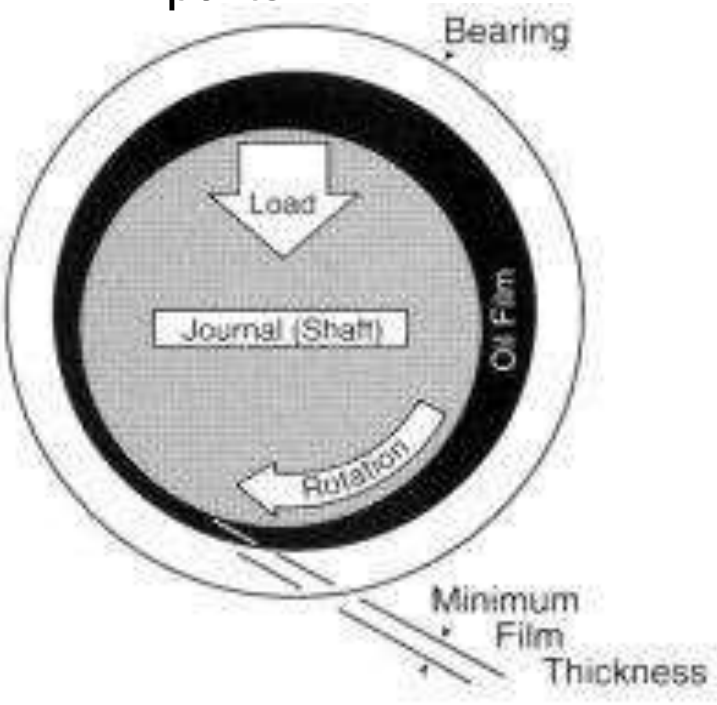
Purpose of Lubrication System

Lubrication

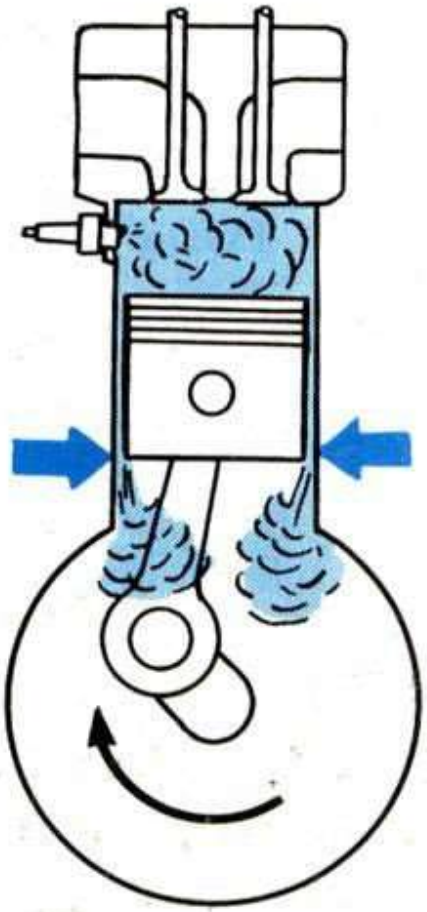
Reduces Friction by creating a thin **film**(Clearance) between moving parts



Sealing

The oil helps form a seal between piston rings and cylinder walls (Reduces Blow-By)

Internal oil leak (blow-by) will result in BLUE SMOKE at the tail pipe.



Purpose of Lubrication System

Cleaning

- As it circulates through the engine, the oil picks up metal particles and carbon, and brings them back down to the pan.

Cooling

- Picks up heat when moving through the engine and then drops into the cooler oil pan, giving up some of this heat.

Reduction of Noise

- Lubrication reduces the noise of the engine.

Purpose of Lubrication System

- **Absorbs shock**

When heavy loads are imposed on the bearings, the oil helps to cushion the load.

- **Absorbs Contaminants**

The additives in oil helps in absorbing the contaminants that enter the lubrication system.

Lubrication Systems

- Mist lubrication system
- Wet sump lubrication system
- Dry sump lubrication system

Two Stroke Engines

Four Stroke Engines

✓ **Mist lubrication system is mainly employed in two-stroke cycle engines, whereas wet and dry sump systems are used in four-stroke cycle engines.**

✓ **The wet sump system is employed in relatively small engines, such as automobile engines, while the dry sump system is used in large stationary, marine and aircraft engines.**

Crankcase

- The bottom of the Cylinder block is called Crankcase
- A cover fasted to crankcase acts as a sump collect and circulate the lubricate oil

Cylinder

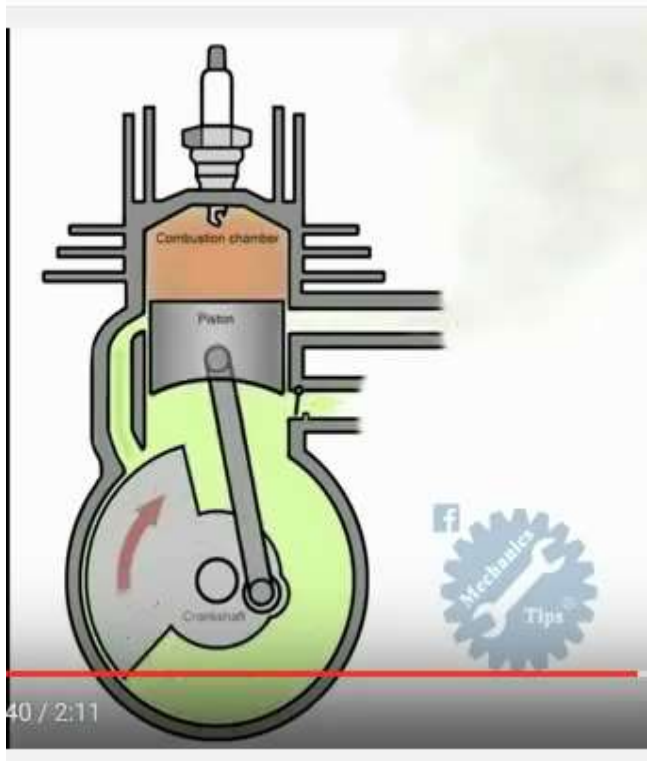
- It is a cylindrical vessel or space in which the piston makes a reciprocating motion.
- The cylinder is supported in the cylinder block
- The volume created in the cylinder varies based on the operations occurs to different thermodynamic processes.

Petroil or Mist lubrication system

- **In two-stroke engines, the charge is compressed in the crankcase, and as such it is not suitable to have the lubricating oil in the sump.**

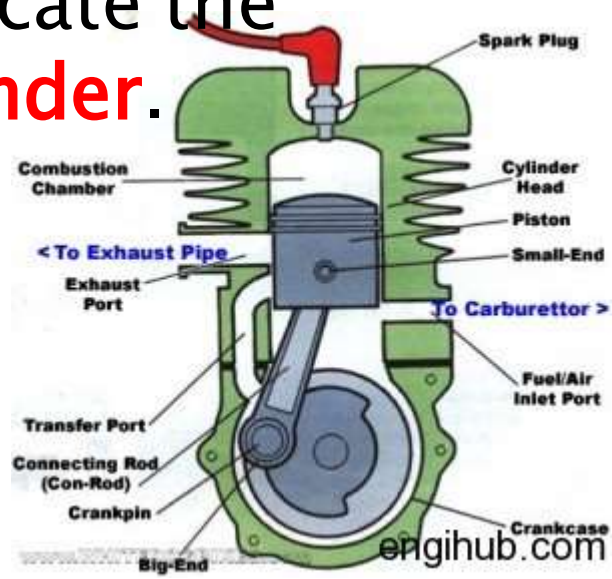
- The lubrication oil is mixed with the fuel, the usual ratio being 3% to 6%.

- Oil and fuel mixture is inducted through the carburetor.



Petroil or Mist lubrication system

- Fuel is vaporized and the oil in the form of mist (film/fog) goes via the crankcase into the cylinder.
- The oil which strikes the crankcase walls lubricates the main and connecting rod bearings and the rest of oil lubricate the **piston, piston rings and the cylinder**.



Advantage:

Simplicity and Low cost as it does not require an oil pump, filter, etc.

Disadvantages:

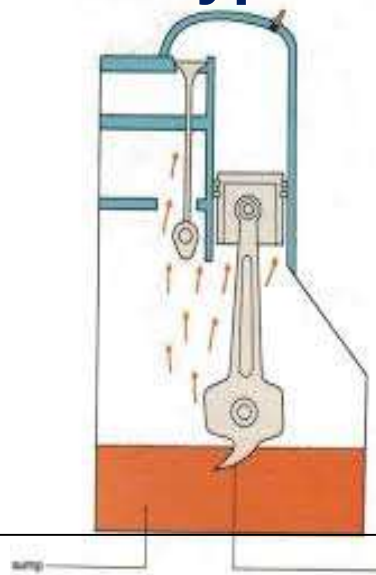
- ✓Cause heavy exhaust smoke due to burning of lubricating oil
- ✓Forms deposit on piston crown and exhaust port which affect engine efficiency.
- ✓ Requires a thorough mixing for effective lubrication. This requires either separate mixing prior to use or use of some additive to give the oil good mixing characteristics.

Wet Sump Lubrication Systems

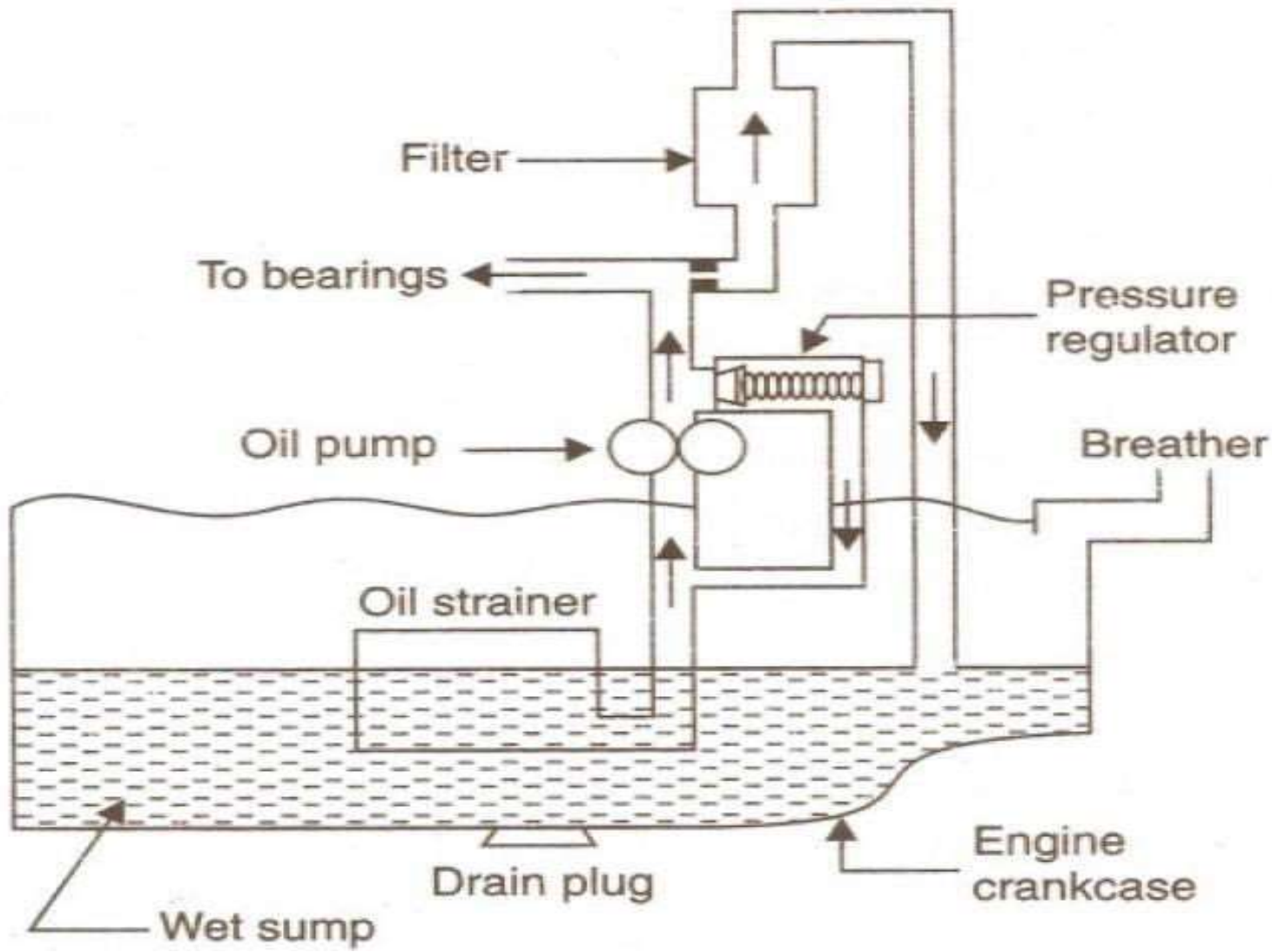
✓In the wet sump system, the bottom of the crankcase contains an oil sump (or pan) that serves as the oil supply reservoir.

✓Oil dripping from the cylinders and bearings flows by gravity back into the wet sump where it is picked up by a pump and re-circulated through the engine lubricating system. The types of wet sump systems used are:

- the splash lubrication system
- the splash and pressure system
- the pressure feed system



Lubrication System – Wet Sump



Lubrication System – Wet Sump

Oil is stored in the sump.

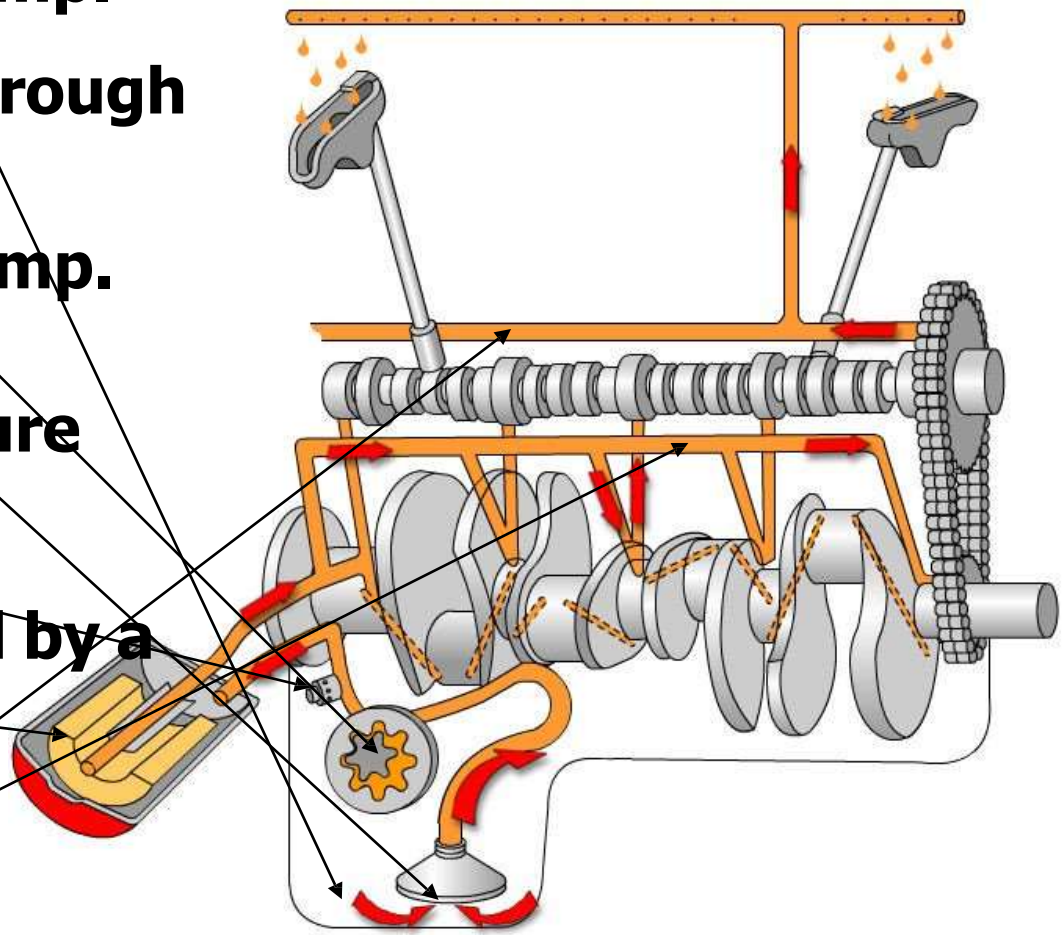
Drawn into engine through the pickup.

Forced round by a pump.

Protected by a pressure relief valve.

Particulates removed by a filter.

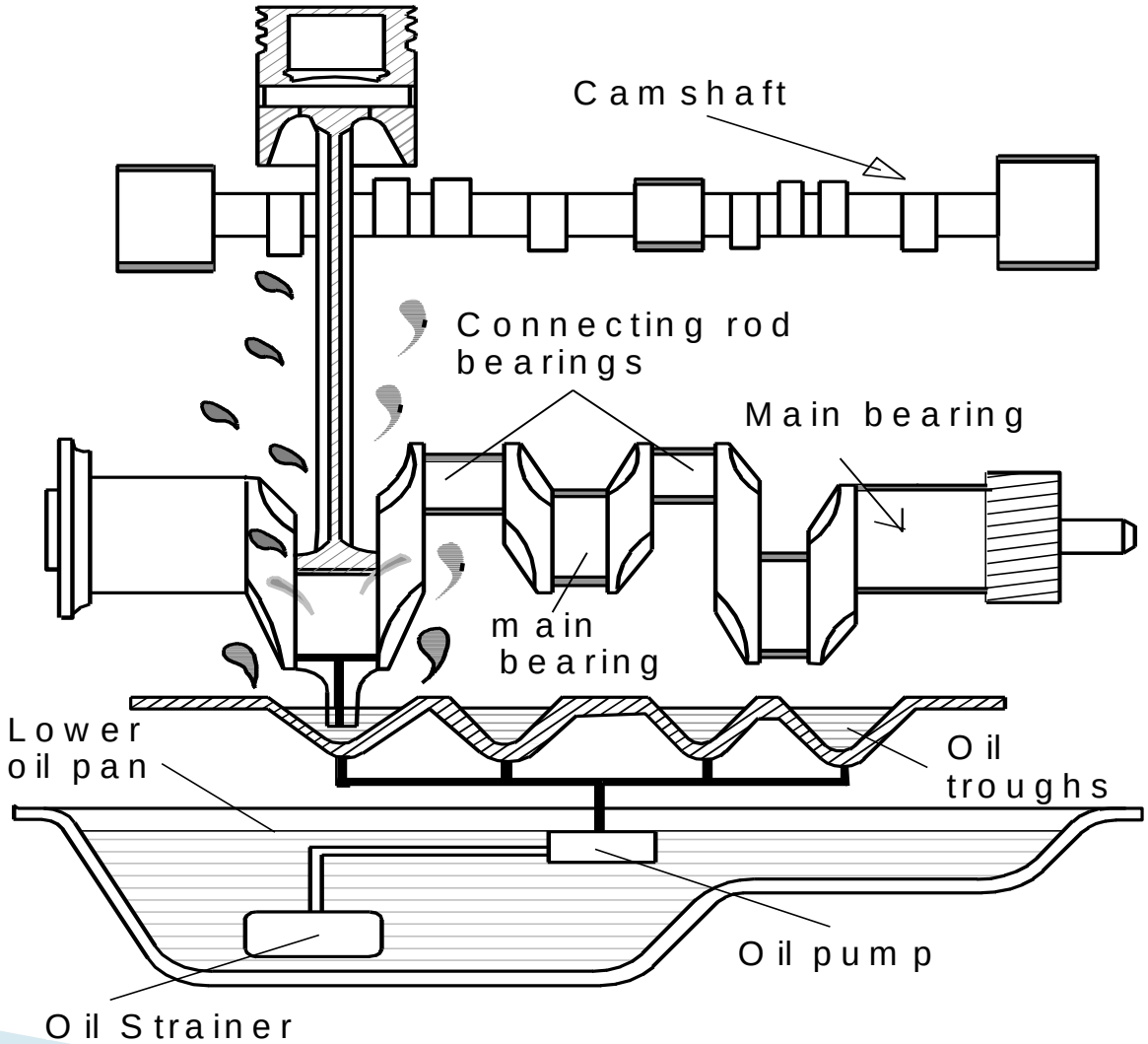
Carried around in galleries.



Splash System

- ✓ Used in light duty, slow speed engines (<250 rpm).
- ✓ Lubricating oil is stored at the bottom of engine crankcase and maintained at a predetermined level.
- ✓ The oil is drawn by the pump and delivered through a distributing pipe into the splash trough located under the big end of all the connecting rods.
- ✓ These troughs are provided with overflows and oil in the trough is therefore kept at a constant level.

Splash and Circulating Pump System



Splash System

- ✓A splasher or dipper is provided under each connecting rod cap which dips into the oil in the trough at every revolution of the crankshaft and the oil is splashed all over the interior of crankcase, into the pistons and onto the exposed portion of cylinder walls.

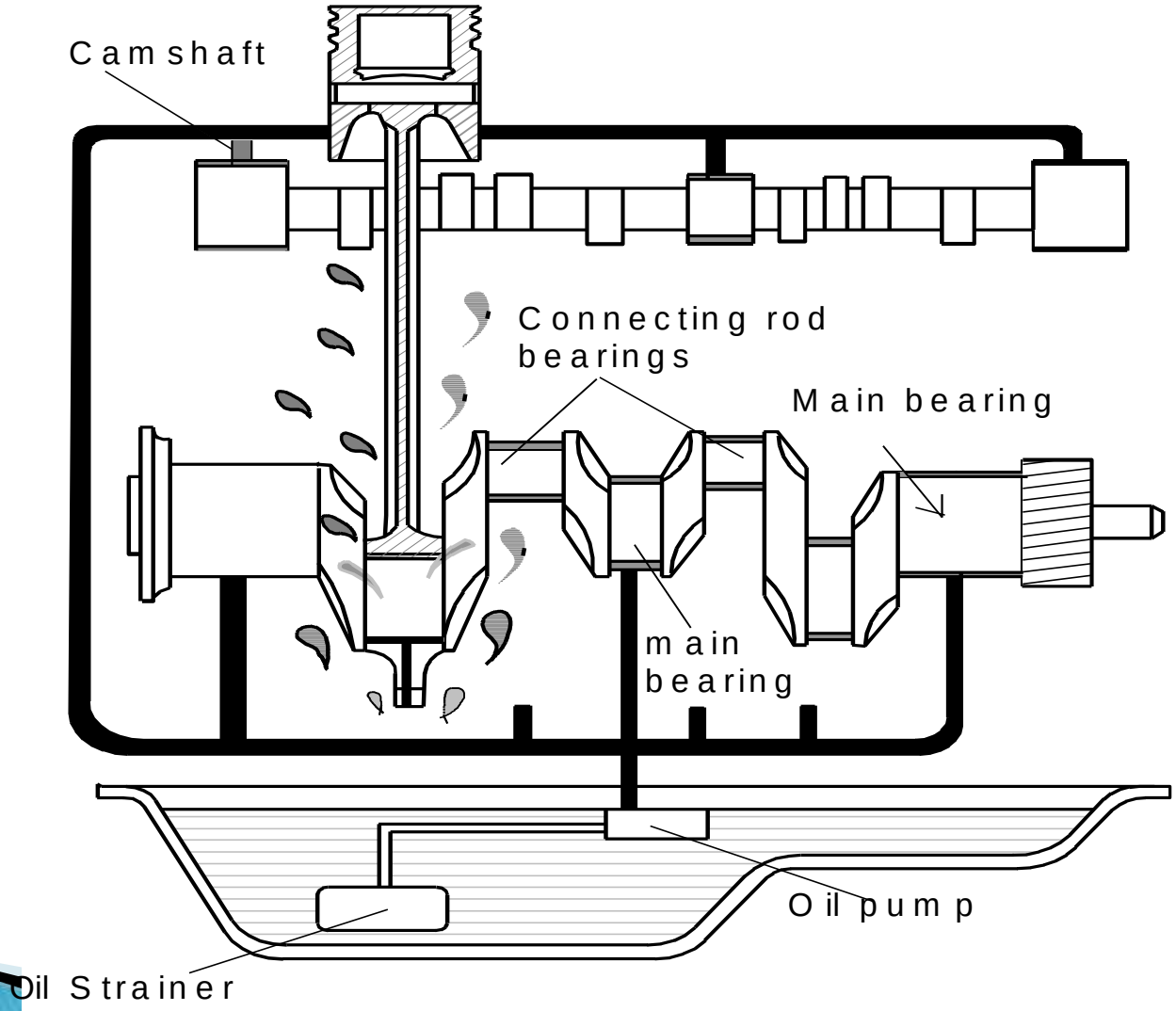
- ✓The oil dripping from the cylinder is collected in the sump where it is cooled by the air flowing around. The cooled oil is then recirculated

Splash Lubrication System

Splash and Pressure Lubrication System

- This system is shown in Fig.2, where the lubricating oil is supplied under pressure to main and camshaft bearings.
- Oil is also supplied under pressure to pipes which direct a stream of oil against the dippers on the big end of connecting rod bearing cup and thus the crankpin bearings are lubricated by the splash or spray of oil thrown up by the dipper.

Splash and Pressure System

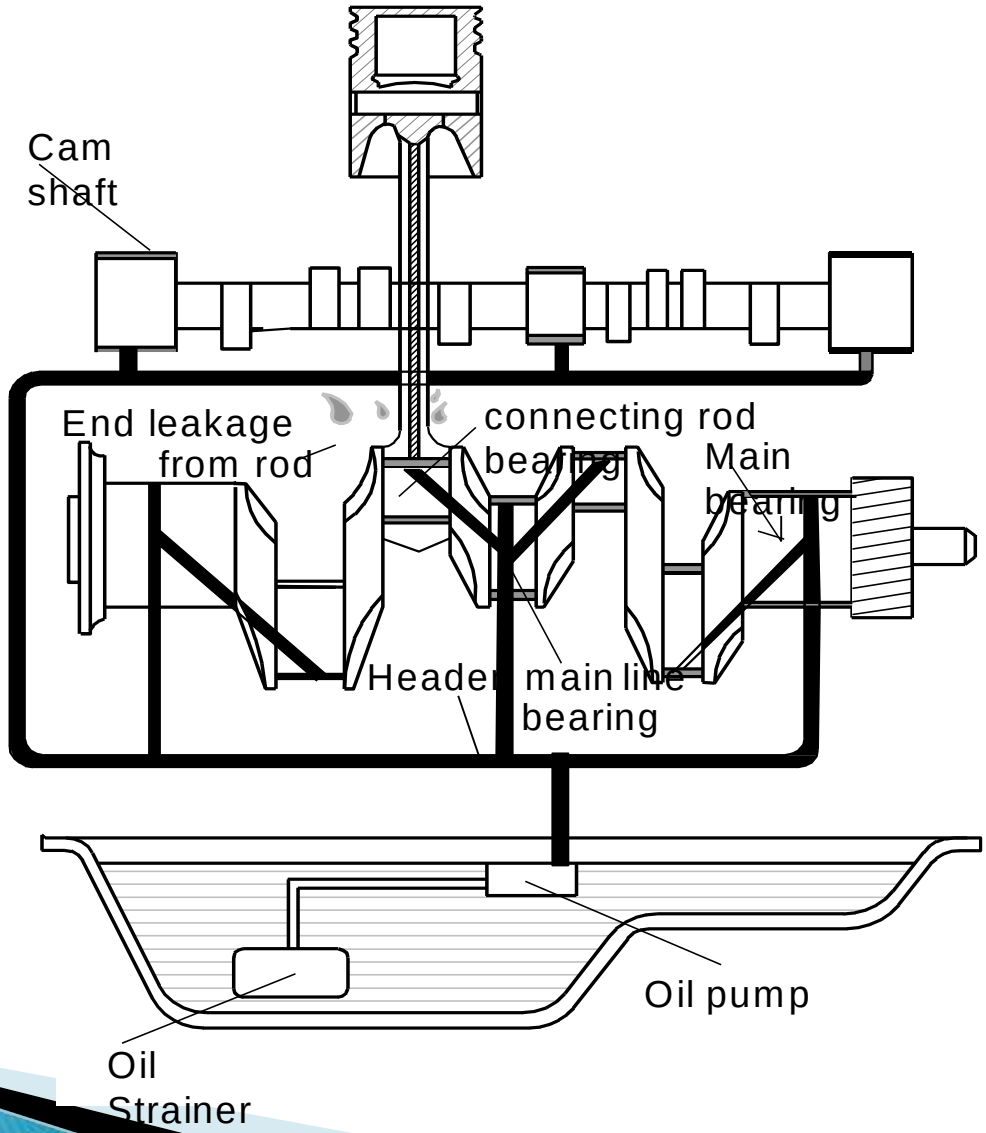


Splash and Pressure Lub Sys…

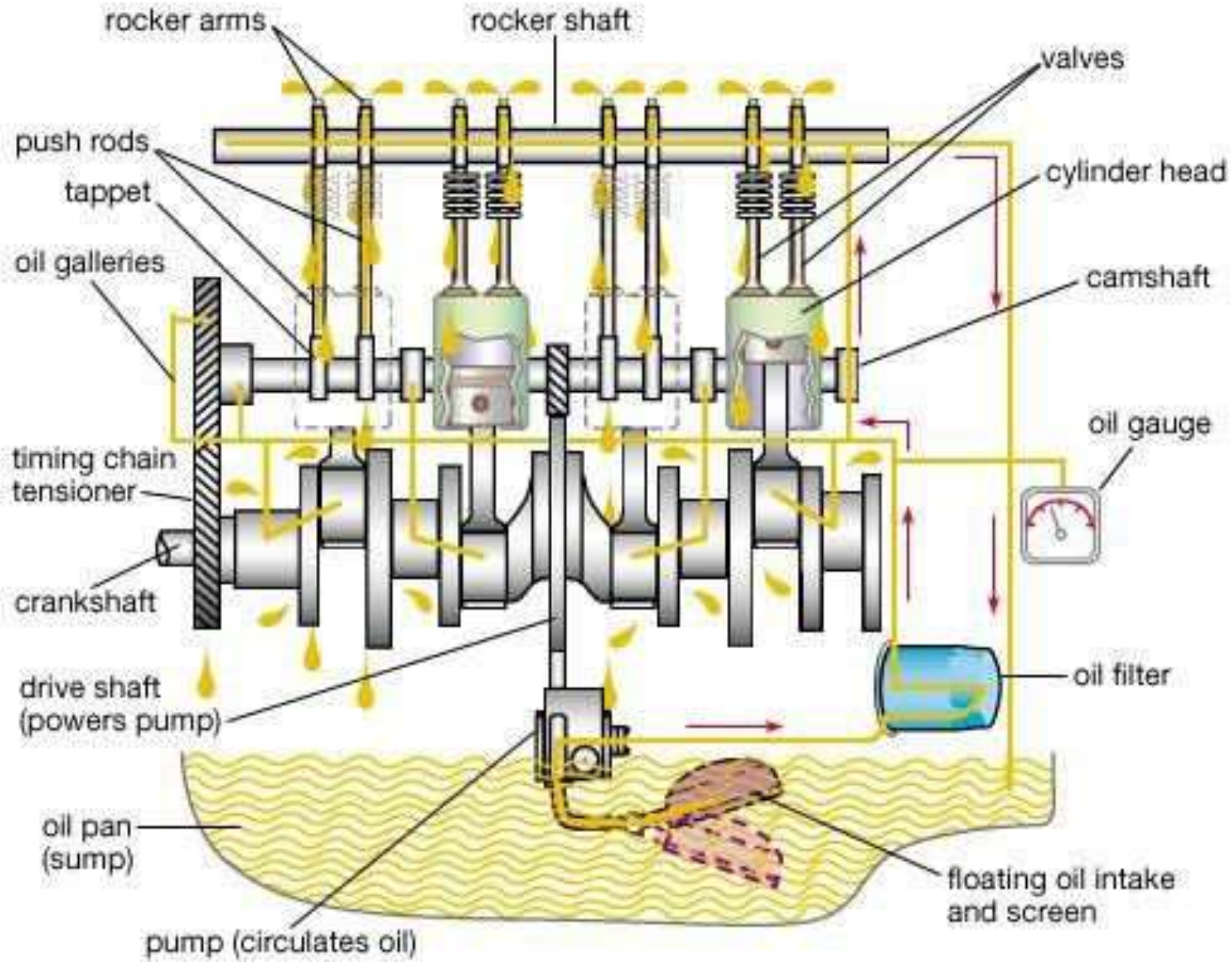
Pressure Feed System

- Pressure feed system is illustrated in Fig 3 in which oil is drawn in from the sump and forced to all the main bearings of the crankshaft through distributing channels.
- A pressure relief valve will also be fitted near the delivery point of the pump –which opens when the pressure in the system attains a predetermined value.
- An oil hole is drilled in the crankshaft from the centre of each crankpin to the centre of an adjacent main journal, through which oil can pass from the main bearings to the crankpin bearing.
- From the crankpin it reaches piston pin bearing through a hole drilled in the connecting rod.
- The cylinder walls, piston and piston rings are lubricated by oil spray from around the piston pins and the main and connecting rod bearings.

Full Force Feed System



Pressure Feed System

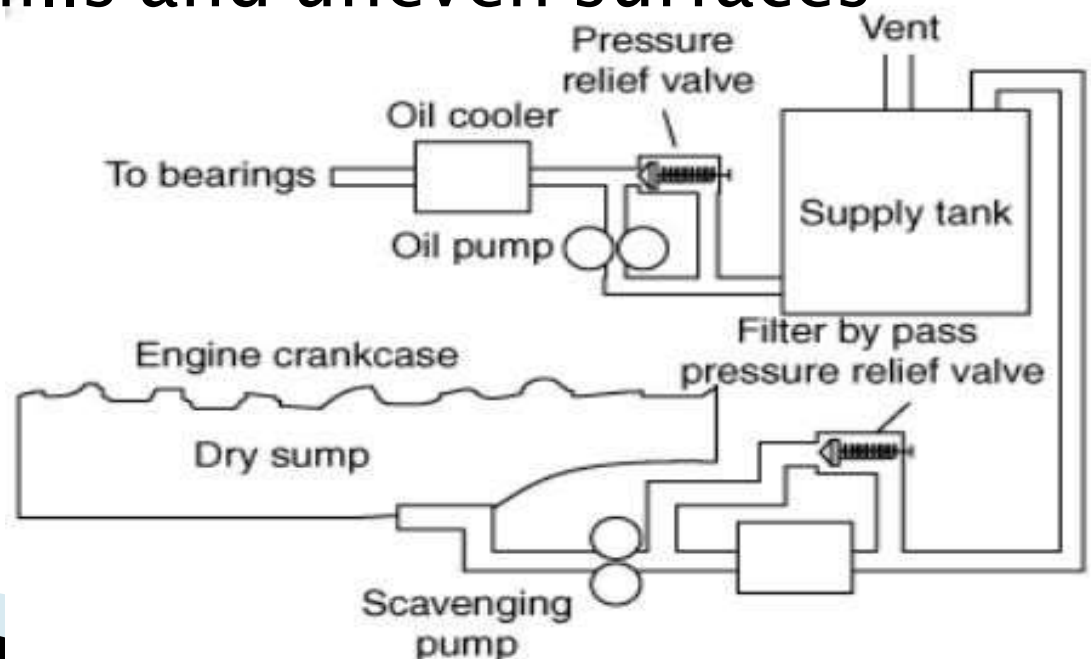


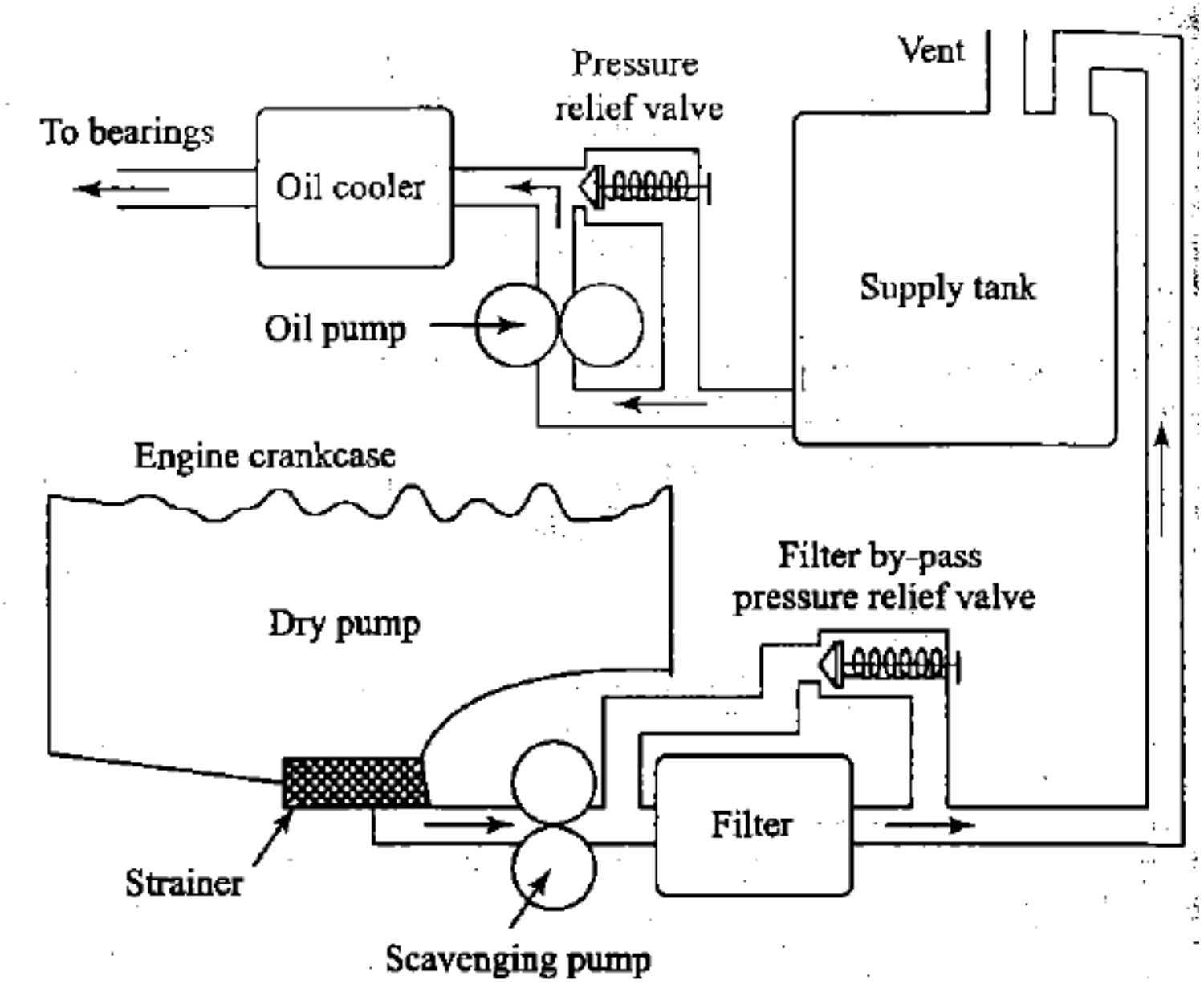
Pressure Feed Lubrication System

Dry Sump

It uses an additional pump as well as a remote oil tank

It is used in situations when a wet sump cannot cope with the oil supply, in unusual or extreme conditions; Heavy acceleration (racing cars), Off road driving, steep hills and uneven surfaces




Vent
Pressure
relief valve
To bearings
Oil cooler
Supply tank
Oil pump
Engine crankcase
Filter by-pass
pressure relief valve
Dry pump
Filter
Strainer
Scavenging pump

Dry Sump Lubricating System

- In dry sump lubricating system, the supply of oil is carried in an external tank
- An oil pump draws oil from the supply tank and circulates it under pressure to the various bearings of the engine
- Oil dripping from the cylinders and bearings into the sump is removed by a scavenging pump which in turn the oil is passed through a filter, is fed back to the supply tank.
- Thus, oil is prevented from accumulating in the base of the engine.

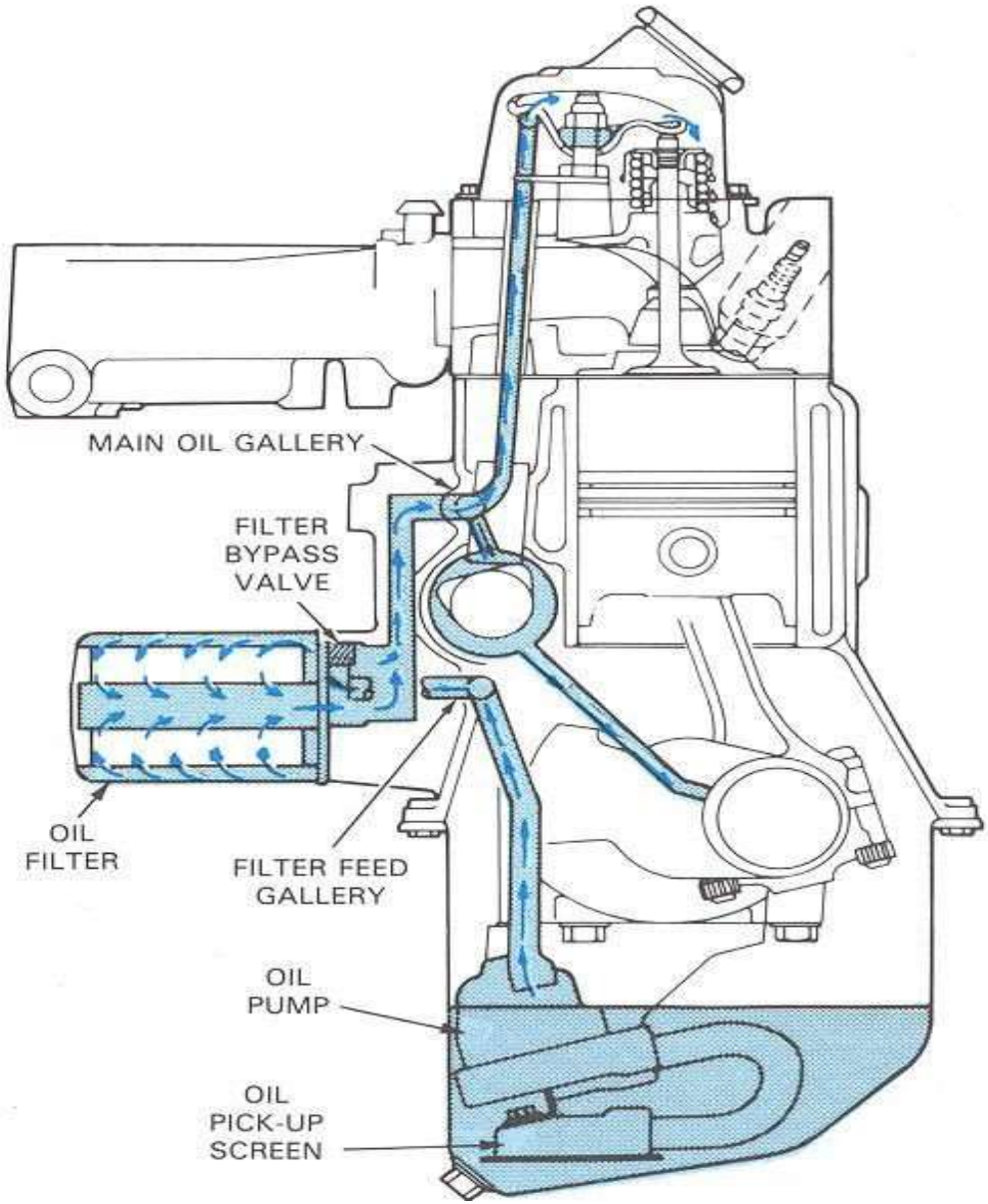
dry sump lubricating system

- The capacity of the scavenging pump is always greater than the oil pump.
- In this system a filter with a bypass valve placed in between the scavenge pump and the supply tank.
- If the filter clogged, the pressure relief valve opens permitting oil to by-pass the filter and reaches the supply tank.

Dry Sump Lub Sys…

Lubricating System Parts

- Oil sump
- Oil pump
- Pick-up screen
- Pressure regulator
- Oil filter
- By-pass valve
- Oil galleries
- Dipstick
- Pressure indicator



Properties of Lubricating Oil

The duties of the lubricant in an engine are many and varied in scope. The lubricant is called upon to limit and control the following:

(i) friction between the components and metal to metal contact

(ii) overheating of the components

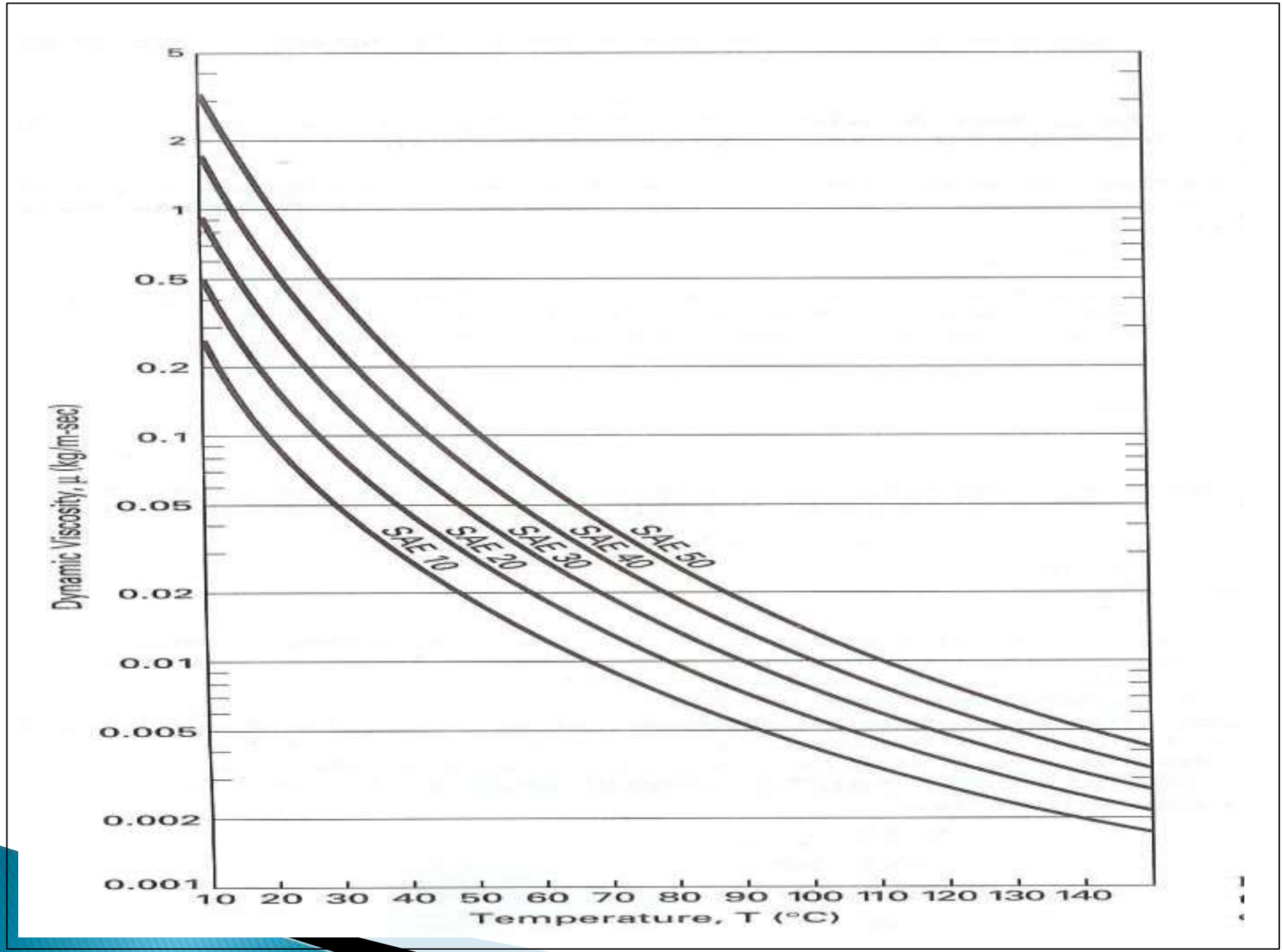
(iii) wear of the components

(iv) corrosion

(v) deposits

Properties of Lubricating Oil

- The Lub oil used in an engine must serve as a lubricant, a coolant and an agent for removing impurities.
- It must be able to withstand high temperatures without breaking down. The oil must operate over a good range of temperature.
- They must not oxidize on the chamber walls, piston crown or at the piston rings.
- Oil should have high strength to prevent metal-to-metal contact even under extreme loads.


Dynamic Viscosity, μ (kg/m-sec)
5
2
1
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001
SAE 10
SAE 20
SAE 30
SAE 40
SAE 50
10 20 30 40 50 60 70 80 90 100 110 120 130 140
Temperature, T (°C)

Rating of Lubricating Oil

- Lubricating oil is generally rated using a viscosity scale established by the SAE.

Commonly used viscosity grades are:

SAE 5
SAE 10
SAE 20
SAE 30
SAE 40
SAE 45
SAE 50

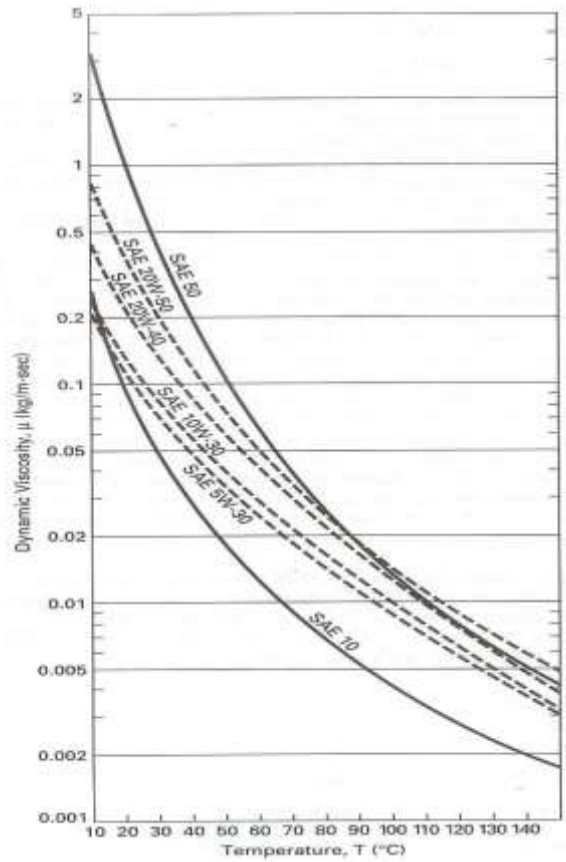
- The oil with lower viscosity grades is less viscous and is used in cold-weather operation. Modern high temperature, high speed, close tolerance engines use high viscosity grades oil.

Rating of Lubricating Oil

❖**When certain polymers are added to oil, the temperature dependency of oil viscosity is reduced. These oils have low viscosity grades when they are cold and higher as they become hot.**

❖**As for example, SAE 10W-30 means that the oil has a grade 10 when it is cold (W stands for winter) and 30 when it is hot. Commonly used oils in this category are:**

SAE 5W-20	SAE 10W-40
SAE 5W-30	SAE 10W-50
SAE 5W-40	SAE 15W-40
SAE 5W-50	SAE 15W-50
SAE 10W-30	SAE 20W-50



Properties of Lub Oil

- Flash Point and Fire Point
  - The flash point of an oil is the minimum temperature at which sufficient flammable vapour is driven off to flash when brought into contact with flame.
  - The fire point is the minimum temperature at which the inflammabl vapours will continue to form and steadily burn once ignited. Flash and fire points may vary with the nature of the original crude oil, the viscosity and the method of refining.
  - Lub oils have higher flash and fire points than fuel.

Properties of Lub Oil

Oiliness or Film Strength

- Film strength refers to the ability of the lubricant to resist **welding** and **scuffing**.
- The lubricating oil used must be of enough film strength to take care of welding and scuffing.

Corrosiveness

- The oil should be noncorrosive and should protect against corrosion. It is probable that the absorbed film that rise to the level of oiliness is also related to the protection of the surface against corrosion.

Properties of Lub Oil

Detergency

- An oil has the property of detergency if it acts to clean the engine deposits.
- A separate property is the dispersing ability which enables the oil to carry small particles uniformly distributed without agglomeration. In general, the term is the name for both detergent and dispersing properties.

Properties of Lubricating Oil

(b)Specific Gravity: This property is of little importance except as an indicator of weight and volume. The specific gravity of oil varies from 0.85 to 0.96

(ratio of the density of a fluid to the density of a standard fluid)

(b)Pour Point: It indicates the temperature below which the lubricating oil loses its fluidity and will not flow or circulate in the system. This characteristics of the oil is important at low temperature Pour point must be at least 15^0F lower than the operating temperature to ensure maximum circulation.

Rating of Lubricating Oil

Oxidation Stability: **Oxidation stability of an oil is its resistance to oxidation.** **Due to oxidation, oil forms deposits on the piston rings, and thereby loses its lubricating property. Some inhibitors are used to counteract these tendencies.**

Acidity and Neutralization Number: **lubricating oil should have low** **The acidity.** **The neutralization number is a measure of acidic or alkaline contents of oil.**

Types of Lubricating Oil

⑨ **Vegetable oils have been used in the past, especially for racing car engines. The main advantages of these oils are their high film strength, and they have a good lubricity.**

⑨ **Later, specially formulated mineral oil have replaced their use in s performance engines. Mineral oils are most readily available and cost effective. They readily respond to additives, and can be produced in a wide range of viscosities. The main disadvantage lies with its wax content that affects cold performance and can clog filters.**

Classification of Lubricants

- Animal
- Vegetable
- Mineral
- Synthetic

Animal Lubricants

- **Lubricants with animal origin:**
  - **Tallow**
  - **Tallow oil**
  - **Lard oil**
  - **Neat's foot oil**
  - **Sperm oil**
  - **Porpoise oil**
- **These are highly stable at normal temperatures**
- **Animal lubricants may not be used for internal combustion because they produce fatty acids.**

Vegetable Lubricants

- Examples of vegetable lubricants are:
  - Castor oil, Olive oil, Cottonseed oil
- Animal and vegetable oils have a lower coefficient of friction than most mineral oils but they rapidly wear away steel.

Mineral Lubricants

- These lubricants are used to a large extent in the lubrication of aircraft internal combustion engines.
- There are three classifications of mineral lubricants:
  - Solid, Semisolid, Fluid

Synthetic Lubricants

- **Because of the high operating temperatures of gas-turbine engines, it became necessary to develop lubricants which would retain their characteristics at temperatures that cause petroleum lubricants to evaporate and break down.**

- **Synthetic lubricants do not break down easily and do not produce coke or other deposits.**

Additives

- Corrosion and Rust Inhibitors
- Anti-foam Agents
- Detergent-Dispersants
- Pour Point Improvers
- Oiliness and Film-strength Agents