Global Journal of Researches in Engineering: C
Chemical Engineering
Volume 17 Issue 2 Version 1.0 Year 2017
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Using Biofuels as Lubrication Oil

By Sabah Alali, Meshal Aldaihani, Waleed Abuhaimed & Khaled Alanezi
College of Technological Studies

Abstract- As environmentalconcerns grow, vegetable oils arefinding their way into lubricants for industrialand transportation applications.These oils offer significant environmentalbenefits with respect to resourcerenewability and biodegradability, as wellas providing satisfactory performance in awide array of applications.

This paper aims to determine the properties of different biofuel lubricants prepared from vegetable oils. The investigations of temperature and viscosity propertiesof the lubricating oil were established and their effect on the property changes of the lubricant.

Experiments are created based on SVM test machine, the results shows density, absolute viscosity, and kinematic viscosity of three vegetable oils, the tested oils are Palm, Corn, and Almond oils.

Keywords: biofuels, lubricants, vegetable oils, environment.

GJRE-C Classification: FOR Code: 850309

Strictly as per the compliance and regulations of :

Using Biofuels as Lubrication Oil

Sabah Alali [α], Meshal Aldaihani [σ], Waleed Abuhaimed [ρ], Abdulqader Alfuraij [ω] & Khaled Alanezi [¥]

Abstract- As environmentalconcerns grow, vegetable oils arefinding their way into lubricants for industrialand transportation applications.These oils offer significant environmentalbenefits with respect to resourcerenewability and biodegradability, as wellas providing satisfactory performance in awide array of applications.

This paper aims to determine the properties of different biofuel lubricants prepared from vegetable oils. The investigations of temperature and viscosity propertiesof the lubricating oil were established and their effect on the property changes of the lubricant.

Experiments are created based on SVM test machine, the results shows density, absolute viscosity, and kinematic viscosity of three vegetable oils, the tested oils are Palm, Corn, and Almond oils.

Keywords: biofuels, lubricants, vegetable oils, environment.

I. Introduction

The use of natural fats and oils by man date back to very ancient times.Fats and oils have specific chemical properties which make them very useful as lubricants. Vegetable, animal and marine sourcesare the main sources of natural fats and oils and their chemical naturewouldmake them very useful in many applications. Fats and oils are naturally occurring substancesthat consist predominantly of mixtures of fatty acidesters derived glycerol [1].

Vegetable oils are a renewable energy source in that they are created from plants that can be regrown and they consist mainly of tri-esters of straight-chained, mostly unsaturated fatty acids with glycerol. [2, 3].What distinguish these vegetable oils is that they have higher levels of biodegradability and lower toxicity than conventional mineral or synthetic oils. Therefore, these biofuels can be utilized with ease in cars and other places since they do not require muchchemical or physical property changes. Many scientists believe that the use of biofuels as carbon neutral would be beneficial to the environment since the carbon produced when burning them is offset by the carbon consumed by the plants they came from. Research suggests that using biofuels would help in reducing carbon emissions by 50-60%. They are other benefits for using vegetable oilsas biofuels, for example biofuels from vegetable oils have a very low volatility, good high lubricity and high viscosity index, as well as lower cost than most synthetic oils [4, 5, 6]. Many researches have pointed out that the use of biofuels as lubricants has its own drawbacks for example using land for biofuel crops this will mean less land for food production. Also, vegetable oils have low thermal and oxidative stabilities, narrow viscosity range and higher pour points than both mineral or synthetic oil-based lubricants, that's why vegetable oils have a limited use as lubricants and their use in the industry is not yet extensive [7, 8, 9].

- Lubricant's performance for a certain systemis a very important characteristic that should be quantified and it can be determined by carrying out specific experimental tests. The lubricity of a substance is not a material property whichcannot be measured directly. The lubricity of the fuel is an indication of the amount of wear or scarring which happens between two metal parts covered with the fuel as these metal parts come in contact against each other. Low lubricity fuel may cause high wear and scarring and high lubricity fuel may provide reduced wear and longer component life. Biofuels such as vegetable oils are used as lubricants, specifically, when there is a leakage of equipment or where the system is designed tofunction by loss lubrications. Systems, such as:Open gear lubricants, arming, mining, and forestry equipment, hydraulic oils etc.

The viscosity index (VI) is a very important property of the biofuels, which is a relative measurement in change of base fluid viscosity between 40°C and 100°C. The viscosity index indicates the change in viscosity over an extended temperature range. It is well documented that vegetable oils display very high viscosity indices (VI) compared to mineral oils. Also, vegetable oils can afford higher flash points as compared to mineral oils[10].

Vegetable oils are high-performance base oils which are extracted from coconut, palm and soy.These vegetable oilsare considered as lubricants and they are compatible withadditives currently used in thelubrication industry. These vegetable oils have many advantages such as: low cost, acceptable low-temperature properties, and acceptable oxidative and thermalstability. Fattyacids are normally contained in some vegetable oils and it would improve its lubricity, forexample fatty acids that exist in the palm oil, tend to cling to metal surfacesmore effectively than mineral oils andtherefore provide improved lubricity.The research main point is using biofuels as light lubricant with low heat applications like joints, track, bearings. So,the experiments were carried out at various temperatures

Author α σ ρ ω ¥: Chemical Engineering Technology Department, College Of Technological Studies (CTS), P.O. Box 42325, Shuwaikh, 70654, Kuwait. e-mail: sas.alali@paaet.edu.kw

and the results showed thatoil viscosity will change with temperature, so the temperature range is the main point.

Table (1): Several types of vegetable-based lubricants developed for industry applications (11)

Canola oil	Hydraulic oils, tractor transmission fluids, metalworking fluids, food grade lubes, penetrating oils, chain bar lubes
Castor oil	Gear lubricants, greases
Coconut oil	Gas engine oils
Olive oil	Automotive lubricants
Palm oil	Rolling lubricant,-steel industry, grease
Rapeseed oil	Chain saw bar lubricants, air compressor-farm equipment, Biodegradable greases
Safflower oil	Light-colored paints, diesel fuel, resins, enamels
Linseed oil	Coating, paints, lacquers, varnishes, stains
Soybean oil	Lubricants, biodiesel fuel, metal casting/working, printing inks, paints, coatings, soaps, shampoos, detergents, pesticides, disinfectants, plasticisers, hydraulic oil
Jojoba oil	Grease, cosmetic industry, lubricant applications
Crambe oil	Grease, intermediate chemicals, surfactants
Sunflower oil	Grease, diesel fuel substitutes
Cuphea oil	Cosmetics and motor oil
Tallow oil	Steam cylinder oils, soaps, cosmetics, lubricants, plastics

The experimental data obtained of vegetable oils showed that low values of kinematic viscosities at 40°C but higher values of kinematic viscosities at l00^{O}C (12) with higher viscosity index range from 203 to 263. Also, vegetable oilsviscosity showed much variation over temperature range and have instability and poor temperature properties. Results showed that corn oil and soybean oil were more viscous at high temperatures than synthetic oil.

II. The SVM Machine

Absolute and kinematic viscosity measurements procedure were used to find the viscosity with temperature relationship from different bio-fuels. The device shown in figure (1) is the SVM 3000 and its measuring process depends on torque and speed measurements. The SVM 3000 uses a rotating magnet which produces eddy current field.

Figure (1): SVM 3000 device

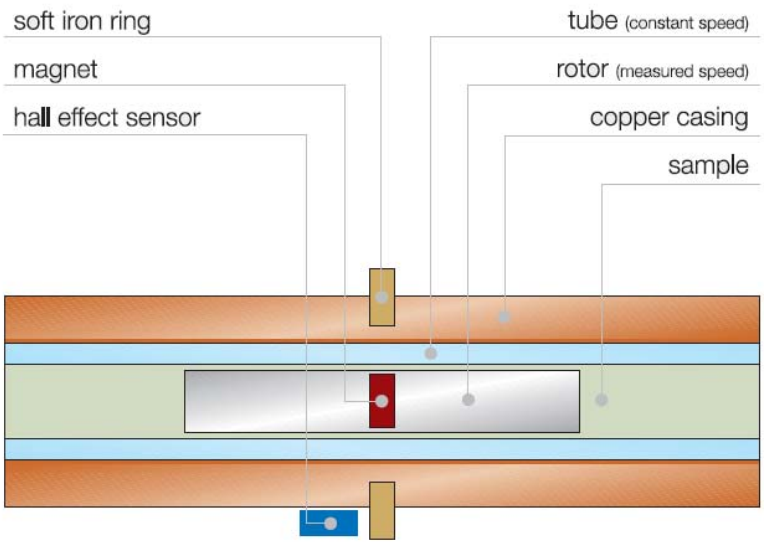

Figure (2): SVM 3000 measuring unit main components

III. Data and Results

Experiment and results are created based on certain procedure related to SVM3000 machine. Corn, Palm, and Almond oils were tested based on Absolute viscosity, kinematic viscosity, and density. The oil samples are taken from commercial oil products available in market, the test is done in College of Technological Studies (CTS) in PAAET (Public Authority of Applied Education and Training-Kuwait).

The first group of results showed the relation between temperature and oil specific gravity as shown in figure (3). The results show that as the temperature increases a decrease in the Corn, Palm, and Almond oils specific gravity was noticed. Therefore, it can be deduced that the specific gravity of these vegetable oils (density) is dropped with increasing temperature.

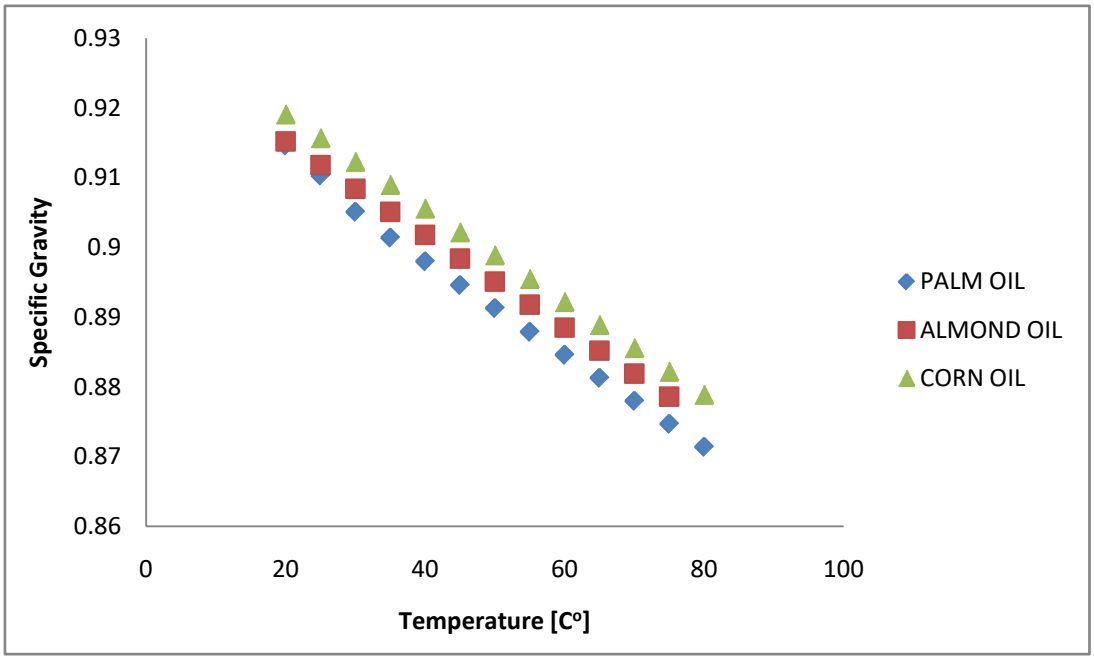

Figure (3): Bio Fuel (oils) Specific gravity vs. temperature

The relation between vegetable oils specific gravity and temperature is linear, by using regression the linear relation is obtained for all oils (Corn, Palm, and Almond). In figure (4) all types of Bio fuels have the same linear inclination (slope), so the behavior of the tested Bio-fuels with temperature is the same if the view point is the oil density or specific gravity.

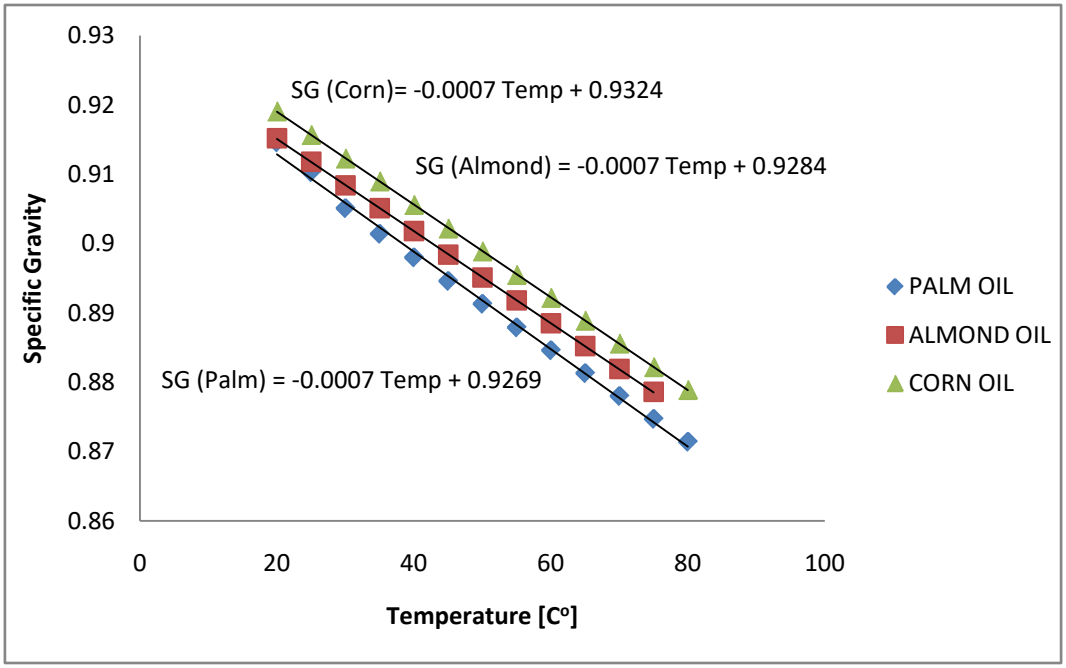

Figure (4): Linear Regression of Bio Fuel (oils) Specific gravity vs. temperature

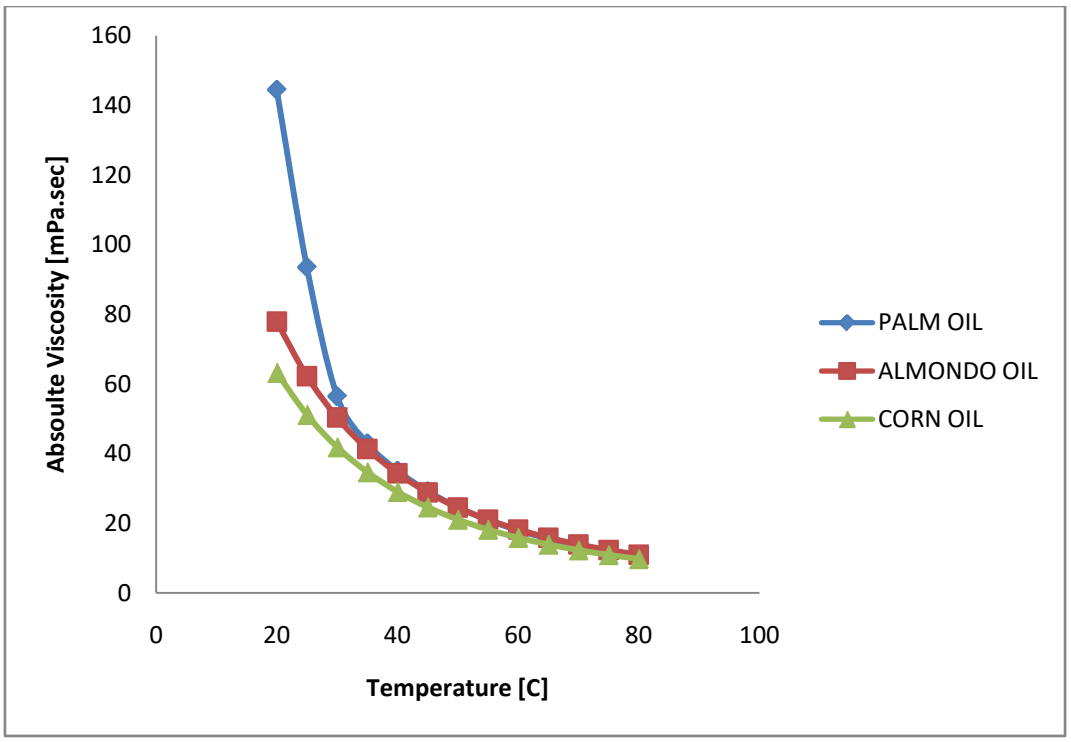

Figure (5): Bio Fuel (oils) absolute viscosity vs. temperature

The oil and new engine oil viscosity is mathematically simulated in sixth order polynomial using Excel software, the mathematical equation is in the form:

$$\mu = a_o + a_1 T + a_2 T^2 + a_3 T^3 + a_4 T^4 + a_5 T^5 + a_6 T^6$$

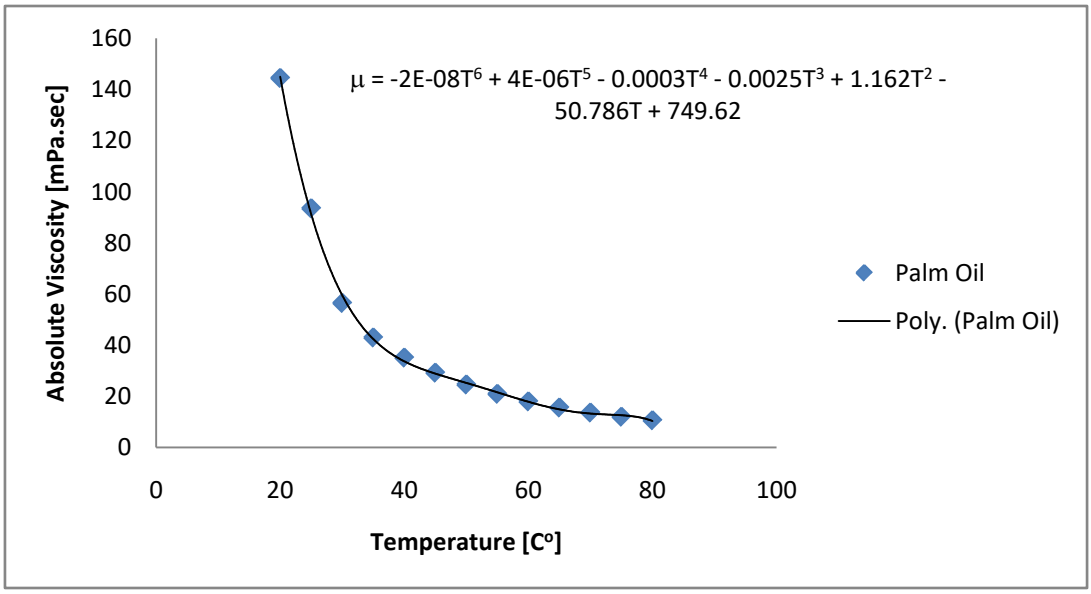

Figure (6): Palm oil absolute viscosity vs. temperature

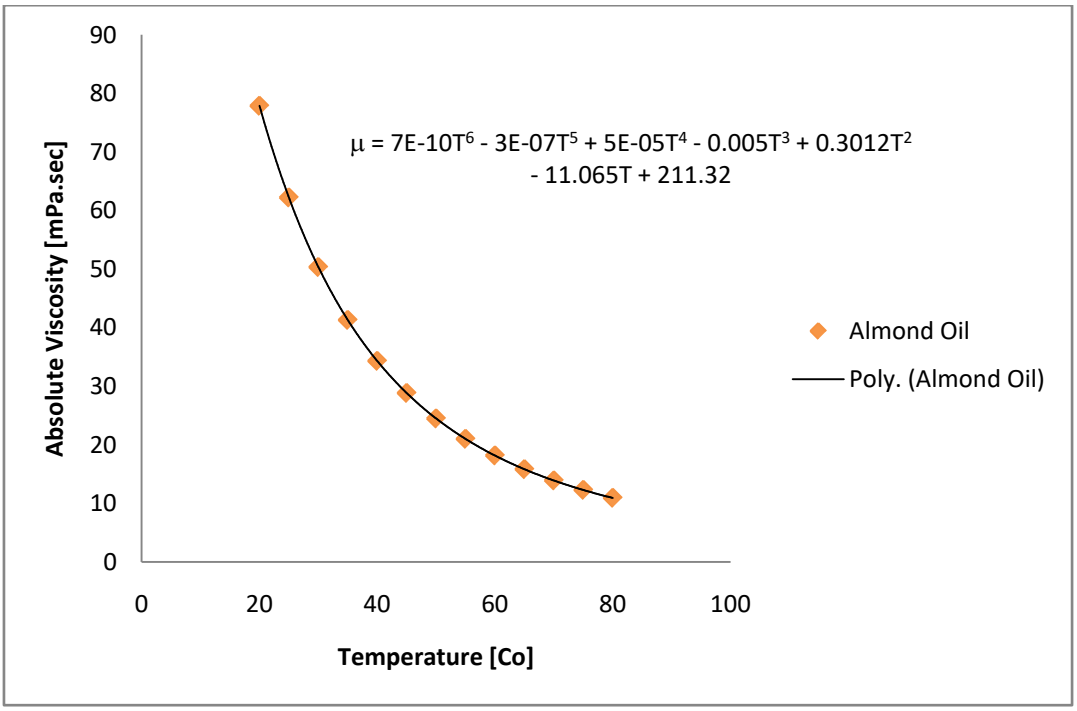

Figure (7): Almond oil absolute viscosity vs. temperature

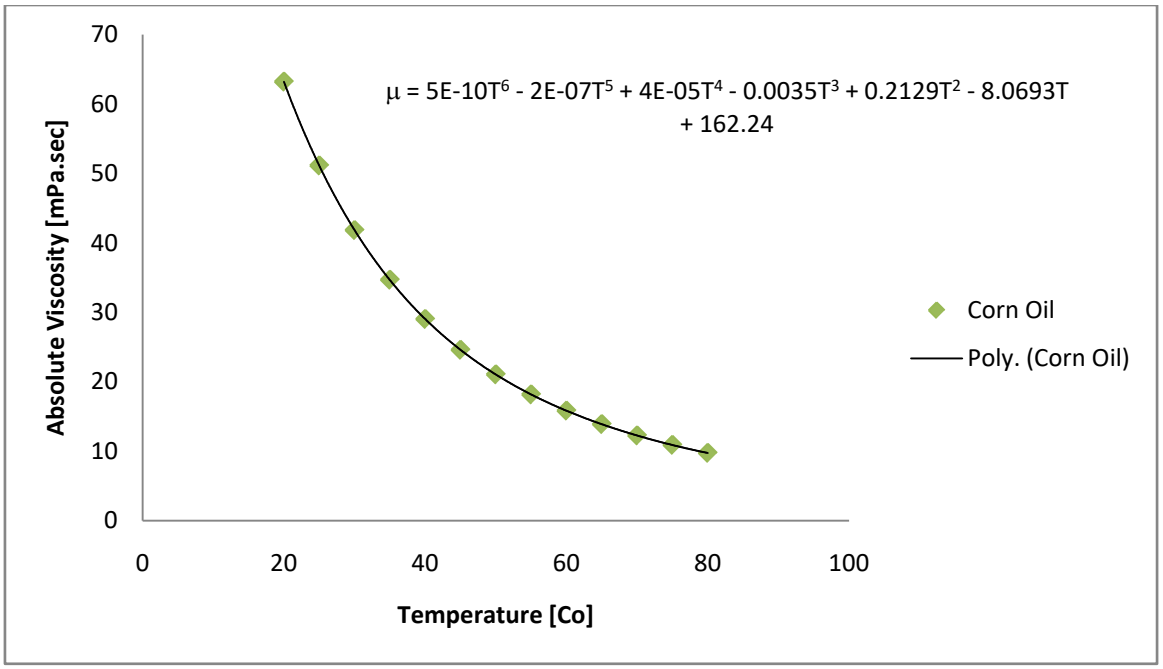

Figure (8): Corn oil absolute viscosity vs. temperature

Figure (6) shows mathematical modelling of Palm oil with temperature, the polynomial of absolute viscosity is of order six, also figures (7) and (8) show mathematical model of Corn and Almond oil, the coefficients of all oil polynomials are obtained.

IV. Conclusions

Different vegetable oils were tested using SVM3000 viscosity machine, this paper aims to create viscosity modelling of these vegetable oils. The tested oils are Palm, Almond, and Corn, the experimental results obtained are oil absolute viscosity, kinematic viscosity, and specific gravity. A sixth order polynomial for absolute viscosity was obtained to show the oil mathematical model, also a linear equation is created using Excel software for the tested vegetable oils specific gravity with temperature.

References Références Referencias

1. Biermann, U., Metzger, J. O. 2008,Synthesis of alkyl-branchedfatty acids: A review. Eur. J. Lipid Sci. Technol., 110, 805–811.
2. Adhvaryu, A., Erhan, S.Z. 2002. Epoxidized soybean oil as a potential source of high temperature lubricants, *Ind. Crop Prod.* 15: 247–254.
3. Erhan, S.Z., Asadaukas, S. 2000. Lubricants base stocks from vegetable oils, Ind. Crop Prod. 11: 277–282.
4. Erhan, S.Z., Adhvaryu, A., Sharma, B.K. 2006, Chemically functionalized vegetable oils. In: Rudnick, L.R. (Ed.), Synthetics, Mineral Oils, and Bio-Based Lubricants. Chemistry and Technology, Taylor & Francis, CRC Press, PA, USA.
5. Campanella, A., Rustoy, E., Baldessari, A., Baltanas, M.A. 2010, Lubricants from chemically modified vegetable oils. Bioresour. Technol. 101: 245–254.
6. Kumar, A., Sharma, S. 2008,An evaluation of multipurpose oilseed crop for industrial uses (Jatropha curcas L): A review.Ind. Crops Prod. 28: 1–10.
7. Sharma, B.K., Stipanovic, A.J. 2003. Development of a new oxidation stability test method for lubricating oils using high-pressure differential scanning calorimetry, Thermochim. Acta 402: 1–18.
8. Duangkaewmanee, S., Petsom, A. 2011, Synergistic and antagonistic effects on oxidation stability of antioxidants in a synthetic ester based oil Tribol. Int. 44: 266–271.
9. Ming KK, Chandramohan D. 2002, Palm oil industry at crossroad and its future direction, Oil Palm Industry Economic Journal 2: 10–5.
10. Fox, N.J., Stachowiak, G.W. 2007, Vegetable oil-based lubricants—A review of oxidation, Tribology International 40: 1035–1046.
11. Shashidhara Y, Jayaram S. 2010, Vegetable oils as a potential cutting fluid—an evolution. Tribol Int 43(5):1073–1081
12. Ibrahim A. and A shikin I., 2013. A Study of Vegetable Oils as a Helical Gear Lubricant, Prosiding Seminar Kebangsaan Aplikasi Sains dan Matematik 2013 (SKASM20 13) Batu Pahat, Johor, 29 - 30 October 2013.