2.4 LUBRICANTS

2.4.1 INTRODUCTION

In all type of machines, the moving surfaces rub against each other. Due to this rubbing.resistance is offered to their movement. This resistance is known as Friction. This friction will causea lot of wear and tear of surfaces of moving parts. Due to the friction large amount of energy isdissipatedintheformofheat, therebytheefficiencyofmachine gets reduced.

2.4.2 DEFINITIONS

Lubricant: It is a substance used in between two moving surfaces to reduce the friction.

Lubrication : Is is a process of reducing friction and wear between two moving surfaces by adding lubricant in between them.

2.4.3 FUNCTIONS OF A LUBRICANT

1. It prevents the direct contact between the moving surfaces and reduces wear, tear and surface deformation of the concerned parts.
2. It reduces wastage of energy so that efficiency of the machine is enhanced.
3. It reduces the frictional heat and thus prevents the expansion of metals.
4. It acts as a coolant by removing the frictional heat generated due to the rubbing of surfaces.
5. At sometime, it acts as a seal preventing the entry of dust and leakage of gases at high pressure.
6. It reduces the maintenance and running cost of the machine.
7. It minimizes corrosion.

2.4.4 Requirements (or) Characteristics of a lubricant

1. A good lubricant should not undergo any decomposition, oxidation, reduction at high temperature.
2. A good lubricant should have higher flash and fire points than the operating temperature.
3. A good lubricant should have high oiliness, viscosity index, aniline point.
4. A good lubricant should not corrode the machine parts.

2.4.5 CLASSIFICATION OF LUBRICANTS

Lubricants are classified on the basis of their physical state as follows

1. Liquid lubricants

i. Vegetable oils (eg): Polm oil, castor oil, etc.
ii. Animal oils (eg): Whale oil, tallow oil, etc.
iii. Mineral oils (e.g): Petroleum fractions.
iv. Synthetic lubricants (e.g): Silicones, polyglycol ethers, etc.
v. Blended oils (or) Compounded oils (e.g) Mineral oils with various additives,

2. Semi-solid lubricants

(eg): Greases, vaselines, etc.

3. Solid lubricants

(eg): Graphite, molybdenum-disulphide, etc.

4. Emulsions

i. Oil in water type (e.g): Cutting emulsions.

i. Water in oil type (e.g): Cooling liquids.

2.4.6 MECHANISMOFLUBRICATION(TYPESOFLUBRICATION)

2.4.6.1 Fluid film(or)Thick film(or)Hydro dynamic lubrication

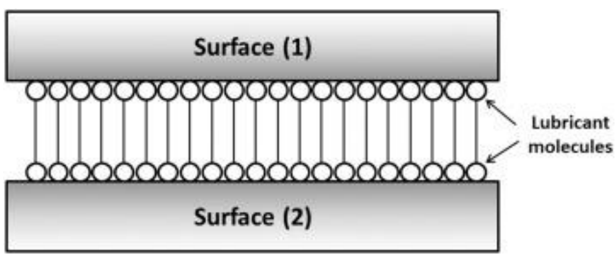
Under the conditions of low load and high speed, a thick fluid film of lubricant is maintained between the two solid surfaces. The thickness of fluid film is atleast 1000 A. Since the thick fluid film separates the two solid surfaces there is no direct contact between the solid surfaces. This reduces wear and tear. The co-efficient of friction in such cases is 25 low as 0.001 to 0.03.

Example: Consider the rotation of a shaft with respect to a stationary bearing. When a lubricant is added to the system, it occupies the annular space between the shaft and the bearing and forms a hydrodynamic wedge so long as the shaft rotates, the hydrodynamic wedge will remain and it prevents contact between the two solid surfaces. When the load becomes very high, the lubricant will be sequeezed out of the wedge and friction will occur.

2.4.6.2 Boundary lubrication (or) Thin film lubrication

Under the conditions of high load and slow speed, a continuous fluid film cannot be maintained between the moving surfaces. Under such conditions, the thickness of the fluid film should be less than 1000 A. such a thin film, consists of 2 or 3 molecules thick. To form a thin film the lubricant has to be adsorbed on the metal surface by physical or chemical forces. In some cases, the lubricant will react chemically with the metal surface forming a thin film of metal soap, which will act as a lubricant. This thin film is known as boundary film. The co-efficient of friction in such cases is around 0.05 to 0.15.

The effectiveness of boundary lubrication depends on the oiliness of the lubricant. Oil mess is the ability of a lubricant to stick on to the surface. Vegetable oils and their fatty acids have more oiliness. (e.g) Oleic acid ($C_{17}H_{33}COOH$), stearic acid ($C_{17}H_{35}COOH$) etc. The polar carbonyl group (COOH) of these oils reacts with the metal surface to form a continuous thin film of lubricant. Hydrocarbon chain of the fatty acid gets oriented outwards in a perpendicular direction as shown in figure.



2.4.7 Extreme Pressure lubrication

Under the conditions of high load (high pressure) and high speed, more heat is generated between the moving surfaces. As a result of this, the liquid lubricant fails to stick and undergoes decomposition or evaporation. Under these conditions, for effective lubrication, special additives known as Extreme Pressure additives are used along with the lubricants. Important extreme pressure additives are organic compounds having active radicals or groups such as chlorine (e.g Sulphurized oils) etc. These compounds react with metallic surfaces to form metallic chlorides, sulphides etc. These metallic compounds possess high melting points and serve as good lubricant under extreme pressure conditions.

2.4.8 PROPERTIESOFLUBRICANTS

2.4.8.1 Viscosity

Viscosity is a measure of the internal resistance of a liquid during its flow. It is expressed in centipoise.

The viscosity of an oil is the time in seconds for a given quantity of oil to pass through a standard orifice under the specified conditions.

Significance

A good lubricating oil must have moderate viscosity.

(i) If the viscosity of the lubricating oil is too high, the movement of the machine is restricted due to excessive friction.

(i) If the viscosity of the lubricating oil is too low, the liquid oil film can't be maintained and excessive wear will take place.

2.4.9 Flash Point and Fire Point Flash Point

It is the lowest temperature at which the oil gives off enough vapour that ignite for a moment, when a small flame is brought near to it.

Fire Point

It is the lowest temperature at which the vapour of the oil burns continuously for atleast 5 seconds, when a small flame is brought near it. Generally the fire point is 5-40°C higher than flash point.

Significance

A good lubricating oil should have flash and fire points higher than the operating temperature of the machine. A knowledge of flash and fire point is useful in providing protection against fire hazard during transport and storage. Lubricating oils of paraffinic base possess higher flash points than those of naphthenic base. Hence the determination of flash and fire points is helpful in identifying the type of lubricating oil.

Determination

Flash and fire points can be determined using the same apparatus. An oil is heated at a prescribed rate in an open cup (Cleve land's) apparatus or closed cup (Pensky Martin's) apparatus of standard dimensions. A small test flame is periodically applied over the surface of the oil. The temperature at which a distinct flash is seen is the flash point. The heating and periodical application of test flame are continued. The temperature at which the oil vapour catches fire and burns continuously for 5 seconds is noted as the fire point.

2.4.10 Cloud and Pour Point

Cloud Point

When oil is cooled slowly the temperature at which the oil becomes cloudy in appearance is called its cloud point.

Pour Point

The temperature at which the oil ceases to flow or pour is called its pour point.

Significance

Most of the petroleum based lubricating oils contain dissolved paraffin wax and asphaltic impurities. When the oil is cooled these impurities undergo solidification which cause jamming of the machine. So the cloud and pour points indicate the suitability of the lubricants in cold condition. A good lubricant must have low cloud point and pour point.