UNIT III : OILS, FATS, SOAPS & LUBRICANTS

(1) I) Define the term lubricant and explain any five properties of Lubricant.
II) what is Lithium grease? Mention it uses.

I) Define the term lubricant and explain any Five properties of Lubricant.

Lubricant

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

Lubrication:

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

Properties of Lubricant

1) Cloud point and pour point.

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

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

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Significance

Most of the petroleum based lubricating oils contain dissolved paraffin wax and asphatic 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.

2) Oiliness

Oiliness is the capacity of a lubricating oil to stick on to the surface of the machine parts under heavy load or pressure.

Significance :

Lubricants which have high oiliness stay in between the lubricated surface, when they are subjected to high load and pressure. But lubricants with poor oiliness will be squeezed out of the machine parts under this condition.

3) Aniline point

Aniline point of an oil is the lowest temperature at which the oil is completely miscible with an equal volume of aniline.

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Significance

Aniline point gives an indication of the deterioration of an oil. when it comes into contact with rubber sealings, packing, etc. Generally aromatic hydrocarbons have a tendency to dissolve natural or synthetic rubbers. A higher aniline point means lower percentage of aromatic hydrocarbon and hence less solvent effect on rubber packings, etc.

4) Oxidation stability

Lubrication oil undergoes oxidation when it contacts with air slowly at room temperature but rapidly as the temperature increases above 100°C. The reaction is accelerated in the presence of metal particles (catalyst). presence of oxidation products in the lubricating oil like insoluble, gummy and sticky materials clog oil holes, filters, pipe lines, etc. The soluble products are acidic and corrode the sufae of the bearings.

Therefore, resistace to oxidation is a desirable property of a lubricating oil. oxidation inhibitors are added to oils to inprove their resistance. The inhibitors get oxidised first and the oil is protected.

Thus oxidation stability of a lubricat should be high.

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5) Carbon residue

Lubricating oils contain high percentage of carbon. On heating, they undergo decomposition depositing a certain amount of carbon on machine, particularly in internal combustion engines and air-compressors.

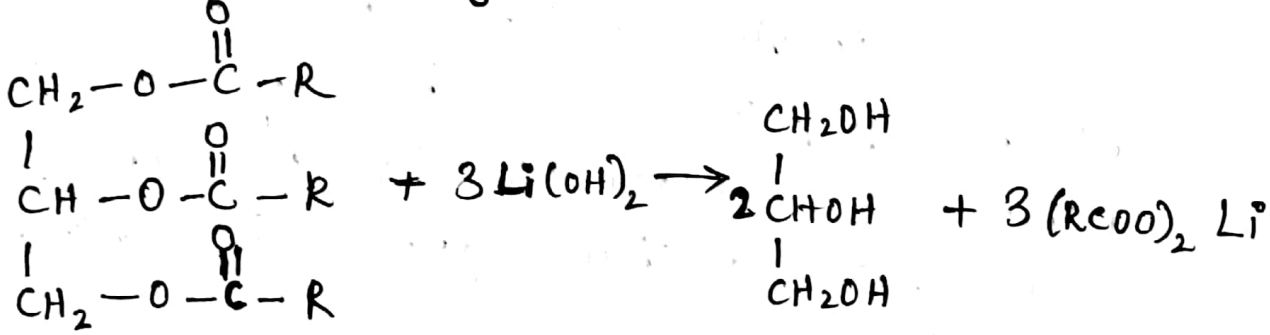
Thus, a good lubricant should deposit least amount of carbon.

II What is lithium Grease? Mention it uses :-

Lithium soap is a soap consisting of a lithium salt of a fatty acid. Sodium-based and potassium-based soaps are used as cleaning agents in domestic and industrial applications, whereas lithium soaps are used as components of lithium grease.

Preparation of lithium soap :

It is prepared by the saponification of oil with lithium hydroxide ($LiOH_2$).



Preparation of lithium grease

It is prepared by thickening of lubricating oil by adding lithium soap.

Properties :

⇒ It is a resistant to water and heat.
⇒ It is expensive.
⇒ It is superior to all other types of greases.
⇒ It possesses high mechanical stability.
⇒ They have high melting point.

Uses :

⇒ It is used in aircraft applications where temperature goes even to $-55^{\circ}C$.

⇒ Due to their high cost, they are for special applications only.

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(2) I.) Write a note on Chemical analysis of oil,

II.) Explain Solid lubricants with examples.

I.) Write a note on Chemical analysis of oil

1) Acid value (or) Acid number

It is defined as, the number of milligrams of caustic pottash required to neutralize the acid in one gram of the sample. The normal acid value for most samples lies within 0.5.

Determination:

Known amount of oil or fat is taken in a 250 ml conical flask and dissolved in 50 ml of pure alcohol. The content is heated to boiling and taken thoroughly to dissolve it completely. The solution is then cooled and titrated against 0.1 N alcoholic caustic potash solution using phenolphthalein indicator. The end point is the appearance of pale pink colour.

Calculations

$$\text{Acid value} = \text{\_\_ ml of 0.1 N Alkali} \times \frac{5.61}{\text{weight of sample}}$$

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Significance

1) It gives the proportion of free fatty acid present in an oil or fat.

2) It indicates the extent of rancidity.

3) Low acid value indicates the freshness of oil.

2) Iodine Value :

It is the number of grams of iodine absorbed by 100 grams of oil or fat.

Unsaturated compounds absorb iodine and form saturated compounds. The amount of iodine absorbed, in percentage, is the measure of unsaturation in the oil. All oils have some iodine value. On the basis of iodine, oils are classified as,

1) Drying oil
2) Semi-drying oil
3) Non-drying oil.

1) Non-drying oils :

These oils have one double an and absorb iodine below 90%.

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ii) Semi-drying oils

These oils contain some proportion of double bonds and have iodine value below 140.

iii) Drying oils

These oils containing some proportion of triple bonds and having iodine value above 140.

Determination:

A known amount of oil sample is taken in a 250 ml stoppered flask. 10 ml of chloroform is added and dissolved. Now 25 ml of Wij's solution (iodine + iodine monochloride + glacial acetic acid) is added into the flask and shaken vigorously and allowed to stand for 1/2 an hour in dark.

Now the solution is diluted with 50-100 ml of water and 15 ml of 10% KI solution is added to the flask. ~~and~~ ~~stud~~ The solution is titrated against Standard 0.1N sodium thiosulphate solution using starch as an indicator. Disappearance of blue colour is the end point.

oil/fat + ICl (Wijs solution) ⟶ Iodine Bromide triglycerides + Unreacted ICl

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$ICl + KI \longrightarrow I_2 + KBr \longrightarrow$ Thio + starch as an indicator
(Disappearance of blue colour)

Calculations

$$\left\{\begin{matrix}\text{Iodine} \\ \text{value}\end{matrix}\right\} = \frac{\left\{\begin{matrix}\text{-ml of} \\ \text{thiosulphate}\end{matrix}\right\} \times \left\{\begin{matrix}\text{Normality of} \\ \text{thiosulphate}\end{matrix}\right\} \times 12.692}{\text{Weight of the sample.}}$$

Significance

⇒ Iodine value is used to find out the percentage of unsaturation present in the oil.

⇒ If iodine value of the oil is greater than 140, that can be used as drying oil in making paint and varnishes.

⇒ Iodine value is directly proportional to the number of double bonds present in the fatty acids.

⇒ It is used to classify the acid into drying, semi-drying and non-drying oils.

3) **Saponification values.**

It is the number of milligrams of caustic

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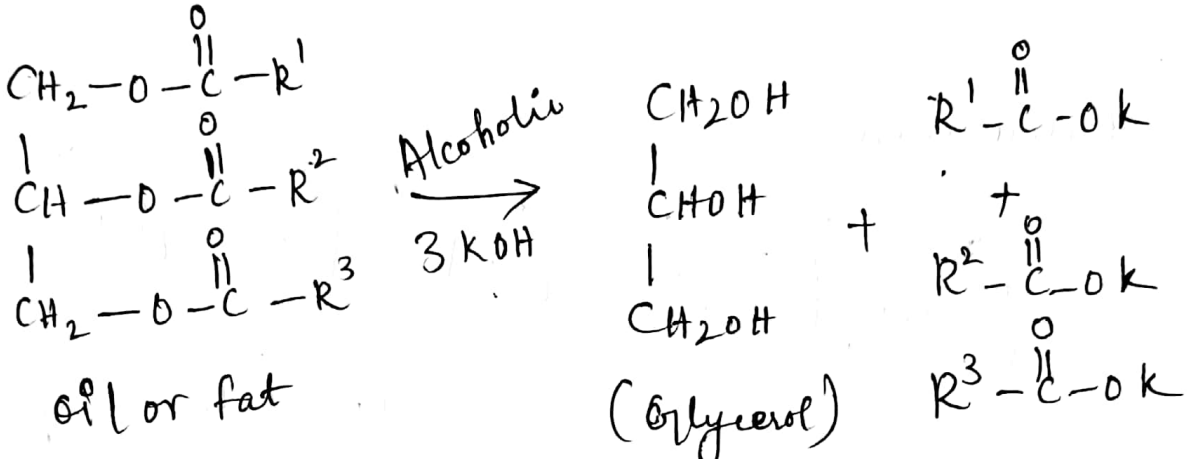
potash (KOH) required to neutralise the fatty acids obtained by complete hydrolysis of 1g of oil or fat.

Fat / oil $\xrightarrow[\text{Hydrolysis}]{KOH}$ Glycerol + Soap + Unreacted KOH



Oil or fat (Glycerol)

The unreacted KOH is titrated against standard HCl using phenolphthalein as an indicator.

Determination:

known amount of the oil/Fat is taken into a 250 ml Conical flask. 50 ml of 0.5 N alcoholic KOH solution is added in the flask. The contents are then refluxed for 1 hour. The excess alkali in the solution is back titrated with 0.5 N HCl using phenolphthalein as an indicator. From the titre value saponification number is calculated as,

Calculations.

$$\text{Saponification value} = \frac{\text{ml of 0.5 N HCl} \times 28}{\text{weight of the oil/Fat}}.$$

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Significance

⇒ Saponification value is used to find out lower or higher proportion of fatty acids.

⇒ It is also used to find out the molecular weight of oil/fat.

$$\text{i.e., SAP value} \propto \frac{1}{\text{Molecular weight of oil/fat}}$$

⇒ The actual amount of KOH required to convert oil/Fat into soap, can be calculated.

⇒ To determine the extent of adulteration in a given oil.

II Explain solid lubricants with examples.

Solid lubricants are used under the following situations.

(i) Where the operating temperature and load is too high

(ii) Where contamination of lube oils or greases by the entry of dust or grit particles are avoided.

(iii) Where combustible lubricants must be avoided.

The most widely used solid lubricants are graphite and molybdenum disulphide.

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3) I) What is the difference between Cloud point and pour point.

II) How do you analyse the extent of adulteration in oils. [Refer Q.NO. 2I subtitle 3]

I) What is the difference between cloud point and pour point.

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Determination

An oil is taken in a flat bottomed tube enclosed in an air jacket and it is cooled in a freezing mixture (ice + $CaCl_2$). Thermometers are introduced into the oil and freezing mixture.

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As the cooling takes place via the air jacket temperature of the oil falls. The temperature at which the cloudiness appears is noted as the cloud point. The cooling is further continued. The temperature at which the oil does not flow in the test tube for 5 seconds on tilting it to the horizontal position is noted as the pour point.

A good lubricant should have low cloud point and pour point. pour point of a lubricating oil can be lowered by, (i) dewaxing, (ii) adding a pour point depressant.

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4) Relate the performances of semi-solid lubricants and solid lubricant.

Semi-Solid lubricants

Advantages:

⇒ Good for inclined/vertical shafts.

⇒ Water resistant & reduce oil vapour problems

⇒ Reduce noise and vibration.

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Disadvantages.

⇒ Because of semi-solid nature of lubricant, it does not perform the cooling, so poor dissipation of heat.

⇒ No filtration. - So contaminants / wear-debris cannot be separated.

Solid lubricants

Advantages

⇒ More effective than fluid lubricants at high loads (high pressure).

⇒ High resistance to deterioration in storage.

⇒ High stable in extremes temperature, radiation, and reactive environments.

⇒ permit equipment to be lighter and simpler.

⇒ Superior cleanliness.

Disadvantages

poor self-healing properties. A broken solid film tends to shorten the useful life of the

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Lubricant.

⇒ poor heat dissipation. This condition is especially true with polymers due to their low thermal conductivities.

⇒ Higher coefficient of friction and wear than liquid lubricated bearings.

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(5) If the iodine values of three oils are 160, 120, and 180 respectively, then classify them with an example. [Q. No. 2 I, subtitle 3].

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(6) Write a note on the mechanism of Lubrication.

(Types of Lubrication).

1) Fluid film (or) Thick film (or) Hydrodynamic 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.

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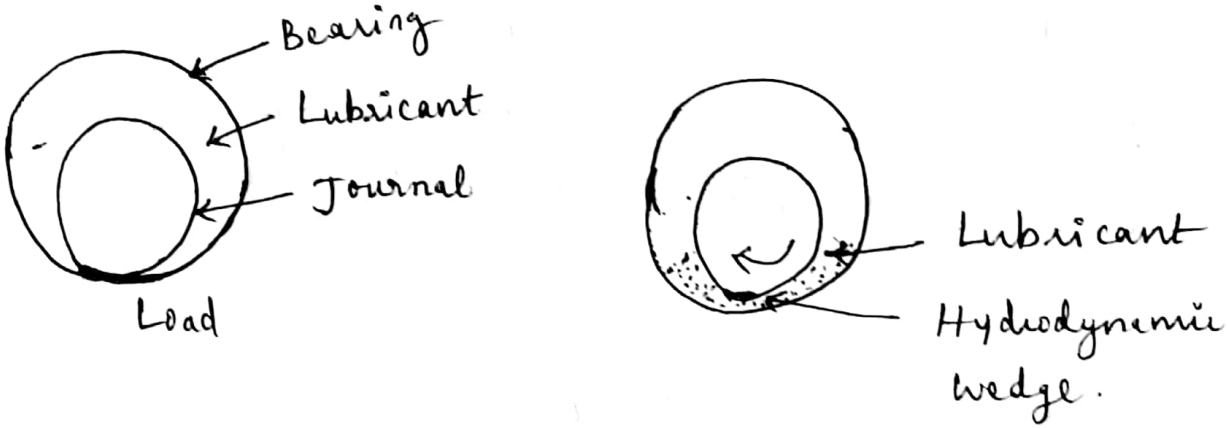
between the solid surfaces. This reduces wear and tear.

⇒ The co-efficient of friction in such cases is as 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 will remain and it prevents contact between the two solid surfaces. When the load becomes very high, the lubricant will be squeezed out of the wedge and friction will occur.

2. Boundary lubrication (or) Thin-film lubrication

⇒ Under the conditions of high load

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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. oiliness is the ability of a lubricant to stick on to the surface. vegetable oils and their fatty acids have more oiliness.

Example

Oleic acid ($C_{17}H_{33}COOH$)

Stearic acid ($C_{17}H_{35}COOH$).

⇒ The polar carbonyl group ($-COOH$) of these oils reacts with the metal surface

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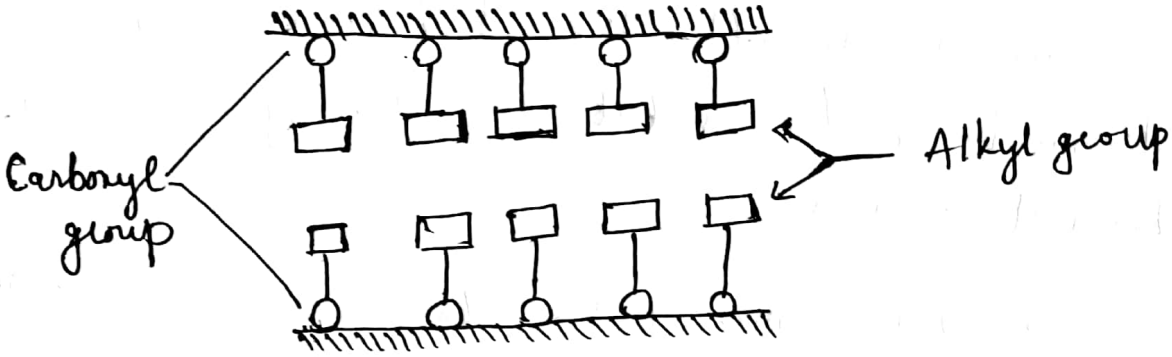
to form a continuous thin film of lubricant. Hydrocarbon chain of the fatty acid gets oriented outwards in a perpendicular direction as shown in figure below.



3) 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 and 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 (ex. Sulphurized oils) etc. These compounds react with metallic surfaces to form metallic chlorides, sulphides etc. ~~These compounds react~~

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⇒ These metallic compounds possess high melting points and serve as good lubricant under extreme pressure conditions.

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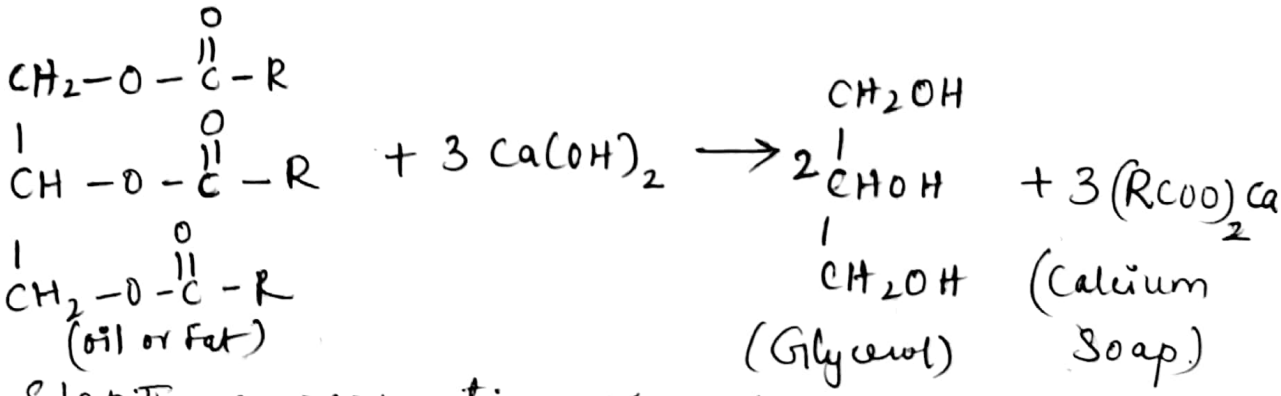
7) How is calcium, sodium and axle greases are obtained ? Explain its properties and uses.

Calcium greases

preparation

Step 1 : preparation of calcium soap

It is prepared by saponification of vegetable oil or fat with slaked lime $Ca(OH)_2$.



Step II : preparation of calcium grease.

It is prepared by thickening of lubricating oil by adding calcium soap.

properties

1) It is cheap and commonly used grease.

2) It is a water resistant grease.

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3) Beyond 80°C it separates into soap and oil.

4) Its dropping point is lesser than soda-base grease.

Uses

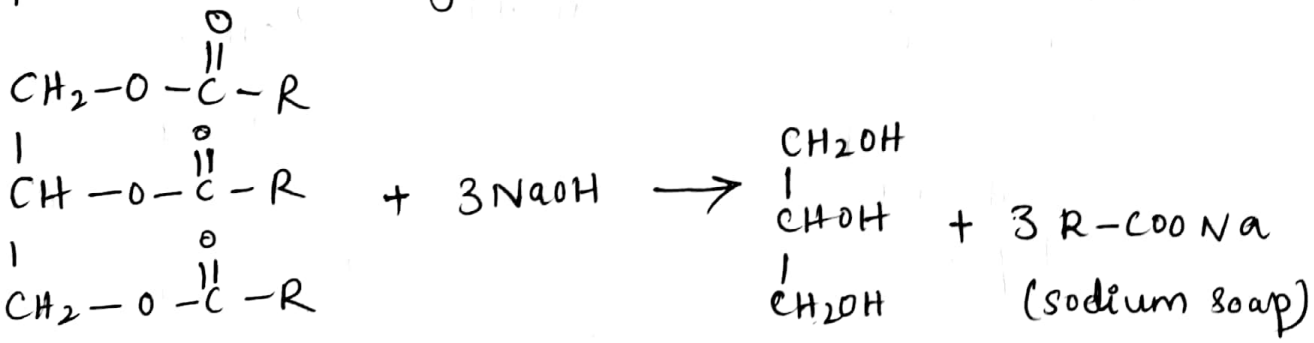
It is a general purpose grease, used for lubricating water pumps, tractors, etc.

Sodium grease

preparation

Step 1 : preparation of sodium soap.

Sodium soap is prepared by the Saponification of vegetable oils or fats with NaOH.



Step II : preparation of sodium grease.

It is prepared by thickening of lubricating oil by adding sodium soap.

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Properties

1) It is soluble in water.

2) It can be used upto 175°C.

Uses

They are suitable for usage of ball and roller bearing greases.

Axle greases

Preparation

It is prepared by adding lime to resin and fatty oils. The mixture is thoroughly mixed and allowed to stand. Grease floats as stiff mass on the reaction mixture. Fillers like talc, mica are also added to them.

Properties

1) It is cheap and water resistant

2) It can be used to the equipments working under high load and low speed.

Uses:

It is used in rail axle boxes, machine bearings, traitor rollers, wires, ropes, etc.

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