Conversion of used Oil intoLubricatingGrease and Characteristics Evaluation

Salah Eldeen F.Hegazi

Department of Chemical Engineering,Faculty of Engineering ,Jazan University,Saudi Arabia .

Abstract: ***Lubricant grease is consist of a mixture of a fluid lubricant usually petroleum oil and a thickener (soap) dispersed in the oil. The oil is one of the main sources that threaten public health and pose a significant threat to the environment. The work aims to convert used oil into lubricant grease; since the petroleum prices were increase each year, using used lubricant as base oil is the best solution to produce grease in the low cost at the same time it will decrease the water pollution. Soap thickeners are formed by reacting metallic hydroxide, or alkali, with a fat, fatty acid, or ester. Two type of routes are used in this production that is sodium soap and second route added calcium carbonate and sulfuric acid to the used oil. The reaction temperature, residence time maintained at 120oC,120minutes and the cooling spent 48 hr. Viscometer was use in this experiment to analyze the quality and performances of grease product to select the best type of soap to produce grease. The different percent of soap are used to know the effect of percent of soap to the viscosity of grease. In the experiment, grease was successfully produced from used lubricant. The best way to produce grease is with sodium soap, where sodium soap is the strongest thickener compare to another thickener. The experiments done in laboratory using different percentage of sodium soap (5%.10%,15%,20% and 25%) and FTIR apparatus was used a fresh standard grease and the synthesized grease were analyzed .The results shows the grease manufactured using20% sodium soap is close to the standard grease. Then it is selected in the design scale. Many parameters were analyzed to investigates the quality of the synthesized grease such as : density, viscosity, composition and dropping point.***

Keywords: Grease; Lubricants; Synthesized; Viscosity; Dropping point

1. Introduction

Grease is a semi fluid to solid mixture of a fluid lubricant, a thickener, and additives. The fluid lubricant that performs the actual lubrication can be petroleum (mineral) oil, synthetic oil, or vegetable oil. The thickener gives grease its characteristic consistency and holds the oil in place. Common thickeners are soaps and organic or inorganic non soap thickeners[1].Soaps are the most common emulsifying agent used, and the type of soap depends on the conditions in which the grease is to be used. Different soaps provide differing levels of temperature resistance (relating to both viscosity and volatility), water resistance, and chemical reactivity. Powdered solids may also be used, such as clay, which was used to emulsify early greases and is still used in some inexpensive, lowperformance greases[1].

The majority of greases on the market are composed of mineral oil blended with a soap thickener. Additives enhance performance and protect the grease and lubricated surfaces. Grease has been described as a temperature-regulated feeding device, when the lubricant film between wearing surfaces thins, the resulting heat softens the adjacent grease, which expands and releases oil to restore film thickness.

Greases are employed where heavy pressures exist, where oil drip from the bearings is undesirable, and/or where the motions of the contacting surfaces are discontinuous so that it is difficult to maintain a separating lubricant film in the bearing.Grease-lubricated bearings have greater frictional characteristics at the beginning of operation. Under shear, the viscosity drops to give the effect of an oil-lubricated bearing of approximately the same viscosity as the base oil used in the grease[1].

Lubricants are applied to moving equipment for several reasons, including friction reduction, heat removal, corrosion prevention and contaminant removal. The most commonly understood reason lubricants are employed is to reduce friction, thereby minimizing wear between moving parts. The three major categories of lubricants are fluids, semisolids and solids. In most cases, fluid lubricants are the most efficient, as they have the best flow properties [2].

1.1 The objectives

The work aims to :

- Recycle used oil after the end of their use in the operation of the equipment or machinery and to be converted to industrial lubricants .
- Keep environment from hazards that caused by mismanagement of used engine oils.
- Provide grease in local market with good quality and low price which leads to economic growth.

1.2 Problem Statement

The oil is one of the main sources that threaten public health and pose a significant threat to the environment when direct contact with or inhalation of vapors produced from burning because they contain some toxic elements such as Iron, lead, tin, etc.

Large quantities of used engine lubricating oil were produced yearly in Saudi Arabia and all of these amounts were disposed in a wrong ways. To keep environment from hazards that caused by mismanagement of used engine oils. Nowadays majority of developing countries face water pollution. The major source of water pollution is oil (petroleum and waste lubricants). Most of factories discard their waste into the river and sea. To rectify this situation we propose to recycle the waste to produce grease.

1.3 Problem Justification and Outcomes

The outcome of this work will provide successful producing grease from recycling used oil to enhance the environment in Saudi Arabia. The investment of recycling used oil should be encouraged from the government. Furthermore it will provide the local market with grease with good quality and low price which leads to economic growth.. It will also lower the cost on the importation of grease. This will ensure self-satisfaction of grease in Saudi Arabia.

1.4Problem Constrains

Recycling of used oil throughsettling tanks used in order to separate water and sludge that found in large quantities from oil to about one days.The small strange contaminants would be removed by filtration. Heating is used to reach a 120 ^{0}C, in order to evaporate the excess water from the oil and other low volatile compounds like gasoline.Soap is milled to provide a consistent dispersionComponents of the grease were heated to reach 150 ^{0}C to get a homogenous mixture with continuous mixing of the componentsGrease was left for one day to be cooled.

2. The Methodology

2.1 The Process Procedure

The experiments were carried out according to the standard procedure outline Figure1. The experiments were divided into two parts. The first part was to prepare the samples of grease by using used lubricant as base oil instead of petroleum oil. The second part of the experiment involved analyzing the product by determines the viscosity of the grease using viscometer and FTIR apparatus. Two different routes of producing lubricant grease are used. The first is to use sodium soap and the second route added calcium carbonate and sulfuric acid to the used oil. The FTIR play important role in testing the quality of the synthesized lubricant grease.

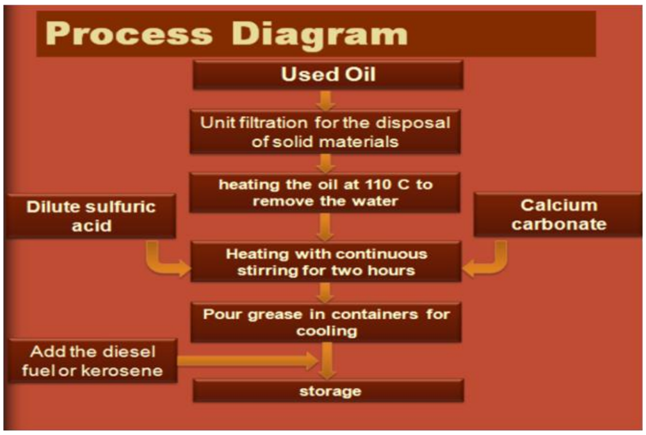


Figure 1: lubricant grease manufacture diagram

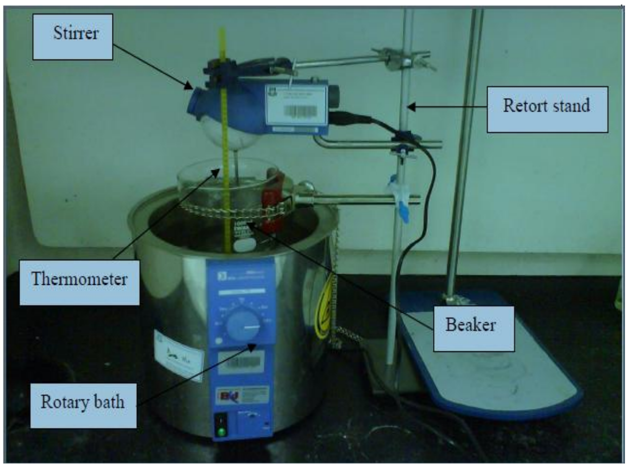


Figure 2: The schematic diagram for the mixed fermented design

2.2 The Experimental Procedure

1. Add amount of 300ml used oil used
2. Start heating the oil to the reaction temperature 120^{o}C
3. Add additives such as sodium soap and zinc oxide
4. Runs the mixer on a certain speed (100rpm)
5. Leave the mixture for 120 minutes
6. Finally turn off the heater and mixer and leaves the product for 48 hours for cooling

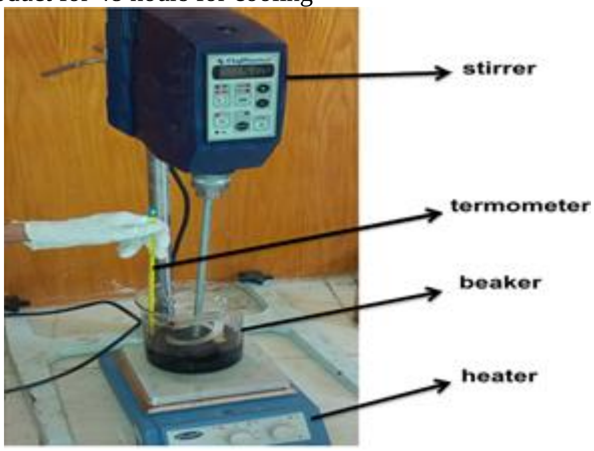


Figure 3: Laboratory grease synthesis

3. Results and Discussion

3.1 Used Engine Oil Analysis

The analysis starts from the analyzing the used oil collected .The results are illustrated in Table(1)

Table 1: Analysis of the engine used oil

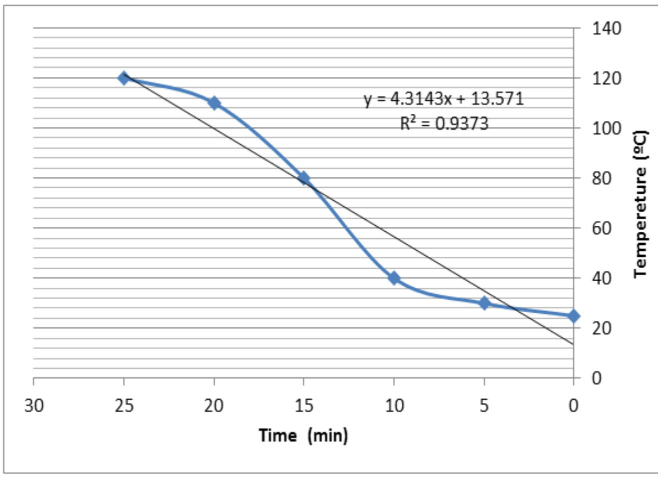
The parameter	Before treatment	After treatment
Density	0.869 g/mL	1.035 g/mL
Viscosity (50 RPM)	5.2 cp	0.80 cp
Moisture content	0.27042 %	-
Ash content	0.685 %	-

The operational objective for the lubricant grease manufacture is to keep the operating condition in certain limits(The operating temperature must be kept at 120^{o}C and the mixing velocity kept constant at 100RPM) The temperature raises observed to estimate the rate of heating till reach the desired temperature sufficient for conversion

;the demonstration is illustrated in Table (2) and Figure(4) respectively.

Table 2: Temperture vs time

Time (m)	Temperature (C)
0	25
5	30
10	40
15	80
20	110
25	120



Figure(4) :The temperature vs time

Figure 4: illustrate the heating rate increases till reaches the reaction temperature 120°C

3.2 Synthesized Grease viscosity Measurement

Initially sodium soap in different proportions is used to synthesize grease, and choose the closest in terms of density, viscosity and dropping point. The experiments for the synthesized grease and fresh standard grease properties are shown in the table (3) and table (4) respectively.

Table 3: Synthesized grease properties

%Sodium Soap	Density (g/mL)	Viscosity (cp)	Dropping point (ºC)
5	0.88	897	-----
10	0.97	1130	-----
15	1.1	1724	100
20	1.16	2256	130
25	1.17	2554	150

Table 4: Standard fresh grease properties

Density (g/mL)	Viscosity (cp)	Dropping point (ºC)
1.2	2260	110

3.3 Synthesized Grease Chemical Composition

The information of FTIR apparatus used to investigate the chemical composition of the grease. Fourier transform infrared (FTIR) spectroscopy identifies the type of base oil and thickener of the used grease [7].

FTIR was used to evaluate the chemical composition of standard grease and the synthesized sample produced in the laboratory. Figs. (5) and (6) represent the spectra for fresh grease derived oil (FG) and synthesized grease waste grease derived oil (SG) respectively.

Further the investigation of the chemical composition of the lubricant grease was analyzed using FTIR. Study the differences between standard and synthesized grease produced from used oil via Fourier transform infrared radiation (FTIR). A standard fresh grease is analyzed firstly and taken as a basis for analysis. The standard grease is shown in Figure (5) which shows the peaks of the fresh standard grease

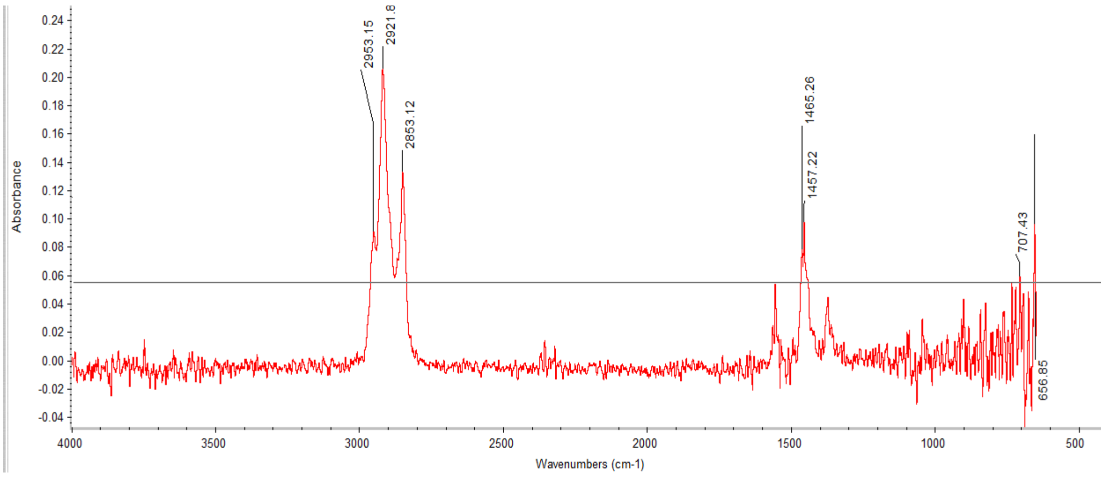
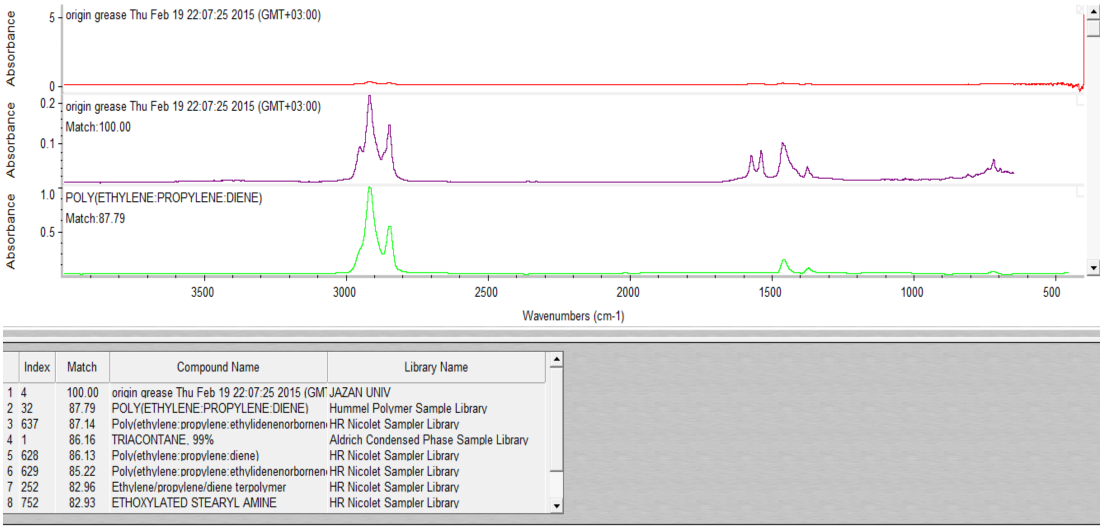


Figure 5: Standard grease peaks using FTIR

The FG spectrum shows two strong absorption bands of long hydrocarbons chains. The first peak in the region of 1080-1375cm-1 represents the CH_3 bend while the second peak in the region of 2950-2800 cm-1 represents alkane C-H stretch. This suggests that the oil contains a very long hydrocarbon chain. The spectrum also showed several very weak absorption bands for additives in the regions of 600-1300 cm-1 and 1500-2000 cm-1.



	Index	Match	Compound Name	Library Name
1	4	100.00	origin grease Thu Feb 19 22:07:25 2015 (GM	JAZAN UNIV
2	32	87.79	POLY(ETHYLENE:PROPYLENE:DIENE)	Hummel Polymer Sample Library
3	637	87.14	Poly(ethylene:propylene:ethylidenenorbornen	HR Nicolet Sampler Library
4	1	86.16	TRIACONTANE, 99%	Aldrich Condensed Phase Sample Library
5	628	86.13	Poly(ethylene:propylene:diene)	HR Nicolet Sampler Library
6	629	85.22	Poly(ethylene:propylene:ethylidenenorbornen	HR Nicolet Sampler Library
7	252	82.96	Ethylene/propylene/diene terpolymer	HR Nicolet Sampler Library
8	752	82.93	ETHOXYLATED STEARYL AMINE	HR Nicolet Sampler Library

Figure 6: Standard grease report using FTIR

Figure (6) shows the report of the chemical composition of the standard grease which indicates the composition which is closed to polyethylene about 87.79% and 87.14% of polyethylene propylene87.14%

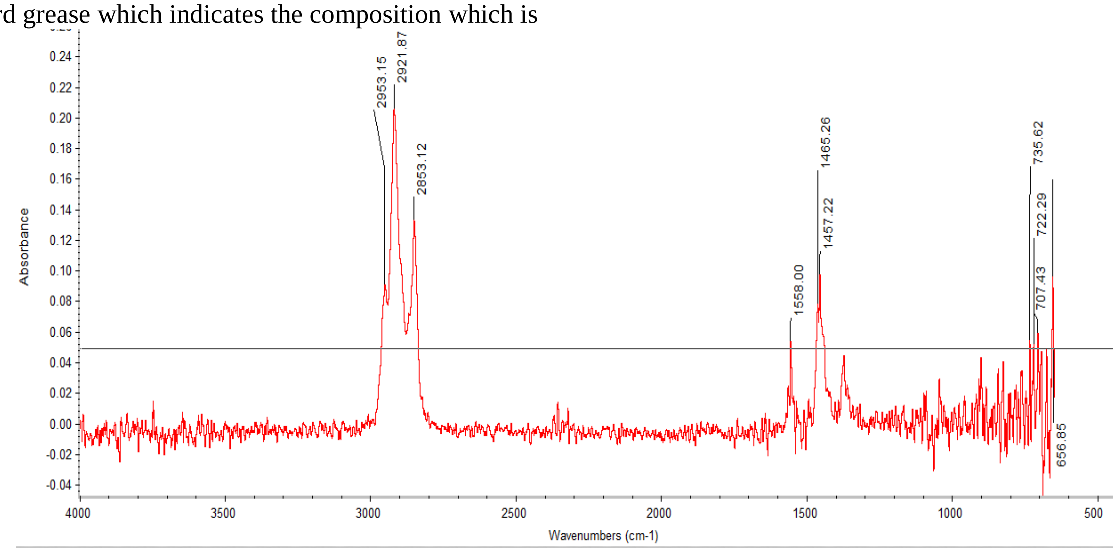
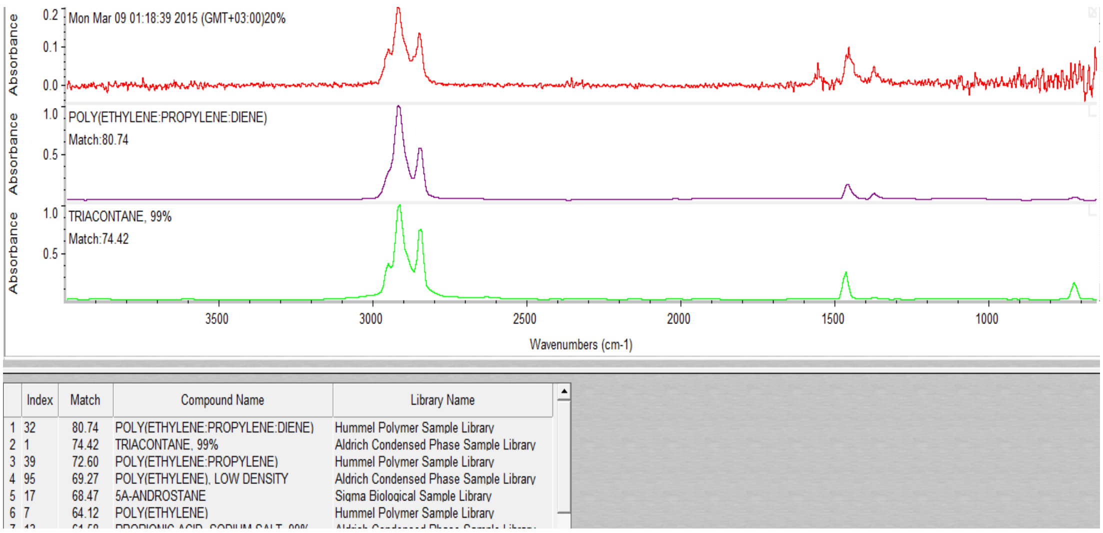


Figure 7: 20% soap grease analysis using FTIR

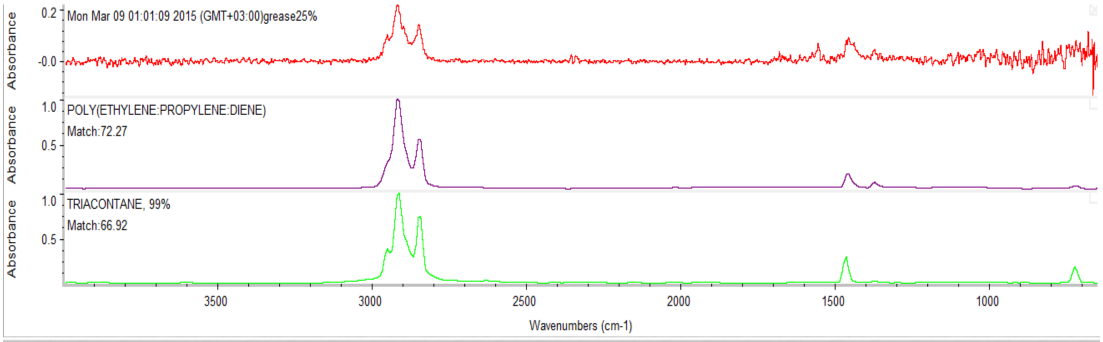
Figure(7) shows the peaks of the synthesized lubricant grease which contains 20% sodium soap when using FTIR apparatus .



	Index	Match	Compound Name	Library Name
1	32	80.74	POLY(ETHYLENE:PROPYLENE:DIENE)	Hummel Polymer Sample Library
2	1	74.42	TRIACONTANE, 99%	Aldrich Condensed Phase Sample Library
3	39	72.60	POLY(ETHYLENE:PROPYLENE)	Hummel Polymer Sample Library
4	95	69.27	POLY(ETHYLENE), LOW DENSITY	Aldrich Condensed Phase Sample Library
5	17	68.47	5A-ANDROSTANE	Sigma Biological Sample Library
6	7	64.12	POLY(ETHYLENE)	Hummel Polymer Sample Library

Figure 8: 20% soap grease report using FTIR

Figure (8) shows the report of the chemical composition of the standard grease which indicates the composition which is closed to polyethylene about 80.74%



	Index	Match	Compound Name	Library Name
1	32	72.27	POLY(ETHYLENE:PROPYLENE:DIENE)	Hummel Polymer Sample Library
2	1	66.92	TRIACONTANE, 99%	Aldrich Condensed Phase Sample Library
3	39	63.83	POLY(ETHYLENE:PROPYLENE)	Hummel Polymer Sample Library
4	95	61.74	POLY(ETHYLENE), LOW DENSITY	Aldrich Condensed Phase Sample Library
5	17	61.55	5A-ANDROSTANE	Sigma Biological Sample Library
6	7	59.60	POLY(ETHYLENE)	Hummel Polymer Sample Library
7	51	56.40	POLY(ETHYLENE:VINYL CHLORIDE)	Hummel Polymer Sample Library
8	99	54.74	LEVORPHANOL HCL IN KBR	Georgia State Crime Lab Sample Library

Figure 9: 25% soap grease report using FTIR

Figure (9) shows the report of the chemical composition of the standard grease which indicates the composition which is closed to polyethylene about 72.27%

4. Conclusion

Grease characterization can be achieved using Fourier Transform Infrared (FTIR), FTIR spectroscopy has found extensive use as an alternative technique to standard wet analytical techniques used to determine key oil quality parameters. FTIR spectroscopy is used for analyzing fresh standard lubricant and at the same time used to test the synthesized lubricant in the laboratory. The results of the FTIR show the 20% soap grease is closed to the standard grease.

References

[1] Nabil Fikri Bin Yaakub, MAY 2008. *Production of grease from used lubricant. A feasibility study*, Faculty of Chemical Engineering and Natural Resources University Malaysia Pahang
[2] www.LElubricant.com "Grease Use and Testing", 2014. *Lubrication Engineers, Inc.*
[3] NIIR Board of Consultants & Engineers, 2008.*Technology Of Petrochemicals, Lubricants Greases & Petroleum Refining*
[4] Jeremy Wright,2008.*Machinary lubrication grease*,A Noriapuplication
[5] H. Scott Fogler ,2006.*Elementsof Chemical Reaction Engineering*,4th.edition, Pearson Education, Inc.
[6] Ronald W. Missen&Charles A. Mims,1999.*Introduction to chemical reaction engineering and kinetics*, John Wiley & Sons, Inc.
[7] http://www.machinerylubrication.com/Read/29284/grease-analysis-system
[8] R. K. SINNOTT,Coulson & Richardson's,2005. *Chemical Engineering Series* , Volume 6,Fourth Edition
[9] Robert H. Perry,1990.*Chemical EngineersHandbook*, Seventh edition,, McGraw-Hill -New York
[10] Adcock, Dennis; Al Halborg, Caroline Ross , 2001.*Marketing: Principles and Practice*