TO STUDY ON THE APPLICABILITY OF BIO-DIESEL FUEL FOR THE SMALL TYPE MARINE DIESEL ENGINES IN VIETNAM CONDITIONS

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Abstract:

At present time, the environmental pollution of the world is one of the most urgent problem for all humanity. To reduce the pollution from the ships, there are many solutions to be used such as: modification of diesel engines, using bio-diesel fuel,... Using of bio-diesel as fuel for diesel engines was well-known, however the using bio-diesel fuel for the marine diesel engine also have been restricted, because of the technology of marine diesel engine or the other problems.

For laying the foundation of the applying bio-diesel fuel for the marine diesel engine in Vietnam conditions, the researcher have carried out a research on the combustion process of the bio-diesel B5 fuel in the small marine diesel engine in Vietnam conditions.

The GT POWER simulation software and MATLAB software have been used to simulate the combustion process of the small type marine diesel engine D243 at Vietnam Maritime University (VIMARU) when the engine used two kind of fuel: bio-diesel B5 and diesel oil (DO). And the experiment has been done on diesel engine D243 SONG CONG at the laboratory of the Internal Combustion Engine Division, Dynamic Mechanical Academic, Hanoi University of Science and Technology linked up with Chemical Technology Academic. Finally, we tested the experimental results for analyzing and evaluating theorical results.

The paper is indicating some theorical studying results of bio fuel combustion process in small marine diesel engine and comparing these results with the combustion process of DO using engine.

Key words: Bio-diesel fuel, combustion process, small marine diesel engine, D243.

1. Introduction

Applying bio diesel fuel for the transport vehicles on city is widespread over the world and somewhere in Vietnam. Whereas, applying bio diesel fuel on the ship also restricts that is caution depend on the technical marine diesel engine or some external problems. To the premise for the studying of applying bio fuel on the marine small size engine in Vietnam. In this article, the studying group chose to study combustion process of bio fuel in the marine small size engine. Because the combustion process will decide to the suitable of the fuel for the marine engine thought the parameters such as: spread velocity when the fuel ignition in the cylinder, ignition pressure, temperature, engine power,…

This article gives some theory studying results of bio fuel combustion process on marine engine and comparing these results for the engines using traditional fuel.

All the authors applied the support facilities: GT POWER simulation software and MATLAB to simulate the combustion process for the D243 marine small size engine that compares the results of the combustion process for two kinds of fuel (comparing of pressure in the cylinder, temperature in the cylinder, heat spread, NO and poison air generates).

Finally, checked these experience results to analysis and evaluate for the theory results. The part of experience results are established and run on laboratory room of the internal combustion division, dynamic mechanic Academic, Hanoi polytechnic University that linkage technology chemical Academic. This studying that carried out on SONG CONG D243 Diesel engine which used on the board. The experience state is done with load state and difference revolutions.

2. The mathematics of bio fuel chemical ignition comparing with the traditional fuel

Comparing chemical ignition of the traditional fuel with bio fuel.

The traditional diesel fuel has formula: C16H34 and fire response:

$$\underbrace{C_{16}H_{34}}_{1\ kg} + \underbrace{24.5O_2 + 92N_2}_{14,9\ kg} \rightarrow 92N_2 + \underbrace{16CO_2}_{3,1\ kg} + 17H_2O \quad (1)$$

So rate air need to fire 1 kg $C_{16}H_{34}$ is 14.9: 1- that mean is to fire 1 kg C16H34 need 14.9 kg air and generate 3.1 kg CO_2.

Bio diesel from soy has formula: $C_{19}H_{36}O_2$

$$\underbrace{C_{19}H_{36}O_2}_{1\ kg} + \underbrace{27O_2 + 86N_2}_{12,5\ kg} \rightarrow 86N_2 + \underbrace{19CO_2}_{2,8\ kg} + 18H_2O \quad (2)$$

And rate air need to fire 1 kg $C_{19}H_{36}O_2$ is 12.5:1 – that mean is to fire 1 kg $C_{19}H_{36}O_2$ need 12.5 kg airs and generate 2.8 kg CO_2. Response (2) need air smaller than response (1) due to the formula of bio diesel has available oxygen.

3. Choosing of Math model to simulate combustion process in the engine cylinder

Establishing the math model to represent the changing ignition pressure in combustion of the engine complexly, because the Ignition between fuel and air in the combustion volume engine happens rapidly including many mechanism happening together.

The basic to build the math model for ignition process is taken from energy balance equation happened in the combustion volume, this is the first law for dynamic heating:

$$dU = dQ - dW + \sum_i h_i dm_i \quad (3)$$

In: dU – the changing internal energy in the cylinder engine
dQ – the moving heat system (engine)
dW – Power of generation system (engine)
$\sum_i h_i dm_i$ - Enthalpy go out from combustion volume
dm_i – Moving physical (in and out thought exhaust valve, suction when supplying fuel into the combustion volume, clearances, leaking thought the segment clearances).

So the amount of moving heat is represented: $Q = Q_{ch} - Q_{ht}$. Warning the engine transmitting heats is loosen, but heating to the mixture between fuel and air. The power that generates from moving piston is positive, so $dW = Dwp$. From it, application the first dynamic heating theory for internal combustion engine:

$$dQ_{ch} = dU_s + dW_p - \sum_i h_i dm_i + dQ_{ht} \quad (4)$$

Power of the piston can represent $dW_p = pdV$. For ideal gas, the energy internal changings can realize dU_s is equal of average temperature of suction gas into the engine T:

$$U_s = m_c u(T) \quad (5)$$

The diferential of equation (4):

$$dU_s = m_c c_v(T)dT + u(T)dm_c \quad (6)$$

In: m_c is mass of the suction air into the engine.

$c_v = \left(\frac{\partial u}{\partial T}\right)_v$ this is the specific calory of physical in the condition is volume constant.

For the average temperature certain from the law of the ideal gas $T = \frac{pV}{m_c R}$ and represent differential equation:

$$dT = \frac{1}{m_c R}(Vdp + pdV - RTdm_c) \tag{7}$$

R regards constants and equation (4) changing into:

$$dQ_{ch} = \frac{c_r}{R}Vdp + \frac{c_r + R}{R}\text{pdV} + (\text{u-c}_v\text{T}) - \sum_i h_i dm_i + dQ_{ht} \tag{8}$$

When known specific calory rate $¥ = \frac{c_p}{c_v}$ and the ideal gas constant $R=c_p-c_v$ so the specific heat flowing the constant volume regards: $c_v = \frac{R}{¥ - 1}$. So I can represent the supply heats into the engine by fuel:

$$dQ_{ch} = \frac{1}{¥ - 1}Vdp + \frac{¥}{¥ - 1}\text{pdV} + (\text{u} - \frac{RT}{¥ - 1})\text{dm}_c - \sum_i h_i dm_i + dQ_{ht} \tag{9}$$

The basic from equation (9), dQ_{ch} element is calory supplied into engine thought supplying fuel and happened the combustion process. So to math dQ_{ch} mean you must the mount of fuel supplied combustion volume, ignition process on it, affect elements,…

4. Simulation the combustion process into D243 engine by using kinds of fuel

The engine which the studied thesis is kind of production internal beside the product supplying stably, used on many small size ships. It is D243 diesel engine.

Calculator algorithm: One new algorithm depends on the theory calculator about the dynamic heatings of the internal combustion engine is carried out thought a programmer of MATLAB. The results in here is a calculator value about temperature, pressure, the graph of compression curve and expansion curve. The calculator results is saved the form of ‘file.txt’ and graph ‘file.pps’ following algorithm graph.

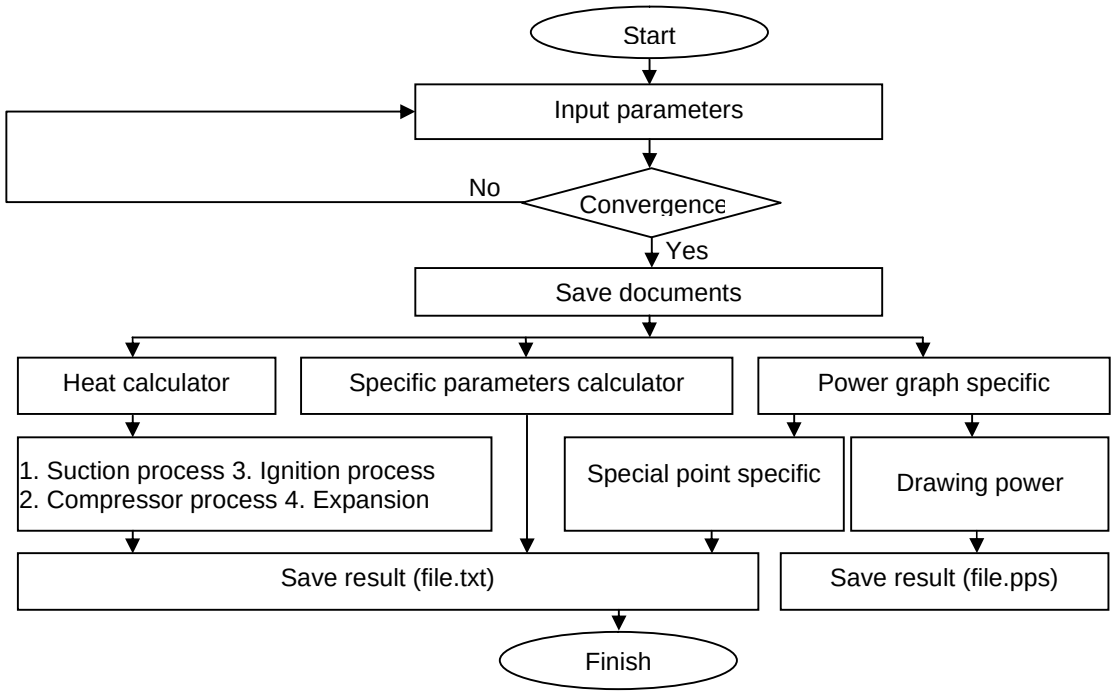

Fig 1. Diagram of calculator algorithm

5. The graph results

By the method of calculator software programer (MATLAB), calculating for two kinds of fuel DO traditional and fuel mixture (DO traditional + 5% soy biodiesel) to compare the parameters: pressure, temperature and heating vislocity and graph of pressure following crankshaft angle.

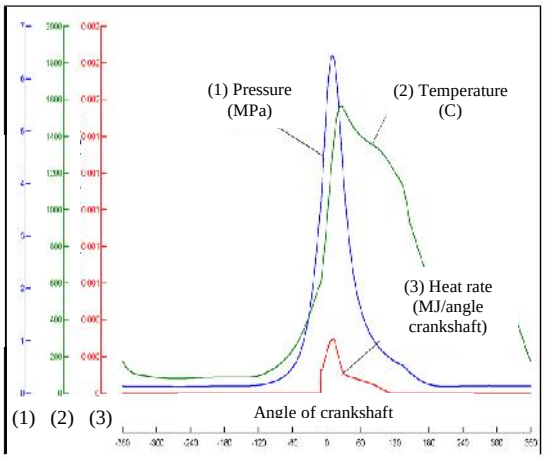

Figure 2 Graph following pressure, temperature and heating vecosity following crankshaft angle of D243 engine in 100% load when using traditional diesel fuel (DO)

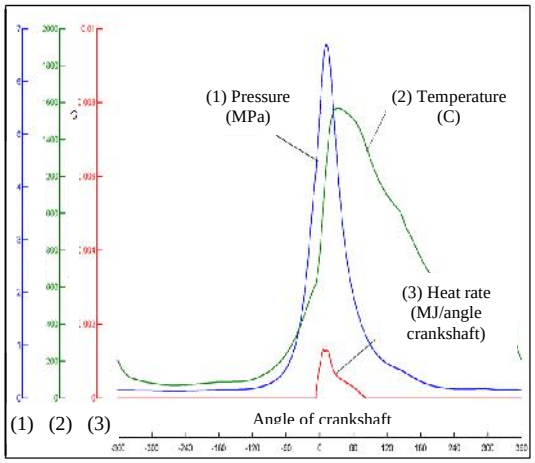

Figure 3 Graph following pressure, temperature and heating vecosity following crankshaft angle of D243 engine in 100% load when using biodiesel B5 (soy)

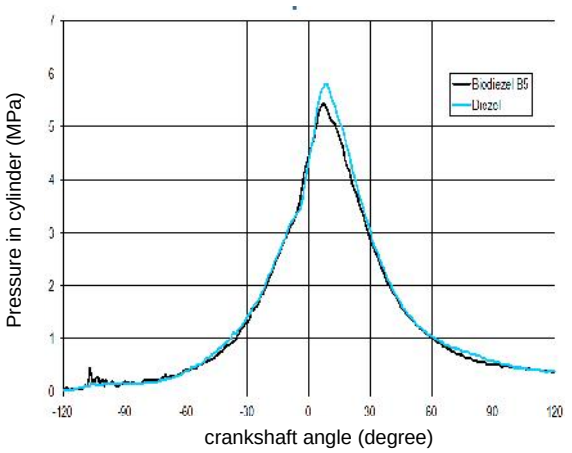

Figure 4 Coparing expanse graph pressure following crankshaft angle D243 engine (50% load, n = 1595 rpm) when using both fuels

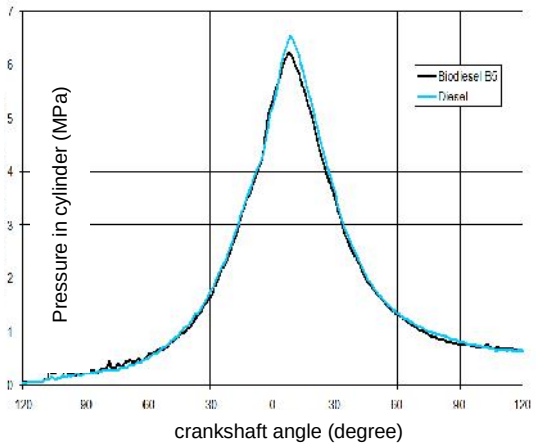

Figure 5 Coparing expanse graph pressure following crankshaft angle D243 engine (50% load, n = 2000 rpm) when using both fuels

6. Conclusion

When simulation D243 engine using both fuels DO and Biodiesel B5, giving some comments:

- When engine using B5 fuel so power losing of engine from 5 to 15 %. Because, the low calorify of fuel B5 is lower than diesel fuel. The max ignition pressure in cylinder when using B5 is smaller than using DO about 3 to 5%; heating vecosity and exhaust gas temperature using B5 is higher than using diesel fuel.
- B5 biodiesel making CO element into exhaust gas to 7 % and CO2 to 8 % and reducing more and more to 20 % all fine exhaust gas, all ignition products of solid, on the seperator device to diesel fuel has low sulfur content (<50ppm).

- B5 biodiesel makes Nox content is smaller than 10 – 25 % to DO. Because B5 biodiesel has sulfur content smaller than DO, Nox exhaust gas can be reduced by using catalytic converters in the normal diesel engine. But, Nox exhaust gas of biodiesel after using the catalytic converters also higher than DO fuel. Because Biodiesel doesn't contain nitrogen, increasing Nox due to xetane index and oxygen content of biodiesel higher DO and this one will permirt to convert nitrogen in the air to Nox rapidly.
- Wherease, in the time studing, all authors recognize biodiesel fuel and them mixture affect the delay time ignition of fuel that reason is the first to affect all the combustions process in the engine and afterward is all working parameter of engine. So the next matter that we will continue is "Studying these affections of the mixture biodiesel – diesel oil for fuel system of marine diesel engine and giving the suitable adjusting mothods".

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