

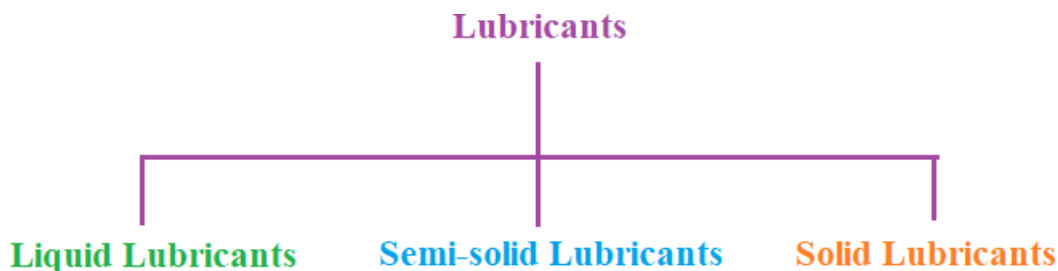


## Lubricants

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.

### 1. 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°C.

**Lithium based:** In this case lithium soaps are emulsifying with petroleum oil. They are water resistance and used up to 15°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 ( $\text{MoS}_2$ ), boron nitride ( $\text{BN}$ )<sub>x</sub> are predominantly used as a solid lubricants.
- They are used under high temperature and high load (pressure).
- Where the contamination of lube oils or greases by the entry of dust or grid particles are avoided
- Where the combustible lubricants should be avoided

### **Graphite:**

It is most widely used as a solid lubricant. Graphite consists of flat layers of hexagonal arrangement of carbon atoms. The carbon atoms in hexagons are bonded together by strong covalent bonds. 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. Since the distance between the adjacent layers is high (3.41 Å), the layers can slide easily one over the other with little friction. This property makes use of graphite as lubricant. 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.

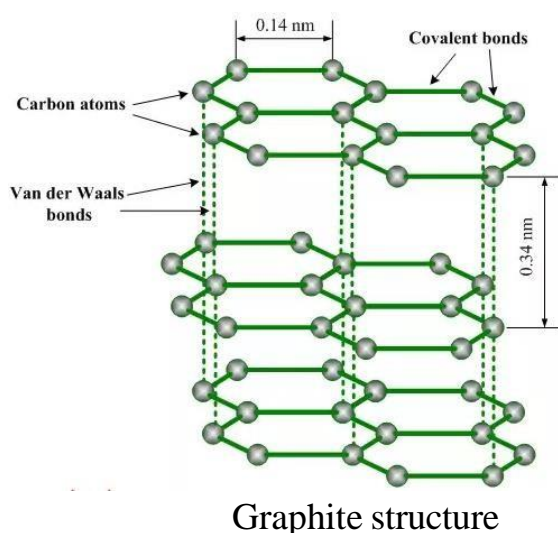
A dispersion of graphite in water is called aqua dag and a dispersion of graphite in oil



is called oil dag

Uses

- Oil is used in internal combustion engines
- Aqua dag is used in air compressors and in food processing equipments
- Graphite as lubricant used in lathes, machine shop works, open gears and chains



## i) **Molybdenum disulphide ( $\text{MoS}_2$ ):**

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  $800^\circ\text{C}$ . 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.

Uses

Used in heavy machineries working under heavy load and high temperature

Used in vacuum of outer space



## Molybdenum disulphide structure

