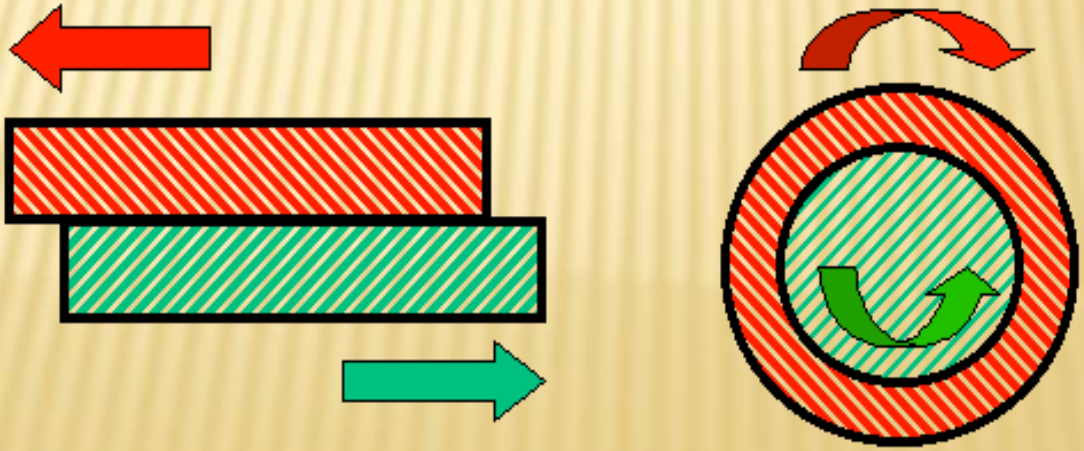
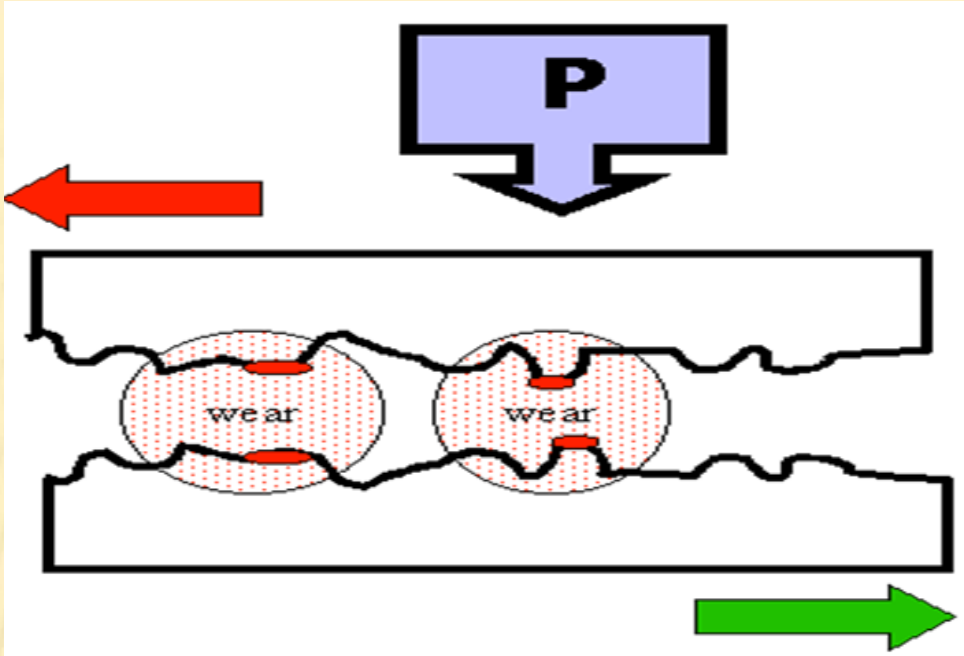
LUBRICANTS

- **The surface of moving / sliding parts rub against each other.**
- **Due to rubbing of one part against the other, a resistance is offered to their movement.**
- **This resistance is known as FRICTION.**
- **Friction is the resisting force generated between two surfaces which move relative to each other.**





FRICTION GIVES ENERGY LOSS WITH TEMPERATURE INCREASE AND USUALLY PRODUCES MATERIALS WEAR WITH DIMENSIONAL CHANGE OF THE SURFACES.

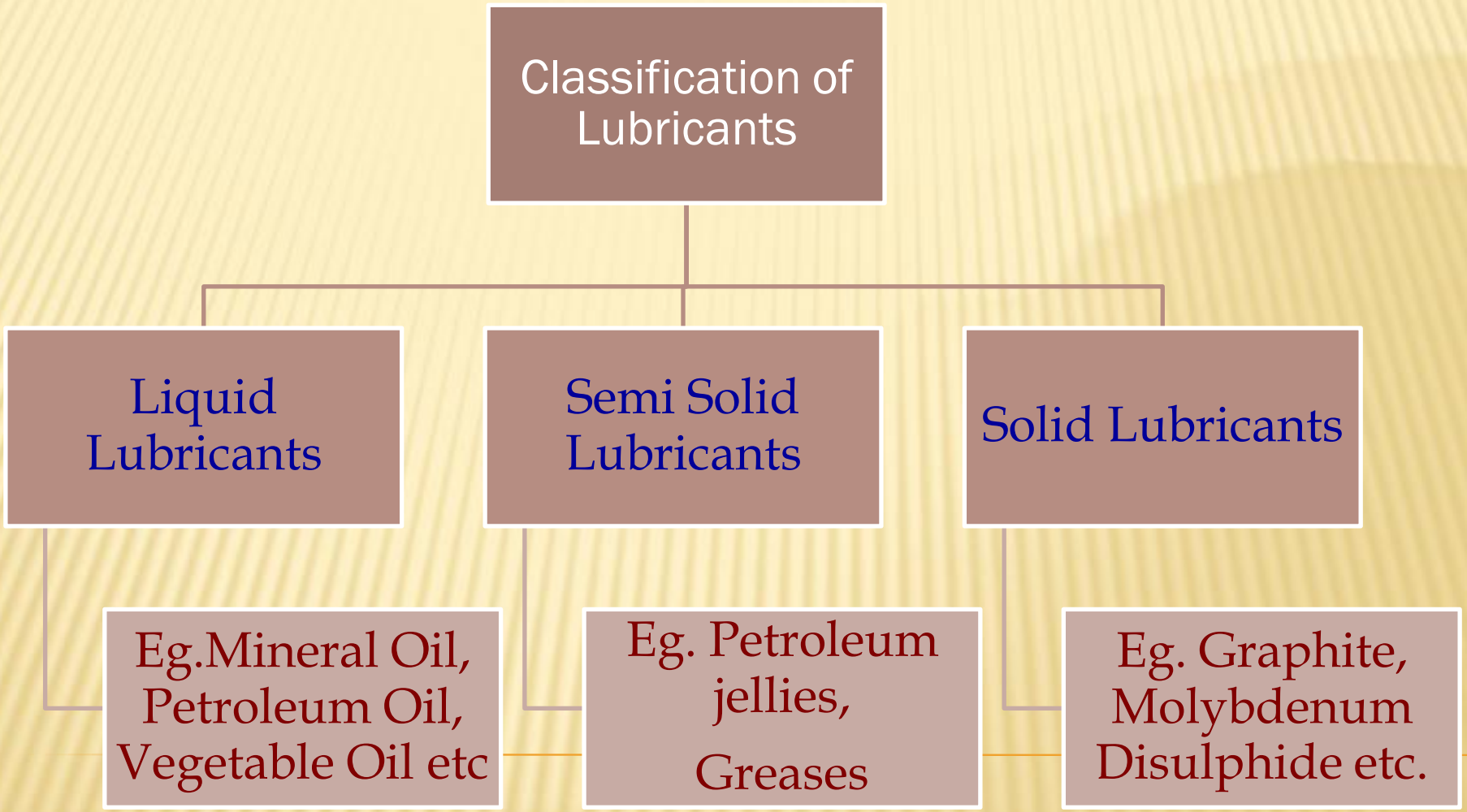
Lubricant: **Any substances introduce between two moving / sliding surfaces to reduce the frictional resistance between them is known lubricant.**

Lubrication: **The process of reducing frictional resistance between moving / sliding surfaces, by the introduction of lubricants in between them is called lubrication.**

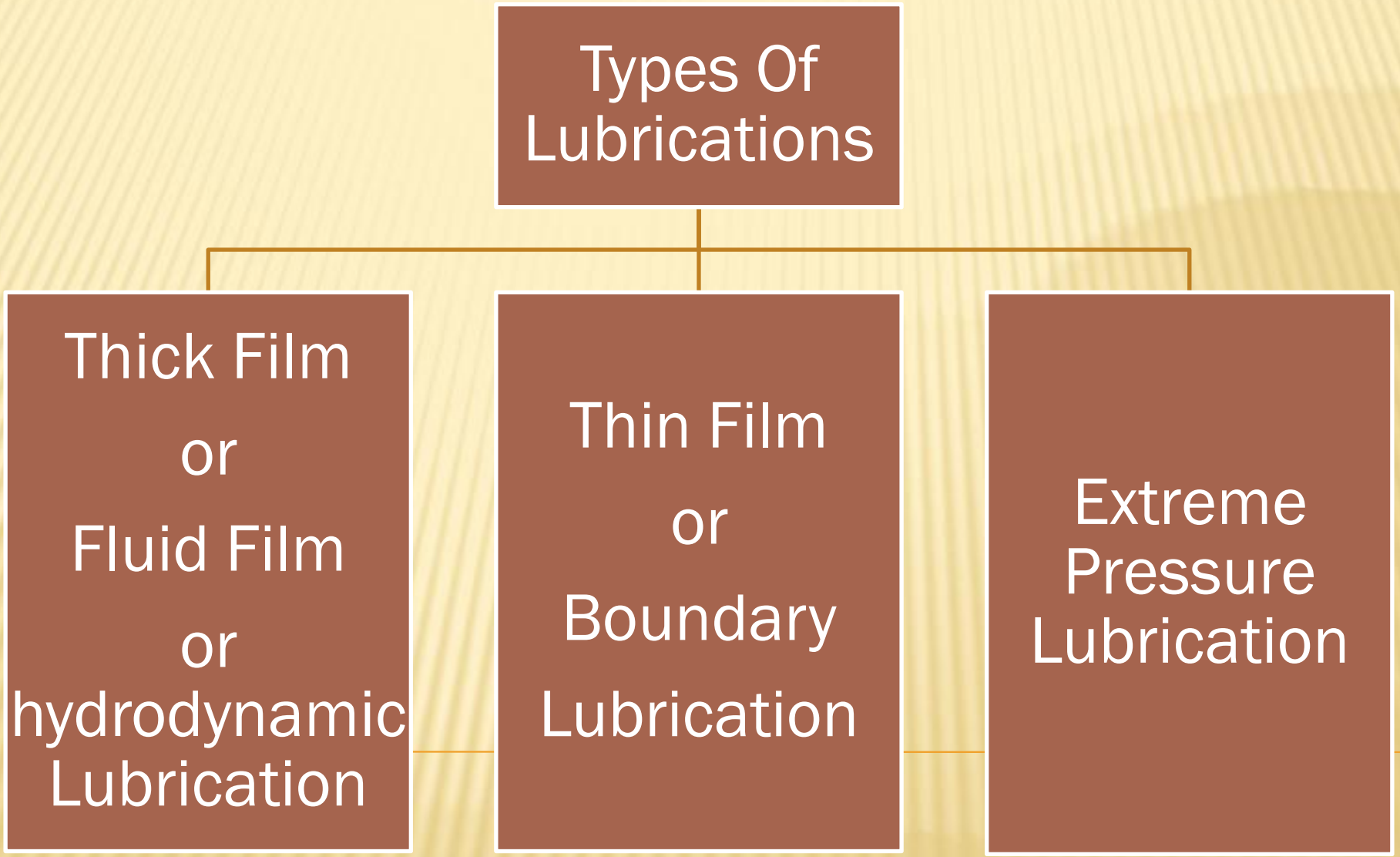
FUNCTIONS OF LUBRICANT

- **Act as a Coolant and to carry away heat.**
- **Act as sealing agent in IC engine.**
- **Reduce wear and tear and deformation of metal**
- **Maintenance & Running cost of Machine**
- **Unsmooth relative motion**
- **Act as cleansing agent and Keeps out dirt.**
- **Prevent resistance and corrosion.**

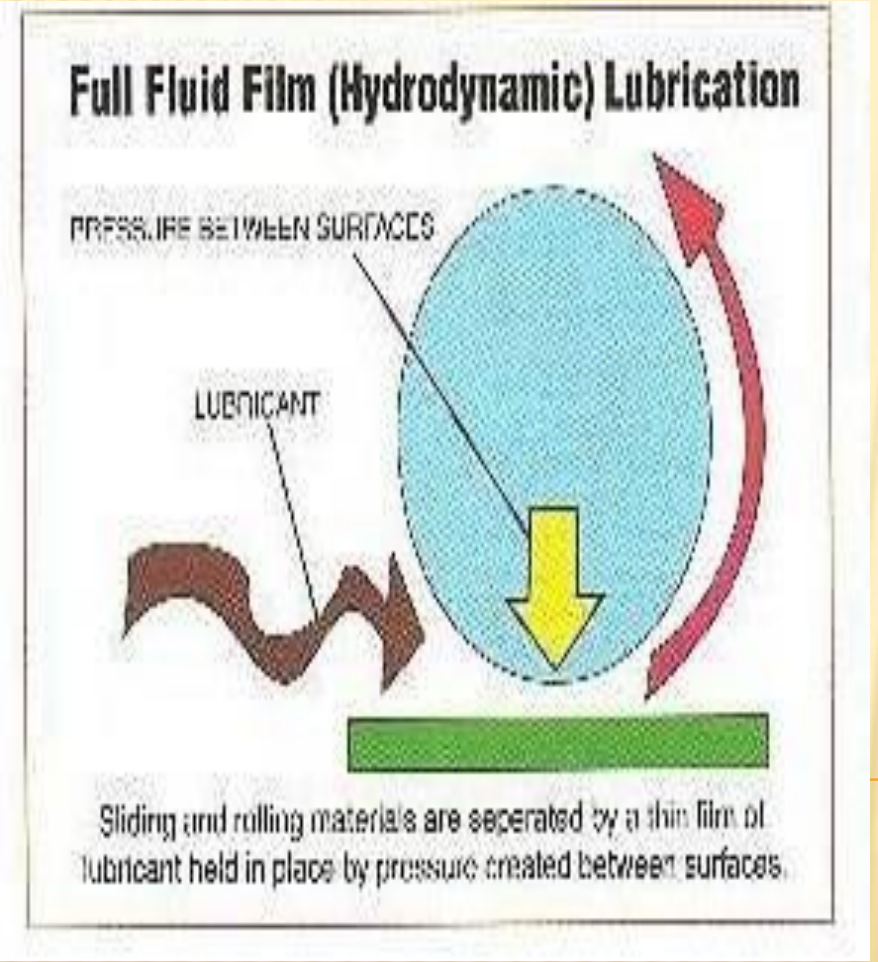
- **Lubricate - Reduce friction**
- **Cooling - Heat transfer**
- **Cleaning - Detergency**
- **Noise pollution - dampening**
- **Sealing – prevent leakage**
- **Protection – prevent wear**


Classification of Lubricants
Liquid Lubricants
Semi Solid Lubricants
Solid Lubricants
Eg.Mineral Oil, Petroleum Oil, Vegetable Oil etc
Eg. Petroleum jellies,
Greases
Eg. Graphite, Molybdenum Disulphide etc.

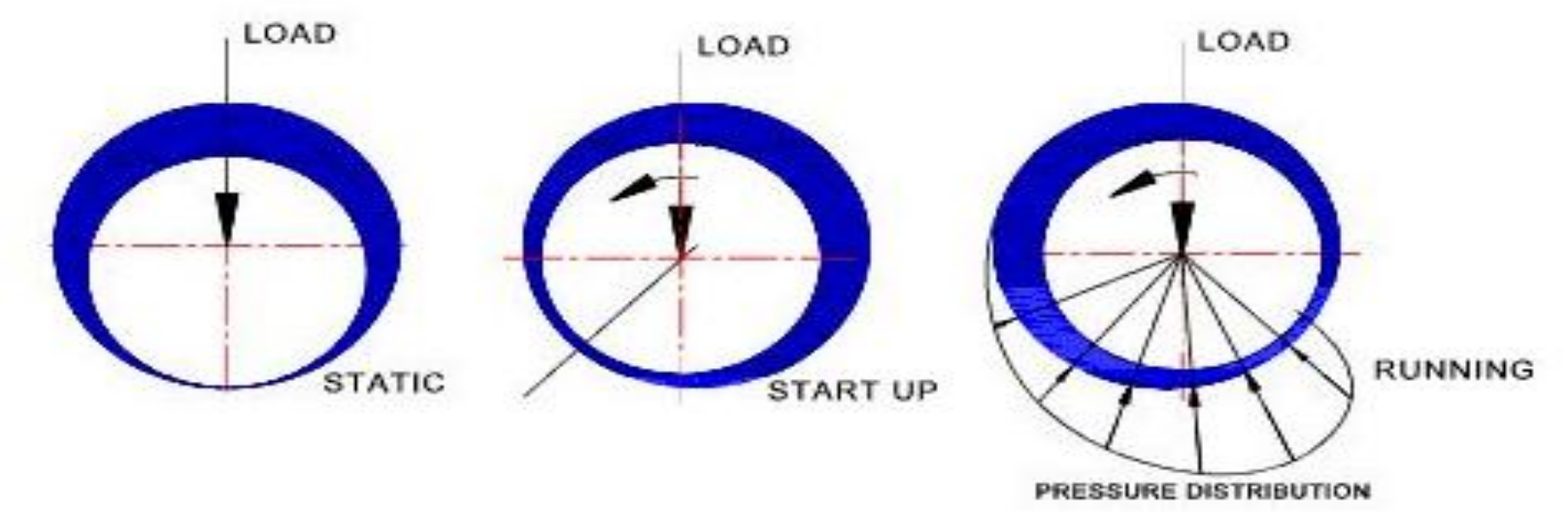
TYPES OF LUBRICATION

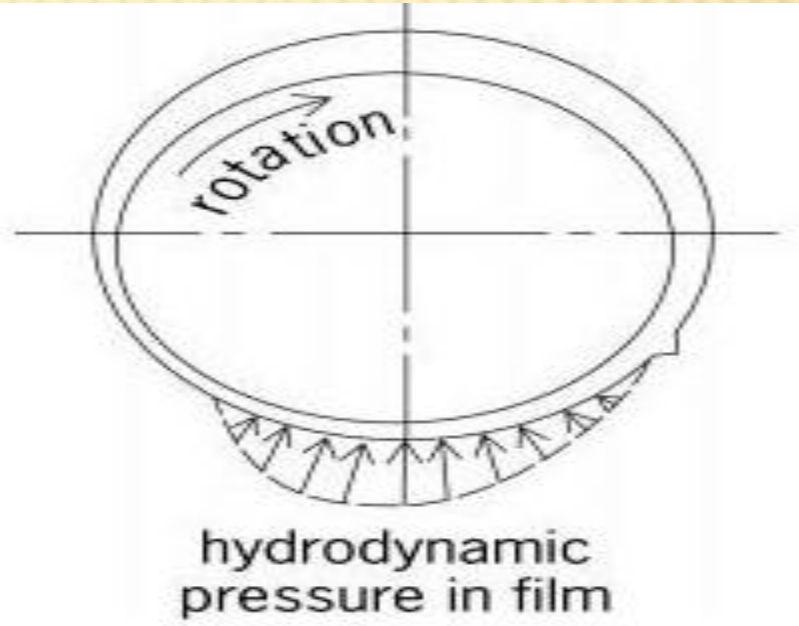

Types Of Lubrications
Thick Film or Fluid Film or hydrodynamic Lubrication
Thin Film or Boundary Lubrication
Extreme Pressure Lubrication

Thick Film Lubrication



- This is also called Hydrodynamic or fluid film lubrication.
- Two sliding metal surfaces are separated from each other by a thick film of fluid (1000 A^{o} thick).
- The coefficient of friction in such cases is as low as 0.001 to 0.03
- Lubricants used : Hydrocarbon Oils.
- Provided in delicate instruments such as watches, clocks, light machines like sewing machines, scientific instruments etc.


LOAD
STATIC
LOAD
START UP
LOAD
RUNNING
PRESSURE DISTRIBUTION

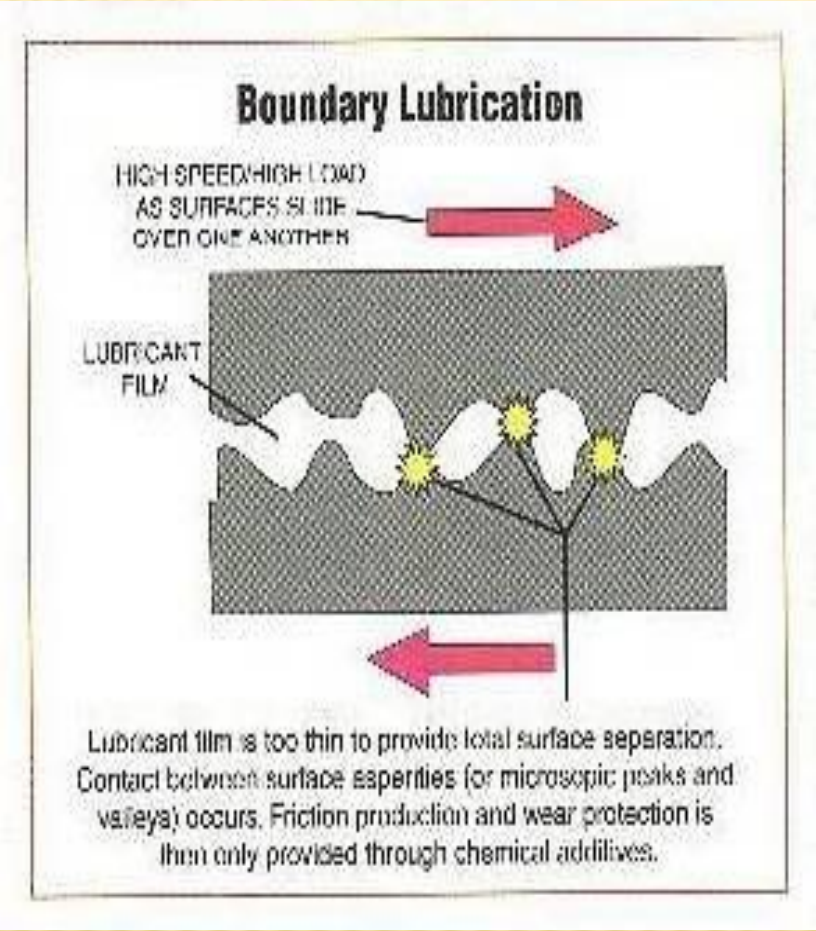

rotation
hydrodynamic
pressure in film

APPLICATIONS OF HYDRODYNAMIC LUBRICATION

- **Delicate instruments.**
- **Light machines like watches, clocks, guns, sewing machines.**
- **Scientific instruments.**
- **Large plain bearings like pedestal bearings, main bearing of diesel engines.**

Hydrocarbon oils **are considered to be satisfactory lubrication for fluid film lubrication. In order to maintain the viscosity of the oil in all seasons of the year, ordinary hydrocarbon lubricants are blended with selected long chain polymers.**

Thin Film Lubrication



This lubrication is also called Boundary Lubrication.

Its used for high load conditions.

Very thin film of the lubricant is adsorbed on the surface by physical or chemical forces or both.

The coefficient of friction is 0.05 to 0.15

Lubricants used for boundary lubrication should have high viscosity index, resistance to heat and oxidation, good oiliness.

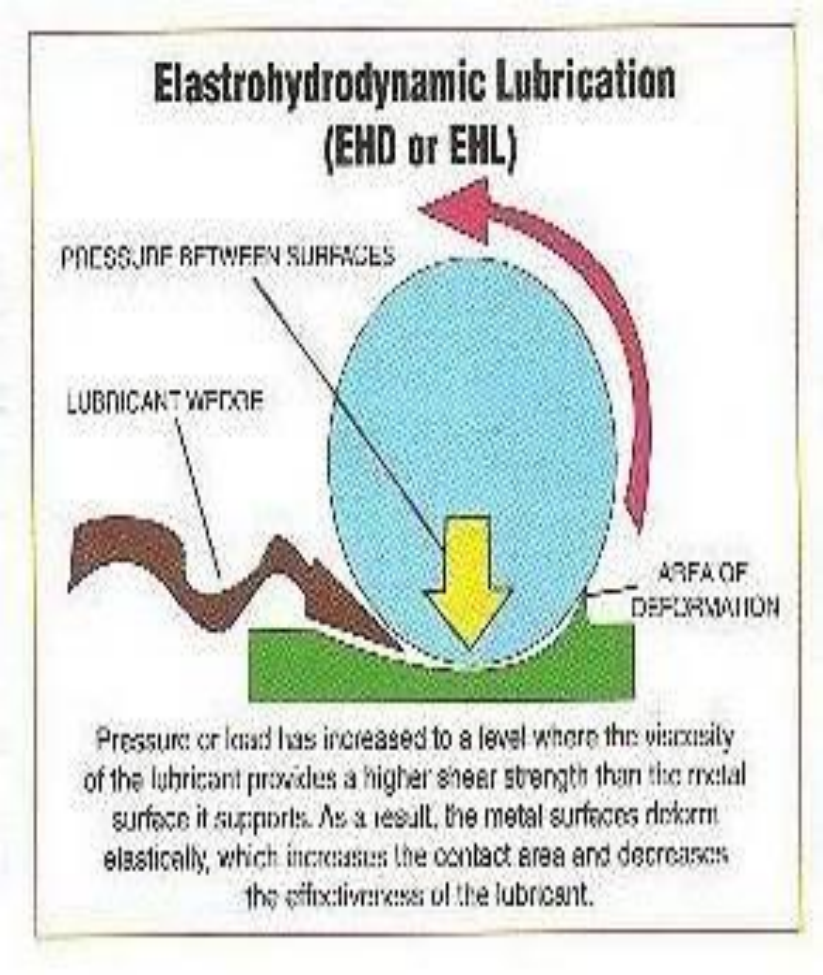
Examples are Organic oils, Vegetable oils, Graphite and MoS_2, Mineral Oils etc.

BOUNDARY/ THIN FILM LUBRICATION

- **Boundary Lubrication is a condition in which the lubricant film becomes too thin to provide total surface separation. This may be due to excessive loading, low speeds or a change in the fluid's characteristics.**
- **In such a case, contact between surface asperities (or peaks and valleys) occurs. Friction reduction and wear protection is then provided via chemical compounds rather than through properties of the lubricating fluid.**

Eg.: Graphite and MoS_2

Extreme Pressure Lubrication



- This lubrication is for very high pressure /temperature /speed sliding surfaces.
- Extreme pressure additives are used along with the lubricants.
- Chemicals used are compounds of Cl, S & P.
- These additives form solid surface films of Cl, S & P.
- High melting point metal compounds are good lubricants.

EXTREME PRESSURE LUBRICATION

Load and Pressure is High

- High Temperature generated between the sliding surfaces,
- Extreme Pressure Lubricants Contains organic compounds containing sulphur, phosphorus, lead, chlorine.
- The organic compounds decompose and form high melting lubricating films on the metal surfaces.

LUBRICANT SELECTION

- Generally based on 4 factors:
- 1. Load
- 2. Speed
- 3. Temperature
- 4. Environment
- Load, speed and temperature are usually directly related.

LUBRICANT SELECTION

- If load or speed increases, the internal temperature also increases.
- If internal or external temperatures are extreme, then lubricant selection must be reconsidered.
- Bearing type (ball, roller, journal, etc.) will also affect lubricant selection.

PHYSICAL PROPERTIES OF LUBRICANTS

Flash point and Fire point

- **The flash point of a lubricating oil is the lowest temperature at which it gives off vapours that will ignite to give a momentary flash (less than 5 sec.) when a small flame is brought near it.**
- **The fire point of lubricating oil is the lowest temperature at which the vapour of oil burns continuously for at least five sec., when the small flame is brought near it.**

Significance: The flash and fire points are useful in determining a lubricant's volatility and fire resistance. The flash point can be used to determine the transportation and storage temperature requirements for lubricants.

- Fire point = flashpoint+5 to 400C.
- Both should be higher than the max temp of country (for transportation)
- If flash point < 140°F = Flammable liquids

  And if flash point > 140°F =Combustible liquids.

The flash and fire points are generally determined by using Pensky-Marten's apparatus.

•Oil under examination is filled in the oil cup up to the mark and heated by the air bath by a burner.

•Stirrer is worked b/n tests at a rate of about 1 – 2 rev/sec.

•Heat is applied so as to raise the oil temp by about 5c/min.

•The temp at which distinct flash appeared in side the oil cup is recorded as flashpoint.

•The heating is continued to record the fire point.

Cloud point and Pour Point

- Cloud Point is the temp at which the lubricant becomes cloudy or hazy when cooled.
- Pour Point is the temp at which the lubricant just ceases to flow when cooled.
- Both indicates suitability of lubricant in cold conditions and thus must be low.
- Pour point of wax can be lowered by dewaxing or adding suitable pour point depressant.
- Pour point of an oil can be lowered by lowering the viscosity of the oil which is achieved by removing the viscous constituent of the oil.
- Lubricating oils used in capillary feed systems should have low cloud points, otherwise impurities will clog the capillary.
- A high pour point leads to the solidification of the lubricant that may cause jamming of the machine.
- **Lower Cloud Point and Pour point is preferred in a Lubricant.**

Viscosity and viscosity index

Viscosity:" It is the property of a fluid that determines its resistance to flow”

Viscosity index:" The rate at which the viscosity of oil changes with temperature by an arbitrary scale”

Measurement devices:

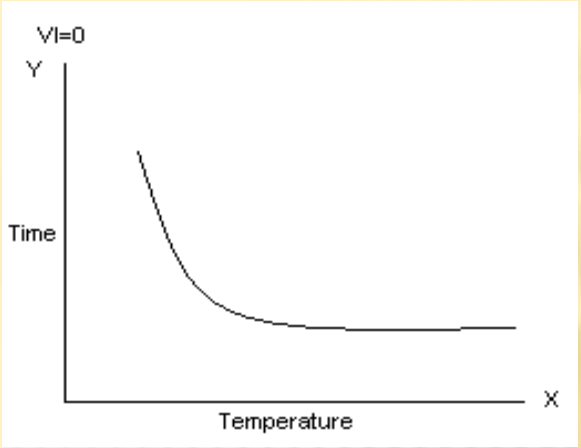
1.Redwood viscometer no.1 and no.2

2.Saybolt viscometer

3.Engler viscometer

4.Kinematic viscometer

$$viscosity\ index = \frac{L - U}{L - H} \times 100$$



	RW No. 1	RW No.2
Dimensions of Orifice	Length 10 mm Diameter 1.62 mm	Length 50 mm Diameter 3.80 mm
Receiving flask	Smaller Mouth	Larger Mouth
Useful for	Low Viscous oil	High Viscous oil

Viscosity Index

The rate of change of viscosity of oil with temperature is measured in terms of viscosity index.

- It is “Avg. decrease in viscosity of oil per degree rise in temp between 1000F & 2100F.”
- Viscosity of liquids decreases with increasing temperature.
- The rate at which viscosity of a lubricant changes with temperature is measured by a scale called Viscosity Index.
- Silicones, polyglycol ethers, Diesters or triesters have high Viscosity Index.

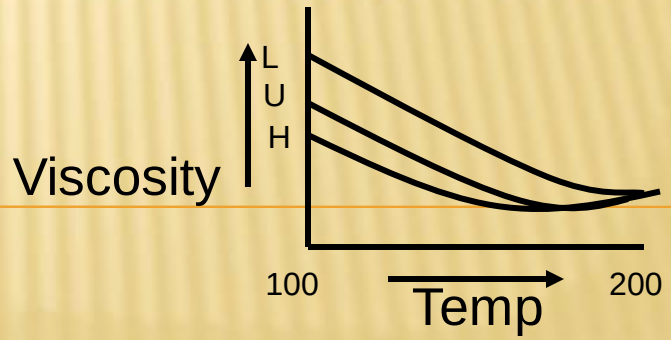
Determination of Viscosity Index :

- First the viscosity of the oil under test is determined at 100°F & 210°F. Let it be U and V respectively.
- Then viscosity of Pennsylvanian oil is determined. Let it be V_H.
- Then viscosity of Gulf oil is determined. Let it be V_L

viscosity Index = $\frac{V_L - U}{V_L - V_H} \times 100$

V.I. = 100 (Pennsylvanian oils.)

V.I. = Zero (Naphthanic-base gulf oils)



Higher the V.I, lesser is the variation of viscosity with change in temperature. Thus, a good lubricating oil should possess high V.I.

CHEMICAL PROPERTY

- **Aniline Point**
- **Stem Eulsification No. (SEN)**
- **Neutrilization No./ Acid Value**
- **Saponification No.**
- **Iodine Value**
- **Carbon Residue**

Soaponification Number

" **It is the no. of milli grams of potassium hydroxide required to saponify the fatty material present in one gram of oil."**

- Saponification is hydrolysis of an Easter with KOH to give alcohol and Na/K salt of acid.
- Mineral oils do not react with KOH and are not saponifiable.
- Vegetable and animal oils have very high saponification values.

Significance

- Saponification value helps us to ascertain whether the oil under reference is mineral or vegetable oil or a compounded oil.
- Each oil has its specific Soaponification Number.

  Deviation from it indicates the extent of adulteration of oil.

Steam emulsification no.

“ It is the time in seconds in which oil and water emulsion separate out in distinct layers.”

- Emulsification is the property of water to get mixed with water easily.
- Emulsions can be oil in water emulsion or water in oil emulsion.
- **Demulsification number** defined as the number of seconds required for an oil to separate from water after it has been emulsified under specified conditions.
- A good lubricating oil should form such an emulsion with water which breaks easily. This property is called **demulsification.**
- Quicker the oil separates out from the emulsion formed, better is the lubricating oil
- **A good lubricating oil should have lower demulsification number**
- In cutting oils the higher the emulsification number, better the oil is. This is because the emulsion acts as a coolant as well as a lubricant.

Iodine value

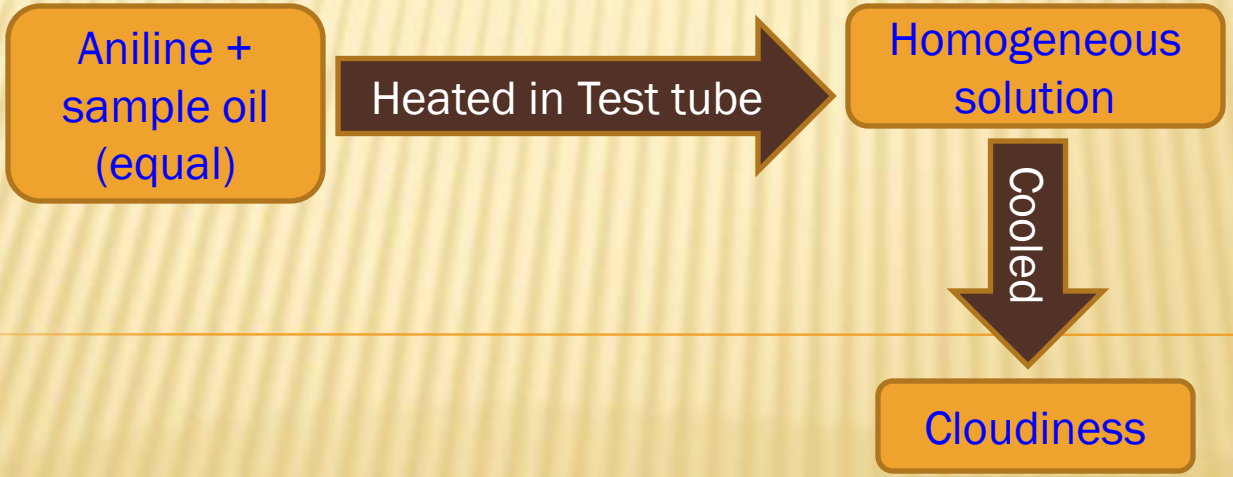
- It is the no. of milligrams of iodine absorbed by one gram oil."
- Each oil has its specific Iodine Number.
- Iodine Number determines the extent of unsaturation present in the oil.
- Low Iodine Number is desirable in oils.
- Some oils and their Iodine Numbers are given below :

Iodine Number	Oil	Example
>150	Drying oil	Linseed oil, tung oil
100-150	Semidrying oil	Castor oil , Soyabean oil
<100	Non-Drying oil	Coconut oil, Olive oil

Aniline Point

- Aniline point is the Min temp at which oil is miscible with equal amt of aniline
- Aniline Point is a measure of aromatic content of the lubricating oil.
- Low Aniline Point oil have high aromatic content which attacks rubber seals.
- Higher Aniline point means low %age of hydrocarbons (desirable).
- Thus Aniline Point is used as an indication of possible deterioration of rubber sealing etc.

Determination of Aniline Point :



The temperature at which separation of the two phases (Aniline + oil) takes place is the Aniline Point.