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Bio-Grease: A Future Lubricant

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Introduction

Grease is a solid-to-semi fluid mixture of a fluid lubricant, a thickener, and additives. Among which fluid lubricant is the main component that performs actual lubrication, which can be petroleum (mineral) oil, synthetic oil, or vegetable oil. Majority of greases on the market are composed of mineral oil blended with a soap thickener. Grease thickeners are formed by reacting an acid with a base to form a soap. This reaction is commonly referred to as saponificationand the thickeners formed in this manner are known as soaps, or soap thickeners. Lastly, Additives are the components that enhance the performance and protect the grease and lubricated surfaces.Fig.1 shows the basic composition of grease.

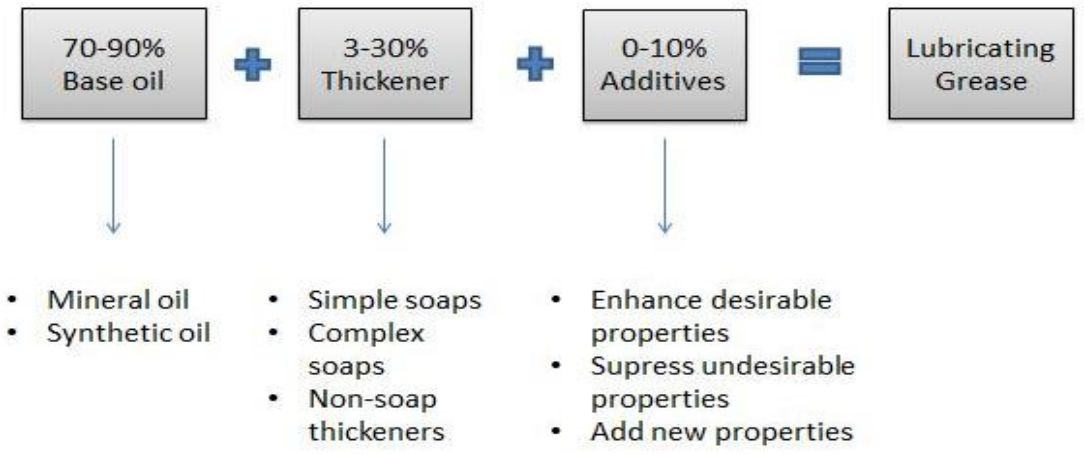

Fig.1: Basic Composition of Grease

Its History

Greases have been used since the ancient times as first the greases were made from animal fats.Soaps were added as thickeners since the middle of the 19th century. Simple calcium and soda based greases are now gradually giving way to lithium soap, extreme pressure, high temperature, complex soap, non soap, and synthetic greases.Hittite chariots

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dated to around 1400 B.C. were found lubricated on the axle with a mixture of tallow and limestone which seems to be an early form of grease (Fig. 2)

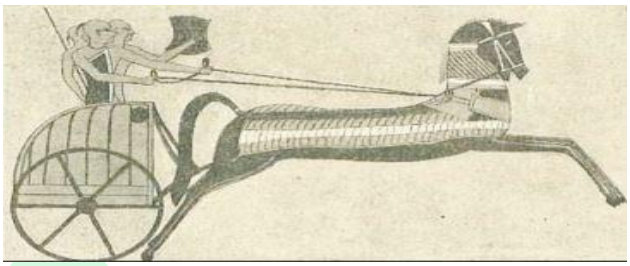

Fig. 2: A Hittite chariot with its three occupants

Its Functions

Greases are used in various mechanical systems to reduce friction and wear between moving components such as metal joints, shafts and bearings in order to maintain their mobility under conditions of application. It provides protection from corrosion by preventing entrance of water and contaminants and also functions as a sealant to prevent lubricant leakage, dripping and throw-off and to keep out foreign materials. Good quality grease maintains its consistency during service and also acts to keep deteriorated seals effective. Greases play an important part in saving energy and reducing carbon dioxide (CO_2) emission by improving the lubrication efficiency and prolonging the service life of machines.

Composition of Grease

1. Base Oil : In lubricating greases base oils are present in majority (> 80 %) and the main function of lubrication is taken care by the base oil. It also influences pumping and flow-ability of lubricating greases, which means how easily a grease can flow through a grease gun or how easily it can flow through the components to be lubricated. High viscosity oil based greases flow / pump slowly compared to low viscosity oil based as it offers more resistance to the flow.

2. Thickener: When combined with the base oil and additives, the thickener forms a semi-fluid structure. Conventional thinking suggests the structure indicates the grease is mainly thickener, however, the thickener is a material that holds the lubricant until it is dispersed. As mentioned above, the overwhelming majority of any grease is composed of base oil. There are many types of compounds that can be used as thickeners.

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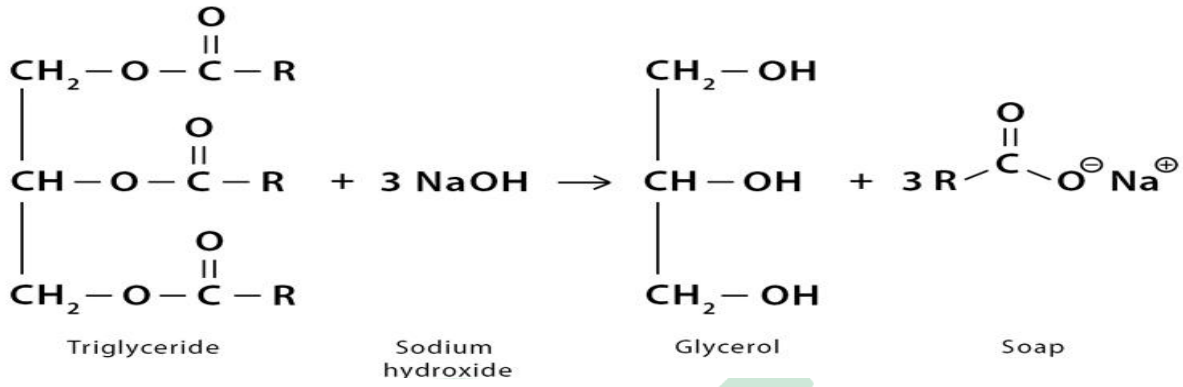
Greases are classified into two major families: soap and non-soap thickeners as shown in Fig. 2. Over 90% of greases worldwide are classified as soap thickeners. Soap-based thickeners are produced via an acid-base reaction known as saponification shown in Fig. 3. The end-result is a soap and water mixture. The water is removed and the remaining soap is used as a thickener for grease. The type of soap thickener will depend on which acids and bases are used in saponification.

Types of Thickeners	
Soap Based	**Non- Soap Based**
Lithium	Clays (Bentonite)
Calcium	Polyurea
Sodium	
Aluminium	
Barium	



3. Additives : The additive content in lubricating oils ranges from just a few parts per million to several percentage points. Depending on the function that the additives develop they may be classed as:

- Substances intended to improve the intrinsic characteristics of the base oils (viscosity index modifiers and pour point improvers).
- Lubricant protective substances (antioxidants).
- Substances giving new properties and protecting the metal surfaces of engines (detergents, dispersants, friction modifiers, anti-wear/Extreme Pressure (EP) additives, rust and corrosion inhibitors).

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The Problem

Only small fraction of lubricants which are consumed worldwide are made up of renewable resources mainly from plants to reduce the environmental harm, and rest are made up of either mineral oil or synthetic oil which are non-renewable.The contamination potential of mineral oil is estimated to be very high, with very slow rate and poor biodegradation.

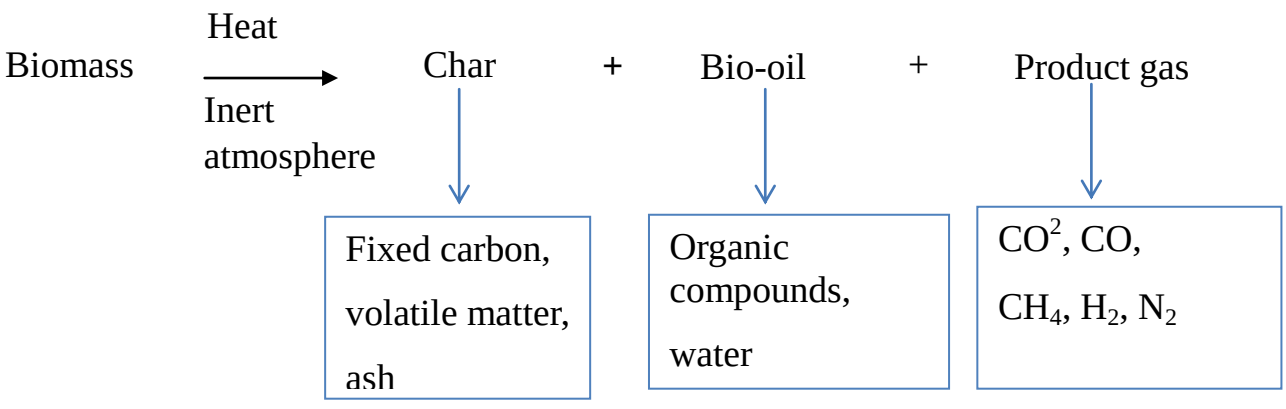
More than 95% of conventional lubricants are directly or indirectly mineral oil based, and 50% of these consumed lubricants are estimated to end up in the environment and cannot be collected for reclamation such as agriculture and forest machinery, rail road and marine applications where grease is lost to soil and water. Another disadvantage with petroleum based lubricating grease is its supply and price fluctuations.

The National Lubricating Grease Institute (NLGI) 2022 Grease Production Survey indicated that about 87% (over 1 billion kilograms) of total worldwide grease volumes were mineral oil based greases, followed by synthetic and semi-synthetic oil based greases at about 6 % and 5% each. Biogreases made their entry in NLGI survey for the first time with about 1-2% market share. The NLGI 2022 Grease Production Survey indicates that only 0.84% of the total reported production worldwide is based on biodegradable base oils.

The Idea

- Bio-oil prepared from different biomass may be used as an alternative of mineral and synthetic base oil for grease preparation.
- Test methods used to analyse the performance of Bio based grease are same as of synthetic or mineral based grease. (Sharma *et. al* 2019)

Preparation of Bio-oil



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Bio oil is produced through pyrolysis process. Pyrolysis is the heating of an organic material, such as biomass, in the absence of oxygen. Biomass pyrolysis is usually conducted at or above 500 °C, providing enough heat to deconstruct the strong bio-polymers mentioned above. Because no oxygen is present combustion does not occur, rather the biomass thermally decomposes into combustible gases and bio-char. Most of these combustible gases can be condensed into a combustible liquid, called pyrolysis oil (bio-oil), though there are some permanent gases (CO_2, CO, H_2, light hydrocarbons), some of which can be combusted to provide the heat for the process. Thus, pyrolysis of biomass produces three products: one liquid, bio-oil, one solid, bio-char and one gaseous, syngas.

Preparation of Bio-grease from Bio-oil

For preparation of Bio-grease we need to firstly add any metal hydroxide with same ratio of water and produce a homogenous mixture in grease making kettle. Secondly we have to add animal fat containing acids which reacts with metal hydroxide when heated at 30^0C for 30 min and produces glycerol and soap. This process of producing soap is known as saponification process.

After the preparation of soap when bubbles start to form in the mixture, we will add bio oil which will be further heated at increased temperature for almost an hour under continuous stirring with the help of mixing mechanism. Under continuous mixing the viscosity of the mixture will increase after which cooling under the influence of water jacket will take place. Once the temperature of mixture reaches to room temperature, then the addition of additives takes place because additives are temperature sensitive. After the addition of additives the preparation of grease will be completed and will be ready for collection.

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