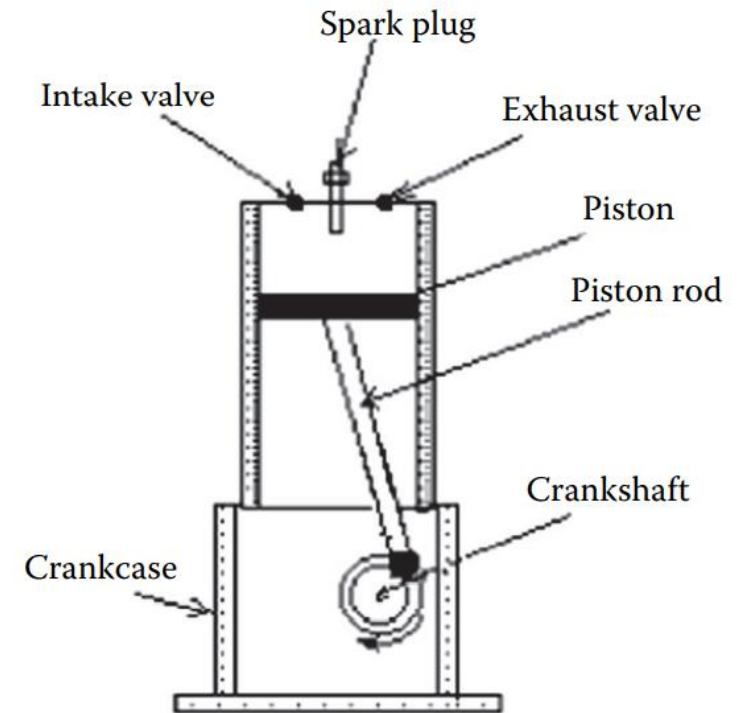


AUTOMOTIVE FUELS

Motor spirit

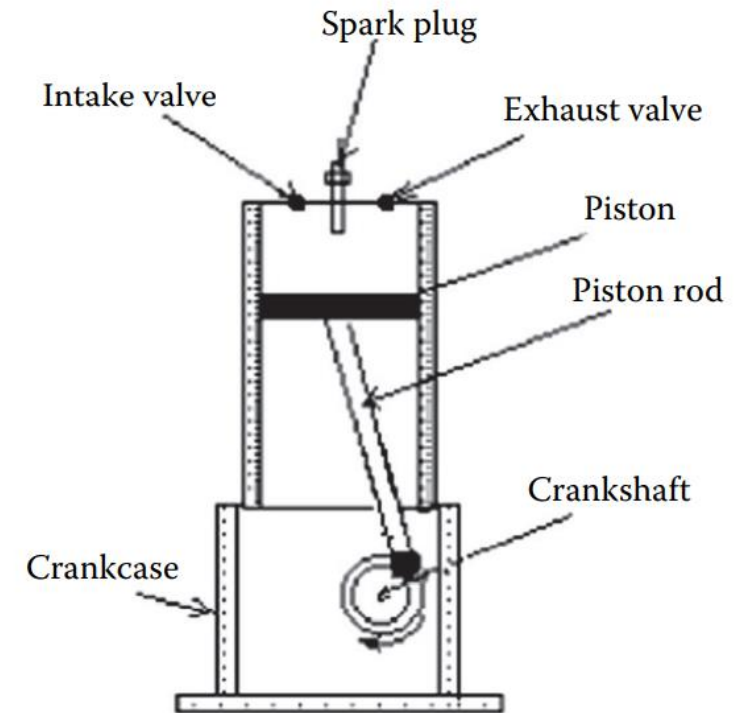
- MS is known as **petrol** in India and Europe but as **gasoline** in the U.S. It is an automotive fuel for running motor cars. Diesel is the other automotive fuel.
 - Petrol or MS is suitable for **spark ignition (SI)** type engines and diesel for **compression ignition (CI)** engines.



Schematic representation of an internal combustion engine.

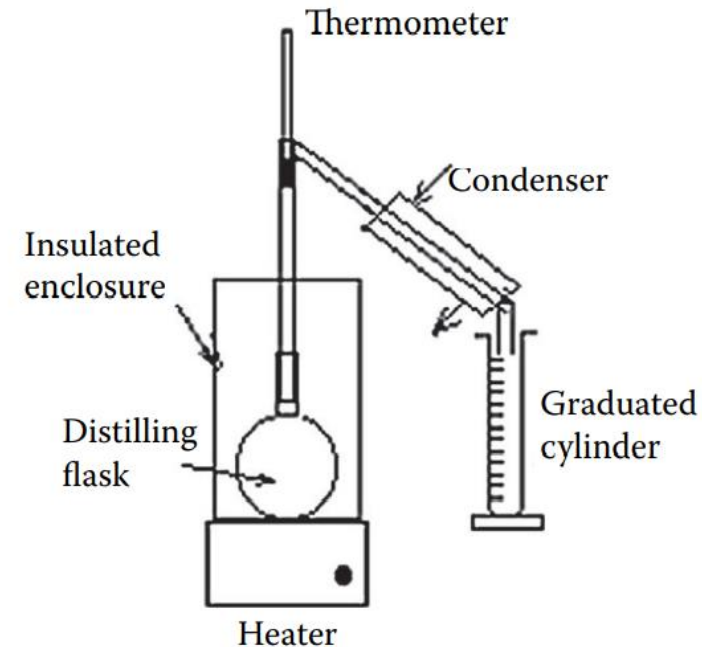
How does spark ignition type engines work?

In the SI engines, fuel is burnt directly by introducing an electrical spark into the mixture of air and vapor of MS through the carburetor (a mixing device of air and vapor of fuel) of the engine. Power is developed due to the volumetric expansion of burnt gases (flue gas) in the engine cylinder during the expansion stroke (forward stroke) and exhausted to the atmosphere in the compression stroke (return stroke) in a repeated cycle. The power developed is dependent on the quality of the fuel and the design of the engine.



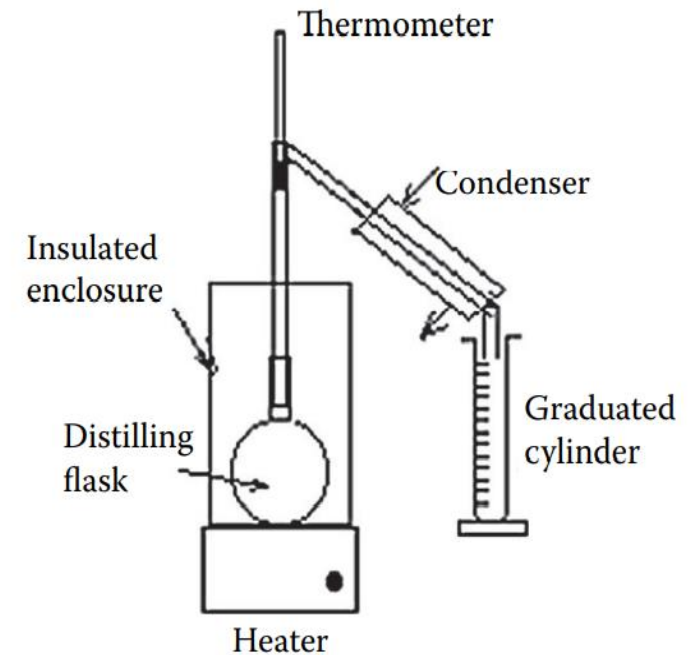
American Standard for Testing Material Distillation

- MS contains a mixture of hydrocarbons boiling from 30°C to 40°C and up to a temperature slightly above 200°C. In the laboratory, MS is distilled at atmospheric pressure according to the standard ASTM method of distillation.
- In SI engines, light hydrocarbon liquid is needed as the fuel because it is readily vaporized, which is the most essential requirement for combustion in an SI engine.



What is procedure for material distillation of MS?

- A sample of 100 mL is placed in a standard distilling flask and the vapour is condensed through a condenser. Liquid is collected in a graduated cylinder. At the beginning of distillation, the vapor temperature is reported as the IBP while the first drop is collected (Figure beside). Then, distillation is continued and the temperature of the vapor and the cumulative volume percent collected are simultaneously reported. The maximum vapor temperature at which the distillate collection is negligible is reported as the FBP.



Observation of MS distillation

ASTM distillation is the easiest test for the boiling ranges of hydrocarbons in MS.

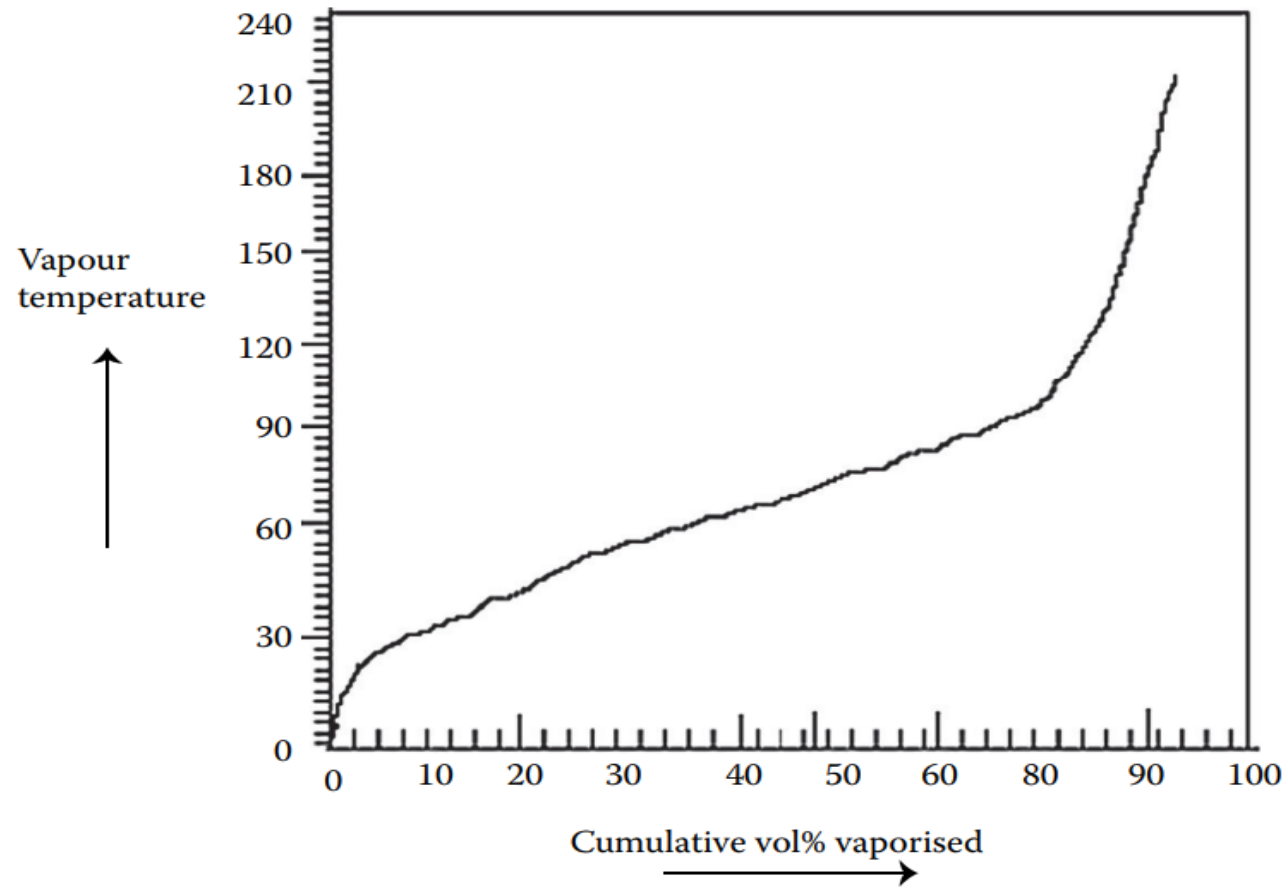
The distillation analysis of MS is that 10%, 50%, and 90% vaporization should occur at maximum vapor temperature of 70 °C, 125 °C, and 180 °C.

The 10% point of distillation is important for starting an engine.

The 50% point is an indication of uniform vaporization in the engine during the warming-up period of driving and the 90% point is important as far as the crankcase dilution is concerned.

If the 90% point is high, a residual part of the fuel will be unburnt and will mix-up with the motor oil used for lubricating the piston of the engine, causing dilution of crankcase oil. This is also the reason for increased fuel consumption per kilometre.

ASTM distillation of MS.



Octane Number

- Engine performance is measured by the maximum power development and the rate at which it is developed at different engine speeds.
- If the rate of power development is not uniform with speed, rather it fluctuates, then this type of situation is called **knocking or hammering** of the engine.
- Several experiments found that the **composition of MS** plays the main role in knocking

How does the composition of hydrocarbon play a role in the knocking of the engine?

- If MS contains more propane, butane (**short chain hydrocarbons**), iso-octane (branched chain hydrocarbons), benzene, toluene, xylenes, and aromatics (ring compounds) in the boiling range of MS then the rate of power development is smooth without knocking, whereas the **long chain hydrocarbons** give rise to severe knocking if present in the fuel in substantial amounts.

Knocking or Hammering of Engines



Engine performance

- MS is a mixture of all the short or long chain, branched, and ring hydrocarbons, it is common practice to use iso-octane as the fingerprint for measuring the relative engine performance of the mixture.
- Specification of MS as far as engine performance is concerned is denoted by octane number.
- Octane number is defined, for any MS fuel, as the percentage of iso-octane in a mixture of iso-octane and n-heptane, which will give the same engine performance as could be achieved by the actual fuel sample.

How we can increase the Octane-Number?

- The octane number of a MS fuel can be increased by adding tetra-ethyl lead (TEL), but this has been prohibited by environment protection laws. Hence, organic substances like methyl- or ethyl tertiary butyl ethers (MTBE or ETBE) are used instead of TEL for boosting the octane number.

Corrosion

- The presence of mercaptan sulfur may cause corrosion in the fuel pipes and the engine cylinder and produce sulfur dioxide during combustion.



How to treat sulfur compounds of MS?

In the past:

- Merox (a catalytic mercaptan oxidation method) treatment was done to convert corrosive mercaptans to non-corrosive disulfides, but this did not remove the sulfur originally present in the fuel.

Nowadays:

- Mercaptans and other sulfur compounds are mostly removed by a catalytic hydrodesulfurization unit in a refinery.

Reid Vapour Pressure

- RVP of MS should not exceed 0.7 kg/cm² (gauge) otherwise there will be the tendency for vapor locking in the engine and vapor loss as well during its storage. Too low vapor pressure will give rise to problems starting the engine.

Oxidation Stability

- MS is a mixture of hydrocarbons obtained from various units of a refinery, such as reformat (obtained from a naphtha reforming plant), thermally (viscosity breaking unit, coking unit, etc.), and catalytically cracked gasoline components (from a fluidized bed catalytic cracking unit).
- Polymerized products make layers of films or gum like substances and reduce the effectiveness of the fuel while used.
- This gum formation is a slow process but may cause severe damage to fuel if stored for a long time.

Additives

- Various additives, like
 - colour (to distinguish octane numbers),
 - anti-icing (to reduce ice formation),
 - anti-static (to disperse the generation of statical electric charges),
 - anti-oxidant,
 - anti-corrosive,
 - and octane boosting agents

are added to the fuel.