15/08/19



# Lubricant and Lubrication

★ Key of chapter / Previous year questions

1. What is lubricant and lubrication? Explain types of lubricant and function of lubricant.

2. Define lubricants and what are the different types of lubricants with examples.

3. Define lubricant. Classify and give example and write their proper uses.

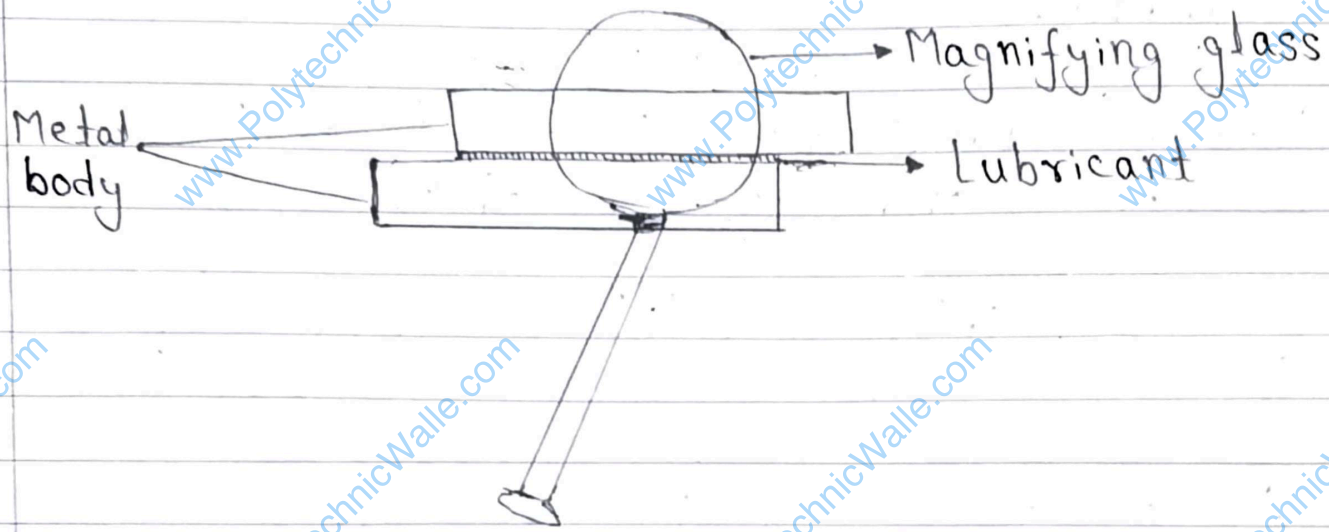
4. Define lubricant. What their chief function with example.

5. Write notes on :-

(a) Viscosity and viscosity index.
(b) Flash point & fire point.
(c)

## ✯ Lubricant :-

In order to reduce frictional resistance and wear and tear of machine parts, a layer of fluid is introduced in between the moving parts. This layer of fluid is known as lubricant.




## ✯ Lubrication :-

The process of application of lubricant between the moving or sliding surfaces of machines to reduce the friction between them is known as lubrication.

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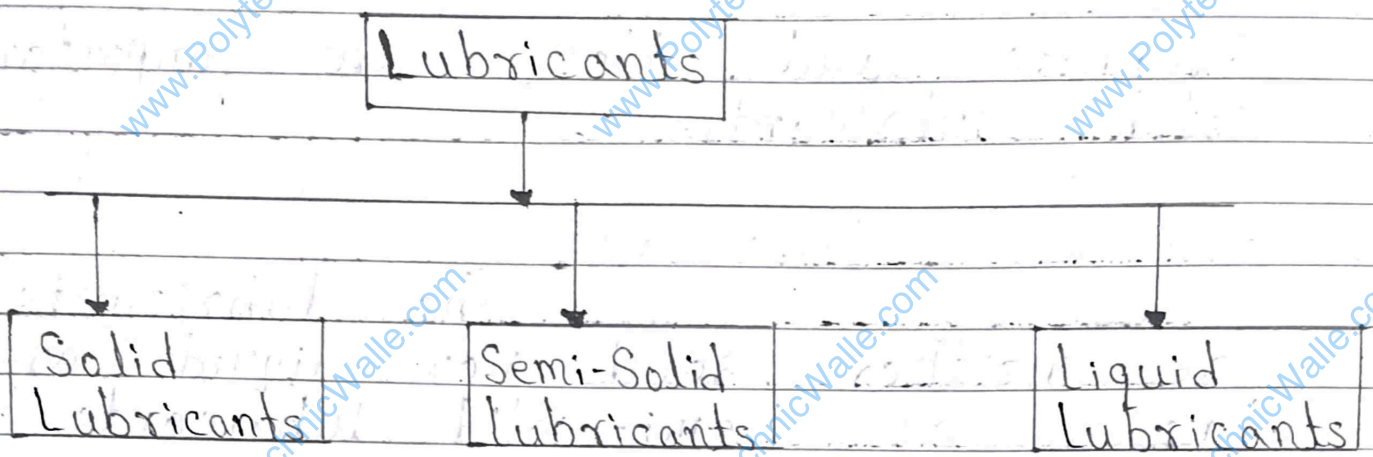
## ☆ Classification of lubricants :-




### 1. Solid Lubricants :-

The lubricants existing in solid form are known as solid lubricants.

e.g. :- graphite, $MoS_2$ (molybdenum disulphide), soap, chalk, mica, vax etc.

### Conditions for using solid lubricants :-

(a) In such type of machines where semi-solid and to liquid lubricants are not suitable.

(b) In the heavy machines which are operated under heavy loads and at low speeds.

(c) When semi-solid or liquid lubricants

lubricating oil → petroleum
thickeners → soaps (Li, Na, Ca, Ba, Al etc).



are highly combustible (inflammable).

Graphite and $MoS_2$ are important solid lubricants.

2. Semi-Solid Lubricants :-

The lubricants are neither solid nor liquid are known as semi-solid lubricants.

A semisolid lubricant is obtained by combining lubricating oil with thickening agent.

e.g. :- grease, vaseline, silica, vaxes etc.

Conditions for using semi-solid lubricants :-

(a) In such type of machines where solid or liquid lubricants are not suitable.

(b) The machine is working at low speed and high pressure. and high temperature upto 80°C.

~~(c) The~~

(c) The lubricating oil isn't suitable for machines.

Soap is one of the main $f^n$ of s.s. lubricants.

e.g.:- mineral oil, petroleum oil, synthetic oil, custard oil, etc.



3. Liquid lubricants :-

The lubricants existing in liquid form and are used to reduce friction between two sliding metal surfaces by providing a uniform film between them is known as liquid lubricants.

e.g.:- vegetable oil and animal oil.

They act as :- (i) Sealing agent.
(ii) Cooling medium
(iii) Corrosion inhibitors.

Conditions for using liquid lubricants:-

(a) When solid and semisolid lubricants are not suitable.

(b) In light machines like watches, clocks, sewing machines etc.

(c) Where the machines are operated at low speed under ordinary load.

(d) In such type of machines whereas less amount of heat is produced during motion.

## ☆ Functions of lubricants :-

(a) Acts as a coolant :- Lubricants act as a coolant by removing the frictional heat generated due to rubbing of the surfaces.

(b) Reduce the frictional resistance :- Lubricants prevent the direct contact between the sliding metal surfaces so that the small peakes of the two metal don't interlock and hence frictional resistance is reduced.

(c) Provide protection against corrosion :- The lubricants cover the metal surface. and hence the attack of atmospheric corrisive environment on metal surface is prevented. Thus lubricants provide protection against corrosion.

(d) Reduce the surface deformation, wear and tear :- Due to lubrication the direct contact between the metal surfaces is avoided and hence the deformation as well as wear and tear of the machine parts is minimized.

(e) Acts as a seal :- The lubricants also act as a seal and hence prevent the leakage of gases at high temperature in internal combusion engine.

(f) Increases the efficiency of the machine :- Lubricants reduce the expansion of metal by local frictional heat and hence increases the efficiency of the machine.

★ Mechanism (types) of Lubrication :-

- Fluid Film (Thick)
- Boundary (Thin)
- Extreme Pressure

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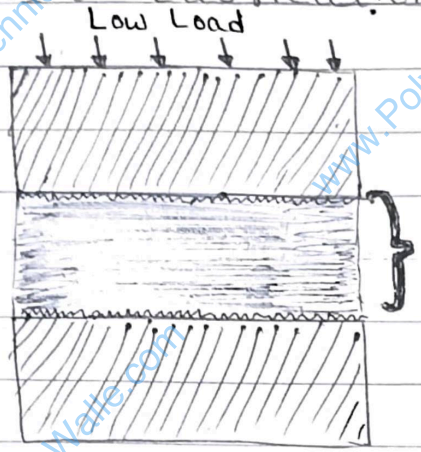
1. Thick Film Lubrication [Fluid Film] :




- Sliding surfaces are separated by thick layer of lubricant.
- Thickness of the layer is 1000°A°.
- Low load and High speed.
- High oiliness - Fluid Film Lubrication.
- ~~Hy~~ Also called Hydrodynamic Lubrication.
- Coefficient of Friction - 0.0000 to 0.03
- Applications: watches, clocks, sewing machines, guns, ~~scientific~~ instruments etc.
  ^ IC engines

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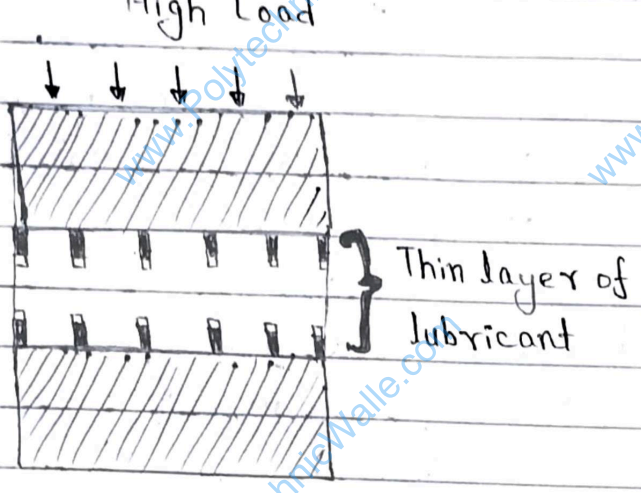
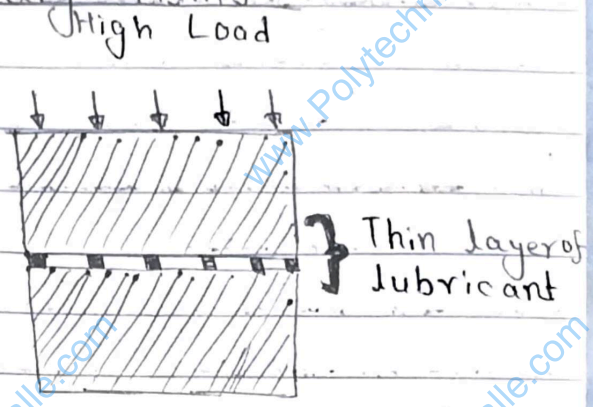
## 2. Thin Film Lubrication [Boundary Film]:




- Sliding surfaces are separated by thin layer of lubricant.
- High load and low speed.
- Also called Boundary Film Lubrication.
- Less distance between the sliding surfaces.
- Coefficient of friction - 0.05 to 0.15.
- Applications: rollers, gear, tractors etc.

## 3. 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 and P.
- These additives form solid surface films of Cl, S and P.
- High melting point metal compounds are good lubricants.
- E.g. graphite is used for drawing wires made up of mild steel.

## ☆ Physical Properties of Lubricants :-

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### 1. Viscosity :-

Viscosity is the property of fluid which is a measure of its resistance to flow which arises due to the internal friction between layers of fluid.

The unit of viscosity is poise or $gcm^{-1}s^{-1}$ $N \cdot s\,m^{-2}$

A high visos viscosity is thick and flows slowly.

A low viscosity is thin and flows ~~readily~~ rapidly (easily).

Ex :- (a) In light weight machines like clocks, watches, guns etc, thin lubricants with low viscosity are used.

Liquid

(b) In heavy machines such as rail track joints, concrete mixers etc. thick liquids of high viscosity are used.

Imp

### 2. Viscosity Index :-

The rate of change of viscosity of liquid with temperature is known as viscosity index.

The viscosity of liquid varies with the change of temperature. A good lubricant is that whose viscosity temperature doesn't vary much or differ with the temperature.

- The oil has low viscosity index means viscosity rapidly decreases on increases the temperature.
- The oil has high viscosity index means viscosity slightly decreases on increases the temperature.

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3. Flash Point :-

- Flash point is defined as the minimum temperature at which oil gives enough vapours which give momentary flash of light when a flame is brought near it.
- Flash point is 5°C to 40°C lower than fire point.
- The vapours don't burn continiosly.

* It is preferable to use a lubricant having high flash and fire points.

Imp

4. Fire Point :-

- Fire point is defined as the minimum temperature at which oil produces enough vapours which catch fire and burn continuosly at least for five seconds when a flame is brought near it.
- Fire point is 5°C to 40°C higher than flash point.
- The vapours catch fire and burn continuosly at least for five seconds.

5. Cloud Point :- and Pour Point :-

- Cloud Point :- Cloud point can be defined as the temperature at which the oil becomes cloudy or hazy in appearance (due to separation of wax).
- Pour Point :- Pour point can be defined as the temperature at which the oil becomes pour or cooling.
- The lubricating oils used in machines working at low temperatures, should have much lower cloud & pour points than the working temperatures.

6. Oiliness :-

Oiliness of a lubricant is a measure of it's capacity to stick on the surface of machine parts under the condition of high pressure and high temperature.

- Liquids having low viscosity (thin oils) may be having high oiliness than the more viscous liquids (thick oils).
- The oiliness
  Mineral oils < vegetable oils or animal oils
  (petroleum oils)
- A good lubricant should have high oiliness.

7. Volatility :-

Volatility of an oil is defined as its tendency to vaporise with the increase of temperature.

- If the lubricant used is highly volatile, it will vaporise rapidly even the temperature is low. As a result, more amount of lubricant is required. and this makes the lubrication process expensive.

mg

$\rho = \frac{m}{v}$

15

- Hence, a good lubricant should have low volatility.

## ✱ Chemical Properties of lubricants :-

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### 1. Acid Value or Neutralization Number :-

- Acid value is defined as the number of milligrams of KOH required to neutralize the free acid present in 1 gram of the lubricating oil.
- The neutralization number is an indication of acidic and basic impurities in the lubricating oil.
- As we know the determination of acidity is more common and is expressed in term of acid value or acid number.
- The acid value of lubricating oil is always less than one.

$$\text{Acid Number} = \frac{\text{Number of cc of 0.1 N KOH} \times 5.6}{\text{Weight of oil taken}}$$

- Calculation :

$$\text{Acid Value} = \frac{V_{KOH} \times N_{KOH} \times 56}{\text{wt of oil in g}}$$

wt of oil = Volume of oil × density, density = $\frac{\text{mass}}{\text{volume}}$

Not Imp

2. Emulsification :-

- Emulsification is the property of oil of get intimately mixed with water, to form the emulsion.
- It have a tendency to absorb dust or dirt, dust particles and foreign matter which spoil the lubricating action
- A good lubricant emulsion is that which doesn't form any emulsion and if it is formed, it shouldn't remain for long time and should break quickly in oil and water again.

3. Saponification Value :-

- Saponification is defined as, "the number of milligrams of KOH required to saponify 1 gm of an oil.
- Saponification is the property of vegetable and animal oils (contain fatty acids) and not of mineral or synthetic oils.
- A good lubricant should have moderate/low saponification value.

Not Imp

## ★ Transformer Oil :-

### * Functions :-

1. It provides insulations.
2. It protects the paper insulation from dirt and moisture.
3. It cools the core winding of the transformer.

### * Characteristics :-

1. It should have sufficient dielectric strength.
2. It should be free from inorganic acid, alkali and corrosive sulphur.
3. It should have low viscosity for providing good transfer of heat.
4. Under normal operating conditions, there shouldn't occur any sludge at the bottom of the oil tank.