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The Potential of Jatropha Curcas for Agriculture and Forest Diesel Engine in Vietnam

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Abstract. The present paper focuses on the experimental investigation of the potential of fresh oil use extracted from Jatropha curcas seed as an alternative for diesel engine operating in the field of agriculture and forest in Vietnam. The blends of varying proportions of jatropha oil and diesel were prepared. The performance of the engine using blends and jatropha oil was evaluated in a single cylinder D15 engine which has four stroke and popular in agriculture and forest. The injection timing was observed and analyzed. Jatropha oil extracted from seed by KK-40 injection molding machines (Germany) and blends with diesel containing up to 100% volume. From the properties and engine test results it has been established that 100% of jatropha oil can be substituted for diesel without any engine modification and preheating of the blends.

Keywords: Jatropha curcas, biodiesel, agricultural machine

1. Introduction

Currently, Vietnam has been many research institutions interested in Jatropha development with aim to get oil as alternative fuel for diesel engines and recovered residues as animal feed [1]. Forest Science Institute of Vietnam planted thousands hectares of Jatropha curcas in the provinces of Ninh Thuan, Binh Dinh, Quang Nam, Quang Tri, Thua Thien Hue, Phu Tho and Son La. As a plan in 2012, the factories of PetroVietnam will provide 240 million liters Jatropha/year[2].

To explore the possibility of using Jatropha as alternative fuel for diesel, especially engines operating in the field of Agriculture and Forest in Vietnam. The power engineering department of Hanoi University of Agriculture has conducted and studied to evaluate of Jatropha properties, the potential to replace Jatropha for diesel and effects of Jatropha on technical and economic index. This paper introduces some initial results with aim to give some recommendations for people who uses Jatropha as substitute fuel for diesel engine in Agriculture and Forest in Vietnam. On the other hand, this research can use for orientation in converting and adjusting the engine for compatible with Jatropha.

2. Material

Currently, there are several joint projects that have started with the cultivation of Jatropha on infertile lands in Ninh Thuan, Quang Tri, Thua Thien Hue, Phu Tho and Son La (Vietnam). Jatropha oil using in this research pressed from seed planted in Sonla and PhuTho Provinces by KK-40 injection molding machines (Germany standard) which generate good, clean and pure oil product.

3. Experimental

3.1. Fuel Properties

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Jatropha oil sample were analyzed at laboratory lubricants countries VILAS 292 – Petroleum products analysis laboratory, Hanoi, Vietnam and the research center for sustainable Energy – Rostock, German [3], [4]. The results of analysis show the physical and chemical characteristics in table 1.

Table 1: the properties of diesel and Jatropha

Properties	Diesel	Jatropha
Density (gm/cc), 30^0C	0.836-0.850	0.918
Cetane No.	46	51
Flash point, ^{0}C	45-60	101
Calorific value (Kcal/kg)	10478	9432
Sulfur (%)	0.43	0.33

From the above table, the cetane value of jatropha oil's higher than diesel so it's suitable for diesel engines. However, the sulfur content in jatropha (0.33) is lower, compared to diesel (0.43). Therefore, jatropha use for engine is environmentally better. With respects to safety and storage, jatropha is safer in storage and transport because the flash point of diesel is a half of jatropha.

In term of Calorific value, diesel is higher than jatropha (10%) but the density of jatropha a little bit higher (10%). Overall, the Calorific value by volume is the same thus it is unnecessary to change the amount of fuel supply.

Table 2: Comparison with Jatropha curcas in Indian

Properties	This study	Indian
Density (gm/cc), 30^0C	0.918	0.93292
Cetane No.	51	38
Flash point, ^{0}C	101	210
Calorific value (Kcal/kg)	9432	9123.913
Sulfur (%)	0.33	

Comparing with Jatropha curcas in Indian [5], the flash point is lower (flash point: 210^0C). On the other hand, the calorific value of Jatropha oil in Vietnam is higher (calorific value: 9123.91 Kcal/kg). Basing on the afore-mentioned comparison, jatropha oil extracted from jatropha curcas from Vietnam has been shown better values and can be used.

3.2. Jatropha and Diesel Oil Blend

To evaluate the different between diesel and jatropha when combustion, we were blended jatropha oil with diesel in varying proportion (show in table 2).

Table 3: Jatropha and diesel blends

J0	J20	J40	J60	J80	J100
100% Diesel	20% Jatropha + 80% Diesel	40% Jatropha + 60% Diesel	60% Jatropha + 40% Diesel	80% Jatropha + 20% Diesel	100% Jatropha

3.3. Engine Test

The purpose of this experiment is to assess performance of jatropha oil on engine. In order to achieve this purpose, we used the engine experiment system with D15 engine and hydrostatic breaking system in power engineering department – Hanoi University of Agriculture (figure 1).

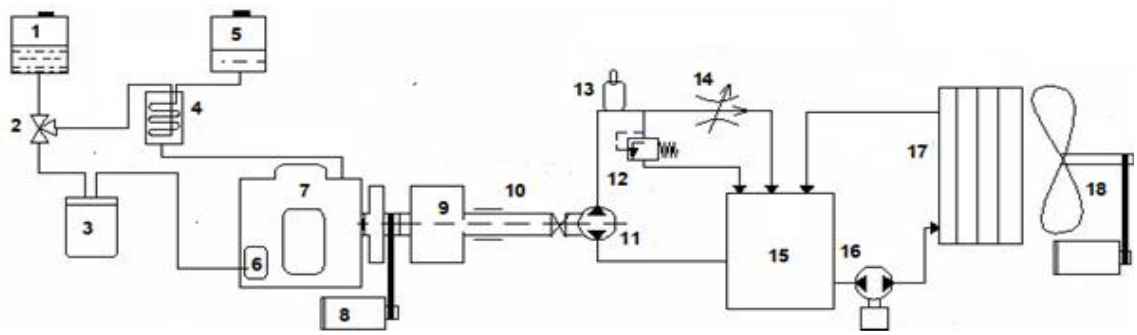

Fig. 1: The engine experiment system

1- diesel tank; 2- valve: 3- filter; 4- thermal addition; 5- Jatropha tank; 6- high pressure; 7- engine; 8- starter motor; 9- reduction gear; 10- connection; 11- hydraulic pump; 12- oil pressure regulator; 13- pressure – capacity meter; 14- capacity adjust; 15- tank; 16- hydraulic pump – cooling system; 17- oil cooling system; 18- fan

4. Results and Discussion

4.1. Engine Performance Graph

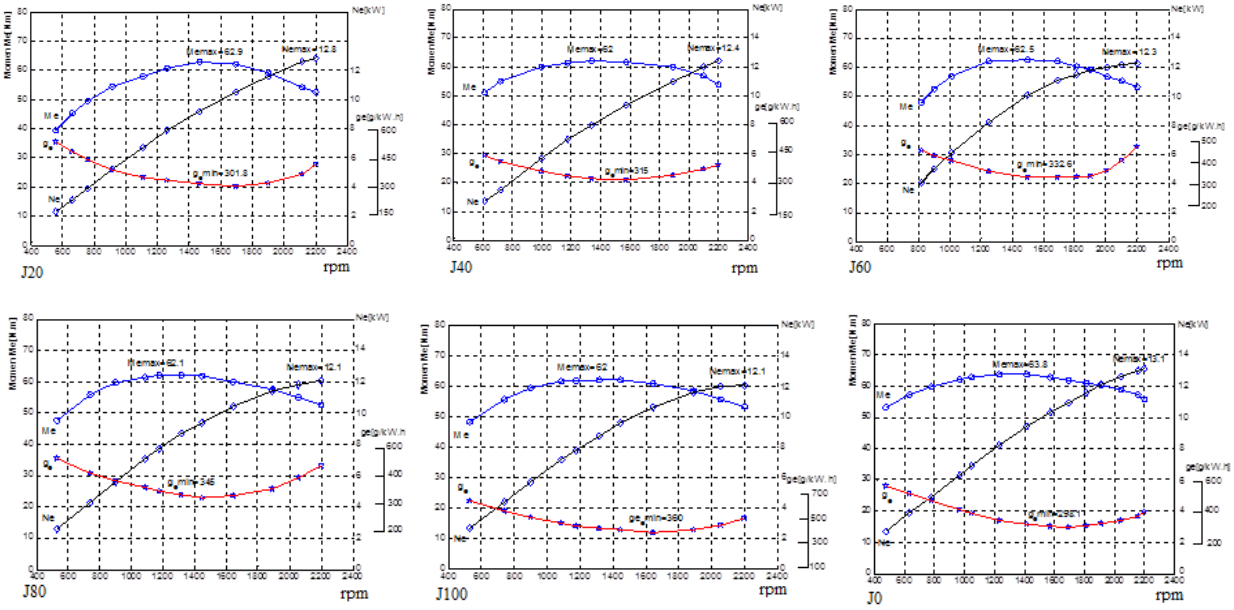

Fig. 2: D15 engine performance graph

The evaluation of alternative diesel fuel of jatropha based on building and comparing the engine performance graphs with differences of blends fuel (figure 2).

Test results:

- D15 engine showed the stable operation without black smoke, temperate of oil and water in permissive thresholds for all tests including full-load mode when running at 100% jatropha.
- The decrease in Maximum power of engine (Nemax) corresponds to the increase of jatropha/diesel (J/D) rate. When using J100 (100% jatropha), Nemax value is declined by 7.6% compared with traditional diesel fuel. Similarly, the maximum torque value also tends to reduce. The reduction of torque and power results from the higher viscosity of jatropha oil 8 times than diesel fuel and its effects on the quality of spray and air fuel mixture. On the other hand, the change in revolutions per minute (rpm) corresponding to the maximum value of torque is unclear when the J/D ratio varies. The cause of this phenomenal can be explained as the heterogeneity of mixed fuel system due to usage of rudimentary tools.
- The increase in total fuel consumption of the testing engine results from the increasing rate of J/D. First cause is the high viscosity of jatropha oil influencing on the spray forming process, leading to

engine power. Second, the density of jatropha greater than 10 % compare with diesel, resulting in the higher cost per volume of fuel when using jatropha.

4.2. Assessing the Impacts of Blends Rate on Injection Timing

Injection timing influences the mixing quality of the air fuel mixture and hence the whole combustion process [6]. With the same structure and condition of the engine, the optimal injection timing will depend on type of fuel [7]. In order to evaluate the impacts of fuel and to find out the optimal point for injection timing when using jatropha blends, we conducted the experiments for determining minimum energy consumption corresponding with different injection timing. The result shows the optimal point of injection timing for each blend (figure 3) and relationship between energy consumption and injection timing (figure 4).

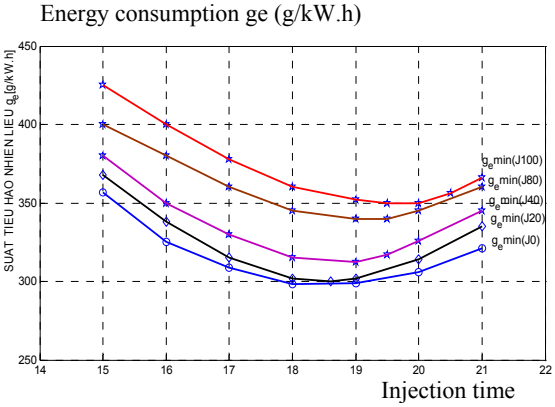

Fig. 3: relationship between energy consumption with injection time

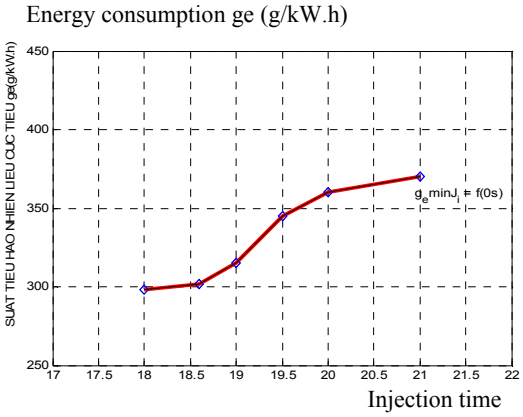

Fig. 4: relationship between minimum energy consumption with injection time

In conclusion, the bigger ratio of J/D is, the sooner injection timing happen. The optimal point of injection timing when using 100% jatropha is 20 before top dead center, sooner than diesel 2 degree.

5. Conclusions and Further Research

5.1. Conclusion

- The physical and chemical properties of jatropha are suitable for diesel engines. However, there are some disadvantages of jatropha fuel. For example, high viscosity, high density, low Calorific value than diesel adversely affect the spraying process, the mixing quality of the air fuel mixture but it can be solved by some easy technical.
- The divided combustion chamber of diesel engine which is widely used in Agriculture and Forestry in Vietnam can use Jatropha oil as a fuel substitute for diesel oil with low economic indicators and without changing the texture engine. Moreover, in remote areas engines operation by Jatropha oil produced and consumed in site leads to low transportation costs. The development of Jatropha as biofuel source as a alternative fuel would be widely applicable.

- Blending traditional fuel with jatropha oil required revising the earlier injection timing. In case of 100% jatropha oil is used, the injection timing should be adjusted by earlier 2 degree.
- If the proportion of blended jatropha is less than 20%, the injection timing is not adjusted and the structure of fuel supplement system is unvaried, there is no change in performance of engine.

5.2. Further Research

The long-term operation should be examined to assess the reliability of engine. Experimental researches on material interaction, the impact of jatropha oil on the details' materials in the fuel system, fuel properties as well as the possibility of making soot should be conducted.

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