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Production of Biodiesel from Refined Palm Oil Stearin and Comparison of Its Lubricating Properties to Other Types of Fuels Used in A Compression Ignition Engine

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Abstract

The objective of this research is to produce biodiesel from the refined palm oil stearin and compare its lubricating properties to other types of fuel used in a compression ignition engine. The optimum mixture is also investigated. The produced biodiesel is tested to determine its identity and purity. The result showed that its purity is 97.75%, which is higher than 96.5% as specified by the standard of Department of Energy Business. The resulting biodiesel is tested in a compression ignition engine, including as an additive to stabilize the ethanol in diesel oil. The four types of fuel blends are; diesohol with a proportion of diesel : ethanol : biodiesel D95E5B5 by volume, pure biodiesel from refined palm oil stearin, biodiesel with low proportion D95B5, and a standard diesel oil. The test results of physical properties of the four types of fuel show that all meets the standard of high speed diesel oil, except the flash point property of the diesohol. To compare the lubricating properties, each type of the fuel has been tested with the High Frequency Reciprocating Rig (HFRR) according the CEC-F-06-A-96 standard. The results showed that the pure biodiesel from the refined palm oil stearin, diesohol D95E5B5, and biodiesel D95B5 have the wear scar 201 μm, 205 μm, and 204 μm respectively. The wear scar of each type of the studied fuels is below the allowable standard wear scar 460 μm.

Keywords: Biodiesel, Transesterification, Methyl Ester, Diesohol

1. Introduction

Most developing countries still need to import fuel for domestic consumption [1,2,3]. Member states of the organization of economic cooperation and development (Organization for Economic Co-operation and Development) OECD

have only 70.5% of their energy not include nuclear power has volume only 59.7% .In Japan, one of the member states (OECD) which self-reliance in energy has volume only 4.3% .In Germany which self-sufficient in energy has volume only 27%, while the United States which self-sufficient in energy has volume up to 65% [4]. However, the member states in the OECD need to import energy mostly.

As the world faces energy crisis several times, higher oil prices, a lot of impact on the country that import energy, include of energy security and economics OECD's member countries have a common energy strategy, taking two main factors: energy security and environmental problems, which led the world's environmental problems increasing from the use of fossil energy. The effects of climate change to support and provide incentives to use of new energy and renewable energy with the issues include ratification of the Kyoto Protocol. Clean Development Mechanism (CDM), greenhouse gas emission reduction and emission trading.

Biodiesel is a one of renewable which the OECD member countries set in the renewable energy strategy except from solar energy, wind energy, energy from biomass and small hydro power, etc.

The present, in many countries around the world and OECD member countries or International Energy Agengy (IEA) includes countries that are not a member of such organizations has led the IEA's energy strategy as a guide for policy making and strategy of the country.

In the present, the quantity of the energy consumption increases, while the source of energy is limited, therefore, a study involving the use of energy from other sources. Biodiesel is an alternative that is possible and has been widely used in many countries, including Thailand. In addition to biodiesel, ethyl alcohol or ethanol is an alternative for use as renewable energy. The government has a policy to support the production and use of ethanol as a renewable fuel source to reduce petroleum imports.

Biodiesel [5] is an ester which synthesized by a chemical reaction between the vegetable oil and animal fat with alcohol. The name of ester depends on the type of alcohol used in the reaction, such as when alcohol is a methanol substance that is known methyl ester. However, the methyl ester in biodiesel is used as an ester of these compounds is used as fuels from plants which can be used as fuel or mixed with diesel fuel only. Currently, the use of vegetable oil directly as fuel in the engine that is available only when you modify the engine, the piston, fuel injection and combustion chambers of engines to suit the user, etc., DMS Dieselmotoren-und Geratebau GmbH (DMS) [6] and ELSBETT technology [7]. If used with a diesel engine and do not modified parts, you must reduce the viscosity of diesel oil into the close by mixing it with diesel or kerosene. It applies only to low-cycle engine and use as an engine for agriculture. For use in high-cycle engine or in a vehicle diesel engine conversion is required. Do not use vegetable oil as fuel directly. Biodiesel produced from vegetable oils through the chemical process has the molecular structure smaller than of the oil. Alternatives to petroleum diesel is more stable than vegetable oils which causes a burning completely not cause a blockage and soot

formation in the combustion chamber. Several studies are the researches of RA Ferrar etc (2005) [8] and G. Knothe and RO Dunn (2003) [9].

Because the diesel and ethanol are not combine successfully, therefore must be requires emulsifier for the homogenous between diesel and ethanol. In this research, Biodiesel is used in emulsifier for diesohol and including improve other feathers such as the properties of diesohol, combustion properties and lubrication properties. Ethanol can be blended with diesel oil used as fuel for diesel engines however, due to the chemical structure of ethanol and diesel are different when mixed together cause an isolation layer so there must be emulsifier which can make a mixture of ethanol and gasoline is homogenous and the mixtures can be physical and chemical properties suitable for use with diesel engines Which is the source of the research.

2. Objective

1. To produce biodiesel from refined palm oil stearin
2. To develop emulsifier for mixing diesohol by using domestic products, biodiesel from refined palm oil stearin
3. To determine the amount of diesel oil, ethanol and biodiesel which used to produce diesohol to mixing the appropriate ratio by comparing the physical properties of diesohol produced from vegetable oil
4. To compare the lubricating properties of fuel types etc. biodiesel from refined palm oil stearin, diesohol at the mixing ratio D95B5E5 from refined palm oil stearin, blending biodiesel at the mixing ratio D95B5 from refined palm oil stearin and standards diesel oil.

3. Methodology

Protocols are divided into different stages

1. The production of biodiesel from refined palm oil stearin
2. Identify the testing of the unique biodiesel from refined palm oil stearin by injection to the GC for finding the composition and comparison with the standard methyl ester
3. Take diesohol from the mixing experiments to test the physical properties of the fuel according to the standards diesel oil property
4. To compare different types of lubricating properties of fuel and pure biodiesel from refined palm oil stearin, blending biodiesel from refined palm oil stearin, diesohol from refined palm oil stearin and standards diesel oil

4. Equipment

5.1 Equipment used in the transesterification process

1. RET BASIC SAFETY CONTROL IKAMAG, Room Temp – 340 $^{\circ}$C, 50 – 1,700 rpm
2. Bar Stirring Cylindrical PTFE 60×10 mm.
3. Condenser (Straight Tube) 45 cm.
4. Flat Bottom Flask 5 Litres
5. Separating Funnel 1000 ml
6. Beaker Glass Low Form 5000 ml
7. Connector 2 Way, L 2 inch,40/40, 24/29
8. Stopper Glass (Solid Glass) 40/40
9. Stopper Glass (Solid Glass) 24/29
10. Add Neck Flask 5 L, 1 Neck, 24/29
11. Adaptor Probe Use with Joint 24/29

12. Adapter Thermometer 24/29, 40/40
13. Thermometer Alcohol 0-100 °C
14. Stand and Base and Condenser Clamp
15. Gas Chromatography (GC) Engine

5.2 The oil used in the experiment

1. Refined Palm Oil Stearin (RPO)

5.3 Chemicals used in the experiment

1. Methanol (industrial grade) purity not less than 99.5%
2. Potassium Hydroxide (industrial grade) purity not less than 90%
3. Sodium Sulfate AR grade

5.Results

Table. 1 The volumetric ratio of methanol to refined palm oil stearin, 0.4%KOH (wt/vol), at 60 °C, 60 min

(Methanol : RPO) (by volume)	Yield (%)	Viscosity at 40 °C (cSt)	GC Injection Test
1 : 6	-	Gel	Not Pass
1 : 5	79	6.45	Not Pass
1 : 4	80	6.36	Not Pass
1 : 3	81	4.63	Not Pass
1 : 2	82	4.62	Pass

Table. 2 The volumetric ratio of methanol to refined palm oil stearin 1:2 (by volume), 0.4%KOH (wt/vol), 60 °C

Time (min)	Oil (CC)	Product (CC)	Yield (%)
30	250	200	80
60	250	205	82

Table. 3 The proportion of the catalyst %KOH (wt/vol), volumetric ratio of methanol to refined palm oil stearin 1 : 2, 60 minutes

% KOH (wt/vol)	Oil (CC)	Biodiesel (CC)	Yield (%)	Viscosity (cSt)
0.2	250	195	78	4.78
0.4	250	205	82	4.62
0.6	250	170	68	4.61

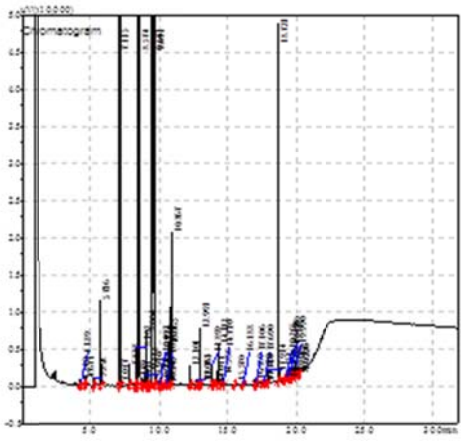

Fig. 1 Chromatogram of methyl ester from refined palm oil stearin

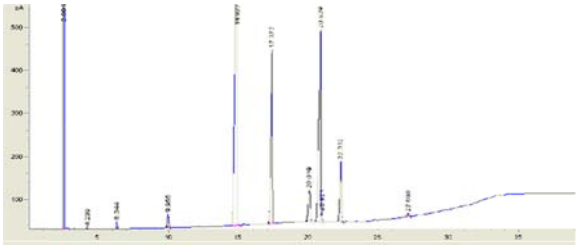

Fig. 2 The percentage of biodiesel from refined palm oil stearin production

Table. 4 show the stability observation of diesohol (refined palm oil stearin)

Diesel	Ethanol	Biodiesel	Stability Observation
95	5	5	Clear liquid 1 Phase
95	5	10	Clear liquid 1 Phase
95	5	15	Clear liquid 1 Phase

Fig. 3 High Frequency Reciprocating Rig (HFRR) and specimen for testing

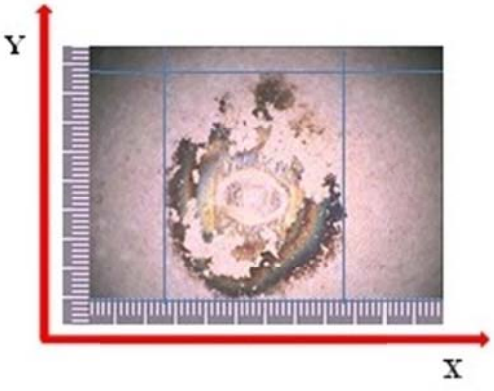

Fig. 4 The Wear Scar Test of 100%Biodiesel from refined palm oil stearin

Fig. 5 The Wear Scar Test of D95B5

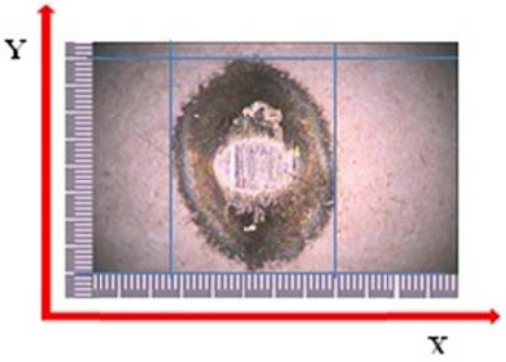

Fig. 6 The Wear Scar Test of D95B5E5

Table. 5 The results of wear scar test

	Wear Scar Test
	μm
100%Biodisel (RPO)	201
D95B5 (RPO)	204
D95E5B5 (RPO)	205

6. Conclusion

1. From Table. 1 show the volumetric ratio of methanol to refined palm oil stearin 1:2 has the maximum percentage of product about 82% at 4.62 cSt viscosity. This ratio can be analysis the identity of biodiesel with GC engine at the following condition, 0.4%KOH (wt/vol), 60°C and 60 minutes of reaction time performed the maximum percentage by volume of the fuel of 82%

2. For the fuel's Identity results at the volumetric ratio of methanol to refined palm oil stearin 1:3, 0.4%KOH (wt/vol) at 60°C temperature performs that the produced biodiesel has the quantities of monoglycerides, diglycerides, free glycerin and total glycerin in the range of the DOEB standard but Triglyceride is over. If this biodiesel is used in the diesel engine, some effect must be happened such as blockage in injector, cylinder and valves in the engine. Therefore, the use of volumetric ratio 1:2 , 0.4% KOH (wt/vol) at 60 C° to identify its identity performed that all above substance meet the standard specification and it's appropriate process to produce the biodiesel in this experiment

3. From Fig.2 show the biodiesel from refined palm oil stearin in this process give the purification of biodiesel higher than the DOEB standard, The purification form these process is of 97.75.% while in DOEB standard is of 96.5%

4. From table 9 to compare the lubricating properties, each type of the fuel has been tested with the High Frequency Reciprocating Rig (HFRR) according the CEC-F-06-A-96 standard. The results showed that the pure biodiesel from the refined palm oil stearin, blending biodiesel D95B5 (RPO) and diesohol D95E5B5 (RPO) have the wear scar of 201 μm, 204 μm and 205 μm respectively. The wear scar of each type of the studied fuels is below the allowable standard wear scar 460 μm.

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