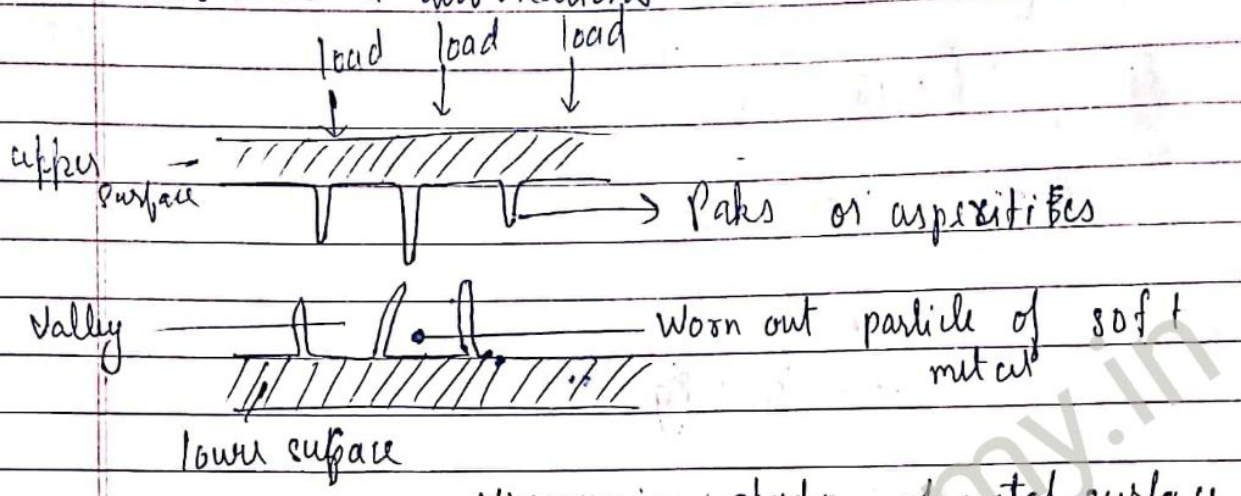
Lubricants & lubrications



Microscopic study of metal surface

Tribology → Study of lubricants & lubrication.

Lubricants & their uses.

→ When a surface slides over another surface there are 3 basic physical factors which can affect the overall problems.

1) Distance btw surfaces.
2) Forces acting on the surface
3) Texture of surfaces
4) Due to mutual rubbing of one part against another, a resistance is offered which is known as friction
Friction causes a lot of wear & tear & and a large amount of energy is released in the form of heat & causing loss of efficiency of machine.

The ill effect of frictional resistance can be minimized by using a suitable substance to reduce the friction resistance is known as lubricants. And the process of reducing frictional resistance between the sliding surfaces by the introduction of lubricants is called lubrication.

Functions of the lubricants.

1) It reduces surface deformation & frictional resistance.
2) → Dissipates energy in the form of heat. It acts as coolant
3) Reduces wastage of energy & avoids it.
4) It removes

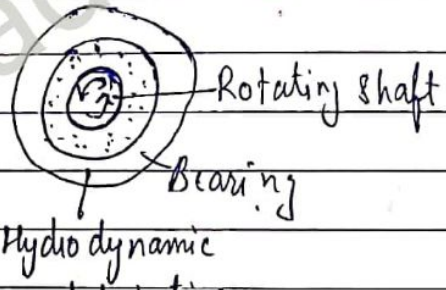
It reduces expansion of metal by local frictional heat.
It reduces ~~local~~ maintance & running cost of the machine.
Sometimes it acts as seal.

Tribology → Science of lubricants & friction is called Tribology.

MECHANISM OF LUBRICATION

1. ~~Thin~~ Thick film / Fluid ~~thi~~ film and Hydrodynamic lubrication.
2. Thin film / Boundary lubrication
3. Extreme pressure lubrication.

I Thick-film

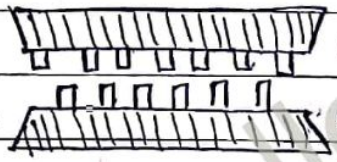


In this type of lubrication the moving or sliding surfaces are separated from each other by a thick film of fluid of more than 1000° Å. It prevents direct contact of surface to surface, so that peaks and valleys do not interlock. This reduces friction ~~ess~~ and prevents wear.
The small friction if ~~any~~, only due to the internal resistance between the particles of the lubricants moving over each other. so lubricants should have minimum viscosity.
In such system friction depends on viscosity of lubricants thickness of

lubricants, relative velocity and areas of moving surfaces.

Hydrodynamic lubrication is used when a shaft is running at fair speed, the load is low and the film of lubricating oil covers the irregularities of moving surfaces. Light machines like sewing machine, watches, clocks, scientific instruments are provided with fluid film lubrication. Example → Hydrocarbon oil. To maintain viscosity of the oil. In all seasons of year, hydrocarbon oils are blended with anti-oxidant Aminophenol.

Thin Film / Boundary lubrication.



When the lubrication is not viscous enough to generate a film of sufficient thickness to separate the surfaces, friction may be reduced with proper lubricants, such an application under high load, low speed and resultant high temperature is known as boundary lubrication. Under such conditions a lubricants is an oil which is adsorb by surface by physical or chemical forces. These adsorbed lubricants avoids metal to metal contact. Here the lubricants is vegetable or animal oil. (glycerides of higher fatty acid)

Which produce a thin ff film act as lubricants.
Fatty acids have good oiliness than mineral oil so some amount of fatty acids are added in mineral oils. Graphite and molybdenum disulphide are also use of for boundary lubrication.
The lubricants should have
1.) Long Hydrocarbon chain
2.) Functional groups
3.) High viscosity index
4.) High oiliness
5.) Low pour point.

Extreme Pressure lubrication
When operating condition are at high temperature and pressure the normal common lubricants fail to stick and may decompose and vapourise. in such application special additives are blended with mineral oil for lubrication. these are are called extreme-pressure additives.
Chlorinated Esters, Sulphurised oils, Tricresyl phosphate.
These additives reacts with metallic surfaces at high temperature form metal chlorides, metal sulfides metal phosphites.
These compounds make a lubricating film film betw the surfaces & can withstand high temperature.

because of high melting point so they serve as good lubricant under extreme pressure and extreme temperature conditions.

Properties of lubricants

1) Viscosity & Viscosity Index (V.I)
2) Flash & Fire Point
3) Cloud and Pour Point
4) SEN (Steam Emulsification Number)
5) Saponification Value
6) Aniline Value
7) Acid Value (Neutralization Value)

	1	2
	1.62m	3.8mm
orifice	10mm	50mm

$$V.I = \frac{L-U}{L-H} \times 100$$

100°F, 210°F → L = Naphthalene based gulf oil
100°F, 210°F → U = Unknown oil
100°F, 210°F → H = Naphthalene based Pennsylvanian oil

that determines

Viscosity is a property of fluid, its resistance to flow.

The lower the viscosity greater is the fluidity. It is mainly due to the forces of cohesion between the molecules of lubricating oil. In C.G.S system unit is Poise.

EFFECT of temperature on Viscosity.

Viscosity of lubricating oil is inversely propersly to temperature. If temperature increases viscosity decreases. Due to intermolecular attraction.

Effect of pressure on Viscosity.

Lubricants are used at extreme pressure as separator between 2 surfaces at such high pressures. Viscosity of lubricants increases.

Viscosity is an important factor. In selection of good lubricants. Light oils have low viscosity and easy floability. so used on parts moving at high speed Viscosity of it a good oil should not change much with change in temperature. The rate at which viscosity of an oil changes with temperature is measured by a scale which is known by viscosity index.

If the viscosity of oil falls rapidly as the temperature is raised. It has low viscosity index. and if the viscosity of oil is slightly affected on raising the temperature. Its V.I is high.

2 types of oils are used

1) Paraffinic Base Pennsylvanian oil (H-oil) V.I=100
2) Napthanic - Based gulf oil (L-Oil) VI=0

It has been marked viscosity at 100°F and 210°F.

$$V.I = \frac{\frac{L-U}{L-H}}{\frac{L-H}{L}} \times 100$$

L Viscosity of Low V.I oil at 100°F
100°F

H Viscosity of High V.I oil at 100°F

U Viscosity of unknown oil 100°F.

The viscosity is determined by redwood viscometer number 1, & number 2.

	Redwood 1	Redwood 2
Dimension of orifice		
diameter	1.52mm	3.8mm
length	10mm	15 mm
used for	thin oil	thick oil.

An oil sample
Saybolt Viscosity of 648sec at 210°F.
560sec at 100°F.

Low oil viscosity	648sec	at 210°F
	770 sec	at
H oil	648sec	at 210°F
	4105ec	at 100°F

$\frac{\quad}{\quad} - 64 \quad \times 100$

$\frac{770 - 560}{770 - 410} \times 100$ = $\frac{210}{360} \times 100$

770
410
360

58.33° SUS at 100° F

[S.U.V.] same as standard gulf oil and Pennsylvanian oil at 210° F.

60, 760, 425

[S.U.V.]

$\frac{760 - 425}{760 - 60} \times 100$ $\frac{760 - 60}{760 - 425} \times 100$

$\frac{335}{700} \times 100$ 208.9

47.8

Flash & Fire Point

Flash Point Minimum temperature at which the oil gives enough vapours which on mixing with atmospheric oxygen forms such an inflammable mixture which on introduction of tiny flames gives momentary flash

Fire Point Minimum Temperature at which the oil gives enough vapours gives atmospheric oxygen such an inflammable mixture which on introduction of tiny flames gives fire for 5 seconds.

The fire point of the oil is greater than flash point about 5-40°C

Significance

Flash & Fire Points are used to indicate the fire accidents of petroleum products & vaporation losses under high temperatures

Knowledge of flash & fire points of oil helps in precautionary measures against fire accidents. A good lubricant should have flash & fire points atleast above A the working temperature at which it is to be used.

Abel's
Pinskey Martin } Closed — water bath — < 100°C
Cleavland — air jacket — 100-200°C
— open — > 200°C

Steam Emulsification No. (SEN) or de-emulsification numbers.

When pure oil is mixed with pure water, it has property to get intimately mixed and form emulsion. This property is called emulsification. These ~~emulsification~~ emulsions have poor lubricating properties thereby causing abrasion and wearing out of lubricated parts of machinery.
The higher the percentage of water, the worse is the lubricating properties, Hence it is desirable that the oil should form such an emulsion with water which break off readily.

This ability of oil to separate from water is called de-emulsibility. Oil that separate rapidly, has good de-emulsiblity and Vice-versa.

The time in second in which oil and water separate out in distinct layer layer is called SEN or de-emulsification.

The quicker the oil separates out from the emulsion the lower the SEN. and better the lubricant.

A good lubricant should have low SEN.

Importance of the test → To avoid corrosion of polished steel surface, it is important to evaluate de-emulsibility properties of oil.

Cloud Point

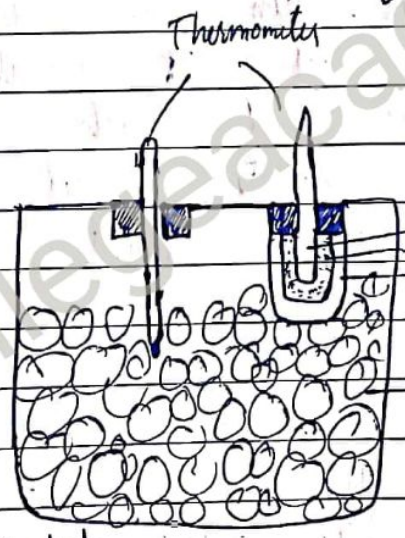
On sufficient cooling oil becomes solid due to the freezing of hydrocarbon present the temperature at which the oil becomes cloudy or hazy it is known as cloud point.

On further cooling the temperature at which oil just ceases to flow and stop pouring. It is known as pour point

Significance

Cloud and pour point indicates the suitablity or efficiency of lubricants in cold conditions like refrigeration plants and aircraft engines, which may be required to start and operate at subzero temperature.

Lubricant used in a machine working at low temperature should have low pour point. Otherwise solidification of lubricants will cause jamming of the machine



Aniline point

Maximum equilibrium solution temperature for equal volume of aniline and oil is known as aniline point.

Significance

A lower point (aniline) means higher percentage of aromatic hydrocarbons since aromatic hydrocarbons have tendency to dissolve rubber & plastic; so higher the % of aromatic hydrocarbons or

lowers the anniline point of oil, more the chances of deterioration of oil when it comes in contact with rubber sealings and packings so low aromatic contents in the ~~low~~ lubricants highes anniline point is desirable!

Determined by mixing equal volume of oil sample and anniline in a test-tube and heating the mixture until homogenous solution is obtained. Then the tube is allowed to cool at controlled rate, the temperature at which oil and anniline layers separate out is recorded as anniline point.

Acid Value (Neutralization Value)

Acid Value of an oil is the number of milligrams of KOH required to neutralize the fatty acids present in one gram of oil.

Determination → Oil sample + alcohol → mixture is warmed for for 10-15 minutes on water bath → titrated by with N/10 KOH using phenolphthalein as indicator.

Acid value = $\frac{\text{ml of } N/10 \text{ KOH} \times 5.6}{\text{mass of oil taken in gms.}}$

Significance of acid value

Low acid value of an oil is an indication of freshness of the oil. The free acids present in an oil gives unpleasant flavour in edible oil causing corrosion in oil and get oxidized by air.

Saponification Number

Saponification number is defined as the number of KOH required to saponify the fatty material present in one grams of oil.

Determination → 5 g of oil + 50 ml of N/2 KOH soln in alcohol → flask heated over water bath → unreacted KOH in the flask is titrated against N/2 HCl. Phenolphthalein indicator is used.

saponified product

$$\begin{array}{l} H_2C-COOR \\ | \\ H_2C-COOR \\ | \\ H_2C-COOR \end{array} + 3\,KOH \longrightarrow \begin{array}{l} H_2C-OH \\ | \\ HC-OH \\ | \\ H_2C-OH \\ \text{Glycerol} \end{array} + \underset{\text{(soap)}}{3\,RCOOK}$$

Saponification Number → No. of ml of $\frac{N/2\ KOH - N/2\ acid}{mass\ of\ oil\ (g)} \times 28$

,

Significance →

① Smaller the saponification number, the higher the molecular weight.

2) It also indicates the average length of the carbon chain of fatty acid components.

3) Mineral oils do not undergo saponification but animal / Vegetable oils do. The test gives an indication of amount of animal / Vegetable oil added to mineral oil to improve oiliness.

④ Most of the animal / Vegetable oil have their own sap value. The test helps to indicate the oil, under study is animal / vegetable / mineral / blended oil.

It also determines the proportion of lower fatty acids in oil.