LECTURE NOTES

ON

LUBRICANTS

ENGINEERING CHEMISTRY

B.Tech 1st year

By

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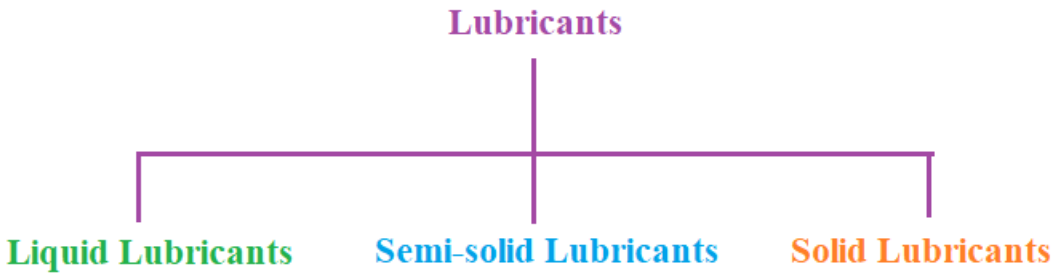
Content

1. Introduction

In machine, the friction between metal to metal parts arises due to moving surfaces and machine experienced a resistance which retards their movement. Due to friction large amount of energy is liberated in the form of heat which reduces the efficiency of machine.

"Substances which apply between two moving and sliding surface to reduce friction between them are known as Lubricants" and the process by which friction between sliding surface is reduce, known as Lubrication.

2. Classification of Lubricants



a) Liquid Lubricants:

It includes animal oils, vegetable oils, petroleum oils, synthetic lubricants.

Animal oils: tallow oil, whale oil etc.

Vegetable oils: castor oil, palm oil etc

Petroleum oils: petroleum fractions

Synthetic lubricants: polyglycol, silicones etc.

b) Semi-solid Lubricants (Grease):

Semi-solid Lubricants are formed by emulsifying oil and fat with thickening agents like soap of sodium, calcium, lithium, aluminum at higher temperature.

Classification

Soda based: In this case sodium soaps are used as a thickening agent in mineral or petroleum oil. They are slightly soluble in water. They can be used up to 175^{o}C.

Lithium based: In this case lithium soaps are emulsifying with petroleum oil. They are water resistance and used up to 15^{o}C.

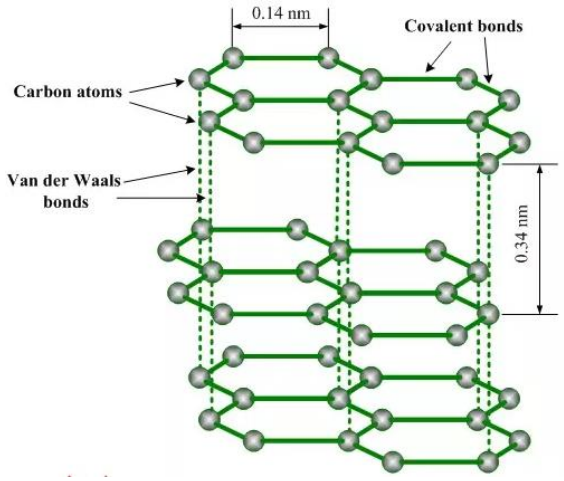
Calcium based: In this case calcium soaps are emulsifying with petroleum oil. They are also water resistant and used up to 80°C. At higher temperature soap and petroleum oil are separate from each other.

c) Solid Lubricants:

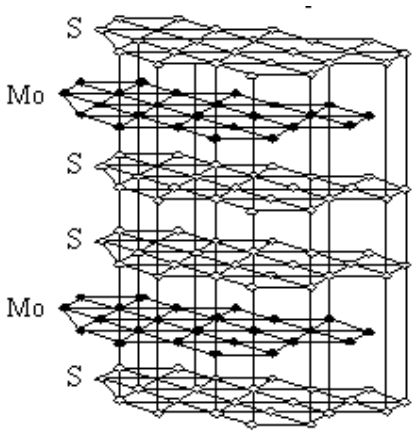
Graphite, molybdenum disulphide (MoS_2), boron nitride $(BN)_x$ are predominantly used as a solid lubricants. They are used under high temperature and high load (pressure).

i) Graphite:

It is most widely used as a solid lubricant. Graphite has layer structure; layers are held together with the help of weak Vander Waals' forces which facilitate the easy sliding of one layer on the other layer. It is very soapy to touch, non-inflammable. It is used at higher temperature (around 450°C) condition. They are either used as powder form or mixed with oil or water.



Graphite structure



Molybdenum disulphide structure

ii) Molybdenum disulphide (MoS_2):

It is sandwich like structure in which hexagonal layer of molybdenum (Mo) lies between two hexagonal layers of sulfur (S) atom. Like graphite each layers are held together with weak Vander Waals' forces. It is stable up to 400°C. It is differ from graphite because it is used in high vacuum unlike graphite (graphite is mixed with water or oil). It adheres even more strongly to the metal or other surface.

3. Properties of Lubricants

a) Cloud Point:

The temperature at which lubricating oil becomes cloudy in appearance is called cloud point.

b) Pour Point:

The lowest temperature at which the lubricant oil become semi-solid and ceases to flow is called pour point. It indicates the suitability of lubricants used in cold condition. Good lubricant should possess low pour point.

d) Flash point:

The flash point of a volatile material is the lowest temperature at which vapors of the material will ignite for a moment when an ignition source brought near to it. The lubricating oil should have flash point reasonably above its working temperature.

e) Fire point:

The fire point of a fuel is the lowest temperature at which the vapour of that fuel will continue to burn for at least 5 seconds when an ignition source brought near to it. Fire point is around $10^{o}C$ higher than flash point.

e) Viscosity:

Viscosity is the property of a fluid that determines its resistance to flow. It is an indicator of flow ability of lubricating oil. The lower viscosity greater will be the flow ability. If temperature increases viscosity of the lubricating oil decreases and pressure increases viscosity of lubricating oil increases. In short we can say that good lubricating oil is that whose viscosity does not change with temperature.

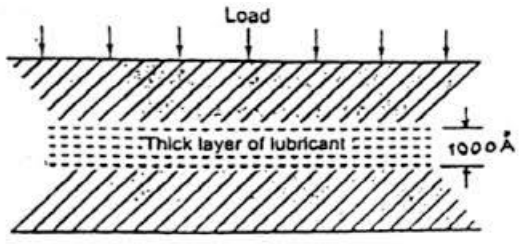
f) Viscosity Index:

The variation of viscosity of a liquid with temperature is called viscosity index. A relatively small change in viscosity with temperature is indicated by high viscosity index whereas, a low viscosity index shows, a relatively large change in viscosity with temperature.

4. Mechanism of Lubrication

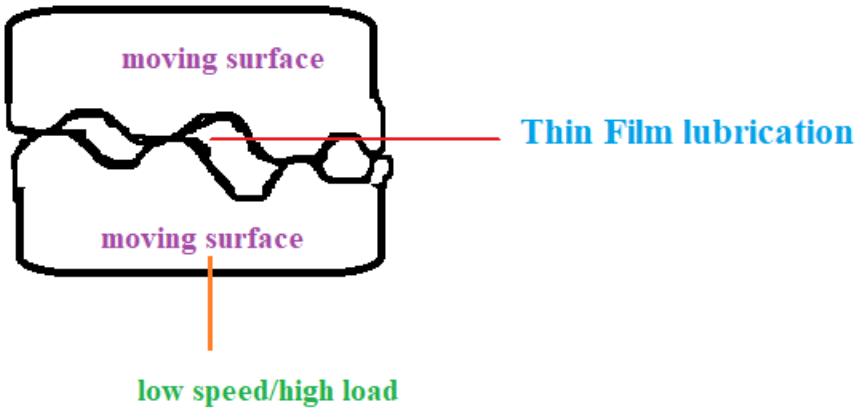
a) Thick Film or Fluid Film or Hydrodynamic Lubrication

It is carried out with the help of liquid lubricants. In this mechanism, two moving and sliding surfaces are separated by thick film of lubricant fluid of about 1000A°, applied to prevent direct surface to surface contact and consequently reduce wearing and tearing of metals. Therefore it is known as thick film or fluid film lubrication or hydrodynamic (hydro meaning liquid and dynamic meaning relative motion) lubrication. In this case fluid is formed by mixing of hydrocarbon oils and anti-oxidants with long chain polymer so as to maintain viscosity. Fluid film lubrication is useful in delicate and light machines like watches, clocks, guns, scientific equipments.



b) Thin Film or Boundary Lubrication

It is carried out with semi-solid (grease) and solid (graphite and molybdenum disulphide) lubricants. Boundary lubrication is a condition in which the lubricant film becomes too thin to provide total separation. In this type of lubrication a thin film of lubricant is adsorbed on the surface by weak Vander Waals forces. Thin film lubrication is operating at relatively low speed and heavy loading (pressure).



c) Extreme Pressure (or Temperature) Lubrication

In this mechanism, moving or sliding surfaces are under high pressure and speed, therefore this is known as extreme pressure lubrication. In such a case high

temperatures generated due to friction, under these condition liquid lubricants are fail to stick and decompose or vaporize. These problems are minimized by special additives are added to mineral oils. These additives form durable films on metal surfaces which can withstand high loads and high temperatures. Important additives are organic compound having group like chloride, sulphur, phosphorus etc. They react with metallic surface to form metallic compound (possess high melting points and serve as good lubricants under extreme temperatures and pressures) like chlorides, sulphides, phosphate as more durable film.

5. Application of Lubricants

i) Lubricants are primarily used to reduce the friction between two moving surface.
ii) Rust and corrosion inhibitors
iii) Used in the soap and paint industries.
iv) Liquid lubricants are used in medicines
v) Lubricants are also used as cutting fluid in cutting, grinding, drilling of metals.
vi) Used as anti-wear, antioxidants, and antifoaming agents.