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Bio Resources in Automotive Engineering Applications

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***Abstract* - The excessive usage of Petroleum - based oils significantly contribute to the pollution of the environment and had caused environmental pollution and awareness from the environmental sectors. Besides that, the demand for fossil fuel and oil products is increasing in numerous areas. Alternative oil should increase to cover about 36 billion gallons in 2022. In other words, there is great demand for oil in the coming few years and high attention should be paid to find alternative resources. To overcome such issue, researchers start developing an alternative fuel and/or oil products from natural resource aiming to replace the fossil products which becomes the main ambitious of many researchers, environmental and government bodies especially in the developed countries such as Australia, US, and Europe. In this article, a comprehensive literature review is introduced and several issue are addressed with regards of the usage of newly developed lubricants which are based on plant oils.**

1. INTRODUCTION

Nowadays, the main dependence on fossil energy consumption had caused environmental pollution and many energy crises. Solving the problem of the environmental deterioration can be through developing alternative renewable energy means. Green energy is an example of a renewable energy which is pollution- free one; it can include wind, solar, bio-energy. Bio-energy generally can be created from bio-materials like plants; these bio-materials can be used as a source of energy such as “alcohol-gasoline blends”, bio-diesel etc [1].

Lubricants are being used widely in all fields of manufacturing for lubricating their materials and machines. Studies showed that more than thirty eight million metric tons of oils were used in Lubrication techniques in 2005. "Petroleum - based oils" are the most used oils in lubrication techniques. The excessive usage of “Petroleum - based oils” had been effects on environment,and this had led to groundwater and surface water contamination, soil contamination and air pollution [2].

A lubricant is used to be a protector between devices. When two devices are in contact with each other a contacting pressure will be created between them causing surface damage if there was not any protector between them. Lubricant is used to reduce and lower the wear between the components of any mechanical devices. Any lubricant can also be used to remove and reduce the heat from a device during its operation. Viscosity is one of the most important properties used to determine and choose the suitable lubricant. When viscosity of any lubricant is too high then the lubricant will require more large force to overcome its intermolecular forces when sliding between the devices. And when viscosity of the lubricant is very small then the surfaces between the devices will be rubbed and this causes the devices damage. Bio lubricants can be developed to avoid any environmental pollution, e.g. sunflower oil, castor oil, soybean oil, Pollock oil , sunflower oil etc. These bio-lubricants are widely used nowadays [1].

Lubricants are commonly used to reduce overheating and friction in a variety of engines, machinery, turbines, and gear. They can be emitted into the environment through cleaning activities and accidental leakage. “Wastewater lubricants” include free oil and emulsified oil created by a mixture of oil with a wastewater and washing agent. The emulsified oils cannot be removed by using conventional treatment techniques such as “corrugated plate interception” or “gravitational oil separation”. Bioreactor is a device used to remove emulsified oils from waste water. Bioreactors control lubricant degrading microorganisms immobilized on sorbent, which is expected to degrade emulsified lubricants instantaneously. Several microorganisms are used to grade lubricants such as zoogloea, bacillus, rhodococcus, nocardiasimplex, commaonasacidovorans, gordonaterrae, and pseudomonas mandelii. Lubricant type affects the degree of lubricant degradation in wastewater [3].

100 years ago, water was mainly used to cool cutting tools due to its high availability and thermal capacity. Lubrication and cooling in machines are vital to reduce the effect of any cutting process at the interface of a cutting tool –work piece. The main drawbacks in the coolant are the poor lubricants and corrosion of the machines. On the other hand, mineral oils were used at that time due to their higher lubricity, but the high costs and low cooling ability of them had led to only using them in "low cutting speed machining operations" [4].

Industrial revolution enhanced human lives by replacing muscular power bymachines. Machines need fuel to run its motion and develop its power. Motion makes the machine parts vulnerable to frequent tear and wear. Antifriction milieu lubricant is often used to guarantee a smoother work, to maintain guaranteed machine operations and to reduce the undesirable failure risks.Lubricants have been used in lubrication sine the invitation of machines [5].

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In the present time, the general tendency and the main interest is to use the natural ingredients in so many manufactured products to protect the environment and replace the non-renewable materials by renewable ones. That affected the market and helped in developing a new market where consumers tend to get products with maybe higher prices in order to reduce the negative impact on the environment [6].
Renewable energy is considered to be an attractive alternative source of energy in future. One of the promising energy alternatives is biodiesel which is used for diesel engines. It is a mono-alkyl esters chain of fatty acids which is derived from animal fats, alcohol and vegetable oils; it is biodegradable, non-toxic, environment- tally friendly, eco-friendly fuel, renewable, portable and readily available fuel [7].

Producing biofuels using waste biomass has several advantages that are noticed in reducing waste volume and toxicity through "recovering a valuable by-product from a waste stream thereby " [8].

The usage of animal fats and vegetable oils as lubricants had started in the year 1650. Later in the 1800s petroleum had been discovered and that led to the replacement of animal fats, vegetable oils and mineral oils, it had gradually started to be the main lubricant base stocks, and that was because of their cheapness and superior performance. Animal fats and vegetable oils kept to be used as lubricants but in special applications. During the1900s, environmental concerns had increased. Most lubricant manufactures had been encouraged to use vegetable oils as base oils because the dependence on the biodegradability had increased .Many studies had showed that it is possible to replace mineral oils by vegetable oils, and this can help in delivering a high viscosity and exhibiting a good lubricity [9].

The addition of oil to water -which has a suitable emulsifier-, will result in having lubrication properties and cooling effects, and this is known as soluble oils, but when considering the environmental challenges, the large scale of MWFs evaluations in machining, in order to decrease the lubricants amount in metal removing processes had revealed the MWFs side effects. Dry machining can be used in order to solve these problems [4].

Manufacturing polymeric materials had been used in the recent years. It contributes in sustainable global attitude and reduce rely on scarce resources, since it has the ability to replace petrochemical derivatives into bio-based derivatives in industries. Furthermore it has extra advantages in decreasingCO_2emission. The oil-based plyometric is often used for producing interpenetrating networks as a toughening factor, since most of these polymers do not have the required strength and rigidity in structural applications [10].

The physical ,wear and chemical properties of two industrial oils for gears the "reference paraffinic mineral oil with a special additive package for extra protection "versus "biodegradable non-toxic ester" were characterized due to their dissipating power in the gear applications. The properties of wear protection were characterized by standard tests of four-ball machine and" FZG test rig "in order to fix the toxicity and biodegradability of the previous two lubricants .Tests of power-loss gear were performed using gears of type C on the "FZG test rig", for the input speed and applied torque on wide ranges, comparing the "energetic performance " of these two oils for industrial gears [11].
Biological oils such as animal, fish, vegetable and algae are superior raw materials for fresh polymers and monomers. The majority of oils like fatty-acids, glycerin and esters are triglycerides oil. In order to convert oils from being non-reactive raw materials into reactive raw materials; functional groups has to be introduced. In the triglyceride molecule there are several adequate sites for chemical attack like ester bounds, double bounds and "allelic positions to double bonds " see figure 1 which has a clarification of double bonds, ester bonds and allelic position in triglyceride molecule [12].

According to [12] the most common chemical reactions happening for double bonds are hydro-formulation and epoxidation," while ester bond is used to make alkyd resins by trans esterification and reaction with phthalicanhydride”. In USA and South America soybean oils are commonly used due to its cheapness in these areas. While in Europe they use rapeseed oil, and palm oil is used in Asia. Soybean and rapeseed oils are semi-dry oils; while fish and linseed oils are dry oils. Palm oils have low unsaturation when compared with the previous oils. As algae type changes, its structure changes in a large domain of compositions. For coating, drying oils are often used.

In order to reach the standards of U.S proposed renewable fuels, the regional outfit of alternative fuels should increase to cover 36 billion gallons in 2022.To solve such conflict, advanced bio-fuels such as hydrocarbon and\or ethanol fuels "from lignocellulosic biomass" should produce 21 billion gallons; by converting the non-grain resources like energy crops and agricultural residues. Pyrolysis is one of the conversion technologies that have an instant effect on the planter's bottom line, when applied with the correct footprint that suites the setting of the farm. It can be defined as the biomass heating when there is no oxygen to produce charcoal and bio-oil. Pyrolysis can retrieve products from "agricultural waste "instead of burning it to produce heat as the only particular product. When “agricultural waste”pyrolyzedfirst, charcoal and the produced gases can be used as petrochemical feedstock, besidestheirdirect use as fuel. Charcoal can be used as climate-mitigating agent and carbon sequestering and for soil amendment which is gaining more and more global attention [13].

There are some representative chemical structure for ester fluids, hydrocarbon fluids, and "water-insoluble polyalkylene glycols (PAGs)", were experienced "ASTMD2619" for evaluation of their hydrolytic stability,

and it was found that chemical structure and purity had highly affected the hydrolytic stability. After oil acid hydrolytic degradation , there were some experimental differences in numbers, layer of water acidity, and weight of copper (Cu) strip are symptomatic of outstanding hydrocarbon oils hydrolytic stability, very good PAG oils hydrolytic stability, and good polyolester oils hydrolytic stability (categorized by an acid number not more than 0.1mg KOH/g and high purity). The hydrolytic stability of polyolesters around the ester bonds are affected by steric hindrance [14].
The standardized tests of lubricants and biodegradability analysis give information about how biodegradability is influenced by chemical structure. Public awareness has been raised because of the technology evolution which includes the penetration of wastes coming from chemical products and how these wastes can affect the environment, and all other risks that can raise the awareness of "the importance of ecological information" [15].

According to [15] it should be clear that "The manufacture of the product should provide the ecological information and relevant standard, this include the information related to the biodegradability assessment, bioaccumulation and Eco toxicity of chemical preparations. Biodegradability assessments results are important when these products serve into the environment during its service or inadequate use, even in utilization, the lubricants act in the same way. In lubricants, the base oil is the main component of the lubricants, which account" 75-80% in engine oils up to 99% in industrial lubricants", and determine the performance and quality of lubricants, and a main contributory factor in the biodegradability of lubricated materials. Optimal usage of local resources and reducing the impact of using the oils on the environment also stimulates the improvements in quality in the produced base oil type. These days 75% of the base oil annual production is " crude oil-derived mineral oils (Group I base oils according to API classification)" because of its low-biodegradability hazardous products ,and 15% production includes " Group II, Group II+ and Group III oils" which is considered to be a low viscous oil with large biodegradability potential, the remaining 10% production covers " poly(a-olefin) oils (PAO) defined as Group IV base oils, as well as the other synthetic base oils referred to as Group V base oils" [15].

According to [16] the first synthesized lubricants were developed in 1877 by using “aluminum tri chloride” as a catalyst. Ester stocks were developed in 1940s and the “synthetic lubricants” were widely used in industrial and military applications. Before those synthetic lubricants, vegetable oils were used. Generally, there are three types of fluids that can be used in forming “biodegradable, environment friendly lubricants”. These fluids include mineral oils, synthetic lubricants and vegetable oils. Vegetable oils were used as lubricants for many years before synthetic ones were developed after the obvious need of making lubricants that are able to cope with the high temperature ranges. Synthetic lubricants can be made through a chemical combination of “low molecular weight components” that are used as building blocks so they can be able to form “high molecular weight compounds”. The molecular structure can be controlled with desired properties. And usually, the choice of base fluids depends on their “performance characteristics”. “The base stocks” used in making the lubricants fall into groups; organic esters, hydrocarbons, phosphate esters and polyglycols. Esters include polyalkylene glycols, “vegetable oil based products”, phosphate esters, polyalphaolefins, polybutenes and alkylated aromatics.
The mechanical hardware used to screen large number of anti-oxidant quantities and base oils is relatively time consuming and expensive method. Therefore, “new oxidation stability tests” were developed to test the field performance within a short time. “Differential thermal analysis” (DTA), “thermo-gravimetric analysis” (TGA) are two methods that had considerable attentions, they offer a high sensitivity and precision, the results can be obtained faster using these type of methods plus they use small amount of samples. The former methods are used to analyze oxidative and thermal stabilities for edible oils but they cannot be used to analyze base oils. The oxidative and thermal stabilities for coconut oil were analyzed to be compared with sunflower oil, sesame oil and “mineral oil based oil” and the effect of adding some anti-oxidants on “the oxidative stability” for coconut oil.

Some specific methods are used to determine “the low-temperature properties” of vegetable oils. These methods are like “pour point (ASTM D97)” and “cloud point (ASTM D2500)”, but the former methods are time-consuming and the data reproducibility is poor. But the “differential scanning calorimetry (DSC)" is a very simple method which can be used to provide direct measurement for DH which is the measure of enthalpy change for any system that undergoes some chemical and physical changes during cooling and heating. “The cooling behavior” for coconut oil was studied to be compared with other types of oil. Also, the effect of adding some additives on coconut oil was analyzed using DSC. After conducting the experiments, results had shown that coconut oil had lesser “weight gain” compared to other types of vegetable oils under “oxidative conditions” and this was due to the saturated nature for the “fatty acid constituents”. But because sesame oil has linoleic acid and Sunflower oil has oleic acid then they possess more thermal stability when they are compared to coconut oil which has “lauric acid”. Modification and determination of the oxidative stability in vegetable oils which are used “as base oil in the industrial lubricants” is more important than thermal degradation because “oxidative degradation” occurs at “lower temperature” [17].

2. RECENT WORKS ON BIO-OIL

The importance of using natural products such as vegetable oils and animal fats which has poor competitive properties has been diverted at the beginning of the industrial revolution due to availability and cheapness of abundant crude products. Recently, the excessive world consumption of crude oil had changed the previous facts about it, it became more expensive, and more challenging to be used during the current global concern about environmental issues; this problem had alerted the reconsideration of using friendly lubricants with renewable properties and sources, like non-editable vegetable oils [5].

Bioenergy characterizes a great solution for the contamination which is caused by fuel ignition either for electrical or mechanical energy generation. “Biomass” is a term used for Bioenergy which is a renewable energy prepared from organic substances. The biofuels environmental effects are evaluated by Life cycle valuations. The "biofuel" term describes the gaseous or liquid fuels that are mainly made from biomass used for the internal ignition engines. Biofuel strategy might take advantage of supporting maintainable agriculture and countryside economic growth. As a result, all analysis had shown that biofuels can replace diesel oil in CI engines, due to their comparable chemistry and physical properties. "Biofuels pure plant oil (PPO)” has lower volatility and higher viscosity than fossil fuels, this help in allowing the usage of PPOs as diesel engines. The usage of PPOs as or diesel engines fuel has many benefits; they are harmless when compared to fossil fuel because they have lesser sulphur content, have biodegradable and renewable fuel properties, and are categorized as environmentally friendly. They can support the national economy by improving safety because they are manufactured in rural areas and can donate the native economy and their agricultural excesses can be recycled to feed animals or use as a source for second generation biofuel [18].

According to [19], the study had focused on studying the technology of a novel "biocide-free metalworking fluids (MWF)" which is based on glycerol/water which is compared to “conventional mineral oil based MWFs”. This technology has been performed using grinding machine experiments. An inner cylindrical grinding process test was used for testing an aluminum oxide (Al2O3) and a cubic boron nitride (CBN) grinding wheel. The tests were executed under the condition of the novel glycerol fluid, grinding oil and an emulsion mineral oil. The results that were obtained from machining tests showed better outcomes of the glycerol fluid oil when comparing to “the conventional mineral oil based fluid” with respect to the deliberate machining forces, the roughness workpiece surface and the instrument wear. Extensive chemical testing ensured that no contrary reaction- or deterioration yields are released when applying the operation from the glycerol-based MWF. Furthermore, to ensure a complete protection against corrosion for the machine and work pieces, some additives were added to the glycerol liquid during the corrosion tests.

According to [20], the objective of the study was to evaluate the behavior of EN + PTFE and EN coatings under bio lubricants lubrication. Coated cylinders tests were applied in lubricated interaction in conjunction with hard AISI 52100 steel on a traversed "cylinder sliding tester". The tests were applies at various sliding speed and the standard applied load. Stribeck curves were used to allow the comparison of different lubricants. The wear scar on the completion of each test was measured to investigate the effect of the altered lubricants by using "Scanning electron microscopy" to classify the wear mechanisms. Lubricated conditions, particularly with bio lubricants were needed to investigate the wear and friction of NiP + PTFE and NiPelectro less coatings .The conditions of boundary lubrication were improved by adding PTFE particles to the NiP coating due to the positive effect of the surface design created by the PTFE particles on the coating surface and its low friction coefficient properties against steel.

Many studies had focused on maximizing the industrial machinery life as function of state- based maintenance and cost-efficient methodology. Main constituents of any successful condition-monitoring program are lubricant and vibration analysis and can be used to predict and identify faults and active engine wear taking place inside apparatus. Machine faults are usually analyzed by conducting each technique independently. On the other hand, the practical experience had shown additional and better dependable information, bringing significant cost benefits to industry, two machine condition-monitoring platform techniques should be integrating. Any Initial information and benefits about the machine’s condition and direct wear modes can be obtained by comparing lubricant analysis with vibration analysis. In many cases, it has been proven that vibration analysis is a leading point of wear for active machine. Furthermore, when monitoring low-speed machines (less than 5 rpm), where techniques of vibration analysis can be applied, and lubricant analysis has advantages. To have an effective program, both lubricant analysis and vibration analysis are essential because wear analysis cannot identify all failure mechanisms individually [21].

According to [22], forging processes are used to obtain desired shapes of work pieces by applying compressive forces using different dies and tools. Good lubricants were used to control grain structure and metal flow of forged parts and obtain toughness and high strength. In the past the usage of Mineral oil lubricants were desired due to its low cost and inherent lubricity. The current increasing awareness about environmental issues the new world trends towards renewable energy sources to find good alternatives for mineral oil base lubricants because of their abundance and simplicity of processing, low toxicity, high flash point, ease of regeneration in rotation plantations and environmental friendliness. Amphiphilic nature gives natural oils biodegradability and environmental friendliness properties to have the priority as alternative lubricants for forging operations [23].

The study was to examine the availability of using rubber seed oil from" Heveabrasiliences rubber tree" as natural oil. In the southern Nigeria Rubber plantations are available with a lot of seeds that are dissipated yearly. When using ring compression test to investigate the friction performance of groundnut oil, sheanut oil and palm kernel oil as upset forging lubrications the results showed 0.072, 0.092 and 0.084 friction factors for groundnut oil, sheanut oil and palm kernel oil respectively and it was noticed that these oils are appropriate for industrial lubricant purposes[24]. It can be observed that when ring compression test was done with plasticize model, the friction performance of sheanut oil, palm oil and groundnut oil as lubricants were obtained 0.068, 0.3 and 0.5 friction factors for groundnut oil, palm oil and sheanut oil respectively[25]. Tribo-chemical process operating with phosphorus additive to observe tribo-chemical behavior of soybean oil as industrial lubricant, it was observed that in the presence of fatty acids, the phosphorus was transformed into a "phosphate-ester based protective layer" to improve soybean oilwear properties. When the wear and oxidation properties of "soybean oil" were using "micro oxidation test" and "sequential four balls wear test" and the obtained results had approved that oxidation stability and good wear performance of oils can be achieved by the selection of composition-dependent additive [26].

The simplification of forging process is called upsetting or "Open-die forging", in this process solid work piece is put inside pair of flat dies and compact in ultimate by compressing it [27]. The effects of barreling are produced initially on the die-work piece interfaces by frictional forces. The interacting surfaces can be separated, cooled and protected against heat generated by friction and oxidation when using a good lubricant. [28]. Choosing suitable lubricants is influenced by the chemo-physical and rheo-thermal properties includeing; specific heat capacity, specific gravity and "viscosity-temperature coefficient" during others. The main approach of physical modeling is to focus on making simulation of forming operation for actual metal by using model dies and work-pieces under conditions like to those in actual forming operation.

The scaled model specimen is from a Plasticine material or any other effortlessly deformed material to be easily formed between a set of model dies to have a similarity to the actual forming tool. The material used in surfaces of model dies are made of aluminium, steel, wood, sandpaper, or plexiglass. The simulation for physical modeling requires having condition factors such as proportional physical properties; similarity for flow stresses, the same friction conditions and equivalent thermal conditions, but practically these conditions is difficult to be met. Therefore, when using Physical model the results obtained showed a various acceptable approximations degrees to the working parts with actual metal. These conditions are satisfied when using "Ring compression test" with model material made from plasticize. Ring-Compression tests can get a good indicator to measure the friction factor-index for steels by operating it on prepared specimens from scaled steel ring using flat dies and presses for forgings production.

The "ring compression test" is practical for forging process especially for bulk deformation method. In this test, if plastically compressing a flat ring through pear of flat dies with zero friction at the interfaces, the diameters for both the outer and inner ring elongate such as solid disk. The inner diameter becomes larger when decreasing friction. For a specific height reduction, the final results approved that there is a critical value for friction. To get tribometric evaluation for "Heveabrasiliences" rubber seed to be used as oil lubricant in upset forging; simulation was carried out for "ring compression tests" using Plasticize model with the rubber and conventional oil lubricant. California Bearing Ratio (CBR) machine was used to compress various rings /die surface combinations with the applied oils. Final Results showed that Rubber seed oil have a potential to alternate "mineral base oils" which is used as lubricants in upset forging through the values obtained for friction factors for rubber seed oil which was ranging from μ=0.20 to μ = 0.577 while reference values for mineral base oil is between 0.29 to 0.42 [22].

2.1 Vegetable bio oil

Nowadays, natural factors are taking high attention in our cultures. Many researchers work so hard trying to minimize the environmental pollution. From an ecological point of view, lubricants do not create problems when compared to other chemical products. About 5–10 million tons of oleochemicals petroleum pollutants enter the environment annually. These oleochemical pollutants are produced from the petroleum products, food industry, and byproducts such as hydraulic, lubricating and cutting oils. There are two criteria for terminology, subjective and objective. The subjective or non-measurable criteria are being compatible and friendly with environment. The objective criteria include biodegradability, ecological toxicity, water solubility, efficiency improvements, etc. Orientation is to use Eco-friendly sources of lubricating such as vegetable oil. Vegetable oil is preferred because it has high biodegradability compared to mineral oil and it isclassified as a renewable source. Vegetable oils are better in biodegradability compared to petroleum-based lubricants. Palm oil is the most desired type of vegetable oils; because it has the potential to satisfy the request for "vegetable-based lubricants". The practicability of palm oil was compared with "additive-free paraffinic mineral oil" in a" plane strain extrusion "apparatus at room temperature to test its performance to be used as a lubricant in cold condition. Annealed pure aluminum A1100 material was used for the workpiece. The results showed that palm oil performance was satisfying as a lubricant, when it was compared to "paraffinic mineral oil", it gave smoothness for the surface and that affected the velocity and strain distribution in the deformation zone of the work zone, palm oil had decreased the extrusion load [29].

Vegetable oils are very good candidates used as lubricants, these oils offer good lubricity, “weak viscosity-temperature dependence”, high biodegradability, nontoxicity. And the negative sides of vegetable oils can be improved by using some additives. We need to mention that making lubricating greases with complete percentage of “biodegradable raw materials” is relatively a hard task because the substitution of the thickener agents by the

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additives is a hard complicated task. The bio-thickener should always convey the rheological characteristics. The work showed that the usage of chitosan, chitin and acylated derivatives can help in obtaining “gel-like dispersions” for vegetable oils, and they are considered to be good biodegradable alternatives to “lubricating greases” [6].

Vegetable oils are triglycerides. Glycerol contains “three hydroxyl groups” which is esterified with “carboxyl groups of fatty acids”. Excess “saturated fatty acids” leads to “low temperature behavior” while excess “unsaturated fatty acids” leads to a bad oxidation behavior at “high temperatures”. Usually, “the triglyceride structure” gives the esters high viscosity. The flash point is relatively high leading to low volatility and vapor pressure. Vegetable oils are less stable and have good filterability. These oils are suitable for “chain drive lubrication”, mill blade applications and they also can be used for medium or low pressure for “hydraulic systems” or small loaded “gear drives” where there is a little chance for high contamination or water ingress [16].

Using vegetable oil as a lubricant is desirable today due to its high biodegradability and renewability compared with mineral oil. Palm oil is the most popular and used vegetable oil. Due to the increasing amounts of pollutants; interest in ecological factors and environmental issues had been increased among societies. Some environmental facts indicate that "5-10 million of petroleum-based oleo chemicals enter the biosphere every year. About 40% comes from spills, industrial and municipal waste; urban runoff, refinery processes, and condensation from marine engine exhaust "most of these oleo chemical pollutants come from petroleum products, food industry and byproducts, like hydraulic, cutting oils and lubricating. There are two criteria dividing the environmental compatibility terminology, subjective and objective. The subjective one which considered as a non-measurable criteria and the objective criteria, which are concerned about water solubility, ecological toxicity, efficiency improvements, biodegradability, etc. at least 60% biodegradability is the criterion of bio-lubricants according to "OECD 301". Vegetable oil is one of the best candidates to fulfill these needs .For many years natural oil from fatty acid such as palm oil, rapeseed oil, sunflower oil, tallow oil, and soybean oil have been used in lubricants, with a biodegradable base; this type, comparing it with mineral oil, will show minimal friction coefficients, excellent wear protection and other tri-biologicalqualities and that’s because of their lower stability contra hydrolytic stress and thermal oxidative, and mainly the low properties of cold flow. Additives on the other hand can improve these limits [29].

Jatropha is a perennial, drought resistant, multipurpose plant which belongs to "Euphorbiaceae Family". Jatropha plant is used to produce bio diesel. Jatropha plants grow in tropical countries and are characterized by low to high precipitation areas. It can be grown either on boundaries as a rail to prevent erosion and to be protected against grazing animals or in the farms as crops. The fruit and wood of Jatropha are used for many purposes including fuels. Jatropha's seeds have viscous oil which can be used for the production of soap and candles, also in cosmetics industry and it can be used as paraffin/ diesel alternate or extender. Jatropha plant canaslo be used to reclaim land and to prevent soil erosion. Its versatility and characteristics are making it very important in developing countries. Lisbon was the first city that used Jatropha in commercial applications likesoap production. Oil which is produced from Jatropha plants can be used as fuel in diesel engines. A new technique is developed to produce biodiesel from Jatropha with high level of “Free Fatty Acids” (FFA). This technique includes two stages which were selected to improve the methyl ester yield. The first one includes “acid pretreatment” process to minimize the level of FFA for Jatropha seeds oil to less than one percent .The second stage includes “alkali base catalyzed trans-esterification” process to produce more than ninety percent of methyl ester yield.The lipase manufacturing whole cells of “Rhizopusoryzae” immobilized onto biomass support atoms is used to minimize the cost of biodiesel fuel which is produced from Jatropha plants [30].

There have been experiments to increase the fuel temperature in order to explore the effects of reducing the viscosity of Jatropha oil, and to eliminate the emission and combustion characteristics effects on the engine. Other experiments were conducted in order to study "the effect of reduced blend viscosity on emissions and performance of diesel engine "using jatropha oil blends and mineral diesel .Results had shown that using the Jatropha oil to operate the engine ,the emission and performance parameters were very similar compared with mineral diesel "for lower blend concentrations", but for the "higher blend concentrations" emission and performance parameters were marginally inferior [31].

In order to produce new polymers fish oil, algae oils and vegetable oils are superior raw materials. They differ in unsaturation and structure, but have many different good qualities. While vegetable oils had different unsaturation degrees; fish oils have higher unsaturation degree. As new raw materials algal oils are considered but with caution as they have some unexplored properties. Except for cashew nuts oils, most oils are considered to be triglycerides, they are long chain of hydrocarbon aromatic compounds. For a long time direct polymerization oils had been used for coating. Using high temperature heating and thermally polymerized oils in order to produce high viscosity oligomers. By new developed methods, the products have the same benefits as lubricants but for high intensive items, more functional groups have to be inserted such as carboxyl, amine and hydroxyls. The most profitable ones are the hydroxyls because it can unfold the entire polyurethanes area (coating, sealants, elastomers, adhesives and foams).A large domain of combinations will be opened when derivatives of fatty acid are used in order to fulfill the various requirements of different materials. Requirements for novel properties, sustainability and answers to ecological problems are the essential elements in bio-based novel materials development [12].

Palm Oil Diesel (POD) and its emulsions are friendly as alternative oils for diesel engine. The effect of POD on deterioration of lube oil wear of engine components is becoming a very important issue. The injection behavior, atomization and combustion appearances of vegetable oils in both indirect-injection and direct-injection diesel engines are clearly different from petroleum diesel oils. Piston ring, piston, bearing, cylinder liner, cam, crankshaft, valves and tappet are the main components of diesel engine which are involved with wear process [32].

In some countries like Malaysia palm oil can be used as lubricant. It is biodegradable oil and available in a way that can meet the vegetable-based oil in lubricants demands. Compared with other vegetable oil sources, palm trees can produce 10 times more oil. The “cold work forward plane strain extrusion experiments and viscoelasticity analysis "of the deformation area in a work piece had been extruded with "RBD palm stearin "the distribution of the effective strain and velocity were investigated. By comparing the RBD palm stearin analytical and experimental results with the mineral oils, particularly the additive-free ones, like VG460 and VG95.The obtained results showed that when the paraffinic mineral oil are with no additives, the RBD stearin of palm tree can minify the extrusion load, and produce a surface with low roughness value, the distribution of effective strain and velocity in the work piece's deformation area are affected by the frictional constraint reduction [29].

Coconut oil is included in the lauric oils group which is a special group of “vegetable oils”. The fatty acids in coconut oil are saturated. Saturated character helps to create strong and excellent resistance to “oxidative rancidity”. During refining processes some of the “natural anti-oxidants” maybe lost and this leads to oxidative stability reduction. But this reduction can be reformed by adding some good anti-oxidants. When the lubricants show more resistance to oxidation the less is their tendency to create sludge, deposits, engine oil, corrosive byproducts, industrial oil applications, “undesirable viscosity" [17].

According to [1] soybean oil can be used as bio-lubricant; soybean oil has some special properties; it is renewable, biodegradable and friendly with the environment, its flash point is high and this helps in avoiding explosions, its viscosity is more stable when compared to other lubricants, its evaporation loss is relatively small, the lubricity of it is good, it is cheaper than any other “industrial lubricants”. Experiments were performed and data were collected to study the working efficiency and viscosity of soybean oil. Viscosity is created from the intermolecular forces of any lubricant. When increasing temperature then the intermolecular forces will decrease, and in this way, the “temperature dependent viscosity” experiments of lubricants agreed with the general theoretical prediction.

According to [6] lubricant greases got the description of being “structured colloidal suspensions”. A gelling agent (or/and) a solid thickener is scattered in lubricating oil and some additives are added too in order to make the functions and properties better. Lubricating greases differ from any other lubricants in their “characteristic, rheological behavior” which can be considered as consistency in “the lubricant industry” and results from the usage of certain thickener. The rheological properties make the lubricating greases more suitable to be used in any application in where liquids do not function in a good way by acting as a “solid or semi-solid” body at small stresses. Lubricating greases can be used in the case of fluctuations with loads, temperature, environmental conditions, and vibrations. Lubricating greases can absorb large amounts of contaminants without reducing its “lubricating properties”. The functional properties and rheological properties of lubricating grease are dependent on used manufacturing process and the composition. Lubricating greases are composed of “mineral oil which is thickened with metallic soaps, silica and bentonite particles” along with some additives such as anti-corrosion and anti-oxidants. Table 1 demonstrates possible applications for different vegetable oils [33].

Table 1: Different types of vegetable oil and their applications [33].

Vegetable oils	Applications
Canola oil	Hydraulic oils, metalworking fluids, "food grade lubes", penetrating oils, "chain bar lubes tractor transmission fluids"
Castor oil	Greases ,gear lubricants
Coconut oil	"Gas engine oils"
Crambe oil	Intermediate chemicals, grease, , surfactants
Cuphea oil	Motor and cosmetics oil
Jojoba oil	cosmetic industry, grease, lubricant applications
Linseed oil	Paints, Coating, lacquers, stains, varnishes ,
Olive oil	Automotive lubricants
Palm oil	Grease ,steel industry, rolling lubricant,
Rapeseed oil	"Air compressor-farm equipment", "chain saw bar lubricants", biodegradable greases
Safflower oil	Diesel fuel, light-colored paints, resins, enamels
Soybean oil	bio-diesel fuel, lubricants, metal casting/working, paints, printing inks, shampoos, soaps, coatings, plasticizers, detergents, pesticides, hydraulic oil disinfectants
Sunflower oil	Diesel fuel substitutes, grease
Tallow oil	Soaps, steam cylinder oils, cosmetics, plastics, lubricants.

2.2 Non vegetable

According to [16], the first synthesized lubricants were developed in 1877 by using “aluminum tri chloride” as a catalyst. Ester stocks were developed in 1940s and the “synthetic lubricants” were widely used in industrial and military applications. Before those synthetic lubricants, vegetable oils were used. Generally, there are three types of fluids that can be used in forming “biodegradable, environment friendly lubricants”. These fluids include mineral oils, synthetic lubricants and vegetable oils. Vegetable oils were used as lubricants for many years before synthetic ones were developed after the obvious need of making lubricants that are able to cope with the high temperature ranges. Synthetic lubricants can be made through a chemical combination of “low molecular weight components” that are used as building blocks so they can be able to form “high molecular weight compounds”. The molecular structure can be controlled with desired properties. And usually, the choice of base fluids depends on their “performance characteristics”. “The base stocks” used in making the lubricants fall into groups; organic esters, hydrocarbons, phosphate esters and polyglycols. Esters include polyalkylene glycols, “vegetable oil based products”, phosphate esters, polyalphaole fins, polybutenes and alkylated aromatics.

There are several ways in which diesel engine industrialists were required to decrease exhaust gas productions to meet European standards for production control. These standards contain the usage of exhaust gas treatments, the improvement of “high pressure fuel injection” apparatus (FIE) and great quality fuel modification. In accordance with the requirement of fuel characteristics, the European Union had set a standard limitation of fifty ppm sulphur in diesel oil, which had been used since the year 2005. Diesel fuels including low levels of sulphur are becoming widely useable in Europe, Germany and United Kingdom. Europeandiesel fuels are used in “Fuels and Engine Technologies programme” (EPEFE). The” lubricity of diesel oil” has a direct influence on the life of the oil injection apparatus. Swedish diesel fuel (MK1) is a fuel which contains low level of lubricity and low sulphur. There are many studies that investigate the ability to use “fatty acid methyl esters derived from rapeseed (RME)” and “ultra-low sulphurdiesel” (ULSD) blends to advance MK1 lubricity. Fuel lubricity is evaluated by using a high “frequency reciprocating rig”. The wear mark diameter of the ball sample is measured by using “optical microscopy” but the surface roughness and wear profile of the disc were analyzed by using a profile meter. Chemical structures of the surfaces and microscopic topography of MK1 are evaluated by using “scanning electron microscopy” with an “energy dispersive spectrometer”. Results approve that MK1 has low lubricity when compared to other fuels [34].

Pipelines networks are seen as one of the most economically and practical effective types of transportation which are used to transport large volumes of potentially and flammable hazardous substances. In most countries, the pipeline networks had become widely used and also the usage of natural gas (NG) had increased. Therefore, the economics of these countries depend on the safe and stable operation of pipeline networks. Leakages of natural gas (NG) from storing / transporting facilities are occurring in many countries and it is not directly noticeable because the natural gases (NG) have colorless, immediately diffusible and odorless properties. The reasons behind the leakage of the NG are mechanical failures, external interference, construction defects, erosion and natural disasters in pipelines. Pipeline leakages led to negative consequences in different dimensions such as environmental damage, large economic losses and fatalities. To detect Pipeline leakages, biosensor substances can be used [35].

"Metalworking Fluids (MWFs)," are type of lubricants which are widely used in operatingthe machines. There are different types of "Metalworking Fluids (MWFs) which can be used in different applications”. Mineral oil based fluids" are the most MWFs that can be used. "Mineral oil based fluids" increase quality and productivity of manufacturing operations by lubricating and cooling during cutting and metal forming processes. Due to their benefits, the usage of MWFs is increasing in manufacturing operations. Around 320,000 tons of MWFs are used in European countries yearly. Although they are used widely, they create major environmental and health hazards during their life cycle [36].

Electroless Nickel coatings are known to have excellent characteristics such as wear resistance and corrosion, lubricity, hardness, uniformity of credit regardless of geometries, bond ability and solder ability and nonmagnetic properties; they are commonly used in the chemical, mechanical and electronic manufacturing. A development in some of these characteristics can be accomplished by the incorporation of solid particles (SiC, Al_2O_3, B_4C and diamond) and dry lubricants (polytetrafluoroethylene PTFE, M_oS_2 and graphite). These components produce a film with excellent anti-sticking and self-lubricating characteristics. This point is reported by several researchers that have reconnoitered the wear behavior of these coatings by using different wear testers [20].

‘’Binary nickel-titanium (NiTi) alloys are used in many application such as dental and medical industries. NiTialloys have unique “super-elastic or shape memory effect (SME)” and biocompatibility characteristics. Generally, metallic alloys which have “high concentrations of titanium” are poor tribological substances and they do not react well to lubrication by using organic fluids [37].

“Carbon based coatings” had been used widely during last decade, the coatings combine between high hardness and “low friction behavior”. Lubricants are designed to manage a suitable interaction between moving surfaces. Sometimes, metal carbon surfaces might produce “physiochemical reactions” with lubricant components. The combination between lubricants and coating can help in protecting the devices from any undesired reactions [38].

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2.3 Edible and inedible oils

Recently there is a big concern about using edible vegetable oil or the feedstock first generation, because it may cause starvation in poor and developing countries, the other problem appears in utilizing the available "arable land", and it can create ecological imbalances when countries start cutting forests. Hence, these feed-stock cause deforestation and wildlife damage .Therefore, feedstock second generation or "non-edible vegetable oils" will be attractive to produce biodiesel, beside for the "sustainable production of biodiesel "the feedstock second generation is very promising .There are examples of non-edible seed crops oils like; Jatrophacurcas, (tobacco), Deccan hemp, (castor), (Jojoba), (Sea mango), Coriander, Salmon oil, Desert date, Cardoon, (Milkweed), Tung, (Lucky bean tree). Microalgae oils are considered to be "inexhaustible source of biodiesel". They are very economical when comparing them to edible-oils. Microalgae give the highest oil yield, and its yield is "25 times higher than the yield of traditional biodiesel crops". Waste of cooked vegetable oils is another biodiesel feedstock with cheap price relatively for production of biodiesel from fresh vegetable. As an economical source biodiesel production from cooked vegetation oil is good option, global consumption of biodiesel feedstock should rely on multiple sources since expiring one source will bring harmful effects on the long term, biodiesel feedstock should be as diversified as possible, depending on geographical locations in the world [7].

Using non-editable vegetables will not contradict with countries demands for food. Vegetable oil lubricants cover a small market segment and raise slowly and steadily, in open applications such as chainsaws, forestry, two stroke engines etc. More efforts had been taken to the change the global laws and policies to ensure the environmental safety, in all cases of lubricants interference environmental compatibility must be checked. On-edible vegetable oils have the potential to divert the agricultural practices and strengthen the economics [5].

Biomass like edible, non-edible crops, microorganisms, algae, recycled cooking greases, wood (lignocelluloses) and animal waste used to derive bio-oils. The most popular virgin crops used for the production of bio-oil are canola, corn, soybean, Rapeseed, mahua, mustard, jatropha, safflower, sunflower and palm. For bio-ethanol production sweet sorghum, straw, sugar cane/beet and, rice, wheat and corn can be used .The debate of fuel vs. food and the environmental impacts concerned about conversion and cultivation will limit using food crops to produce fuel. Converting residues from lignocellulose Material or wood into biofuels is difficult the next decades advanced technology are expected to "reach their commercial stage ", it does not require lands to produce algae, fungi, Yeast and bacteria and it can reach 70%. However, production of a large scale of oil from microorganisms and microalgae can be a challenge [8].

3 BIO OILS AS LUBRICANTS

Bio-oils are liquids that are manufactured by thermolysis or (fast pyrolysis) of "low-grade wood". Although there are different processes of fast pyrolysis but circulating fluid beds and fluidized bed are the most processes used in New Hampshire. The main advantage of using Bio-Oil facility in New Hampshire is it can help the economy by producing new jobs. Also, producing Bio-Oil creates little wastes in environment and it can be used as fuel. It creates less emission than other fuels such as petroleum fuels. Highly acidity of bio-oils and Possibility of immiscible bio-oils with petroleum fuels are the main obstacles in using bio-oils as fuels [39].

Vegetable-based lubricants and solid lubricants are other alternatives that can be used in lubrication techniques. Generally, vegetable oils are very attractive alternatives for "petroleum-based oils" because they are friendly for environment, readily biodegradable and less toxic. Nowadays, "vegetable based oils" are the most alternatives that have high potential to be used in manufacturing as lubricants/MWFs. Many researches are being developed to create a new "bio based cutting fluids" based on different vegetable oils accessible around the world .Vegetable oils mainly include triglycerides, which are glycerol particles with three extended "chain fatty acids" connected to the "hydroxyl groups" by ester connections. Generally, fatty acids in natural vegetable oils have different number of double bonds and different chain length. The fatty acid structure is determined by the position and ratio of "carbon-carbon" double bonds [33].

The manufacturing and transportation regions need huge amount of energy which is produced for diesel engine. Diesel oil is the most used fuels in the world when comparing it to other conventional fuels. Due to huge uses of diesel and diminishing the oil resources day by day, most investigators had studied other resources of energy. More attention is needed to focus on the alternative fuels. Pure bio- diesel is an alternative fuel which is produced from vegetable and animal fat; it is non- toxic, bio degradable and also friendly to the environment. From an environmental perspective; the bio diesel is more suitable when compared to manufacturing diesel fuel. It produces low smoke and carbon which can influence the global warming. Palm oil can be used as a bio diesel which is also known as "Palm Oil Methyl Ester" (POME). Using POME in diesel engine does not effect on performance of engine. Using of mixtures of POME and some additives as lubricants reduce air pollution. To enhance the performance of diesel engine (about thirty percent), the "turbocharger with intercooler" is used. But the usage of turbocharger in bio diesel engine is not appropriate, but it can be used to enhance emission behaviors. Lubricant, fuels, emission reduction system and engine operating situation are also affect the emission behaviors [40].

Crude oil is limited sources for lubricants and fuels. Also, it is not environmentally friendly and not renewable. Therefore, many searchers studied the ability to produce lubricants from oil plants. Bio-lubricants and biodiesel are

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the main plant lubricants. Esterification of plant oils is a technique used to produce bio-lubricants. Esterification technique includes the reactions of "long-chain fatty acids" and oleic acid (12-20 carbon atoms).The usage of bio-lubricants which are produced from this technique depends on the length of the chain of the alcohol substrate. Biofuel and biodiesel can be produced from short-chain (3-5 carbon atoms) and from alcohols molecular which have low molecular weight. Biofuels become the major component in the manufacturing of detergent, food, pharmaceutical and cosmetic. Lubricants can be produced from reactions of "long-chain alcohol" (5 to 12 carbon atoms). Usage of bio-lubricants reduces the chemical risk in environment. Ester group which exist in bio-lubricants effect on physical properties of bio-lubricants. It leads to increase flash point, decrease the volatility and provide a good lubricating ability for bio-lubricants. High molecular weight, low evaporation loss and good viscosity-temperature characteristics are the typical properties of biofuels. Poor "cold flow" and low "oxidative stability" are the most disadvantages of bio-lubricants. The most important advantageof using bio-lubricants in mechanical equipment is it resists stress in machine. They have wide region of application such as high temperature positions and machines with moving parts friction between the surfaces. Forestry machines, mining chain saws, water transport, railway vehicles and installations, agricultural and fisheries machines are the main applications of using bio-lubricants [41].

Biofuels can be derived through chemical, physical, thermochemical and biochemical extraction processes of biomass, where waste oils extracted from vegetable and animal sources which are considered to be a valuable biomass feedstock and that's because the petroleum and fuels are based on vegetable oil There are many possible feedstock in order to derive biofuels such as animal waste, plant matter, industrial effluents and agricultural crops and residues. Bio-char, bio-oil and bio-gas are all converted by using thermochemical, biochemical, chemical and physical processes from biomass into biofuels. Through anaerobic digestion, pyrolysis and gasification bio-gases are produced and for the production of bio-char partial gasification are used with CO_2 or steam or both as a mixture through chemical activation and pyrolysis processes. Beside pyrolysis, hydrolysis, fermentation, chemical/physical conversion and extraction processes are used for the production of bio-oils [8].

Fuel economy has been raised due to the need to increase the performance. On the other hand, the need to reduce emission sustained the demand to start research for lubricants and fuels. The new lubricants should not only respond to certain requirements such as the engine nature and operations happens among it, but also to respond to any change in its design ,fuel types and fuelling methods. The engine performance is affected by the engine lubricants, there is an interaction between fuel and lubricant in the upper part of the ring zone "which has implications on fuel economy and lubricant degradation rates". It is required to clarify lubricant degradation effect and fuel\lubricant interactions through researches in order to let the lubricants play; it is a part in maintaining economy of fuel and responding to new technologies. It is essential to consider the engine lubricant as an integrated component like the engine fuels, due to the increasing demand on engine lubricants. To achieve the best system performance; combustion and exhaust control systems are considered, Till now there is no evidence that this will become true, it is expected that lubricant design will respond to conflicting requirements established by OEMs, legislators, formulation restrictions and modern technologies [42].

Many recent researches focused on developing technologies to manufacture biodiesel from renewable sources like palm, soy, coconut, jatropha and rapeseed. Other studies focused on the biodiesel use on vehicle drivability, exhaust missions, fuel system compatibility and fuel economy [43].

3.1 Conversion Of Bio Oil Into Lubricants

Oil Soluble Synthetic Poly-alkylene Glycols (PAGs) is a new type of oil soluble Poly-alkylene Glycols, that has been developed and derived recently from downstream derivation of "butylene oxide", this new type offers a lot of the traditional benefits of PAGs and offers formulators by an additional tool for promoting hydrocarbon oils through using them as additives to enhance the performance, progress deposit control, extend fluid life and friction control, or using them as a co-base oil. Conventional (PAG) are typically observed as "niche synthetic" lubricants that are used to fix the problems that petroleum oils cannot resolve .Generally most PAGs are made from downstream derivatives of propylene oxide and ethylene oxide, they have many advantages over mineral oils that make them suitable to be used in many applications, these advantages are like; good low temperature characteristics, excellent lubricity, perfect load bearing features, large flash point and great viscosity indices. Synthetic process is the process of manufacturing PAGs; it is very multipurpose process that lets polymers to be designed to have a variety of functional properties [44, 45].

Today in lubricant industry nearly 100 different types of polymer chemistries are used, this versatility can be demonstrated in the design of "water soluble" PAGs from co-polymers of propylene oxide with ethylene oxide. These polymers could be manufactured to have a wide range of viscosities and molecular weight with different ethylene oxide/ propylene oxide ratios and polymer constructions as block or random structures. These soluble lubricants are the main "water soluble lubricant "base oil that is available nowadays, this exclusive feature gives purposeful advantages for fire resistant metalworking fluids, hydraulic fluids, "quench-ant textile" lubricants and others. Conventional PAGs have poor oil miscibility that has two main implications, the first one is if end users want to convert their tools from hydrocarbon oil to a conventional PAG that requires an extensive flushing techniques. The second implication is the conventional PAGs that cannot be used by formulators as co-base fluids or as additives to

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enhance performance. On the other hand, other synthetic lubricant like polyisobutylenes and polyalphaolefins (PAO) can meet greater performance qualifications. So, the design of oil soluble PAGs can provide chances to promote hydrocarbon oils and resolve a lot of lubrication challenges that appear today [46].

Fast pyrolysis and bio-oil upgrading are studied .Fast pyrolysis has many advantages; it can operate at modest temperature (450 C^o) and atmospheric pressure, producing o bio-oil. There are several types of fast pyrolysis reactors such as "bubbling fluidized bed", 'circulating fluidized bed/transport reactor", "rotating cone pyrolyzer', ablative pyrolysis and auger reactor. In bubbling fluidized bed heat is provided externally to bed. It has good heat and mass transfer. In circulating fluidized bed/transport reactor, hot sand circulated between pyrolyzer and combustor. Heat is provided from burning char. In "rotating cone pyrolyzer", biomass and sand are brought to contact in rotating cone. Inablative pyrolysis, high pressure of particle is achieved by mechanical and centrifugal motion on hot reactor wall. In vacuum pyrolysis, rotating and gravity scrappers move biomass through "multiple hearth pyrolyzer" with increasing temperature from 200 C^o to 400 C^o. In auger reactor biomass and sand mixed by auger. Figures 1-6 demonstrate the different type of fast pyrolysis reactors and figure 7 demonstrate fast pyrolysis system [47].

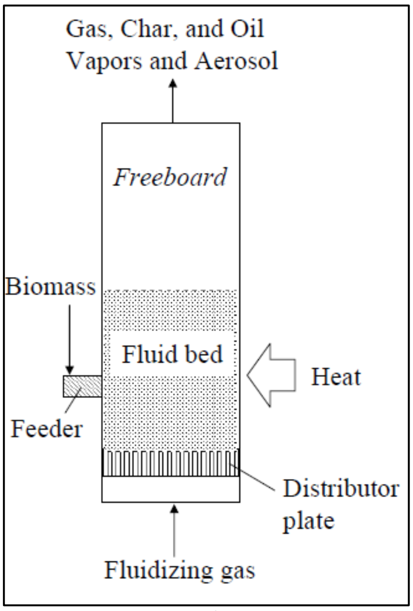

Figure 1 bubbling fluidized bed [47]

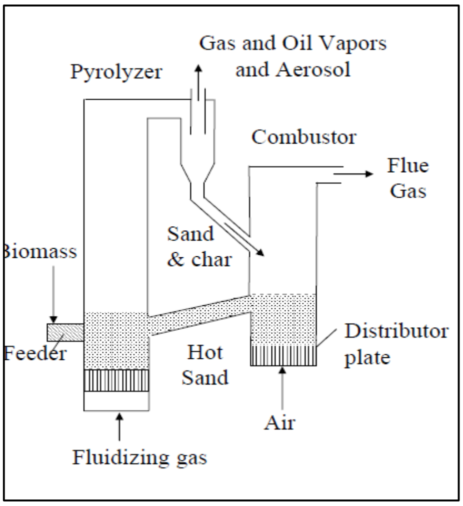

Figure 2 Circulating fluidized bed/ transport reactor [47]

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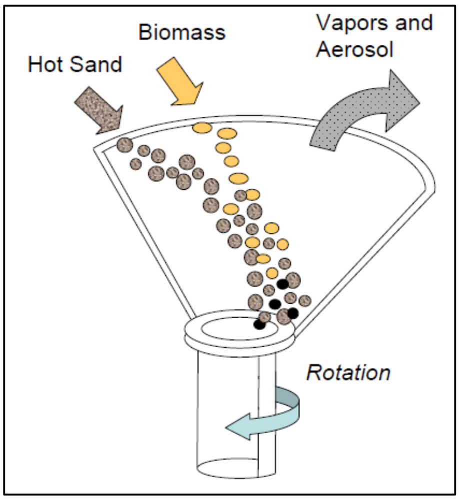

Figure 3 rotating cone pyrolyzer [47]

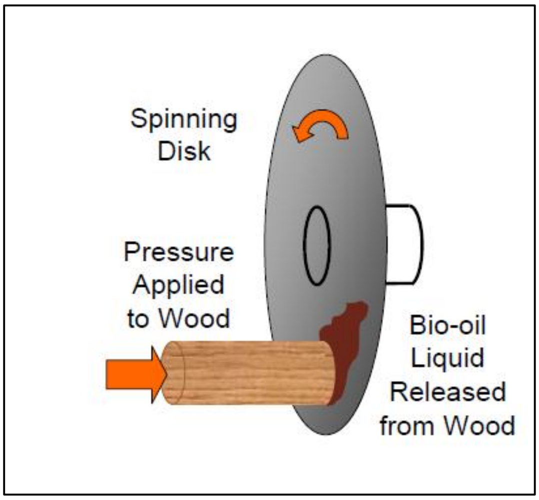

Figure 4 ablative pyrolysis [47]

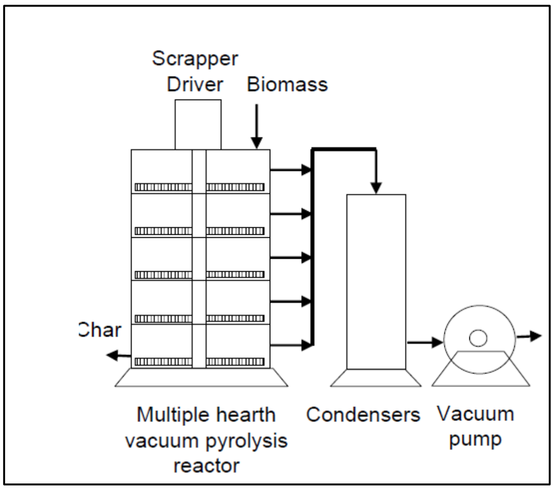

Figure 5 vacuum pyrolysis [47]

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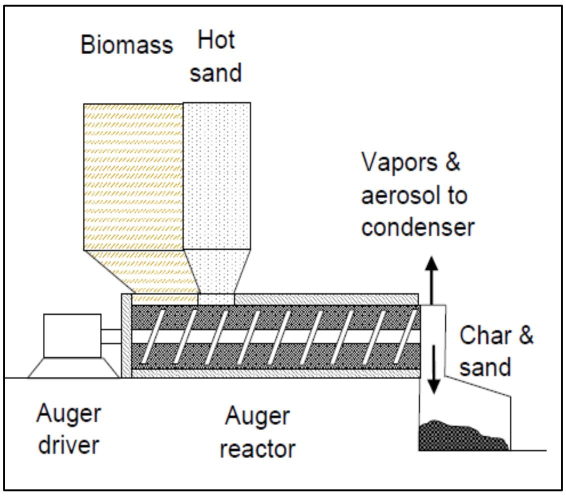

Figure 6 auger reactor [47]

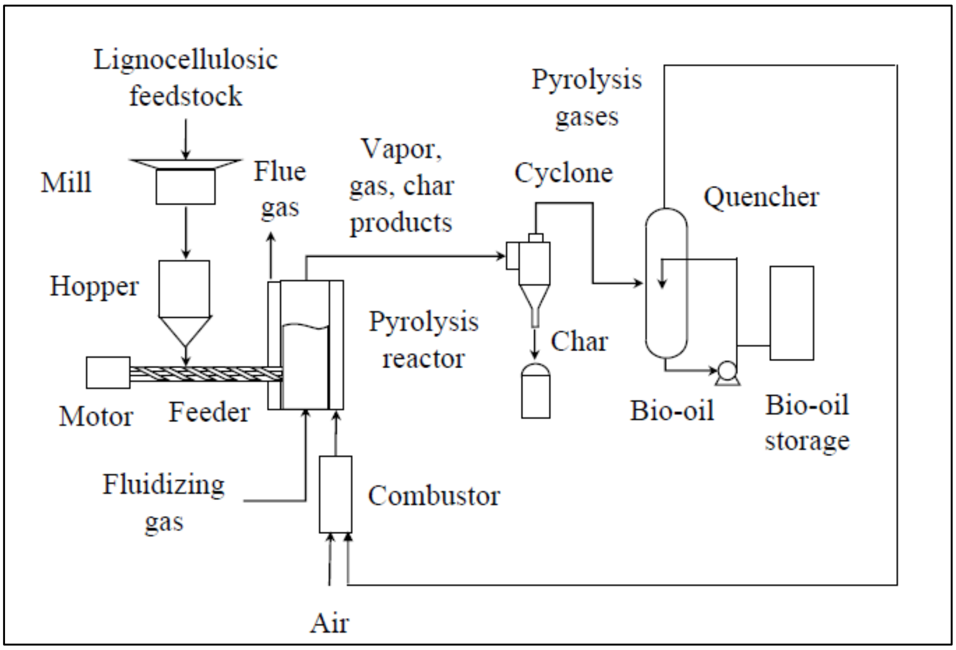

Figure 7 fast pyrolysis system [47]

Direct application of bio-oils, gasification of bio-oils, hydrocracking of bio-oils and fermentation of bio-oils are the main application to use bio-oils as engine fuels. Bio-oils are used directly as diesel fuels and it is only appropriate for stationary power applications. Hydrocracking method is used to convert biomass to liquid bio-oils such as carbohydrate derivatives, lignin and water. Bio-oils are catalytically transformed to hydrocarbon fuels (green diesel). In gasification of bio-oils, char and bio-oil are mixed together [47].

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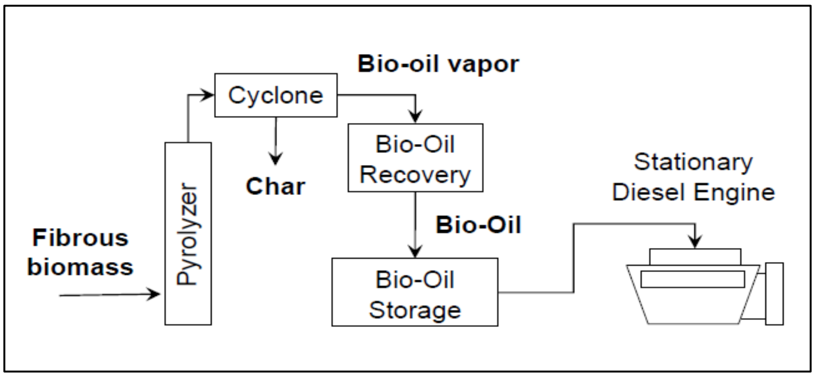

Figure 8 stationary diesel engine [47]

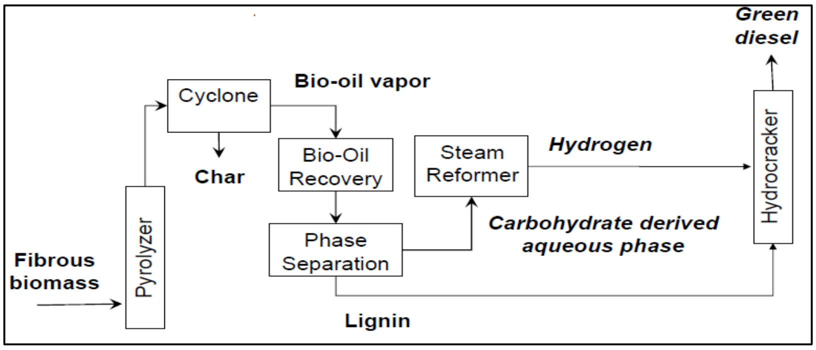

Figure 9Bio-oil Hydrocracking [47]

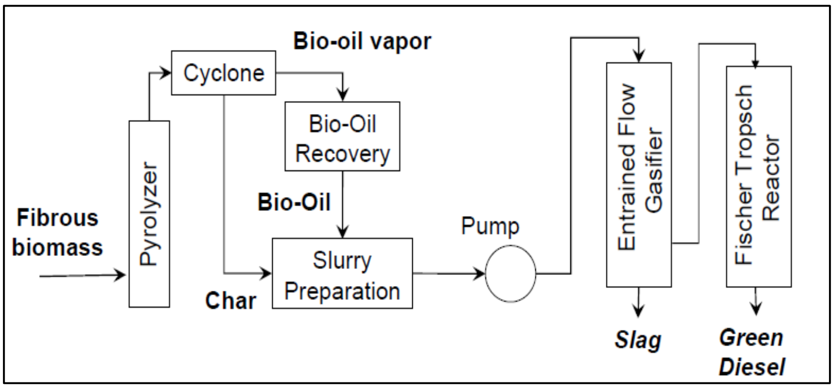

Figure 10 Bio-oils gasification [47]

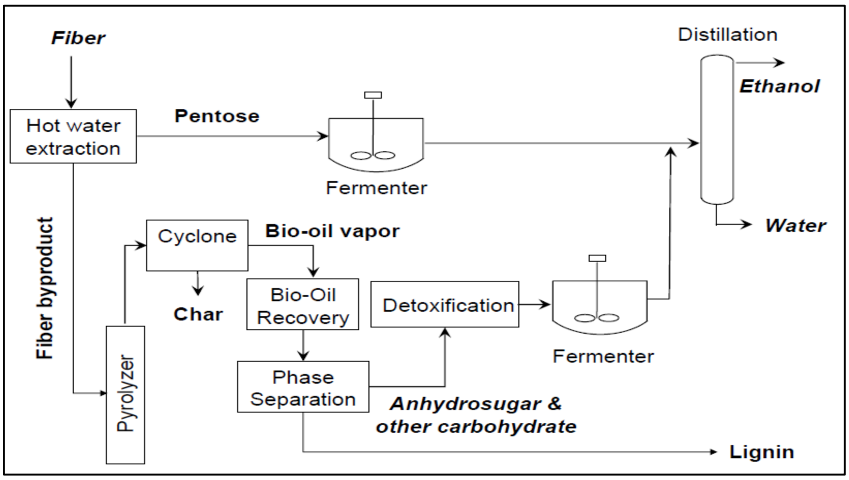

Figure 11 Bio-oils fermentation [47]

Researches are being conducted to improve a variety of bio-based products with lubricants, transportation fuels and polymers. Soybean oil exists in bulk from a natural renewable resource which is recyclable oil. It is possible to copolymerize or polymerize these natural oils into beneficial new resources due to the "low-saturation soybean oil" and "polyunsatura- tion of soybean oil" with great fatty polyunsaturated acid content. For this, a variety of polymeric resources had been developed like tough to elastomers, rigid plastics equipped withthe "low-saturation soybean oil", "regular soybean oil cationic copolymerization", and "low-saturation soybean oil". It was shown that the mechanical and thermo physical properties for thermosets are better than petroleum properties. Low cost, availability of a renewable natural source and their possible biodegradability are advantages of these polymer materials. Improvements in characterizations of interfacial and mechanical tribological (wear and friction) properties for these "soybean oil-based polymeric materials" are estimated depending on the polymers crosslink density to evaluate the ability in replacing products of petroleum-based for engineering uses. Crosslinking reduces the molecular movement of chains between the joints and increases the rigidity of the polymer network. As a result, if the crosslink density increases the number of conformations that a polymer can approve drops and this will increase the polymers stiffness. The preparation of the friction and wear behavior of "soybean oil-based polymers" is by using cationic polymerization of "low saturated soybean oil (LSS)" with polystyrene and divine benzene [48].

Another study focused on the improvement of oleo gels to be used as biodegradable lubricating oils by studying their "rheological properties" and microstructure using some thermo-mechanical treating variables. Microstructure Oleogels were prepared by separating "sorbitanmonostearate (SMS)" in "castor oil" at different agitation situations and thermal proprieties. The evaluation for the effect of treating variables was made by AFM observations, which were made at "small amplitude oscillatory shear (SAOS) measurements and some tribological tests were used to check lubrication stability and performance of lubricating oils. Oleogels rheological properties can be checked *in situ* through a treatment using a rheo-reactor. Processing conditions like extreme temperature was applied to disperse the heating time, gelling agent; cooling rate and agitation speed. Cooling profile is the most significant process variable which influences the rheological reaction of oleogels. Changes in the values of SAOS were found for the treated oleo gels by using altered cooling profiles. A moderate agitation produces extreme values of linear viscoelasticity functions for oleogel. The maximum treating temperature during this step should be only a little higher than the melting point of SMS. Generally, oleogel samples showed a low mechanical stability when they were employed in a rolling element, but they had totally recovered to their original consistency after enough resting time, and they were able to exhibit some notable lubricant properties [6].

Advanced research focused on the gel-like preparations based on mixtures of cellulosic products and castor oil, which are environmentally-friendly lubricating oils. The effect of molecular weight of ethyl cellulose, mixed with methylcellulose or α-cellulose, on the rheological and thermal properties of the designed gel-like spreading was explored. Rheological and thermal performances were tested by linear viscoelasticity (SAOS) measurements and TGA tests means. In order to estimate the suitability of these oleo gels some typical mechanical tests were carried out. From the experimental outcomes, it was realized that SAOS roles of gel-like spreading are not considerably subjective by the molecular weight of ethyl cellulose. On the other hand, a major increase in both SAOS roles was observed when MW values were greater than the critical ones for ethyl cellulose. Furthermore, temperature does not have a great influence on oleogels SAOS roles, which is opposed to the performance found in typical lubricating greases. Preparations which were enclosed by ethyl cellulose/methylcellulose mixtures had displayed perfect mechanical stability factors, and were improved by increasing the molecular weight for ethyl cellulose. All the oleo gel studied preparations showed greater putrefaction temperatures than typical lubricating greases [6].

According to [49], titanium alloy Ti–6Al–4V show promising result as a replacement for heavier steel as ground vehicles materials in certain wear-critical and diesel engine components like connecting rods, movable turbocharger vanes, intake valves, and pistons due to its lower weight properties. Ti–6Al–4V is mainly used in aerospace structures, because it has exceptional corrosion resistance, satisfactory fracture toughness and adequate fatigue strength; On the other hand, it is poor in its sliding characteristics. Titanium alloys often show unstable and high friction coefficients and have a tendency to fail by galling. In this investigation, designated techniques for surface engineering were compared to determine the best one to improve the tribological efficiency of Ti–6Al–4V alloy and 60Ni–40Ti alloy. Applicant improvement involved hard coatings (CrN and TiN), diffusion manipulation, a soft covering (Cu–Ni–In), shot peening, and in situ-formed combined for "titanium-matrix TiB2". Diffusion manipulation involved oxygen diffusion, carburizing and nitrating. The individual surface engineering methodologies effects should be determined, to get the best effects and using the appropriate heat cure to retain the mechanical properties of the titanium alloy ASTM G133 was used to conduct both dry and lubricated friction and wear tests (ball-on-flat linearly responding). Using "AISI 52100 bearing steel" ball specimens. Test coupons were categorized using micro indentation, optical interferometry, stylus and metallographic examination. Lubricated tests were presented using diesel engine oil in engine-conditioned. This study approve that the Ti–6Al–4V alloy wear performance improved significantly with using Surface engineering techniques, on the other hand their comparative rankings had differ considerably between non-lubricated and oil-lubricated conditions [49].

According to [50], the investigation had focused on the improvement of gel-like formulations, by diffusing "eucalyptus Kraft cellulose pulp", or its methylated derivative, in an ethyl castor /cellulose oil medium to obtain appropriate decomposable lubricating greases. The rheological properties, thermal resistance and mechanical stability of these oleogels properties were tested as a function of weight and concentration ratio of the altered cellulosic derivatives. The results showed that the "linear viscoelasticity function" with frequency for gel-like formulations was very comparable to that found for traditional lubricating oils. Generally, as Kraft methylcellulose or cellulose pulp concentrations and "ethyl cellulose/Kraft cellulose pulp" weight ratio increase, the linearity of viscoelastic also increases. However, the relative elasticity of gel-like dispersions is not affected by the composition of thickener blends of on ethyl cellulose/Kraft cellulose pulp, so empirical superposition system can be applied for characterizing the viscoelastic response of these formulations by general master curves. In contrast, the structure of "methylated cellulose pulp/ethyl cellulose" composites affect the "methylcellulose-based gel-like" diffusions relative elasticity. The thermal of linear viscoelastic functions can be measured by an Arrhenius-type equation subjected for these gel-like diffusions. Generally, mechanical stability for compositions of "Kraft cellulose pulp/ethyl cellulose" mixtures drops by increasing the "ethyl cellulose/Kraft cellulose pulp" ratio. However, mechanical stability for "methylcellulose-based gel-like" diffusions was bad [50].

Biodiesel is from new/used animal fats and vegetable oils. It has bio-degradable properties and has minor hydrocarbon emission levels; it is an alternative of conventional Diesel fuel for Diesel engines because it has similar performance characteristics. After a trans-esterification process that modifies the molecular structure, then compression ignition fuel engines can use biodiesel "rapeseed oil methyl ester – RME" as an alternative devoid of any change. To decrease the environmental pollution levels and operating costs, longer periods of oil drain must be done for recent inner ignition engines. Associated studies show that biodiesel fuel can decrease engine wear. These experimental investigations study the effect of the deplete emissions and performance of lubricating oil for commercial RME and Diesel fuel. A single cylinder marine was used to converse and execute long-term wear and emissions tests for both 100 % RME and Diesel fuel. Results indicated that the RME decrease oil viscosity degree and base number, they both have a relapsing effect on lubricating oil execution. Dropping fuel viscosity and increasing running period had increased engine wear. RME affected hydrocarbon and carbon monoxide contaminants in exhaust gas by decreasing them. “Rapeseed methyl ester" had showed parallel performance when compared to Diesel fuel, "Rapeseed methyl ester" reduced the THC, CO emissions and burn denseness of consume gas whereas NO_xemissions had been amplified; After 150 hours of durability test the RME fuel had affected the lubricating oil which aged faster than Diesel fuel. When related to Diesel grades, TBN and viscosity results had lowered biodiesel and the content of iron had increased when replacing Diesel fuel by the RME fuel Also biodiesel can be diluted by engine oil, whereas Diesel fuel has no fuel dilution [51].

There are numerous used techniques to create bio-oil from dissimilar kinds of biomass. One of these methods is “Fast Pyrolysis”, as well as it is characterized that it has a very small residence time that could attain a great outcome of bio-oil. Mainly, the benefit of using "fluidized bed" procedure that it could stimulate heat transfer from heat resources to raw substances. Therefore, the "fast pyrolysis" is commonly utilized in manufacturing scale of creation. "Pyrolysis" is a thermochemical procedure that converted organic substances into practical fuels. "Pyrolysis" that generates energy fuels with "fuel-to-feed" ratios, is considered to be the greatest proficient procedure for biomass plus the most efficient technique .The "wheat-sawdust" bio-oil consists of elevated percent of water in related to the reported bio-oil compared to other biomass. The convolution of the bio-oil structure is suitable for attaining chemicals. But the challenge is the departure of artifacts to chemicals plus liquefied fuel in a cost-effective approach from the basic bio-oil. The basic bio-oil is polymerized at room temperature as a result of elevated oxygen accompanied by water. Therefore, the subtraction of water from the bio-oil is important for storing, as well as calorific value of the liquefied fuel. Usually, the supercritical CO_2 abstraction is utilized for abstraction of natural substance as a result of the non-flammable and non-toxic features of CO_2, as well as its accessibility in elevated pureness with low price [52].

The awareness to find a new renewable unpolluted fuel has increased in recent years. All researchers are working to find alternative fuels like bio-alcohol and biodiesel from biomass sources. Some studies had focused on Pyrolysis oil which is produced from wood for diesel engine. However, its properties do not allow it to be used directly for diesel engine, these properties are like; small calorific value, high viscosity and components corrosion. To avoid such problems, Pyrolysis oil is mixed with biodiesel or diesel. When Pyrolysis oil was mixed with "jatropha biodiesel" with 2% Triton x100 mixed surfactant and Span 80, the results were analyzed to compare combustion and emission characteristics performance of emulsions with biodiesel and diesel, it was detected that "brake thermal efficiency" for "Jatropha Methyl Ester" JOE 15 is higher than diesel by 2% but JOE5 is less than diesel by 6%. At specific full load as "wood pyrolysis oil" WPO concentration rises, energy consumption reduces. The HC and CO emissions of JME and emulsions are lower than that of diesel. The NO emissions for JOE5 and JOE10 are 8.29%, 5.5% higher than diesel, while JOE15 is less than diesel by 1.3%. As final result, when WPO concentration increase, emission of NO decreases [53].

4. CHARACTERISTICS OF THE BIO OIL

Low resistance to oxidative degradation and poor low temperature properties are the main performance issues accounted in using vegetable oils as a lubricant oils. Therefore, there are different methods to solve these problems such as reformulation of additives, chemical modification of vegetable based oils and genetic modification of the seed oil crop. Triethanolamineoleate, triethanolmine and oleic acid are the main additives of the base oils which are used as lubricant oils. These additives affect the thermal stability of rapeseed and tribological behavior of base oils. The additives demonstrated significantly better thermal stability and tribological behavior. Also, the thermal stability of vegetable oils can be enhanced by chemical modification techniques. Modifications of the "carboxyl group" and Modifications of the "fatty acid chain" are the two main chemical modification techniques. Modifications of the carboxyl group include 'Esterification / Trans esterification techniques and Modifications of the fatty acid chain include selective hydrogenation (Dimerization / oligomerisation), formation of C–C and C–O bonds, metathesis and oxidation techniques. The different methods under genetic engineering are used and new vegetable oil types are being used. Sunflower and "high oleic soyabean oils" are some good examples. These oils have higher "thermo-oxidative stability" and higher load transportation capacity. These oils need less adjustment to be used as "base oil lubricants", compared to conformist plant based [33].

"Low temperature performance" is one of the main limitations for the usage of vegetable oils as lubricants, more than synthetic oil-based or mineral lubricants. [54], studied the low temperature behaviors of different types of vegetable oils which are used in lubricating applications .Also, [54] studied vegetable oils behaviors after blending them with "pour point additives". Blends are prepared by rotating the samples at 300 rpm at 100-150 C° for 5-10 hr, depending on concentration of additives and types of them. This thermal process is required to make surethe additives are completely soluble in vegetable oils. After that, samples are cooled at room temperature. Different vegetable oils are used as base stocks such as: castor (CO), soybean (SYO), rapeseed (RO), sunflower (SO) and high-oleic sunflower (HOSO). CO oils are received from Spain, SYO, RO and HOSO oils are supplied by Germany and Spain and SO oils are obtained from local supermarket. Main physical properties of vegetable oils are demonstrated in table 2 below.

Table 2: Main physical properties of vegetable oils [54].

Vegetable oils	Palmitic (16:0)	Stearic (18:0)	Oleic (18:1)	Linoleic (18:2)	Linolenic (18:3)	Linolenic (18:3)	Unsaturated/saturated ratio
Castor oil	2.63	1.51	4.74	8.36	–	82.80	23.20
Soybean oil	11.28	2.70	24.39	56.28	5.34	–	6.15
Rapeseed oil	4.56	–	65.99	21.13	8.16	–	20.90
Sunflower oil	6.18	2.16	26.13	65.52	–	–	11.00
High oleic sunflower oil	3.84	4.42	83.66	8.08	–	–	11.10

Thermal analysis by "Differential scanning calorimetry" (DSC), "Pour point temperature measurement", "Viscosity measurements at low temperature" and Statistical analysis are the main methods used to study the behavior of vegetable oils. Thermal analysis by "Differential scanning calorimetry" (DSC) can be defined as the analysis of cooling curves (heat flow (W/g) vs. temperature) and their blends with cold flow and viscosity improver additives which are obtained by using a various scanning calorimeter (Q-100). In this method, samples are heated in hermetic aluminum tubes at 25 C°, and directly cooled with a cooling rate of 5 C°/min to -80 C°. Also, Samples are cleaned with nitrogen which has a flow rate of 50mL/min and then to determine freezing temperature and wax appearance, the cooling curve for each sample is analyzed. The pour point can be defined as the lowest temperature for the vegetable oil when it is cooled. The pour point of vegetable oils and their blends with additives are determined by (Standard Test Method for Pour Point of Petroleum Products (ASTM D97-02). In viscosity measurements at low temperature method, the dynamic viscosities for vegetable oils will be measured by using coaxial cylinder in" rotational controlled-strain rheometer" [54].

"Differential Scanning Calorimetry" (DSC) is a method used to determine the crystallization for "vegetable-based lubricants". Also, DSC method is more accurate and faster than viscosity measurements and pour point temperature at low temperature methods. In all tests, castor oil demonstrates a better behavior at low temperature, because it has low content of saturated fatty acids and it has hydroxyl groups in the fatty acid chain which can obstruct the crystal packing system of triacylglycerols (TAG) molecules. Vegetable oils which have lower ratio of "unsaturated/saturated fatty acids" crystallize at higher temperatures. Additionally, the concentrations of "Polyunsaturated Fatty Acids" (PUFAs) in vegetable oils have more impact on low- temperatures properties than the concentration of "saturated fatty acids". Therefore, the "rapeseed oil" has better behaviors at low temperatures compared with other types of oil which have similar molecular structure such as HOSO, SO and SYO oils. Generally, "The Pour Point Depressant" (PPD) additives are used to improve the low-temperature behaviors of vegetable oils. PPD additives increase the low-temperature performance and decrease the pour point for vegetable oils which depend on fatty acid composition in vegetable oils. The results demonstrate that the blend of sunflower and the pour point depressant (SO/ PPD) has lower pour point than neat oil (HOSO/PPD) [54].

Biodegradability investigation of lubricants by using standardized tests used to provide valuable information for regulation assessment and purposes of how chemical structure of lubricants influences biodegradability. Poor solubility of lubricating base oils in water is the major problem which obstructs the biodegradability analysis. Ultimate and primary biodegradability are two phases of biodegradability which are used for analyzing different chemical structure oils such "syntheticpolyolester" oils, rapeseed oil, conventional mineral oils and poly (a-olefin) oils. "Co-coordinating European council for the development of performance tests for lubricants and engine fuels "(CEC L-33-A-93 test) is used to evaluate primary biodegradability of lubricants. "Organization for Economic Cooperation and Development Guidelines for Testing of Chemicals". 301B Ready biodegradability" (OECD 301 B and OECD 310 tests) are used to evaluate ultimate biodegradability of lubricants. Primary biodegradability is evaluated according to the (CEC L-33- A-93 test) by using triplicate flasks containing "Di-IsotridecylAdipate" (DITA) as the reference material, triplicate flasks contain the test oils, "duplicate neutral flasks" and "duplicate poisoned flasks" , which are prepared for various duration of time (0,7,14 and 21 days) during the test [55]. Despite, the low temperature properties and oxidative stability of vegetable oil based lubricants compared with petroleum based lubricants it is used in many countries. For example in USA people use corn oil and soybean oil, while in Europe and North America rapeseed oils is used [9].

5 TRI-BIOLOGICAL PERFORMANCE OF METAL COMPONENTS UNDER LUBRICANT CONDITIONS

Extreme pressure tests are carried out to estimate the performance of some "Oil-in-Water" (O/W) emulsions used as cooling and lubricating fluids in operating machines. The influence of concentration of three various emulsifiers (non-ionic, anionic and cationic surfactants) on the extreme pressure characteristics of the O/W emulsions is investigated in more details. Results demonstrated that O/W emulsions have a lubricating performance which is the same as base oils under different conditions. Also, lubricating performance and tribological behavior depend on concentrations and types of emulsifier [56].

Motorcycles are spread in large areas in Asian countries such as Taiwan, china, Vietnam and Thailand .for example in Thailand there was more than 16 million registered motorcycles in the year 2007.These vehicles can play a big factor in air pollution and increasing air emissions due to the high population in these countries. The motorcycles manufactures are shifting "from two-stroke to four-stroke engine technology", thus when the four-stroke engine spread in the market, it will be worth formulating a new biodegradable lubricant for these engines.The blend of mineral oil, palm oil, and an extra package are used to formulate "biodegradable lubricants for four-stroke motorcycle engines". This formulated blend has better properties when compared to commercial oil in terms of flash point, wears car, viscosity index and evaporative loss. The improper additives had caused the sulfate ash and foaming characteristics to be poorer. It was found by the performance tests on the "Bangkok driving cycle for a motorcycle" that the emissions ofNO_x, $CO_2$and THC between commercial and biodegradable lubricants has no obvious difference. The same thing applies to the fuel consumption and engine performance [9].

Because biodegradable oils have good tribological properties and are less damaging to the environment than conventional oils; however, they have poor oxidation stability, the thing that creates limitations on their operating temperature. A creative way to reduce the biodegradable oils oxidation and avoid extreme frictional heating system in any machine elements and hence elongate the oil lifetime-could be offered through the usage of carbon coatings, with their low-friction goods. Therefore, considerations were made for the impact of wheel/pinion material integrations, on the wear resistance and the frictionally prompted oil temperature, by using "FZG gear-scuffing test" method. The results had shown that the combination of the W-DLC/W-DLC-coated gears could highly decrease the oil temperature across a range of loads and provide adequate wear resistance (about1.4 GPa). The steel/steel gear pairs displayed the lowest wear over the all range of loads, but formed extra frictional heating. Both "mixed" combinations (steel-wheel /W-DLC-pinion and

W-DLC-wheel/steel pinion) achieved poorer quality than the combinations of self-mated [57].

"Binary nickel-titanium (NiTi)" alloys are used in the dental industries and medical applications because they have "Shape Memory Effect (SME)" and biocompatibility features [58] and [59]. In recent times "shape memory alloy activated structures" have been recommended and demonstrated in the aerospace industry like the ones used in adaptive inlets and nozzles, general flow control, variable camber fan blades, variable geometry chevrons, and flaps and other hinged components [60] and [61]. Large change for reversible strain inherent in "equi-atomic NiTi" alloys and "ternary high-temperature shape memory" alloys (HTSMA) were carried out. In addition nickel rich alloys, are also being pioneered to be used in aerospace adaptive systems [62], and "NITINOL 60 variable geometry chevrons" test with a full-scale proved their ability to be used for such purpose [63]. Although, to have shape memory performance for Ni-rich alloys, multistep complicated heat treatments are required [64]. An "intermetallic nickel-titanium (60NiTi)" alloy approved its ability to be used in oil-lubricated sliding and rolling contact applications such as gears and bearings. NiTi alloys are highly used for their shape memory characteristics. In addition, NITINOL 60 has beneficial structural properties and exceptional dimensional stability. 60NiTi showed great physical properties when it was processed via high temperature, high-pressure conditions. 60NiTi is electrically conductive, hard, lighter than steel, greatly corrosion resistant, easily machined before last heat treatment, nonmagnetic and non-galling. It can be concluded that under the conditions of oil-lubricated, 60NiTi has significant tribological performance with comparison to other bearing alloys used for aerospace applications [65].

5.1 Tri-biological machines for Lubricants studies

Catalytic hydro-treatment technologies are used to produce refined base-oils which have good antioxidant response, low sulfur content and low volatility characteristics. But, they lack the lubricity property. Lubricity is known as the slipperiness of lubricant films which are formed in boundary lubrication, and also lubricity is defined as a condition which is between “fluid-film lubrication” and un-lubricated sliding. Additionally, lubricity is defined as the resistance of friction between surfaces which is determined by the properties of lubricant and properties of surfaces. Boundary lubrication includes a significant part of lubrication application in metalworking processes. The reduction of the wear and friction are the major function of lubricants in “tribological systems”. Severe wear and friction occur in un-lubricated rubbing surface. Thus, the reduction of the wear and friction are occurred by forming a lubricant film which can separate between rubbing surfaces. The operating conditions such as sliding velocity and applied load and chemical properties of base oils and additives are the main factors that affect the thickness of lubricant film. Severe wear and friction occur in un-lubricated rubbing surface. “Extreme pressure” (EP) additives are used to reduce the effect of dry frication. Usually, additives contain chlorine, phosphorus, molybdenum and sulfur derivatives which can react with the material of “rubbing surfaces” to produce a thin layer of sulfide, phosphate or chloride, which are used as a solid lubricant. Lubricant additives are used to form sufficiently resilient protective and thick film, to combine between surfaces also, it have ability to dissolve in base oils. Usually, increasing the polarity of additives leads into increasing the absorptivity of surface, while increasing in viscosity of additives leads into increasing the thickness of the adsorbed films. However, excessive viscosity and polarity will weaken connection of additive with base oils. So, “amphiphilic molecular structure” is used to reconcile these opposed tendencies. Oxidation stability thermal stability, low volatility, health safety and ecological considerations are other factors that must be considered during lubricity technique. Lubricity additives form protective layers which are self-regenerating. That means; it can be restored after it is damaged by applying high stress. Protective layers are restored by lateral diffusion of adsorbed atoms which are produced by a surface pressure gradient and adsorption of a new portion of friction modifier [66].

Tribological properties of “fatty oiliness additives” and “bio-based lubricity” which are produced by Elektrionizationof “vegetable feed stocks” are studied. Elektrionization is a proprietary technique used to treat feed stocks by using electro ionizing treatment, and this leads to increase viscosity and polarity index of fatty oiliness and bio-based lubricity additives. This type of fatty oiliness and lubricity additives has many benefits such as extended instrument life and improved wear protection, ability to operate at higher speeds, minimize lubricant consumption, clean running and good surface finish, good emulsion stability in base-oils and it is environmental and safety additives. It can be used in mechanical operations in forming, drilling, rolling, cutting, “wet wire drawing”, and deep drawing [66].

A certain study had focused on the elaboration of a fresh technology for heavy-loaded machine, which is lubricated with ecological oils. The tribological tests were performed withcone-three balls pitting trial size (fatigue life), four-ball trial size (scuffing resistance), as well as gear test rig (oiled gear stoscuffing resistance).Thetribo systems were lubricated with a number of vegetable-based-eco-oil and base oil. Making low-friction layers (a-C: H: W, MoS2/Ti) and typical single layers (TiN, CrN). The gained results showed that heavy-loaded machine components take great benefits from low-friction a-C: H: W covering. This covering can take over the functions of extreme-pressure / anti-wear (EP /AW) additives and while this, it is probable to decrease the need of contaminated lubricating additives and gain ‘‘ecological lubrication’’ [67].

2.6 Conclusions and Recommendations

Antifriction / Antiwear lubricants usually include base oils that had been mixed with certain amount of additives to improve the ability of these base oils to resist the mechanical stresses of interrelating working surfaces that face certain limited lubrication conditions. Currently, many additives and most lubricants originate from “petroleum base stocks”; they have negative effects on the environment and difficult process for safe disposal. Therefore, the demand of using green lubricant additives and lubricants had increased. A new resource, vegetable oils are a good alternative to mineral oils because they are environmentally friendly, nonhazardous and eagerly biodegradable nature .The triacylglycerol arrangement of vegetable oils are amphiphilic in character the thing that helps in considering them good alternatives to be functional fluids and lubricants. Also, the existence of double bonds in triacylglycerol structure helps in creating extra functionalization, and adding some technical characteristics like low temperature lubricity, stability and being thermo-oxidative. Thus, vegetable oils are being widely used for manufacturing applications that might have possible accidents like leakage and dripping large quantities of waste materials to the environment. Low temperature behavior, tribo-chemical degrading procedures and thermo-oxidation stability of natural vegetable oils which are used as manufacturing fluids occur under different conditions of pressure, temperature, metal surface, shear stress and environment. To achieve the demands for stability throughout several tribo-chemical processes, the oils structure have to resist shear degradation, variation of temperature, and maintain good boundary lubricating characteristics over strong chemical and physical adsorption with the metal. “Triacylglycerol molecules” organize themselves with a “polar end “on the solid surface to create packed multi-molecular or mono molecular layers that form a surface film which can helps in the progression of asperities and pits on the metallic surface and inhibit metal-to-metal connection. Range of adsorption on the metallic surface and strength of the fluids film are both influenced by the efficiency of lubricants performance. The adsorption energy of the lubricants depends on wear rate and friction coefficient rate. The anti-wear characteristics of marketable additives are produced from a change of elements capable to be connected with the metallic surface and create a stable protecting film. Sulfur, phosphorus, zincand nitrogen are examples on the most active substance used as commercial anti-wear additives [68].

The bio-oil that is generated from biomass would be the greatest promising alternative fuel for transportation in the future due to its environmental benefit. These "renewable" energy resources had turned to be rapidly promoted as a result of the absence of any ecological troubles and pollution. Biomass substances are considered to be ordinary elevated molecular substances, which include oxygen, nitrogen, carbon plus hydrogen. Biomass could be simply obtained from sawdust, discarded wood plus cultivation waste, it is considered to be a maintainable "renewable" energy resource. Biomass could decrease the dependence on fossil fuels and moderate universal warming slightly by decreasing CO_2 emissions. Additionally, certain formulas of biomass could be utilized as alternative substances in chemical feed stocks [69].

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