LUBRICATION &LUBRICANTS

Lubricants

"substances which are used to reduce the wear & frictional forces between two surfaces in contact with each other"

FUNCTIONS

- Reduces the frictional forces
- Reduces the cost of maintenance
- Reduces the loss of heat energy
- Increases the efficiency of machine
- Acts as a sealing agents.

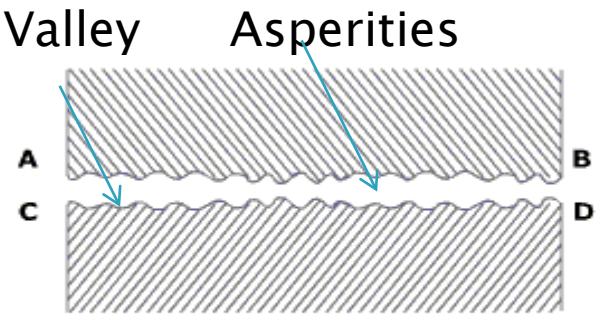
FRICTION

"Resistance which come into existence due to mutual rubbing of two surfaces"

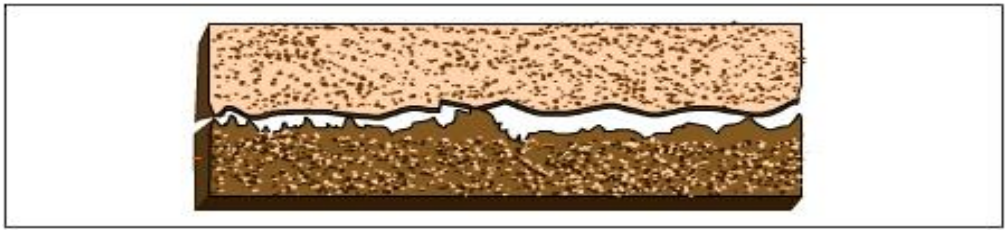
- Contact $_{\text{real area}}$ < Contact $_{\text{apparent area}}$ ===due to the presence of **asperities** & **valleys** on the surface of metal.

WEAR

"Progressive loss of substance from the surface of a metallic body by the mechanical action"



Irregular project of two surfaces


Projections and cavities in surfaces

Functions of Lubricants

i) Lubricants avoid the damage of the moving parts of machines by minimizing the production of heat.

ii) Lubricants reduce the wear and tear of machinery by keeping the moving parts of machines apart.

iii) Lubricants reduce the maintenance and running cost of machine.

iv) Lubricants act as the coolant because it reduces the production of heat between the moving parts of machine in contact.

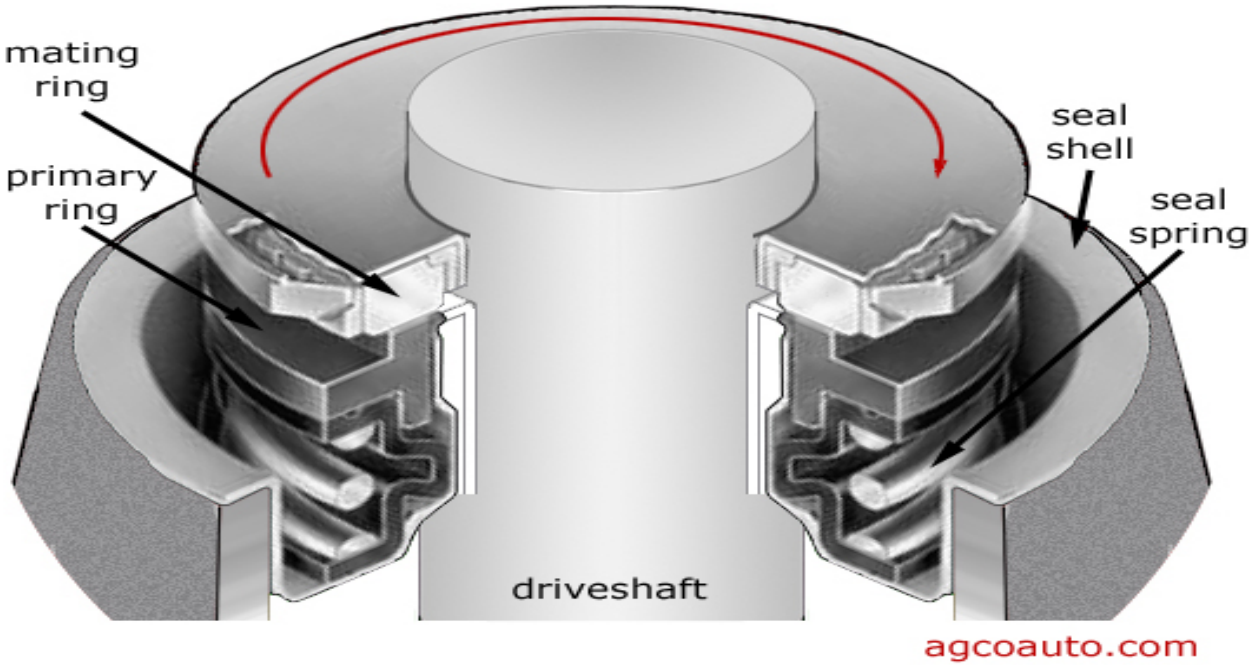
Functions of Lubricants

V. Lubricants increases the efficiency of machine by reducing the loss of energy.

VI. By using the lubricants, the relative motion of the moving parts of machine becomes smooth and noise level of running machine reduces.

VII. Lubricants also act as the corrosion preventers.

VIII. Lubricants also act as a seal as in piston. Lubricant used between piston and walls of the container (cylinder) prevents the leakage of hot gases produced by the internal combustion i.e.it act as seal.



Mechanism of Lubrication

Depending upon

(i) Condition of using lubricants

(ii) Characterstics of lubricants

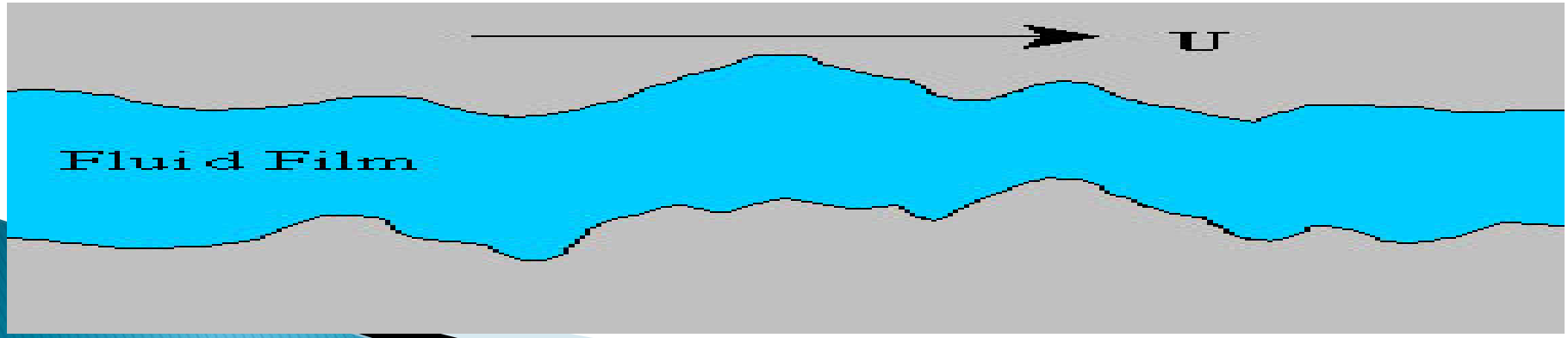
The 3 types are

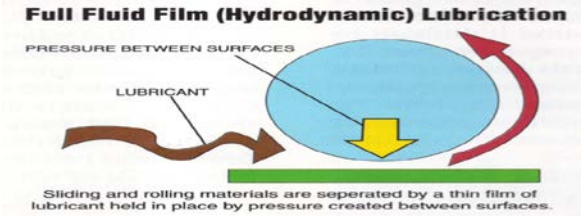
- **Hydrodynamic or Fluid Film or Thick Film Lubrication**
- **Boundary Lubrication or Thin Film Lubrication**
- **Extreme Pressure Lubrication**

Hydrodynamic or Fluid Film or Thick Film Lubrication

- moving surfaces are separated from each other by a thick film of 1000 °A ,a thick film of liquid lubricant is placed between them so direct metal to metal contact is not there between material surface

1. peaks and valleys do not interlock----lowering of friction, no wear & tear, no welding junction

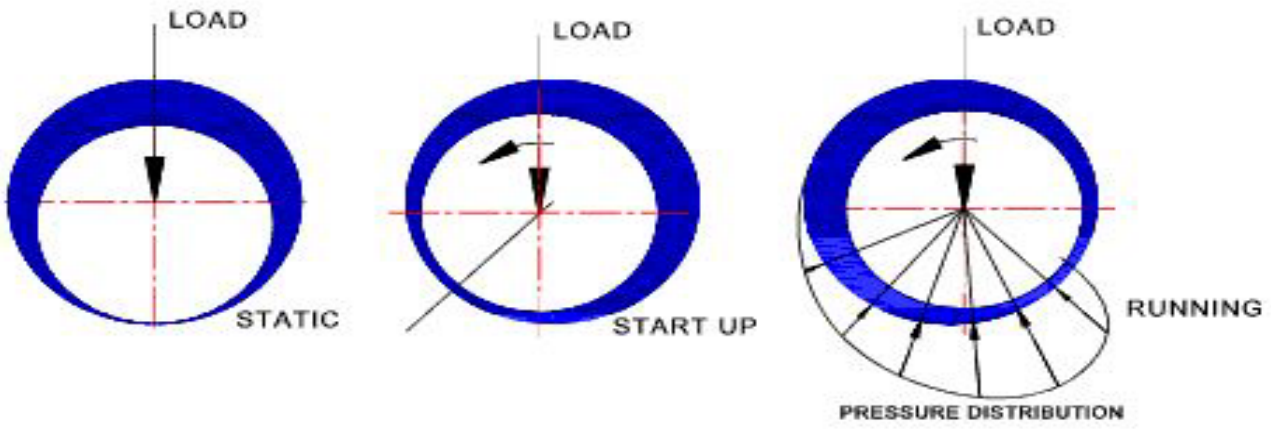




example:

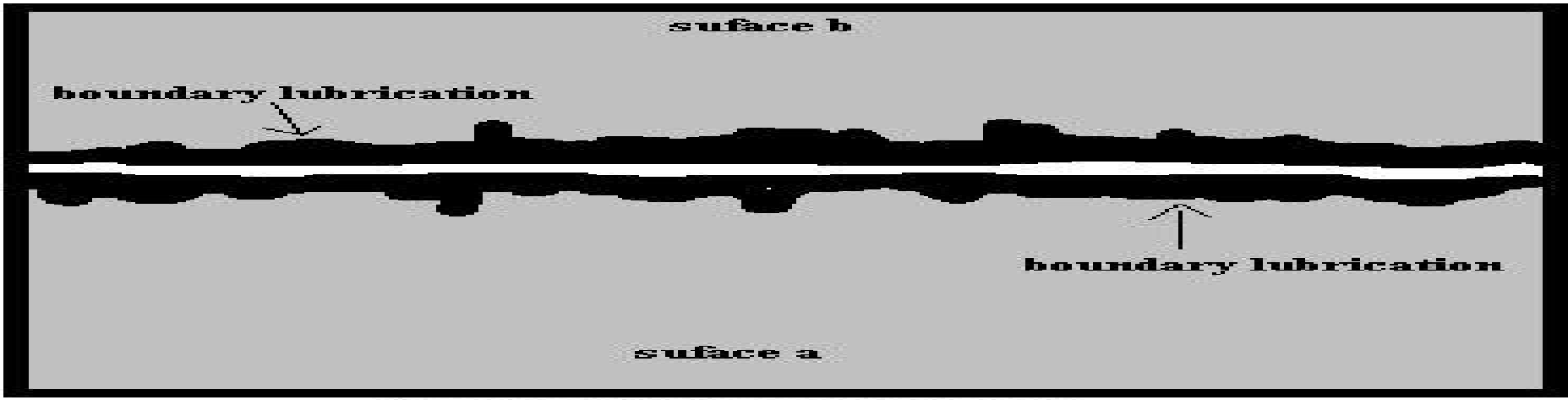
Machinary-----Shaft running at fair speed, Well lubricated bearing with fair load. Light machines (sewing machins, watches, clocks)

Lubricants Example: Hydrocarbon oils mixed with long chain polymers to maintain required viscosity of oil which is constant in al'



Boundary Lubrication or Thin Film Lubrication

- Thin film or boundary Lubrication is done for those cases in which the continuous film of lubrication cannot persist and direct metal to metal contact is possible.
- Lubricant is adsorbed on the rubbing surfaces either through physical or chemical forces.

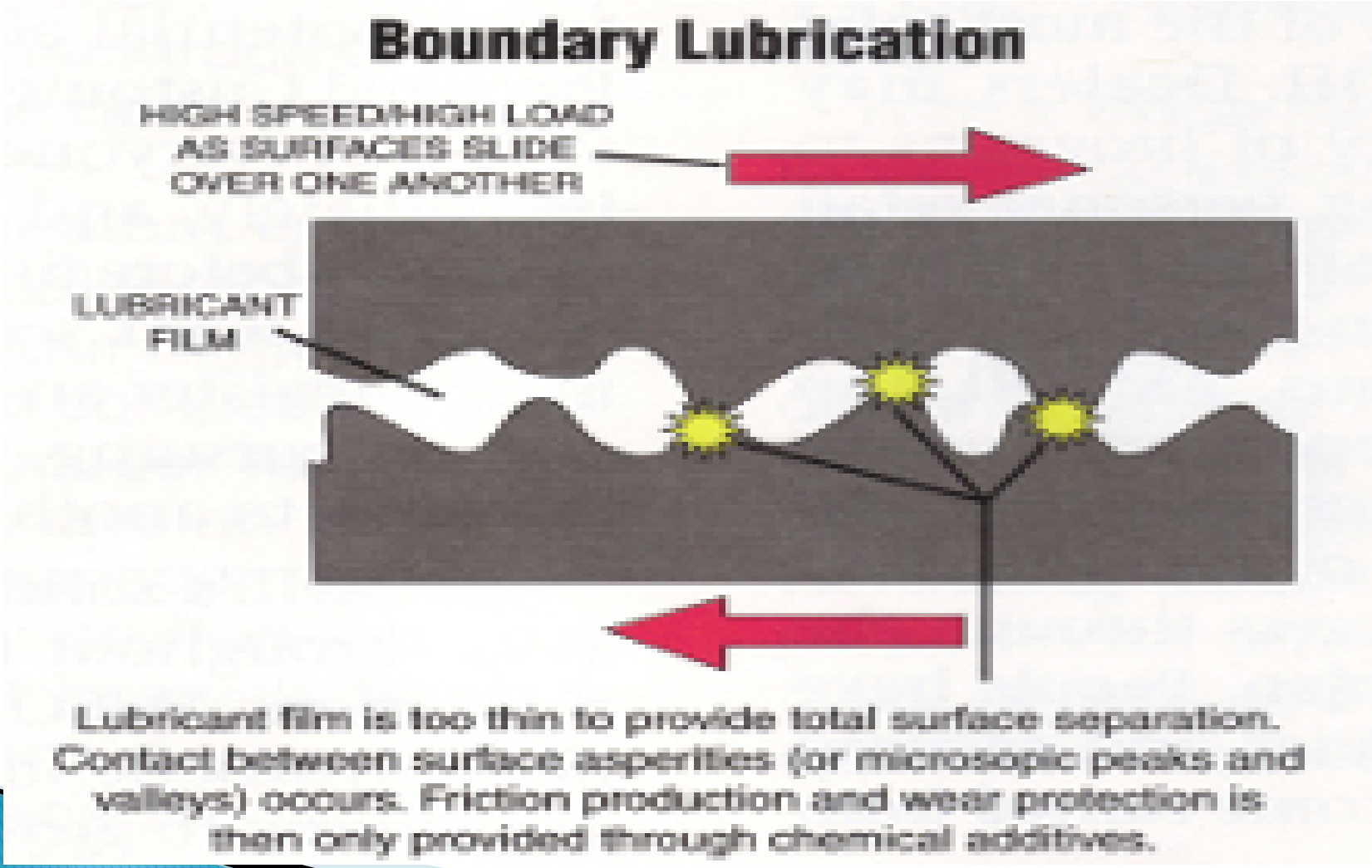


BOUNDARY LUBRICATION

This happens when

- Shaft starts moving from rest
- the speed is very low
- load is very high and
- viscosity of lubricating oil is very low.

Boundary Lubrication



Characterstics of lubricants

- Long hydrocarbon chain
- Polar groups to promote wetting or spreading over the surface.
- Active functional group which can form chemical bonds with the metal or other surfaces.
- High viscosity index
- Resistance to heat and oxidation
- Good oilness
- Low pour point and oxidation

Lubricants used forBoundry lubrication

(i)Graphite and MoS_2 either as solid or as stable emulsion in oil.

(ii)Mineral oils

(iii)Vegetable and animal oils and their soaps

Extreme Pressure Lubrication

When the sliding surfaces are subjected to high pressure and high speed (automobiles),excessive frictional heat is generated and in such conditions liquid lubricants fails to stick, may decompose and even vapourize.

Extreme pressure Additives---organic compounds possessing the active radicals or groups

Examples of additives:

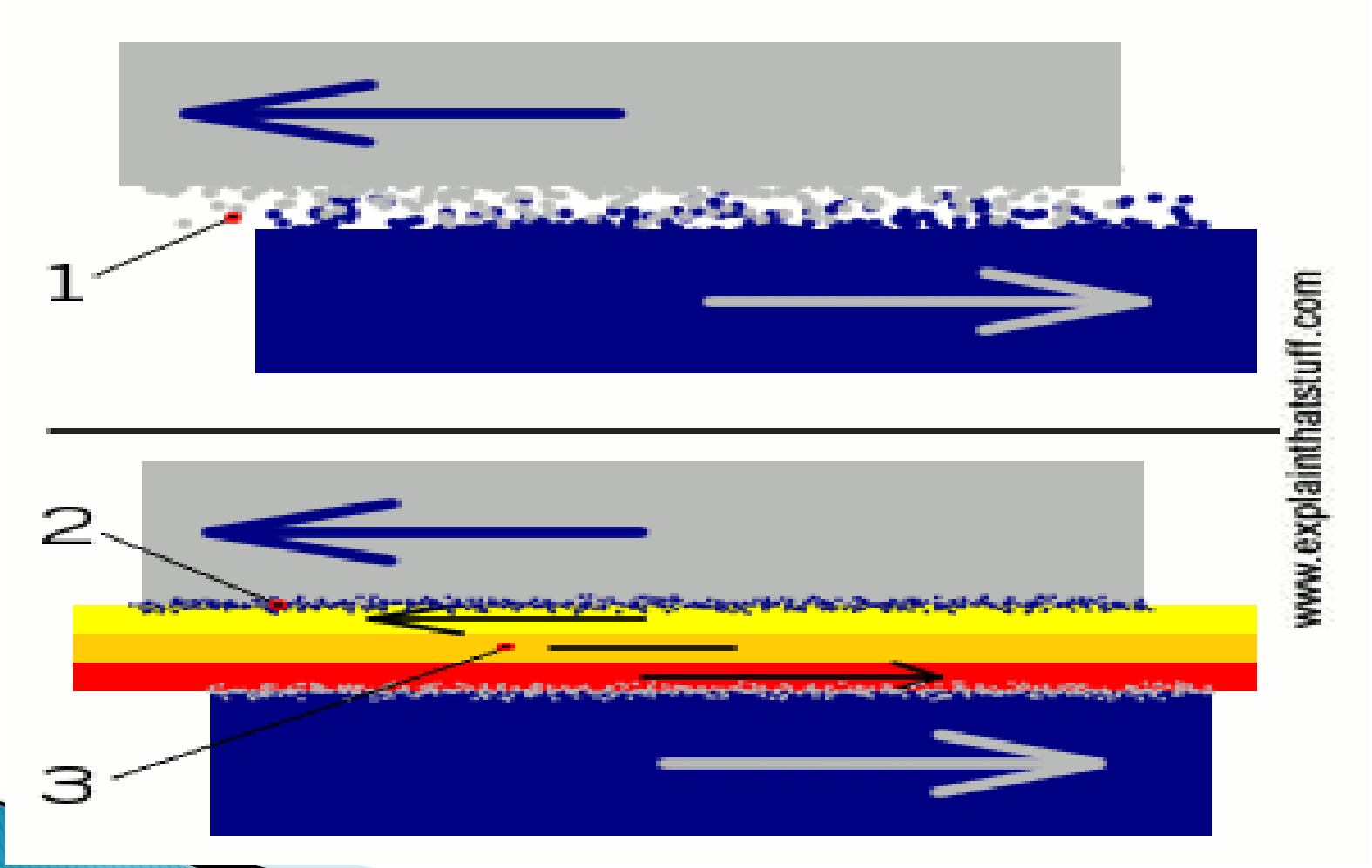
Special additives are added to lubricants:

- Chlorinated esters
- Sulphurized fats and oils
- Tricresyle phosphate

At high temperature these additives react with metal surfaces to form metal compound which have high melting point------serve as a good lubricant,under extreme pressure conditions.

-----Even if the film formed on the moving part is broken by rubbing action ,they are immediately replenished.

Extreme Pressure Lubrication



Applications of Extreme pressure lubrication

- Wire drawing of titanium require chlorine containing additives which react with the stable oxide film on the metal surface.
- In cutting fluids in machining of tough metals,A typical lubricant consist of hydrocarbon oil ,a small amount of fatty acid as boundary lubricant and an organic chloride or sulphide additive is used.
- For hypoid gear used in rear axle drive of cars which has both longitudinal sliding motion and normal rolling movement.

Classification Of Lubricants

- Solid lubricants
- Semi- solid lubricants
- Liquid lubricants
- Emulsion lubricants

Solid Lubricants

"Solid materials which are used to separate two moving surfaces under boundary conditions to reduce wear"

Used:

- Heavy machinery to be operated under very high load & low speed
- Operating temperature or load is such that oil or grease does not stay at the desired place
- Lubricants catches fire or chars under the operating conditions

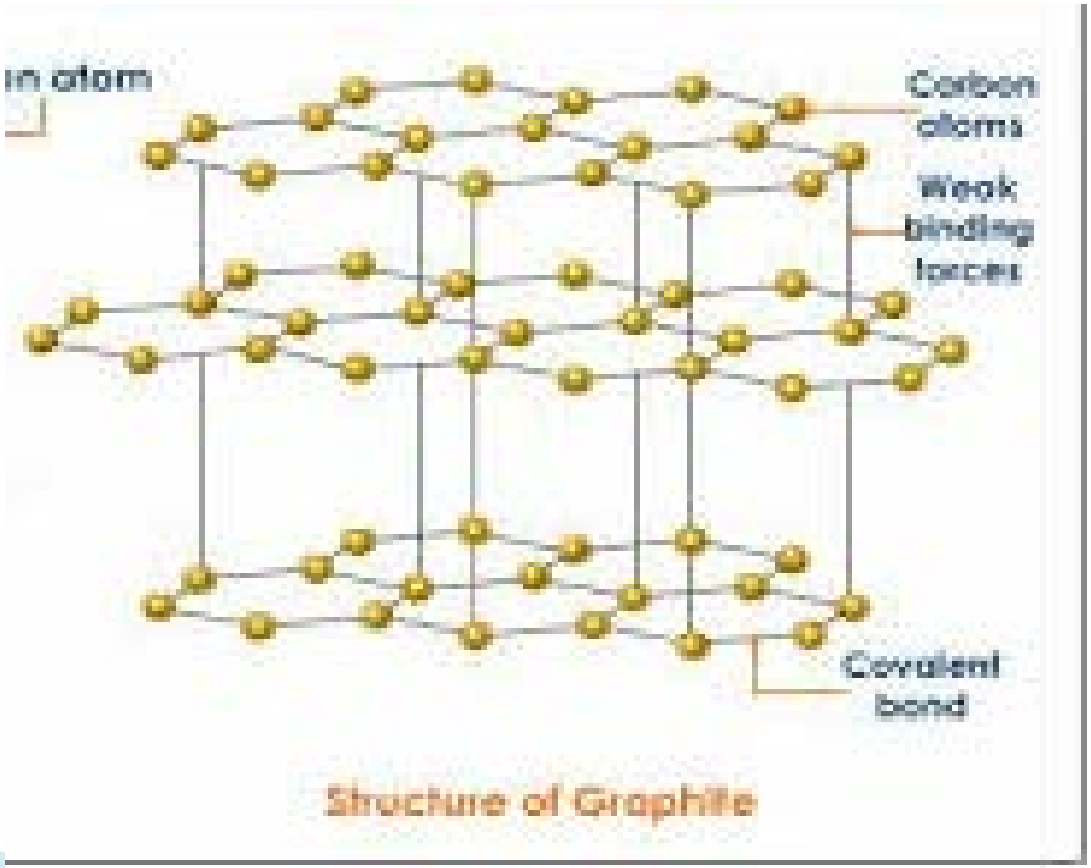
Example:

- Graphite
- Molybdenum Disulphide

GRAPHITE:

Sp2 hybridisation
C-C bond =1.42Angstrom

Vander Waals distance=
3.4 A



Structure of Graphite

- Very soapy
- Non-flammable
- Does not oxidize in air below 375 ^{0}C
- For lubrication: powder form, as an aerosol form a freon pressurised container, as a paste in grease, or as liquid dispersion

  Dispersion of graphite in water----Aquadag

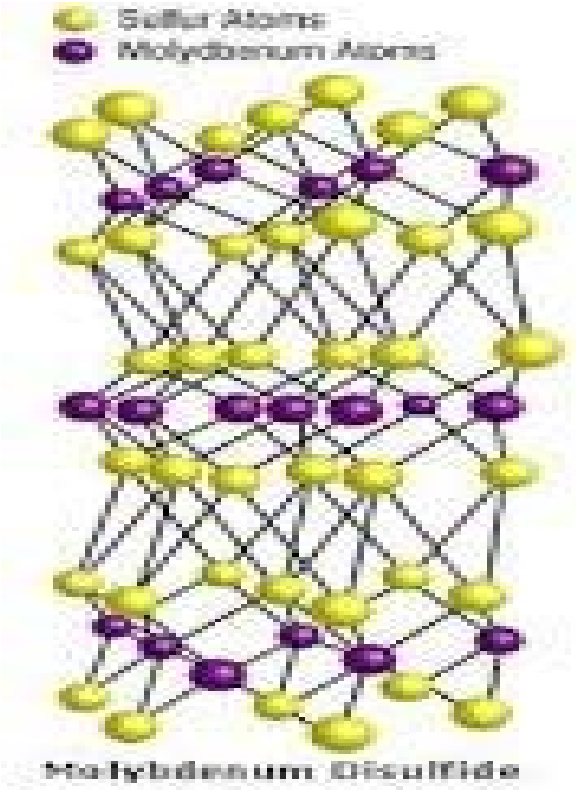
  Dispersion of graphite in oil----Oil dag

Oil Dag: use in internal combustion engine, as it form a film between the cylinder and piston rings to give tight-fit contact

Structure of MOS_2

Higher specific gravity than graphite
Slightly softer
Very low coefficient of friction
Stable in air upto 400^oC
Used as an additives to oil and grease in shaft bearing of jaw crushers, machine tool gearing

Sandwich like structure---Mo in between two layers of sulpur



Properties of Lubricants

- Viscosity and viscosity index
- Saponification Number/Koettsoerfer No.
- Flash and Fire point
- Acid Value
- Cloud and pour point
- Aneline point
- Iodine value

Properties of Lubricants

1. Viscosity : "resistance to flow"

coefficient of viscosity (η) ----the tangential force required per unit area to maintain unit velocity difference between two parallel planes unit distance apart.

Unit: Poise (CGS), Pascal sec (SI)

Effect of temperature: **$\eta \alpha 1/T$**

due to decrease in intermolecular force of attraction.

At higher temperature-----oil must have sufficient velocity to carry loads.Hence heavier oils are used at higher temperature, similarly light oils are used at low ambient temperature.

Effect of Pressure: **$\eta \alpha P$**

- Lubricating oils are subjected to extreme pressure at the interphase between gears and rolling element. At such higher pressure, viscosity of lubricating oil increases considerably.
- Vicosity helps in selecting good lubricating oil.

Light oils

Having low density

Easy flow ability

Used for; High speed, low pressure & Low temperature

Heavy Oils

High density

Low flow ability

Used for; Low speed, high pressure & high temperature

Significance of viscosity

Helps in selection of good lubricating oils.

Viscosity is the property of lubricating oil that determines it ability to lubricate and through its film strength, viscosity values are used in evaluating load carrying capacity. In denoting the effect of temperature changes and for determining the presence of contaminants in used oil during service. Absolute viscosity values are required for use in all bearing design calculations and other lubrication engineering technical design problems.

Example-

Hydrodynamic lubrication----that lubricant is selected which should have a sufficiently high viscosity to adhere to bearing and resist being squeeze out due to high pressure and get fluid enough to resist excessive friction due to shearing of oil itself. Thinner oils can easily dessipate

Determination of viscosity

Measurement of viscosity of lubricating oil

The instrument used for measuring the viscosity are known as viscometers

Different types of viscometers are

- Saybolt Viscometer
- Angler's Viscometer
- Ostwald Viscometer
- Kinematic Viscometer
- Redwood Viscometer

Redwood Viscometer

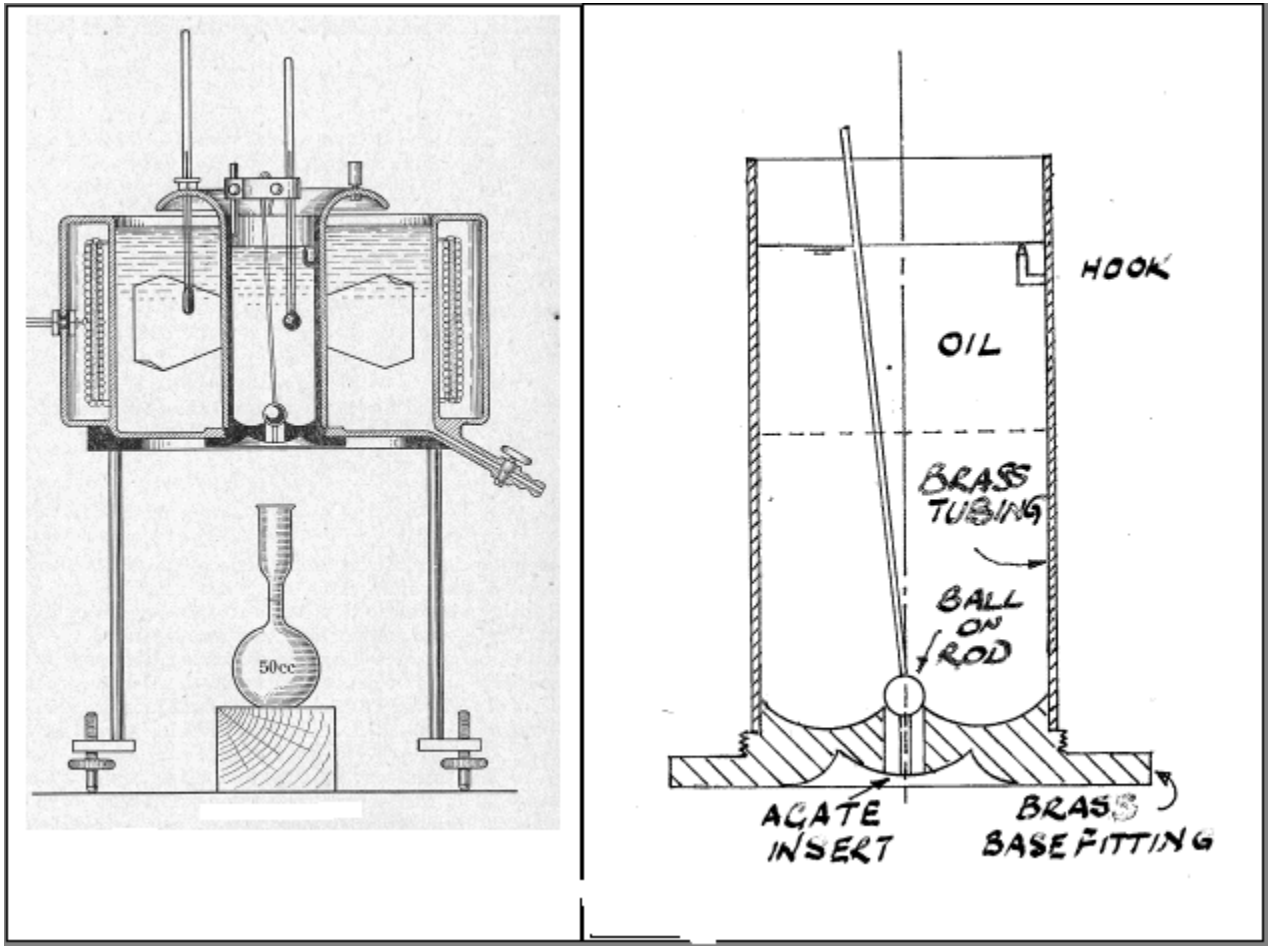
It is of two types
Redwood viscometer No.1- Universal
Redwood viscometer No.2- Abmiralty
Both the above viscometers are identical in principle, shape and mode of testing. The essential differences between the two are

Difference between redwood 1&2

	Redwood viscometer No.1- Universal	Redwood viscometer No.2- Abmiralty
Dimensions of orifice	Length-10mm, Dia-1,62mm	Length-50mm, Dia-3.8mm
Kohlrausch flask	Smaller mouth	Wider mouth
Useful for	Low viscous oil having flow time between 30s-2000s e.g. Kerosine oil and mustard oil	Higher viscous oils having flow time greater than 2000s e.g. Fuel oil, mobile oil

- **Description of the Redwood viscometer**
- It is divided in to three parts
- **Oil Cup**;
- Material- Silver plated brass
- Height-90mm
- Diamtere-46.5mm
- It holds the test sample of lubricating oil. The bottom of the cup is fitted with polished-agate discharge tube containing an orifice of specified dimension
- **Water Bath**
- Oil cup is surrounded by water bath for adjusting the temperature
- **Kohlrausch Flask**
- It receives the oil from polished-agate discharge tube

Redwood Viscometer



PROCEDURE

- Select the appropriate viscometer, either Redwood viscometer No.1 or 2 depending up on the nature of lubricating oil
- Clean the viscometer cup properly with the help of suitable solvent e.g. CCl_4, ether, petroleum spirit or benzene and dry it to remove any traces of solvent.
- Level the viscometer with the help of leveling screws.
- Fill the outer bath with water for determining the viscosity at 80 ^{o} c and below.
- Place the ball valve on the jet to close it and pour the test oil into the cup up to the tip of indicator.
- Place a clean dry Kohlrausch flask immediately below and directly in line with discharging jet.
- Insert a clean thermometer and a stirrer in the cup and cover it with a lid.
- Heat the water filled in the bath slowly with constant stirring. When the oil in the cup attains a desired temperature, stop the heating.
- Lift the ball valve and start the stop watch. Oil from the jet flows into the flask.
- Stop the stop watch when lower meniscus of the oil reaches the 50 ml mark on the neck of receiving flask.
- Record the time taken for 50 ml of the oil to collect in the flask.
- Repeat the experiment to get more readings.

Viscosity Index

With change in temperature ,viscosity of lubricating oil varies, The higher the temperature ,the lower the viscosity and vice a versa.

The maintenance of viscosity with temperature is called viscosity index.

Determination of viscosity index

The rate at which the viscosity of an oil changes with temperature is measured by an empirical number, known as **viscosity index (V.I.)**

Small change------High V.I.

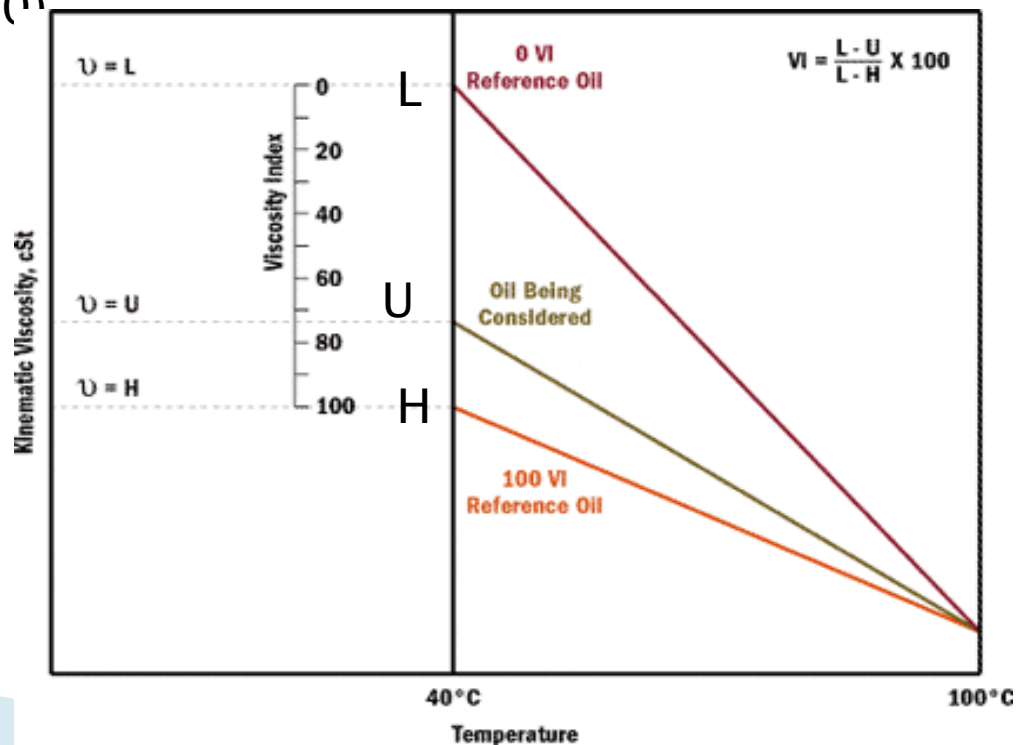
Large change------Low V.I.

Viscosity index of test oil is determined with the help of two type of standard oils viz. 1. Pennynsylvanian oil (V.I=100)

2. gulf oils having (V.I.=0)

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

VI gives molecular structure idea
High VI—linear or rod like shaped molecules with high molecular weights(greater intermolecular attraction



flash point and fire point

Flash point is the lowest temperature at which the lubricating oil gives off enough vapors that ignite for a moment when tiny flame is brough near it.

Fire point is the lowest temperature at which th vapors of the oil burn continuously for at least five seconds when a tiny flame is brought near it.

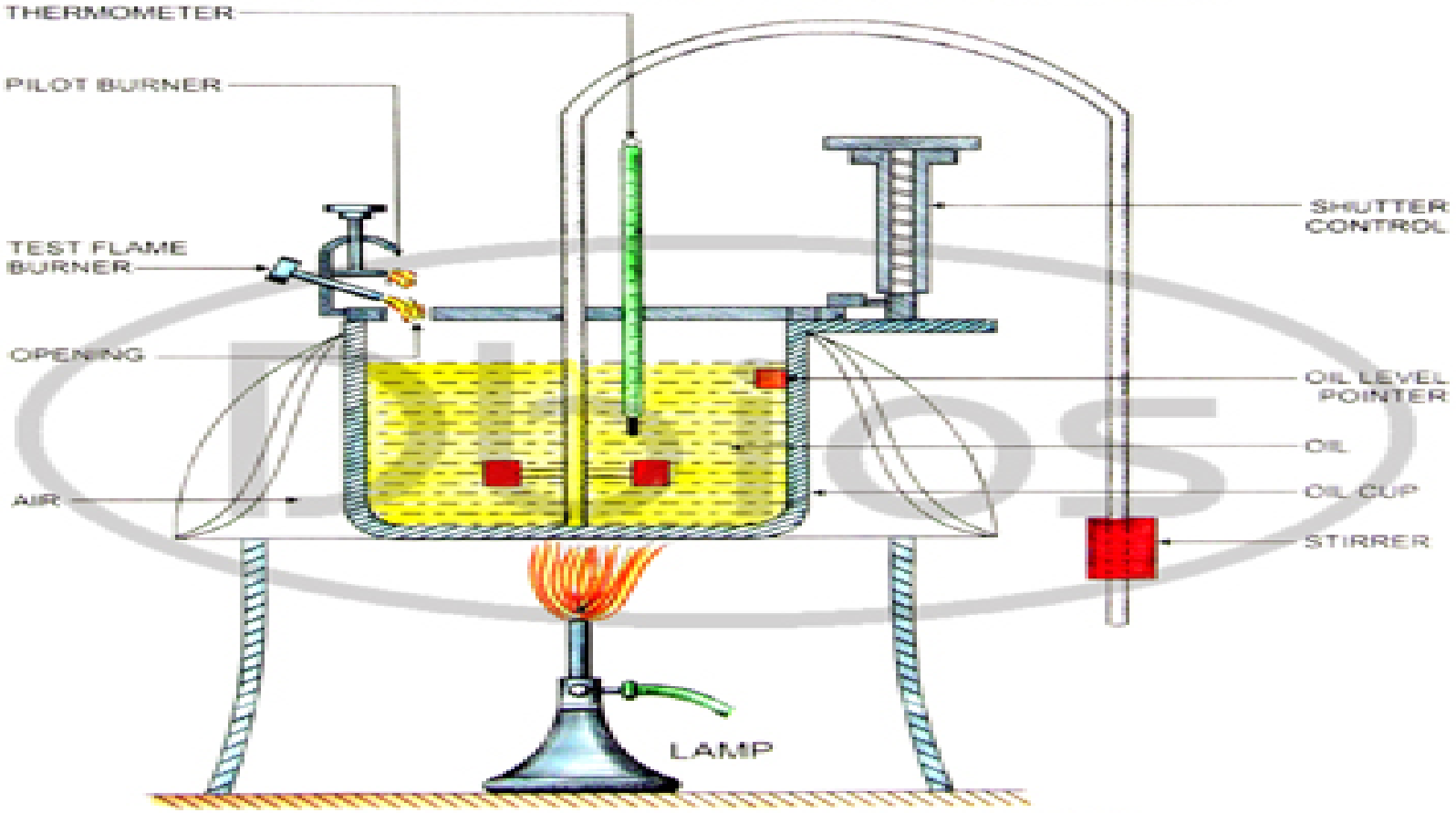
Significance

Flash and fire points are used to indicate

- Fire hazard of petroleum products and evaporation loses under high temperature
- It gives us the idea about the maximum temperature below which the oil can be used.
- It is used as the means of identification of specific lubricating oil
- For detection of contamination in the given lubricating oil

DETERMINATION OF FLASH POINT BY PENSKY MARTEN'S APPARATUS

- FLASH POINT IS THE MINIMUM TEMPERATURE, AT WHICH AN OIL GIVES ENOUGH VAPOURS, WHICH BURN FOR A MOMENT, WHEN A SMALL FLAME IS BROUGHT NEAR IT.
- IT GIVES THE MAXIMUM TEMPERATURE UPTO WHICH A LUBRICANT CAN BE SAFELY USED.



PENSKY-MARTEN'S FLASH POINT APPARATUS

PROCEDURE

- FILL THE OIL CUP LUBRICANT UPTO POINTER LEVEL
- HEAT AT A RATE OF 5-6 °C PER MINUTE WITH CONTINUOUS STIRRING
- DIP THE TEST FLAME INTO OIL VAPOUR, WHEN TEMPERATURE IS WITHIN 10°C OF PROBABLE TEMPERATURE
- CHECK AFTER EVERY 1°C RISE IN TEMPERATURE
- WHEN TEST FLAME PRODUCES DISTINCT FLASH , NOTE THE TEMPERATURE

Description of Pensky Marten's apparatus

It is used to determine the flash point of the lubricating oils, fuel oils, solvents, solvent containing material and suspension of solids.

It consists of three parts

Oil Cup

Material- Brass
Height – 5.5cm
Diameter-5cm

Lid of the cup is provided with four openings of standard sizes, first opening is for stirrer, second is for admission of air, third is for thermometer and fourth is for introducing test flame.

Shutter

At the top of the cup shutter is provided. By moving the shutter, opening in the lid opens and flame is dipped in to this opening, bringing the flame over the oil surface. As the test flame is introduced in the opening, it get extinguished, but when the test flame is returned to its original position, it is automatically lightened by the pilot burner

Stove

It consists of 1. Air bath 2. Top plate on which the flange of the

PROCEDURE:

1. Clean and dry all parts of the apparatus with the help of suitable solvent e.g. CCl_4, ether, petroleum spirit or benzene and dry it to remove any traces of solvent.
2. Fill the oil cup with the test oil up to the mark.
3. Fix the lids on the top through which are inserted a thermometer and a stirrer. Ensure that the flame exposure device is fixed on the top.
4. Light the test flame and adjust it to about 4 mm in diameter.
5. Heat apparatus as temperature of oil increases by 5 to 6^0 per min. as stirrer is continuously rotated.
6. At every 1^0 C rise of temp. Introduce test flame into the oil vapor. This is done by operating the shutter. On moving knob of shutter, test flame is lowered in oil vapors through opening.
7. When test flame causes a distinct flame in interior cup, note temp. Which represent the flash point.
8. Further heat the oil at the rate of 1^0C/ min. and continue applying the test flame as before.
9. The temperature at which the vapors of the oil give a distinct blue flash for five seconds is recorded as the fire point of the oil.

OBSERVATIONS

The flash point of given oil sample =___°C.

The fire point of given oil sample =___°C.

Significance of Flash and Fire Point

1)A good lubricant should have Flash point at least above the temperature at which it is to be used.

2) Flash and Fire Point are used to indicate the fire hazard of petroleum products and evaporation losses under high temperature operations.

3)Knowledge of these points in lubricating oil aids in –precautionary measures against fire hazards.

4)It gives us the idea about the maximum temperature below which the oil can be used

5)It is used as the means of identification of specific lubricating oil

Significance:

- The flash point is just one flammability characteristic that is used to assess the hazardous nature of a material. A low flash point can be indicative of the presence of highly volatile materials in the fluid. The fire point is used to assess the risk of the materials ability to support combustion. These values can also affect how the fluid may be shipped, stored, and discarded. For mineral oils the minimum accepted value for the flash point oil used in outdoor transformers is 145°C, although this could vary according to local codes. In general the fire points are about 10°C higher than the flash point.
- Another related flammability property of a fluid is its auto-ignition temperature. This is much higher than the flash point and it represents the temperature at which the sample will ignite from only the heat being applied and no external souce of ignition. The procedure for determining this value is covered in the ASTM E 659 mehod.
- The values for some non-mineral oils are a minimum flash point of 300°C and a minimum fire point of 340°C for silicones.

Factors affecting Flash and Fire Point of an oil

- Moisture
- Low molecular weight constituents
- Contaminations with small amount of volatile organic compounds
- Experimental factors

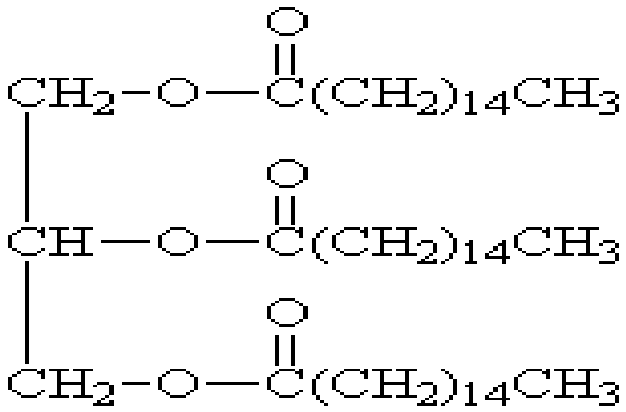
Determination of Saponification(Koettsdoerfer) Number

Saponification Number

On refluxing with alkali, triacylglycerols (fatty acid esters) are hydrolyzed to give glycerol and potassium salts of fatty acids (soap).

Such process is known as, *Saponification.*

Determination of Saponification Number

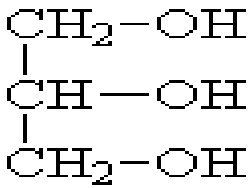


a fat

$$\left[\begin{array}{l} 3(39+16+1) \\ =3\times 56 \\ =168 gms \end{array}\right]$$

+ 3 K OH
sodium hydroxide
(or KOH, potassium hydroxide)

H_2O, Δ ↓ saponification



glycerol

+ $3\ CH_3(CH_2)_{14}CO_2K$

a crude soap

Determination of Saponification Number

saponification value

"number of milligrams of KOH required to neutralize the fatty acids resulting from the complete hydrolysis of 1g of fat"

$$SN = \frac{168000}{M} mgKOH$$

Where M= mol. Wt of oil or fat

Significance of Saponification Number

- saponification value-----the nature of the fatty acids constituent of fat and thus, depends on the average molecular weight of the fatty acids constituent of fat.

$$SN\alpha\ 1/M$$

- greater the molecular weight (the longer the carbon chain)-------smaller the number of fatty acids is liberated per gram of fat hydrolyzed and therefore, the smaller the saponification number and vice versa.
- Indicate the average length of carbon chains of the fatty acids components
- Gives an estimate of non-fatty impurities present in oil
- Mineral oil---do not undergo saponification, animal & vegetable oil---undergo saponification. This test indication of amount and type of oil present

Materials:

1- Fats and oils (olive oil, coconut oil, sesame oil, and butter)

2- Fat solvent (equal volumes of 95% ethanol and ether)

3-Alcholic KOH (0.5 mol/liter)

4-Reflux condenser.

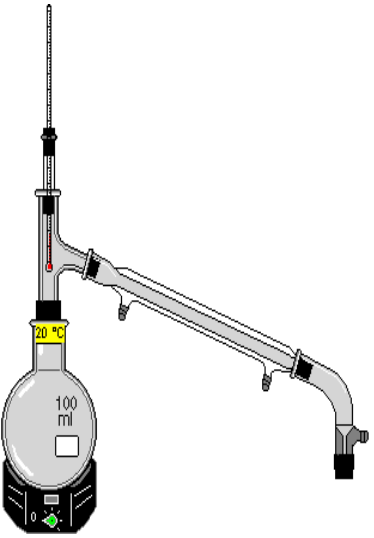
5-Boiling water bath.

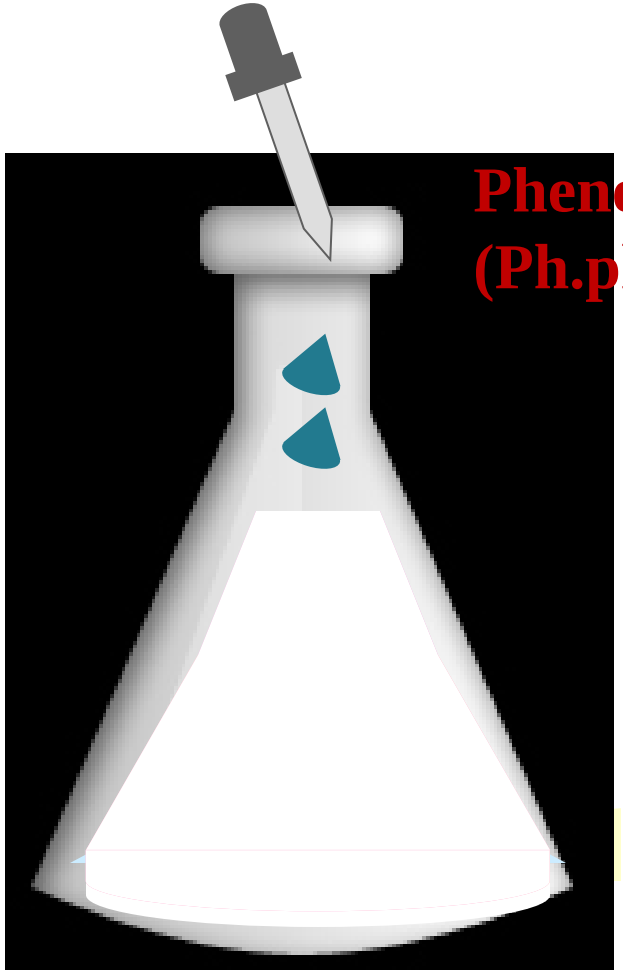
6-Phenolphethalein.

7-Hydrochloric acid (0.5 mol/liter)

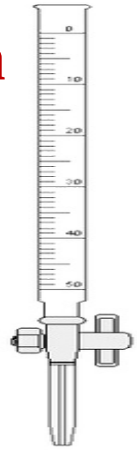
8-Burettes (10 ml and 25 ml)

9-Conical flasks (250ml)





Phenolphthalein
(Ph.ph)



0.5mol/L
HCL

25 ml alcoholic KOH

3 ml fat solvent

ml fat

Heat flask on a boiling water bath for 30 min.

Leave to cool to room temperature

Acid Value/Neutrilization No.

"Determination of acidity/alkalinity of oil"

TAN(Total acid No)

"No of milligrams of KOH required to neutrilize any acid present in 1 gm of oil"

TBN(Total base No)

"No of milligrams of HCl required to neutralize any free base present in 1 gm of oil"

Significance:

Indicates:

1. **Freshness of oil---low acid value**
2. **Extent of deterioration**
3. **Age of oil**
4. **Cause of corrosion due to lubricating oil**
5. **indicates the development of harmful products or the effect of additive depletion----- indicates**

Determination: Acid value can be determined by simple acid base titration with std. acid (HCl) using suitable indicator.

Calculation :

$$NeutralizationNumber = \frac{Totalmloftitratingsolution}{wt.ofsample} \times 5.61$$

Cloud and pour point

Cloud point: When a lubricating oil is cooled in a standard apparatus ,at specified rate ,the temp. at which oil first become cloudy of hazy in appearance

Pour point: the temperature at which the oil just ceases to flow or pour is called pour point.

Determination of Cloud and pour point

- The specimen is cooled inside a cooling bath to allow the formation ofparaffin wax crystals.
- At about 9 °C above the expected pour point, and for every subsequent 3 °C, the test jar is removed and tilted to check for surface movement.
- When the specimen does not flow when tilted, the jar is held horizontally for 5 sec.
- If it does not flow, 3 °C is added to the corresponding temperature and the result is the pour point temperature.
- It is also useful to note that failure to flow at the pour point may also be due to the effect of viscosity or the previous thermal history of the specimen.
- Cooling mixture:

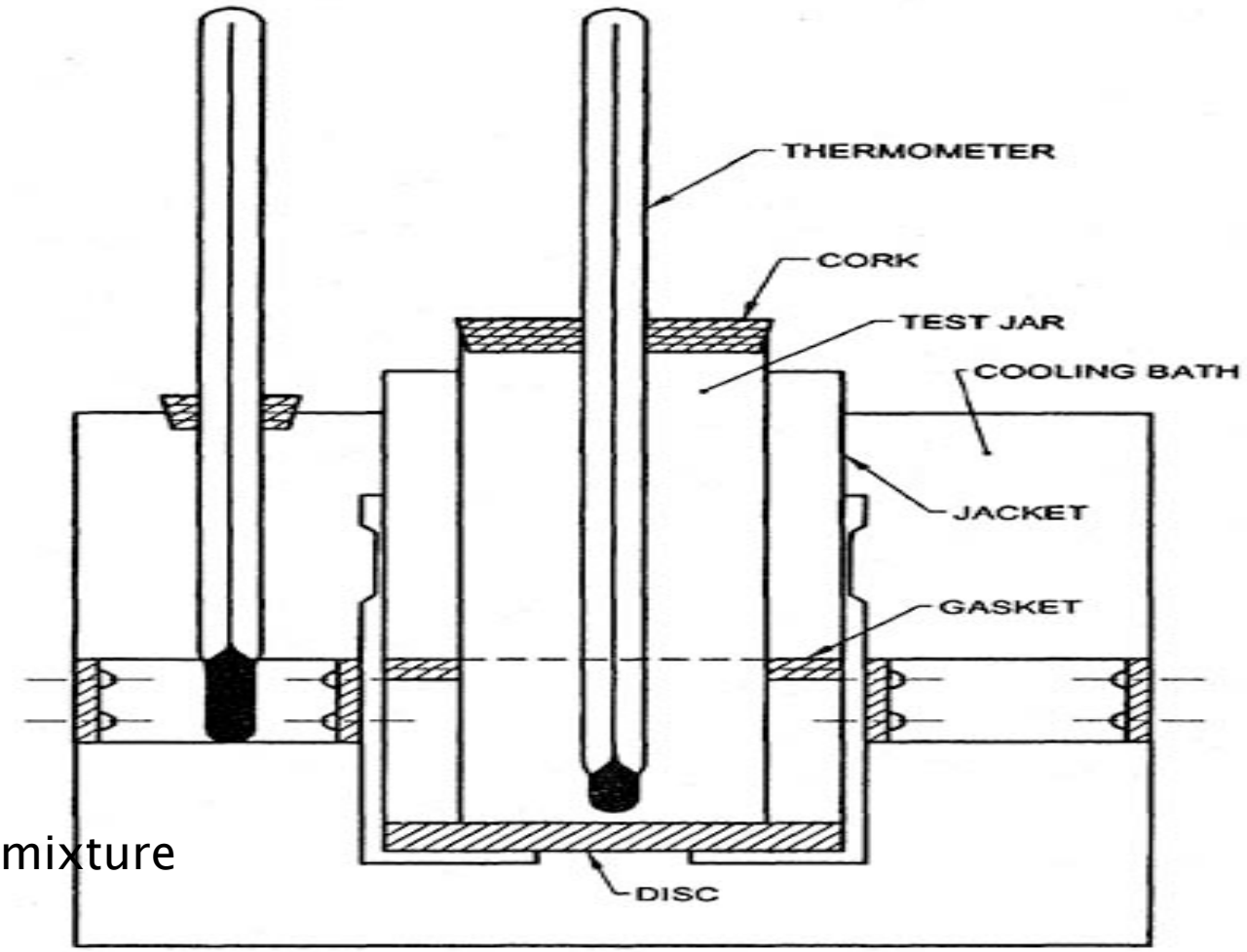
Ice+ water----up to 10 °C

Crushed ice + salt----- up to 102 °C

Ice + $CaCl_2$---------- up to 26 °C

Solid CO_2+ petrol---------- up to 57 °C

Determination of Cloud and pour point



Cooling mixture

Significance of cloud and pour point determination

1) indicates the lowest temperature at which lubricating oil can be used
2) Pour point detects the suitability lubricants for low temperature installation which may be require to start/installation
3) A good lubricating oil should have low pour point because at low temp. the impurities in the oil get separated out which cause
   - Clogging of capillaries
   - Clog the filter screen in the diesel engine
   - Jamming of machine

Aneline point

Aneline point: “minimum equillibrium solution temperature
For equal volume of aniline and oil sample”

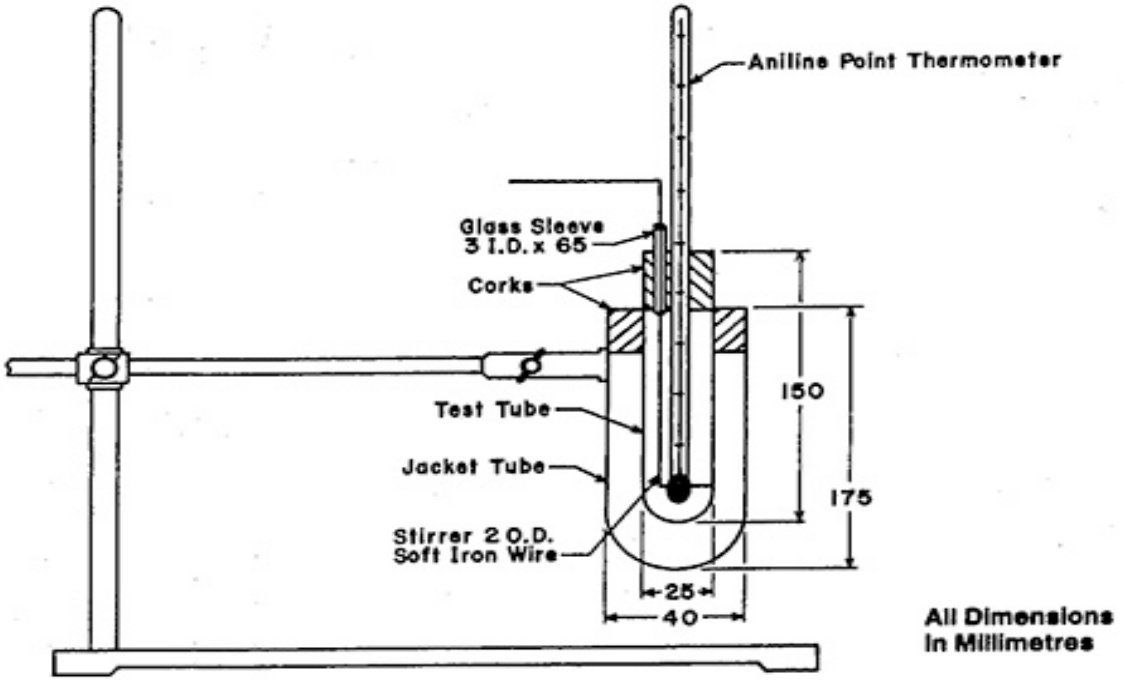
Temperature at which oil and aniline phase separate out ----Aniline point

Significance:

1) It tells us about aromatic content of the lubricant oil (Aneline No. α 1/aromatic content)
2)It indicates the extent of possible deterioration of rubber sealing etc.
3)A lubricating oil having higher aneline point i.e. lower percentage of aromatic compounds will be **desired.**
4) Aromatic hydrocarbons have tendency to dissolve natural rubber, their higher percentage can deteriorate the sealing, packing

Determination of Aneline point

- Equal volumes of aniline and oil are stirred continuously in a test tube and heated until the two merge into a homogeneous solution.
- Heating is stopped and the tube is allowed to cool.
- The temperature at which the two phases separate out is recorded as aniline point.



Iodine Number/Value

“ Number of grams/mass of iodine absorbed by 100 g of the sample.

- Indicate
- Degree of unsaturation --------unsaturated fatty acid residues of the glycerides react with iodine

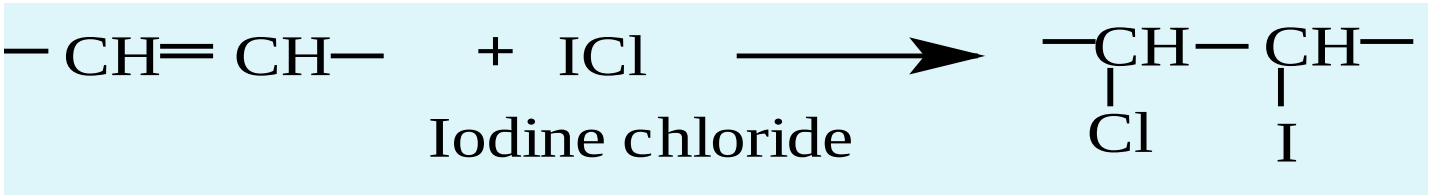
- It is constant for a particular oil or fat, but depends on the method used.
- Animal fats (butter, dripping, lard) 30 - 70 Iodine Value

  - Non-drying oils (olive, almond) below 100 Iodine Value
  - Semi-drying oils (cottonseed, sesame, soya) 100-130 Iodine Value
  - Drying oils (linseed, sunflower) above 130 Iodine Value

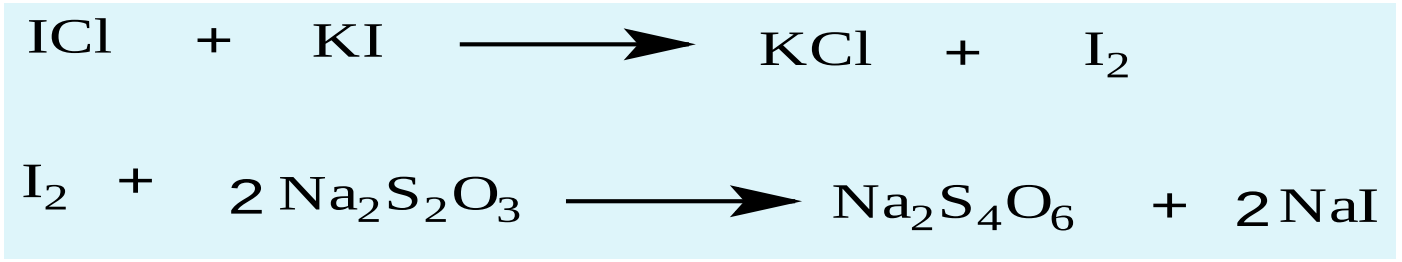
- The iodine value is often most useful in identifying the source of an oil.
- higher iodine values ------oils
- lower iodine values ---------fats.

determined using Wigs or Hanus methods.

Determination of Iodine Number



Excess unreacted ICl



The consumed amount of hypo solution gives the value of untreated iodine

Theoretical Iodine Value

Unsaturated fat or oil + $x\,I_2$ $\xrightarrow{HgCl_2}$ diodide

Mol. Wt = M

Number of gms of iodine needed for 100gms of oil or fat

$$I.N. = \frac{x \times 126.9}{M} \times 100$$

Biodegradable lubricants

- Those substances which in addition to acting as lubricants are able to decompose in the natural environment, eg. Water bodies, soil et. Without yielding harmful substances .
- Such lubricants undergo decomposition by the action of microorganisms.

Eg.

Pure vegetable oils but with limitations: (a) oxidise quickly (b) high pour point

Characteristics of ideal Biodegradable lubricants

1. Low temperature fluidity and pumpability
2. Oxidation and thermal stability
3. Protection from corrosion and wear
4. Demulsibility and pumpability
5. Load carrying capacity
6. Water toleration and filterability
7. Environmental friendly

Additives for lubricants

- Specific compounds which improves the desired qualities of lubricants

Type of additives and their function

1. Oiliness improvers
2. Viscosity index improvers
3. Anti-oxidant
4. Corrosion inhibitors
5. Rust inhibitors
6. Anti-wear additives
7. Extreme pressure additives
8. Pour point depressants
9. Antifoam additives
10. Emulsifier
11. Detergents and deflocculants
12. Dispersants

Grease (lubricant) Semi solid lubricants

Grease : semisolid lubricant.

a soap emulsified with mineral or vegetable oil

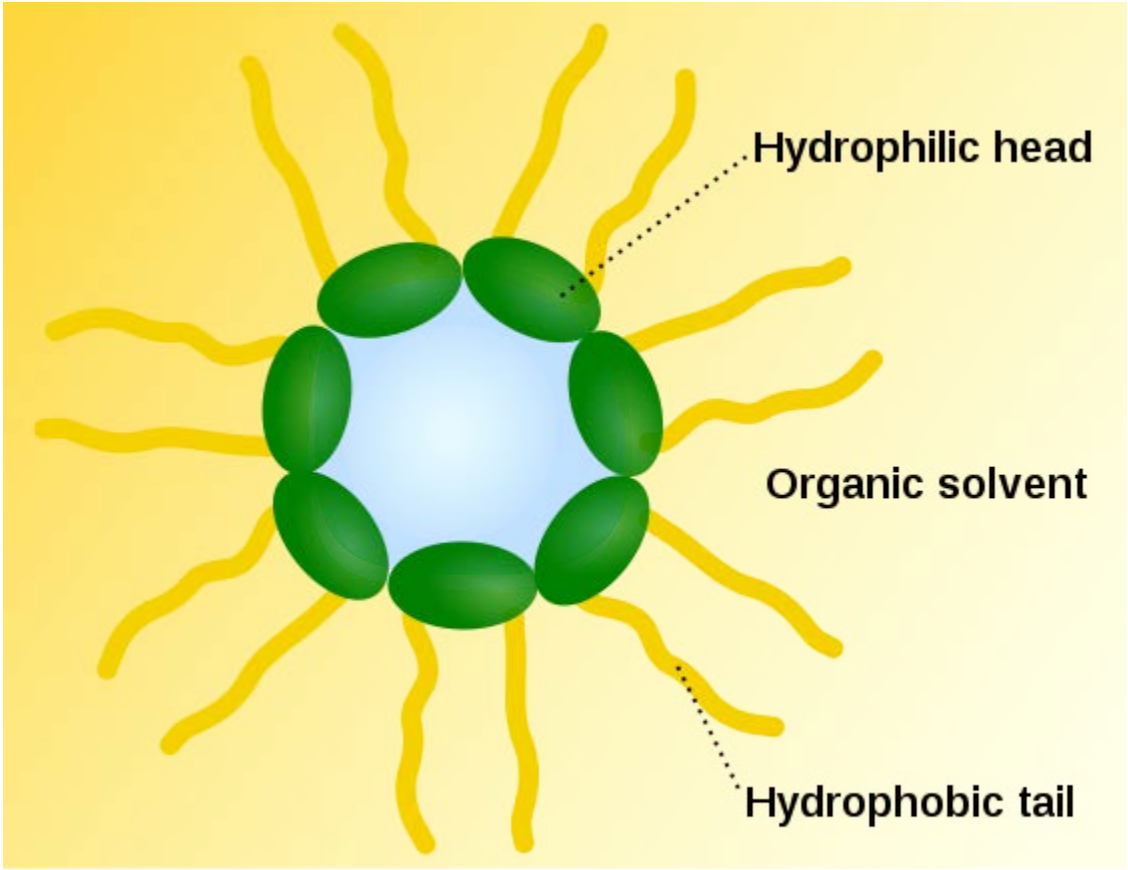
The characteristic feature of greases

Is that they possess a high initial viscosity, which upon the application of shear, drops to give the effect of an oil-lubricated bearing of approximately the same viscosity as the base oil used in the grease. This change in viscosity is called thixotropy.

Grease is sometimes used to describe lubricating materials that are simply soft solids or high viscosity liquids, but these materials do not exhibit the shear-thinning (thixotropic) properties characteristic of the classical grease. For example, petroleum jellies such as Vaselineare not generally classified as greases.

Thickeners

- Soaps are the most common emulsifying agent used.
- Types of Soaps
- calcium stearate,
- sodium stearate,
- lithium stearate,
-
- The nature of the soaps influences the temperature resistance (relating to the viscosity), water resistance, and chemical stability of the resulting grease.
- Powdered solids may also be used as thickeners, especially asclays, which are used in some inexpensive, low performance greases. Fatty oil-based greases have also been prepared with other thickeners, such tar, graphite, or mica, which also increase the durability of the grease.


Hydrophilic head
Organic solvent
Hydrophobic tail

Types of greases

Lithium-based greases

Lithium soaps are thickening agent in petroleum oils.

These greases are resistant to water and have good high temperature properties.

These greases are stable in storage have high mechanical and oxidation stability.

They have high melting point about 150°.

Applications:

For aircraft lubrication application at extreme heights, where temp as low as −55 °.

These lubricants are used for special applications only, due to their high cost.

Sodium- based greases

Are having sodium soaps as thickning agent in petroleum oil.
These are water souble greases.
These can withstand temperature upto 175 °.

Applications: They are suitable to use in ball bearing which generates frictional heat.

Calcium based greases: Calcium soaps are thickening agent in petroleum oils.
These greases are also known as cap greases.
These are cheapest and most commonly used.
These are water resistant and can be used upto 80 °C.
The amount of lime can be varied from 10-30 % for getting wide range of consistency. from soft paste to smooth hard solid.
Axle Grease :They are very cheap resin grease.

Properties of Greases

Consistency

1. Definition-The distance in Millimeters ,that a std. cone penetrates vertically into the sample of grease under the standard condition of load(150gm),Temperature (25 degree) and time 5 sec.
2. Factors on which it depends-

1. The structure and interaction of gelling element in it.
2. The viscosity of oil used in its preparation.

Drop Point

Definition-The temperature at which grease passes from semi solid to liquid state.

Significance- It determine the upper limit of temperature upto which a grease can function as a satisfactory lubricant.