AEC-1031

Comparison of Lubricating properties of Biodiesel Developed from Refined Palm Oil Stearin and Biodiesel from Jatropha Seed Oil to Other Types of Fuel for A Compression Ignition Engine

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Abstract

The objective of this research aims at studying the utilization of biodiesel developed from the refined palm oil stearin and jatropha seed oil as fuels used in a compression ignition engine, including as an additive to stabilize the ethanol in diesel oil. The types of fuel blends are; diesohol with a proportion of diesel : ethanol : biodiesel D95E5B5 by volume (Refined palm oil stearin), and D95E5B5 (Jatropha seed oil). The procedure in producing the biodiesel from jatropha seed oil has been described. The purity of the biodiesel produced from jatropha seed oil is 98.38%, which is higher than that from refined palm oil stearin, 97.75%, as studied previously. The physical properties of pure biodiesel (Jatropha seed oil), diesohol D95E5B5 (Jatropha seed oil), biodiesel D95B5 (Refined palm oil stearin) and the standard high speed diesel were tested. The test results showed that all meets the standard of high speed diesel oil of the Department of Energy Business, except the flash point property of the diesohol D95E5B5 produced from jatropha seed oil and the refined palm oil stearin. To compare the lubricating properties, each type of the fuel has been tested with the High Frequency Reciprocating Rig (HFRR) according theCEC-F-06-A-96 standard. The results showed that the pure biodiesel from the jatropha seed oil, diesohol D95E5B5 (Jatropha seed oil), and blending biodiesel D95B5 (Jatropha seed oil), pure biodiesel from the refined palm oil stearin, diesohol D95E5B5 (Refined palm oil stearin), and blending biodiesel D95B5 (Refined palm oil stearin) have the wear scar of 169 µm, 205 µm, 204 µm, 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

Biodiesel is a one of renewable which the OECD (Organization for Economic Co-operation and Development) member countries set in the renewable energy strategy, except from solar energy, wind energy, energy from biomass and small hydro power, etc.

Biodiesel 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, for example, 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, which is used as fuels from plants, which can be used as fuel or mix with diesel fuel only. Currently, the use of vegetable oil directly as fuel in the engine that 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) [1] and ELSBETT technology [2] If use with a diesel engine and do not modify 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 uses that as an high-cycle engine for agriculture or in a vehicle diesel engine conversion. Do not use vegetable oil as fuel directly. Biodiesel produced from vegetable oils through the chemical process has the molecular structure smaller than that the oil. Alternatives to petroleum diesel is more stable than vegetable oils which causes a burning completely and not cause a blockage and soot formation in the combustion chamber. Several studies are includes in the researches of RA Ferrar etc (2005) [3] and G. Knothe and RO Dunn (2003) [4].

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 involves 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 used as an alternative for renewable energy. The government has a policy to support the production and use of ethanol as a renewable fuel source to reduce petroleum imports.

Because of diesel and ethanol are not be combined successfully, it must requires emulsifier for the homogeniety between diesel and ethanol. In this research, biodiesel is used as an emulsifier for diesohol and includes the improve of 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 they mix together, cause an isolation layer. So there must be an 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.

2. Objective

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

3. Methodology

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

4. Equipment

4.1 Equipment used in the transesterification process

1. RET BASIC SAFETY CONTROL IKAMAG, Room Temp – 340 °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

4.2 The oil used in the experiment

1. Refined Palm Oil Stearin (RPO)
2. Jatropha Seed Oil (JTP)

4.3 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 jatropha seed oil , 0.8%KOH (wt/vol), at 60 °C, 60 min

(Methanol : JTP) (by volume)	Yield (%)	Viscosity at 40°C (cSt)	GC Injection Test
1 : 5	74.28	4.40	Not pass
1 : 4	70.52	4.12	Not pass
1 : 3	71.04	3.95	Pass
1 : 2	62.92	3.94	Pass

Table. 3 The volumetric ratio of methanol to refined palm oil stearin 1:2 (by volume), 0.4%KOH (wt/vol), 60 °C

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

Table. 4 The volumetric ratio of methanol to jatropha seed oil 1:3, 0.8%KOH (wt/vol), 60 °C

Biodiesel (JTP)	Time (min)	Oil (CC)	Product (CC)	Yield (%)
	30	250	155.9	62.35
	60	250	177.6	71.04

Table. 5 The proportion of the catalyst (%wt/vol), volumetric ratio of methanol to refined palm oil stearin 1: 2, 60 min

% 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

Table. 6 The proportion of the catalyst, the volumetric ratio of methanol to jatropha seed oil 1:3, 60 min

% KOH (wt/ Vol)	Oil (CC)	Biodiesel (CC)	Yield (%)	Viscosity (cSt)
0.6	250	196.2	78.48	4.06
0.8	250	177.6	71.04	3.94
1.0	250	170.9	68.36	3.95

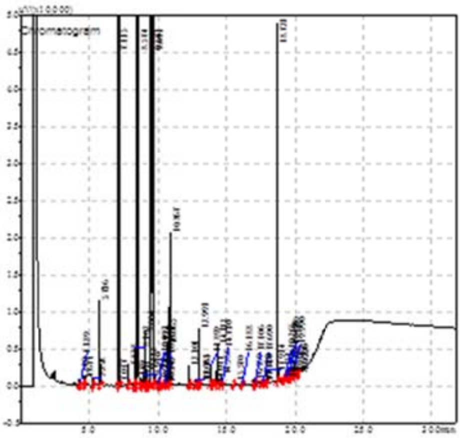

Fig. 1 Chromatogram of methyl ester from refined palm oil stearin

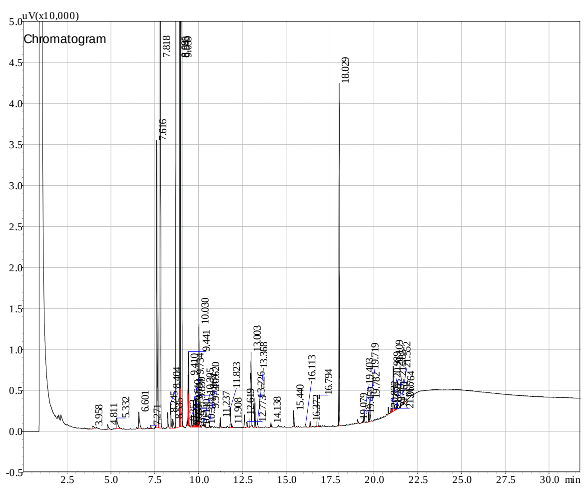

Fig. 2 Chromatogram of methyl ester from jatropha seed oil

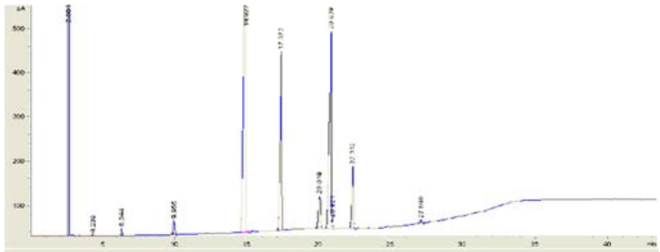

Fig. 3 The percentage of biodiesel from refined palm oil stearin production

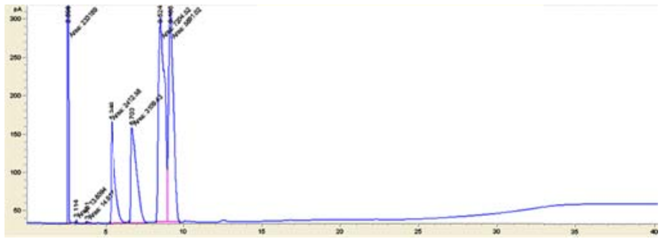

Fig. 4 The percentage of biodiesel from jatropha seed oil production

Table. 7 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

Table. 8 show the stability observation of diesohol (Jatropha seed oil)

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

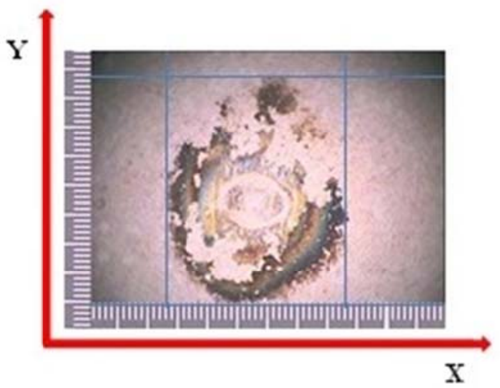

Fig. 6 The Wear Scar Test of 100%Biodiesel from RPO

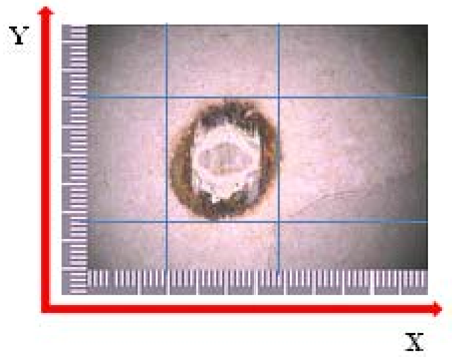

Fig. 7 The Wear Scar Test of 100%Biodiesel from JTP

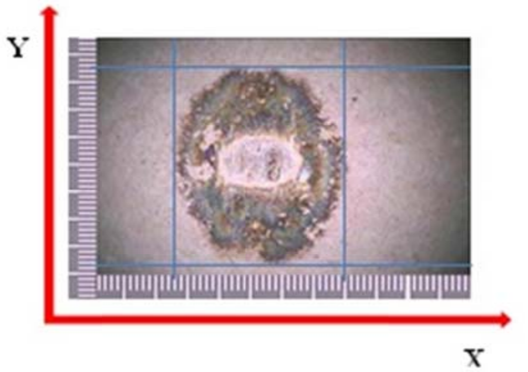

Fig. 8 The Wear Scar Test of D95B5 from RPO

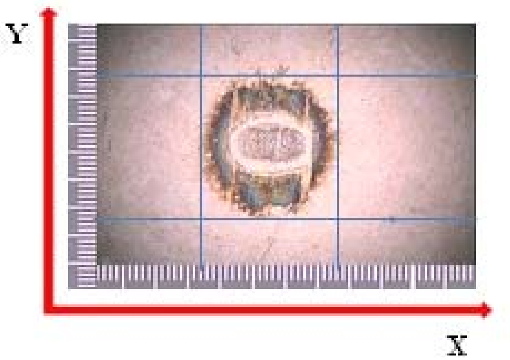

Fig. 9 The Wear Scar Test of D95B5 from JTP

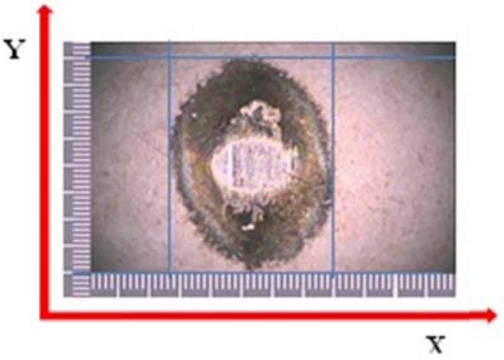

Fig. 10 The Wear Scar Test of D95E5B5 from RPO

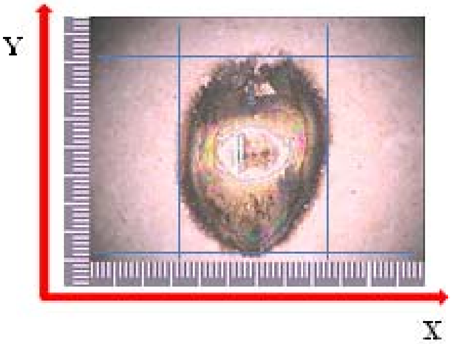

Fig. 11 The Wear Scar Test of D95E5B5 from JTP

Table. 9 The results of wear scar test

	Wear Scar Test
	μm
100%Biodisel (RPO)	201
100%Biodisel (JTP)	169
D95B5 (RPO)	204
D95B5 (JTP)	204
D95E5B5 (RPO)	205
D95E5B5 (JTP)	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. From the Table 2 show the volumetric ratio of methanol to jatropha seed oil 1:3 has the maximum percentage of product about 71.04% at 3.95 cSt viscosity. This ratio can be analysis the identity of biodiesel with GC engine at the following condition, 0.8%KOH (wt/vol), 60°C and 60 minutes of reaction time performed the maximum percentage of biodiesel

3. 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

4. For the fuel's Identity results at the volumetric ratio of methanol to jatropha seed oil 1:3, 0.8%KOH (wt/vol) at 60°C temperature and the volumetric ratio of methanol to jatropha seed oil 1:2, 0.8%KOH (wt/vol) at 60°C temperature performs that have the quantities of monoglycerides, diglycerides, triglyceride free glycerin and total glycerin in the range of the

DOEB standard. Therefore select the volumetric ratio 1:3 , 0.8%KOH (wt/vol) at 60 C° to produce biodiesel in this experiment because the maximum percentage of product about 71.04%

5. From Fig.3 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%

6. From Fig.4 show the biodiesel from jatropha seed oil in this process give the purification of biodiesel higher than the DOEB standard, The purification form these process is of 98.38% while in DOEB standard is of 96.5%

7. 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 jatropha seed oil, diesohol D95E5B5 (JTP), and blending biodiesel D95B5 (JTP), pure biodiesel from the refined palm oil stearin, diesohol D95E5B5 (RPO), and blending biodiesel D95B5 (RPO) have the wear scar of 169 μm, 205 μm, 204 μm, 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

7. References

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