AIM OF THESIS

Petroleum (or crude oil) is a complex, naturally occurring liquid mixture containing mostly hydrocarbons, but containing also some compounds of oxygen, nitrogen and sulfur. It is often referred to as the “black gold.” The most common type of lubricant is petroleum derived. Wide use of petro-based lubricants is due to three major reasons. Firstly, petro-based lubricants are the cheapest alternative, making them attractive for application or inclusion into a wide variety of consumer goods. Secondly, petroleum is abundant readily accessible to satisfy the global demand for lubricant. Lastly, petro based lubricants have the longest drain interval (the operating life of a lubricant) of the lubricant alternatives, which lowers the downtime of the machine as completely changing the lubricant takes a significant amount of time.

Although petroleum based lubricants possess many useful physical properties, they are also non-renewable and toxic to the environment. If improperly disposed, petro based lubricants may leech into water systems, cause infections and possibly death to organisms. Industrial machines used in offshore drilling or agriculture require machinery to be in close proximity with a water source, and using petro based
lubricants can potentially be dangerous to the environment. Environmental groups have pressured industrial groups to use bio based lubricants instead of petro based lubricants in these situations.

As the idea that oil soon may no longer be available, industries have been searching for a cheap, renewable source of lubricant. Bio-based lubricants have been the most promising as they have useful physical properties, but they are also have undesirable physical properties that make petro based lubricants the obvious alternative. Much research is being done to vegetable oils to improve the physical properties so that they may compete as an economical alternative with petro based lubricants. Currently there are steps being taken towards creating an economy that prefers a bio-based lubricant through policy, but there are complications in the perception of bio-based oil and the allocation of arable land. The world cannot completely switch over to bio-based lubricants, it must be a gradual process requiring the collaboration of government support, agriculture, industry and research.

Present work aims towards chemical modification of non-traditional vegetable oils, characterizing it and evaluating
its various properties. The work focuses on developing a value added product-lubricants, from vegetable oils. As we know that nonfood uses of vegetable oils have grown little during the last few decades. Although some markets have expanded in this area, still there are many scopes of expansion in use of non-traditional vegetable oils. India has a great potential of producing edible and non-edible tree borne oils, which remain untapped and can be used as potential source for vegetable oil based lubricants with an objective of ecological compatibility in addition to technical performance. Increased markets for such uncommon seeds and oil could increase farmer incomes and maximize the application of agriculture products. Development of new industrial products or commercial processes is the objective of this research in both public and private interests. Vegetable oils have superb environmental credentials, such as being inherently biodegradable, having low eco-toxicity and low toxicity towards humans, being derived from renewable resources, and contributing no volatile organic chemicals. Due to which they been used in various industrial applications such as emulsifiers, lubricants, plasticizers, surfactants, plastics, solvents and resins. Although vegetable oils possess many desirable characteristics, currently they are not widely used
as lubricant base oils. Largely this is due to undesirable physical properties of most vegetable oils viz. poor oxidation stability, poor low temperature properties, poor viscosity index, etc. Monounsaturated fatty acid oils present optimum oxidative stability and lower temperature properties. Vegetable oils with high stability and low pour points—the temperature below which a liquid stops flowing—can be produced by converting all the fatty acids into monounsaturated fatty acids. Therefore, base fluids for lubricants must have a balance of fatty acids, preferably a high level of monounsaturated, minimal poly-unsaturated, and ideally, no saturates at all for use in cold climates. Such balanced chemical structure can be obtained by chemically modifying vegetable oils. Chemical modification of oil involves series of chemical reaction viz. trans-esterification, epoxidation, hydrolysis etc. Trans-esterification of vegetable oil includes reaction of oil with various alcohols to obtain long chain lengths of fatty acids. These longer chain lengths of hydrocarbon have an advantage of entrapping the debris formed during friction. Epoxidation of vegetable oil is done to remove the unsaturation present in the oil, unsaturation is an undesirable property in any of the oil. Unsaturation leads to oxidation and due to oxidation the fatty acid chain breaks
down generating free fatty acid in the oil. Hence use of renewable resources for different industrial applications has a remarkable importance in our society, due to its positive effect on the environment. The formulated products were compared with petroleum based products and the results were tabulated. Entire work is distributed in four chapters which is elaborated as below.

The challenges in this field are to improve certain characteristics of vegetable oils without impairing their excellent tribological and environmentally relevant properties. This implies the utilization and sustainment of the natural chemistry of vegetable oils to a high extent. A preliminary chemical evaluation of base-stocks should detect defects that may cause problems during in-use operation. Also continuous availability of non-traditional oils is a matter of concern.

Chapter-1 deals with general introduction, brief description about the vegetable oils and its use as lubricant, Theories of lubrication, properties of lubricant, and types of friction. This chapter also covers brief description of various type of lubricants and their application.
Chapter-2 is divided into two parts. This chapter focuses on lubricating grease from non-traditional vegetable oils.

Part-1 describes chemical modification of vegetable oils and making it fit as a base oil for grease. Chemical modification of oil includes transesterification of oil using various alcohols. The esterified oil was characterized by GC-MS. Chemically modified oil was then formulated to grease. The grease formulation was done using lithium-12-hydroxystearate as thickening agent. The soap was thermo-mechanically dispersed in the oil and thus various samples of grease were prepared.

Part-2 describes various application tests of the formulated grease. The tribological properties of the grease were then compared with the petroleum based grease and the study was concluded.

Chapter-3 focuses on development of lubricating oil by epoxidation of vegetable oils. The unsaturated fatty acids are the main drawback of vegetable oils. This unsaturation in vegetable oil can be chemically modified by epoxidising vegetable oils using per-acetic acid and acid catalyst. The epoxidised oil was further hydrolysed and the unstable epoxy
ring was replaced by hydroxyl groups. The advantage of hydroxyl group is that it enhances the metal adhesion of the oil which ultimately improves the performance properties of lubricating oil. The resultant oil was then evaluated for its various physical and tribological properties and the results were compared with petroleum based lubricating oil.

Chapter-4 contains development of lubricating oil by forming estolide esters of vegetable oil. Estolides are class of esters based on fatty acid. Their structure is identified by the secondary ester linkage of one fatty acyl molecule to the alkyl backbone of another fatty acid fragment. Estolides are a developing class of natural and synthetic compounds that have been synthesized from hydroxy oils. In this chapter castor oil was blended with non-traditional vegetable oils at various ratios. Estolide esters were prepared using oleic acid and 2-ethyl hexyl alcohol. The esters of vegetable oil were evaluated for its physical and tribological properties and the results were compared with petroleum based lubricating oils.