

The utilization and sustainability of jatropha oil biodiesel in the agricultural sector of Myanmar

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Abstract:

In Myanmar, Jatropha trees grow naturally and abundantly. But currently there are only a few commercial farms just in starting. Agriculture is backbone of Myanmar economy and it contributes 36.4% of GDP in 2011/2012 and over 70% of population work in it. In agriculture sector most of the machineries used are driven by diesel engines. Considering green and renewable energy, biodiesel is one of the best alternative fuels for diesel engines. Basically biodiesel can be processed from vegetable oils by the transesterification by using alcohol and catalyst. From our research on Jatropha oil, we processed methyl ester type Jatropha oil biodiesel namely Jatropha oil methyl ester (JME) and analyzed the fuel properties. The five stages speed-load engine experiments were carried out with a single cylinder DI diesel engine by fuelling with JME and, rapeseed oil methyl ester (RME), soybean oil methyl ester (SME) and diesel fuel (JIS No. 2) were used for comparison. From the analytical and experimental results, we found that JME has good fuel properties, fair ignition ability, less exhaust emissions and good thermal efficiencies. Base on these findings, our main purpose of this study is to get the interest and on the development of Jatropha plantation and to point out the potential of Jatropha oil biodiesel utilization and sustainability to the government, public and private sectors of Myanmar.

Keywords: Jatropha oil; alternative diesel fuel: combustion characteristics; utilization and sustainability

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1. Introduction

Biodiesel is a renewable biodegradable and nontoxic alternative diesel fuel with life cycle CO₂ reduction. The benefits of biodiesel have been observed since two decades ago. However there are some barriers have been remaining in the actual utilization of biodiesel (Hamasaki et al., 2001). Recent years some reasons such as the environmental concerns and the unstable of crude oil price make more interest on biodiesel. In the South East Asia region palm and coconut oil are being mainly focused for biodiesel manufacturing and it is commercially available in some countries like Thailand and Malaysia (Myo and Kinoshita, 2014). But feedstock competition between food and fuel production make slowdown on the development of biodiesel production. Therefore it should be more emphasized on inedible oils such as Jatropha oil. In Myanmar, Jatropha trees grow naturally and abundantly almost the whole country. In the rural area, the Jatropha is traditionally used for some medicines and as fencing trees only. Although Jatropha plantations were carried nationwide intended to produce biodiesel last ten year ago, but it was not success. Considering on this experiences it was found that even Jatropha trees grow very well, the fruit and oil yield are low and not sufficient for commercial production. It may be because of the lack good Jatropha species and agricultural practice on Jatropha plantation.

As mentioned above agriculture is backbone of Myanmar economy and agricultural mechanization has been carrying out. Therefore the uses of agricultural machineries like farm tractors, harvesters, threshers and water pumps are sharply increasing. Most of these machineries are driven by internal combustion engines. Especially, diesel engines are mainly used in agricultural machineries because of its better fuel economy, durability and easier maintenance (Heywood, 1988). Considering green and renewable energy, biodiesel is one of the best alternative fuels for diesel engines and on the other hand locally produced biodiesel can give the benefits for the agricultural sector of Myanmar.

2. Jatropha oil methyl ester

From our research on Jatropha oil biodiesel, we investigated methyl ester type Jatropha oil biodiesel namely Jatropha oil methyl ester (JME). JME was processed by transesterification reaction using crude Jatropha oil, methanol and potassium hydroxide. Also rapeseed oil methyl ester (RME) and soybean oil methyl ester (SME) were processed. JME, RME, SME and diesel fuel (JIS No. 2) were used in engine experiment and the test fuel properties are as expressed in Table 1.

Table 1 Test Fuel Properties

Properties	JME	RME	SME	EU Std.	Diesel
Cetane No.	54	54	52	51>	56
Net Calo. Value (MJ/kg)	37.04	37.09	37.29	-	43.12
Density@15°C (kg/m ³)	883	886	892	860-900	837
Viscosity@40°C (mm ² /s)	4.2	4	4.2	3.5-5.0	2.5
Pour Point (°C)	-2.5	-10	-2.5	-	-12.5
Sulphur (mg/kg)	5	6	-	<10	<500
Phosphorous (mg/kg)	<2	<10	-	<10	-
Methanol (mass%)	0.001	0.001	0.001	<0.2	-
Triglyceride (mass%)	0.13	0.05	0.02	<0.2	-
Flash Point (°C)	172	166	-	>120	62
50% Dist.Temp. (°C)	336	339	329	-	278

The fuel properties of JME are comparable to EU biodiesel standard in all parameters and as fine as those of RME and SME. In the engine experiments, the fuel consumption rate, the thermal efficiency, the combustion characteristics and the exhaust gas emissions of JME were studied. The five stages speed-load engine experiments were carried out with a single cylinder DI diesel engine. The application of loads were five steps, 0% (0MPa), 25% (0.17MPa), 50% (0.34MPa), 75% (0.50MPa) and 100% (0.67MPa) by an electric dynamo meter at 2000 rpm engine speed. The ignition delays of test fuels are as shown in Fig. 1. JME has longer ignition delay and same injection timing as RME and SME. But JME has later injection timing and almost the same ignition delay as diesel fuel. Generally, the injection timing can be affected by viscosity of the fuel and high viscosity causes faster injection (Myo et al., 2007). Also shorter ignition delay shows better ignition ability of the fuel. Therefore from these results JME has good ignition ability and combustion characteristics as diesel fuel.

The hydrocarbon (HC) emission, carbon monoxide (CO) emission, nitrogen oxides (NO_x) emission and smoke emission were measured and recorded. The HC, CO, Smoke and NO_x emissions of test fuels are expressed in Fig. 2. The HC emissions from JME, RME and SME are lower than that of the diesel fuel in the most of the load conditions. The lower HC emissions of methyl ester fuels are probably due to the oxygen in the methyl ester fuels takes better combustion process and reduces incomplete combustions (Kinoshita et al., 2006). The highest oxygen content in JME may also affect on the reduction of HC emission relative to other methyl ester fuels. The CO emissions from JME, RME and SME are higher than that of diesel in lower load levels and almost the same as in the higher load levels. Only slight differences can be seen in methyl ester fuels.

The NO_x emissions from the methyl ester fuels are slightly higher than that of diesel. Among methyl ester fuels, the NO_x emission from JME is slightly lower than those of RME and SME at higher load levels. The smoke emissions from methyl ester fuels and diesel fuel are only slightly

different at lower load levels. But at higher load levels, the smoke emissions from JME, RME and SME are lower than that of diesel fuel. The smoke emission in methyl ester fuels vary with the oxygen content of the fuel. In this experiment the more oxygen content JME shows the less smoke emission in the highest load levels.

Fig. 3 shows the brake specific fuel consumption (BSFC) and the brake thermal efficiency (BTE) of the test fuels. These are the parameters of the thermal properties of the fuel. The BSFC of JME, RME and SME are higher compared to the gas oil. The higher in BSFC of methyl ester fuel is due to the lower net calorific value of the methyl ester fuels. The net calorific value differences between the methyl ester fuels and diesel fuel is about 5 MJ/kg. The BTE of JME, RME and SME are almost the same as that of the diesel fuel. This indicates that, the methyl ester fuels including JME have comparable energy conversion rates with respect to the diesel fuel and they have good thermal efficiencies as the diesel fuel. Also it does not find the difference in BTE in methyl ester fuels.

From our study, we could confirm the feasibility that JME made from Jatropha oil can be processed simply and easily, and it possesses good fuel properties. And also from the engine experiments JME has fair ignition ability and less exhaust emissions and good thermal efficiencies compared to RME, SME and diesel fuel. Therefore deducing from these factors, Jatropha oil biodiesel is a very favorable and suitable alternative fuel for diesel engines.

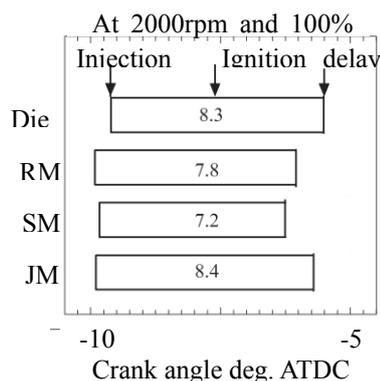


Fig. 1 Ignition delay of the test fuel

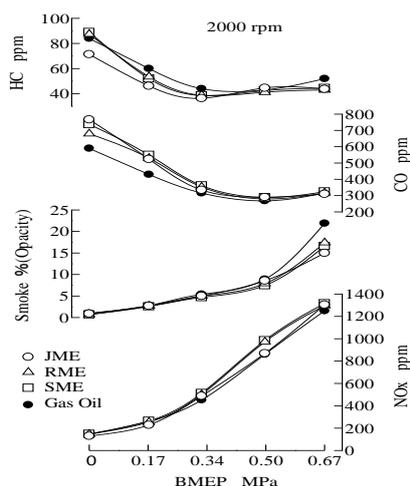


Fig. 2 Emission from test fuels

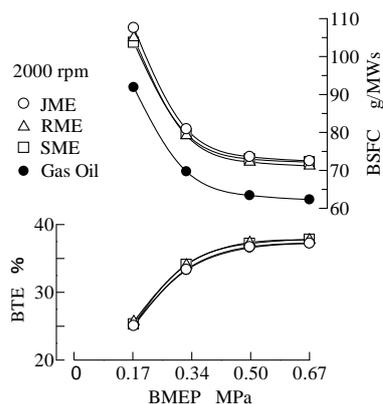


Fig. 3 BTE and BSFC of test fuels

3. Utilizing and sustainability of Jatropha oil biodiesel

In Myanmar, currently biodiesel is just under research and not commercially available. Also it may not be feasible to produce biodiesel from edible oil because local edible production does not meet the local consumption and imported from foreign countries. So under this situation only such plant can be considered for biodiesel which produce inedible oil in applicable quantity can be grown in non cropped marginal lands and waste lands like Jatropha. Until now there are only a few Jatropha plantations like research scaled and, commercial scaled are still very rare. Our purpose of this study is to point out that JME is a very fine alternative diesel fuel based on the experiment results that we achieved, to get the significant attention on the potential of Jatropha oil biodiesel and to promote the development of systematic Jatropha plantations in Myanmar. As motioned above, agriculture is backbone of Myanmar and more than 70% of population work in agricultural sector and live in rural areas. By establishing commercial plantation of Jatropha, it could give employment opportunities and income for people in rural areas. And also by utilizing Jatropha oil biodiesel in agricultural sector

partially such as blending with diesel fuel in 5-10%, it could support rural energy security and energy self-sufficiency and reduce the environmental impact.

Considering the utilizing Jatropha oil biodiesel for agricultural sector of Myanmar, firstly it is needed to point out the potential of Jatropha and to promote the Jatropha plantation. Learning from the previous experiences of Jatropha plantation, it is necessary to choose and grow high yield and high oil content Jatropha species, to use proper cultural practices and agro-techniques for different landraces and to conduct research and development. For the sustainability of Jatropha oil biodiesel, it necessary to develop the policy on the development of renewable energy including biodiesel. And it is needed to give the bank loan, tax exemption and other incentives on renewable energy related industries. Therefore the interest and awareness from government, private and public are very much important on the utilization and sustainability of Jatropha biodiesel and it can give many benefits to rural areas and the agricultural sector of Myanmar.

4. Conclusion

JME can be processed from Jatropha oil by transesterification reaction and the process is simple and easy, and even farmers can produce fuel for their machineries themselves. From the experimental results, JME has fair ignition ability and less exhaust emissions and good thermal efficiencies compared to conventional diesel fuel. So we have confirmed JME can be utilized for diesel engines and can be considered as an alternative and renewable fuel for agricultural machineries in the agricultural sector of Myanmar. By implementing so, we can achieve many advantages in environment, renewable energy sector, rural energy security and energy self-sufficiency. Therefore, for the utilization and sustainable of jatropha oil biodiesel, the interest, the initiative and both financially and technically encouragement from the government, private and public are needed and very important to develop the commercial Jatropha farming and to establish home industries to large scaled biodiesel industries.

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6. References

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