Part II

Vegetable Oil-based Eco-friendly Lube Oil Additives

Chapter I

BACKGROUND OF THE PRESENT INVESTIGATION

Mineral lubricants are not environmentally friendly because of their non-biodegradability and toxicity [1], [2]. Mineral lubricants contaminate drinking water, soil, seawater, affect human health, aquatic animal, plant life to a great extent. Therefore strict specifications on various environmental issues such as toxicity, biodegradability, health, and safety emissions are required in certain specific areas [3]. For this reasons demand are being placed on the lube oil production company to produce biodegradable and environmentally benign lube oil and the lubricant industries have been trying to prepare bio-degradable lubricants which are of superior quality to those based on petroleum [4]. Most of the additives which are generally used in lubricating oil are synthetic ester and are very harmful to the environment. The additives prepared from vegetable oils (Triglycerides of long-chain carboxylic acids) for lube oils are highly accepted from the viewpoint of the increasing global environmental solutions [5]. The most commonly used vegetable oils are soya bean oil, rapeseed oil, sunflower oil, castor oil, neem oil, Karanja oil, mahua oil [6], etc. All of the vegetable oils contain triglycerides of long-chain carboxylic acids. These vegetable oils are biodegradable and non-toxic.

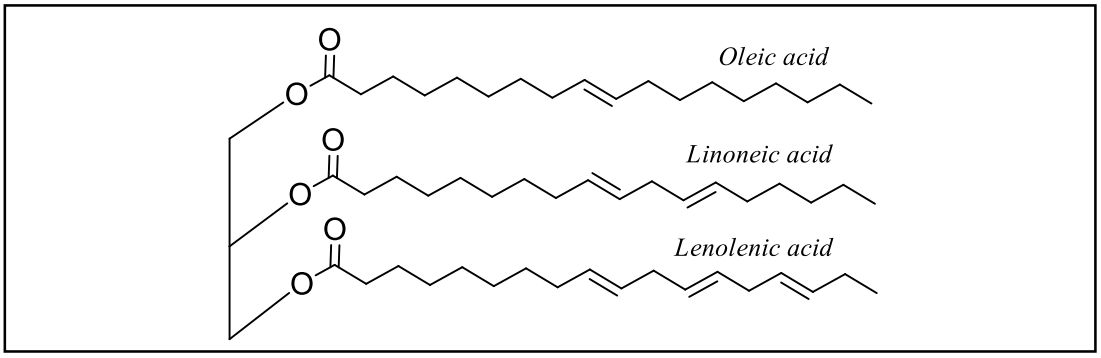

Figure 2.1 General structure of vegetable oil (triglyceride)

In the competition of vegetable oils with mineral oils, vegetable oils have high viscosity index [7], excellent tribological properties [8], high flash point, and low volatility. Therefore vegetable oil can be used in various applications such as self-lubricants or lubricant additives, additives in polymer, etc. Though vegetable oils don't have satisfactory pour points but pour point values can be improved by chemical modification [9]. There are some drawbacks of vegetable oil-based lubricants or additives. They have poor oxidation and thermal stability, high temperature-sensitive tribological behaviour, and poor cold flow improvers are considered as the limitations for their application in the field of industrial lubricants [10], [11]. But the limitations can be modified through chemical modification [12] of the olefin group or carboxylic group or fatty acid chain. There are several references from where it is evident that the chemically modified vegetable oils have eminent scope for use as base fluids.

Vinci et al have prepared a Thermo oxidative stable lubricant based on methyl 12-hydroxy stearate which is a derivative of castor oil with 70% renewable carbon content [13]. Regueira et al studied the compressibility and the viscosities of vegetable oils for their use as a hydrolytic fluid and lubricant [14]. Joseph et al studied and found that a mixture of amine and phenolic antioxidants can be applied to increase the thermo oxidative stability of vegetable oils when used as lubricant base oil at a temperature around 120^0C [15]. There are numbers of references where vegetable oils are used as mineral lube oil additives or as lubricants [16]-[18] U.S. patent number 4970010 described that vegetable oil derivatives can be used as lubrication oil additives. U.S. patent number 522 9023 described the synthesis of vegetable oil-based lubricant additive that can be used as thermo oxidative stability enhancer and viscosity modifiers. In 2009 Franco et al reported that the blending of high oleic sunflower oil (HOSO) with polymeric additives, such as ethylene-vinyl acetate and styrene-

butadiene-styrene (SBS) copolymers at different concentrations in the lubricant formulation and studied the enhanced Kinetic viscosity and viscosity index [19]. In 2015 Nasser et al showed that homo and copolymer of jojoba oil as lubrication oil additives and the performance of the additives was evaluated as viscosity index improver and pour point depressant [20]. In 1993 Bisht et al reported that the application of jojoba oil as an additive in lubricating oil base stocks. They reported that jojoba oil or its compound can enhance properties such as viscosity index improver, antifoam antiwear antirust, and fiction reduction properties to the blend with lubricating oil [21]. In 2013 Karmakar et al studied the homopolymer soybean oil and sunflower oil as lube oil additives. The performance of additives in lube oil was studied as viscosity index improver (VII) and pour point depressant (PPD) [22]. Again in 2015 Karmakar et al reported the soybean oil and its copolymer with 1-Decene, styrene, and methyl acrylate. The performance of these additives was evaluated as PPD, VII, and AW in different lube oils.In 2011, Ghosh et al reported the copolymer of sunflower oil with decyl acrylate and methyl acrylate, and their performances were evaluated as VII for lube oil [23]. Again in 2014 Ghosh et al reported the homopolymer of sunflower oil as lube oil additives. They prepared the homopolymer by two different methods. Thermal and microwave methods and the performance of the polymer were evaluated as viscosity index improver, pour point depressant, and anti-wear for lube oil [24].

From the above literature study, it is clear that vegetable oil-based homo and copolymers are very effective as lube oil additives because of their natural sources and biodegradable nature. Considering the present demand of green technology, in our present investigation we have prepared castor oil and rapeseed oil base eco-friendly lube oil additives i.e. homopolymer of castor oil and rapeseed oil and copolymer with styrene and their performance as viscosity index improve (VII) pour point depressant

(PPD), antiwear additive for base oils were studied. The biodegradability of the prepared vegetable oil-based additives was also studied in different methods and showed considerable biodegradability in all cases.

References

References are given in *BIBLIOGRAPHY* under "Chapter II of Part I" (Page No. 144-146)