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A Comparative Study on Performance of Diesel Engine using Jatropha Biodiesel as Fuel

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ABSTRACT

The idea of waste recycle and energy recovery plays a very important role for the economical growth of nation. The world faces the crisis of regular rise of petroleum prices, energy demand and exhaustion of fossil fuel resources. As a renewable, sustainable and alternative fuel for compression ignition engine, biodiesel instead of diesel has been increasingly became popular. Biodiesel, derived from the transesterification of vegetable oils or animal fats. In this paper we investigate the prospective of Jatropha oil to use as a Bio-fuel in the conventional diesel engine. The aim of the present paper is to do a comprehensive review of engine performance and emissions using Jatropha biodiesel from different feedstock and to compare that with the diesel. From this review it is found that the use of Jatropha biodiesel and its blends leads to the substantial reduction in CO and HC emissions accompanying with the imperceptible power loss, the increase in fuel consumption and the slight increase in CO2 and NOx emission on conventional diesel engine without modification. Since Jatropha biodiesel has many similarities to diesel fuel, it can be directly used in diesel engine without any modification.

KEYWORDS: *diesel engine, Jatropha Biodiesel, blends, performance, comparison, emissions*

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1. INRODUCTION

The energy demand is increasing daily. This increasing energy demand should be met by a cleaner source of energy [1, 2, 3]. The preservation of energy is decreasing now a days and it alleged that it leads to energy demand. In the last two decades, alternative fuels have obtained and identified as an essential [3,4] Increasing energy consumption and environmental deterioration drive human to finding out alternatives fuels for replacing petroleum fuels, especially for replacing diesel fuel which is widely used by vehicles [3, 5]. Biodiesel is made from renewable plant or animal fats that contain fatty acids [6-9], which can be converted into biodiesel using the transesterification reaction [10, 11]. Biodiesel can also be produced from a wide array of feedstocks such as waste cooking oil, edible and non-edible oil seeds, wood and wood waste etc. [12-14]. Jatropha Biodiesel can be can blended with diesel at different strengths and can be used directly into the diesel engines without any modifications [15]. Jatropha Biodiesel is renewable and eco-friendly source of energy for diesel engines. It can be a potential and sustainable alternative source of fossil fuel with significantly lower emission of greenhouse gases [3, 16]. Biodiesel is better than diesel fuel as it is having very low sulfur content and higher flash and fire point temperatures than diesel fuel. It will reduce the environmental issues as well [4, 16]. A lot of research work pointed out that biodiesel has received a significant attention and it is a possible alternative fuel. Biodiesel and its blends with diesel were employed as a fuel for diesel engine without any modifications in the existing engine [4, 5, 17]. The scientists have seen that the properties of Jatropha biodiesel are very close to commercial diesel and thus it has a promising future as an alternative fuel for diesel engine [18, 19]. Biodiesel being renewable, biodegradable and green fuel can reduce our dependence on conventional/ non-renewable fossil fuels as well as improve environmental quality by reducing emissions [20-23]. Biodiesel is a biodegradable and non toxic fuel produced from vegetable oil and animal fats which are renewable [23].

2. LITERATURE SURVEY

A. K. Azad et al. [3] the study investigated the engine performance and emission using biodiesel from soybean oil and waste cooking oil. As the blend ratio (i.e. B5, B10, B15, B20 and B50) increases the thermal performance of the engine slightly decreases and if the increase biodiesel blends ratio then the emission are decreases. BSFC of both biodiesels is (6.05%, 9.13%, 12.36% and 18.57% for soybean) and (8.17%, 11.40%, 17.71% and 14.96% for waste cooking oil) higher than diesel, respectively. The overall performance of B5 and B10 soybean biodiesel was

found to be better than other biodiesel blends. These two blends produced 45.85 kW and 218 Nm output power and torque, which are only 0.22% and 0.92% lower power and torque production values compared to diesel fuel.

Dipak Patil and Rachayya Arakerimath [17] their main objective was to investigate and evaluate the performance characteristic of engine with the Jatropha Biodiesel. It was observed that JBD40 shown less indicated and BTE and more SFC than diesel and other blend viz JBD20 and JBD60. Performance of JBD20 at full load condition shows same to diesel. JBD20 is more suitable blend of jatropha oil. It shows high BTE, ITE and less SFC. The Jatropha Biodiesel is found to be a promising alternate fuel for diesel engines.

Gaurav Pal et al. [22] in their study the effect of adding Jatropha biodiesel to diesel fuel on engine performance and emission of a diesel engine has been investigated experimentally and compared those results with simulated data using Diesel-RK software. The experiments were carried using pure diesel (B0) and pure Jatropha Biodiesel (JB100) as fuels. The performance characteristics show that BSFC increases and BTE decreases with the use of JB100. Experimentally, B0 has maximum efficiency 29.6%, where as JB100 has 21.2%. In the simulation, the B0 has maximum efficiency 30.3% where as JB100 has 27.5%.

Mohammed EL-Kasaby and Medhat A. Nemit-allah [24] according to the results obtained from their work, they concluded that, peak pressure of B50 is higher at low and high engine speed, while that of B10 (Blend A) and B20 (Blend B) are optimum at economic engine at medium-speed. The effects of dual biodiesel were examined in diesel engine at various loads with constant engine speed of 3000 rpm. The BTE of blend A was found higher than diesel. The emissions of smoke CO and CO2 was lower but HC and NOx of dual biodiesel blends were higher than diesel. The exhaust gas temperature obtained lower for dual biodiesel blends than diesel fuel. From the experimental analysis results, the thermal efficiency and mechanical efficiency of Blend A were slightly higher than the diesel.

J. Sadhik Basha and R.B. Anand [25] experimental investigation was conducted on diesel engine to establish the effects of Carbon Nanotubes (CNT) with the Jatropha Methyl Esters (JME) fuel. The experimental results revealed that, at the full load, the BTE for the JME fuel observed was 24.80%, whereas it was 26.34% and 28.45% for the JME2S5W and JME2S5W100CNT fuels respectively. At the full load, the cylinder gas pressure for the JME fuel observed 72.3 bar, whereas it was 79.77, 76.21, 74.11 and 72.15 bar for the JME2S5W, JME2S5W25CNT, JME2S5W50CNT and JME2S5W100CNT fuels respectively. When compared to neat JME fuel, the exhaust gases (NOx and smoke) were drastically reduced. Overall, observed that the CNT blended emulsions has potential advantages on improving the performance and reducing the emissions from the diesel engine.

K. A. Abed [26] A single cylinder diesel engine was run using different sources of biodiesel such as Jatropha, palm, algae and waste cooking oil biodiesel blends B10 and B20. The conclusion of his work could be summarized as CO, HC and smoke emissions were lower for the tested four biodiesel mixtures B10 and B20 as compared to diesel fuel. The CO2 emissions from biodiesel blends B10 and B20 produced from waste cooking oil were higher compared to diesel fuel and the other biodiesel fuel. The NOx emissions; from biodiesel mixtures, B10 and B20 increased compared with diesel fuel.

A. Sanjid et al. [27] this experimental study supports, motivates, and encourages to use of palm and jatropha combined biodiesel-diesel blends in diesel engine without any modification. By using PBJB5 considerable amount of CO (9.53%), HC (3.69%) and Sound level (2.5%) reduction occurred whereas by using PBJB10 the amount of CO (20.49%), HC (7.81%) and Sound level (5%) reduced compared to D100 fuel. But the NOx emission was increased in case of all tested biodiesels compared to D100.

Bhaskar Kathirvelu et al. [28] The engine performance and emission characteristics of 20% JOME and 20% FOME blends were investigated without any modification in engine and compared with those of normal diesel fuel. The results shows that HC, CO and soot emissions of these fuels are lower compared to those of diesel and JOME is better than FOME in this regard. Exhaust gas temperature and NOx are observed to be higher for these fuels compared to diesel. The BTE of the engine with these fuels is found to be slightly lower than that of diesel. The efficiency of JOME is higher than that of FOME at all loads.

Saurabh Sharma et al. [29] The Experimental work carried out in this study was analyzed. Jatropha biodiesel blends gives a good improvement in thermal efficiency due to the additional lubricity and oxygen content is the possible reason for it. For all the tested fuels the variation obtained in the power was very less. It is found that the performance of the diesel engine at the 80% load is efficient.

Devendra Vashist and Mukhtar Ahmad [30] the best engine operating condition based on lower BSFC and higher BTE were identified and compared. The thermal efficiency obtained 13% substitution of COME and 18% for JOME in diesel. An analysis of variance test was applied to the observed data for both the fuels.

M. Mofijur et al. [31] an average reduction in brake power for B10 and B20 by 4.67% and 8.86% respectively was observed compared to B0. The average BSFC for B10, B20 were found to be higher compared to B0. The use of B10 and B20 as a partial diesel fuel substitute produced lower HC and CO emissions but slightly higher NOx emission compared to B0. These results show that Jatropha biodieseldiesel blends (B10 and B20) can be used in diesel engines. Therefore, it can be concluded that Jatropha crop can be considered as a promising source of biodiesel production in Malaysia.

D. Ramesh and A. Sampathrajan [32] In the case of jatropha biodiesel alone, the fuel consumption was about 14 per cent higher than that of diesel. The percent increase in SFC ranged from 3 to 14 for B20 to B100 fuels. The BTE for biodiesel and its blends was found to be slightly higher than that of diesel fuel at tested load conditions and there was no difference between the biodiesel and its blended fuel efficiencies. The exhaust gas temperature increases with increase in load and amount of Jatropha Biodiesel and its blends. The CO reduction by biodiesel was 16, 14 and 14 percent respectively at 2, 2.5 and 3.5 kW load conditions. The NOx emission from biodiesel was increased by 15, 18

and 19 percent higher than that of the diesel fuel at 2, 2.5 and 3.5 kW load conditions respectively.

Amar Pandhare and Atul Padalkar [33] for 100% Jatropha biodiesel, the maximum fuel consumption was 15% higher than that of diesel fuel. The BTE for biodiesel and its blends was found to be slightly higher than that of diesel at various load conditions. The increase in SFC ranged from 3% to 15% for B10 to B100 fuels. AS the biodiesel blend increase the exhaust gas temperature also increases. The highest exhaust gas temperature observed was 430oC with biodiesel for load conditions 1.5 kW, 2.5 kW, and 3.5kW, where as for diesel 440oC was the maximum exhaust gas temperature. 15% CO emissions obtaine lower with Jatropha fuel.

Bhupesh Sahu et al. [34] their study was about technical feasibility of Jatropha Biodiesel in the CI engine without any modification. The engine performance and various emission characteristics were analyzed. The BTE for J100 and J0 at full load is 21.72% and 24.64% respectively, indicating decrease in efficiency. The BSFC increases with increase in blend ratio. It is highest for J100 for all loading condition. Percentage increase in BSFC at full load for J100 is 27.3% more than neat diesel (J0). Exhaust gas temperature increases with increase in blending ratio. There is about 40% and 29% decrease in CO and HC emission respectively for J100 than diesel (J0) at full load conditions. The J100 has 10.5% CO_2 emitted while J0 emitted 8.9% CO_2, showing an increase of about 18%. It is least for J100 at 60.4% while for J0 it is 84.5%, showing a decrease of about 29%.

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3. CONCLUSION

The performance and exhaust emissions of Jatropha biodiesel reviewed in this paper. Among the numerous biofuels available, vegetable oil is foremost economical in case of farmland usage, potency and productivity as it is the crop having oil carrying tendency. The problem associated with edible-vegetable biodiesel is that there's competition among oil as source of fuel or food. After reviewing the above literature survey, it is observed that the biodiesel received much more attention because of its environmental benefits and economic as well as its availability in the form of natural resources. It has also comes to know the biodiesel is increase the efficiency, exhaust gas temperature of diesel engine and decrease the particulate matters (CO , HC etc.) from exhaust gases which are released to environment. After reviewed this research we can say that the jatropha oil is economical and efficient for the diesel engine, it has low carbon emission comparison than pure diesel used in CI engine. The diesel engine performance analysis shows that the Jatropha as a fuel not much differ from the pure diesel fuel. The thermal efficiency of Jatropha increases with increases in load rapidly but increases slightly for diesel. The brake power of Jatropha Biodiesel fuel increases with increase in load but when load increase, Brake power of diesel decreases. BSFC of Jatropha drastically decrease but for diesel it is decreases gradually. In case of jatropha biodiesel alone, the fuel consumption was about 14% higher than that of diesel. Jatropha biodiesel and its blended fuels, the exhaust gas temperature increased with increase in load and amount of biodiesel. The carbon monoxide reduction by biodiesel and NOx emission from biodiesel was increased than that of the diesel fuel. Finally we can conclude that the JBD20 biodiesel blend has shown better performance than the any other blends and diesel.

REFERENCE

[1] Azad A. K, Rasul MG, Khan MMK, Ahasan T, Ahmed SF. Energy scenario: production, consumption and prospect of renewable energy in Australia. Journal of Power and Energy Engineering. Vol. 2, pp.19-25, 2014.

[2] Ball A, Feng A, McCluskey C, Pham P, Stanwix G, Willcock T. Australian energy update. bureau of resources and energy economics. (cited on 29 August 2014); Available from: <http://www.bree.gov.au/publications/australian-energy-statistics>. 2014.

[3] A. K. Azad, M. G. Rasul1, Brady Giannangelo and Rubayat Islam, "Comparative study of diesel engine performance and emission with soybean and waste oil biodiesel fuels", International Journal of Automotive and Mechanical Engineering, ISSN: 2229-8649 (Print); ISSN: 2180-1606 (Online) Vol. 12, pp. 2866-2881, July-December 2015.

[4] K. Srithar, K. Arun Balasubramanian, V. Pavendan and B. Ashok Kumar, "Experimental investigations on mixing of two biodiesels blended with diesel as alternative fuel for diesel engines", Journal of King Saud University – Engineering Sciences, Vol. 29, pp. 50–56, 2017.

[5] C. S. Cheung, X. J. Man, K. W. Fong and O.K. Tsang, "Effect of waste cooking oil biodiesel on the emissions of a diesel engine", 12th International Conference on Combustion & Energy Utilisation – 12ICCEU, Energy Procedia, Vol. 66, pp. 93-96, 2015.

[6] Azad AK, Uddin SMA, "Performance study of a diesel engine by first generation bio-fuel blends with fossil fuel: An experimental study". Journal of Renewable and Sustainable Energy, Vol. 5, pp. 1-12, 2013.

[7] Vashist D, Ahmad M. Statistical, "Analysis of Diesel Engine Performance for Castor and Jatropha Biodiesel-Blended Fuel", International Journal of Automotive and Mechanical Engineering, Vol.10 (21), pp. 55-69, 2014.

[8] Rostami S, Ghobadian B, Kiani Deh Kiani M, "Effect of the Injection Timing on the Performance of a Diesel Engine Using Diesel-Biodiesel Blends", International Journal of Automotive and Mechanical Engineering, Vol. 10, pp.945-58, 2014.

[9] Kumaran P, Gopinathan M, Kantharrajan S, "Combustion Characteristics of Improved Biodiesel in Diffusion Burner", International Journal of Automotive and Mechanical Engineering, Vol. 10, pp.112-21, 2014.

[10] Amir Uddin MA, Azad A. K., "Diesel Engine Performance Study for Bio-fuel: Vegetable oil, A Alternative Source of Fuel", International Journal of Energy Machinery, Vol.5, pp. 8-17, 2012.

[11] Mofijur M, Atabani AE, Masjuki HH, Kalam MA, Masum BM, "A study on the effects of promising edible and non-edible biodiesel feedstocks on engine performance and emissions production : A comparative evaluation", Renewable and Sustainable Energy Reviews, Vol. 23, pp. 391-404, 2013.

[12] Azad AK, Rasul MG, Khan MMK, Sharma SC, "Review of non-edible biofuel resources in Australia for second generation (2G) biofuel conversion", International

Green Energy Conference. Tainjin, China, pp. 867-78, 2014.

[13] Atabani AE, Silitonga AS, Ong HC, Mahlia TMI, Masjuki HH, Badruddin IA,, "Non-edible vegetable oils: A critical evaluation of oil extraction, fatty acid compositions, biodiesel production, characteristics, engine performance and emissions production", Renewable and Sustainable Energy Reviews, Vol.18, pp.211-45, 2013.

[14] McCarthy P, Rasul M, Moazzem S, "Comparison of the performance and emissions of different biodiesel blends against petroleum diesel", International Journal of Low-Carbon Technologies, 2011:ctr012.

[15] Atadashi IM, Aroua MK, Aziz AA, "High quality biodiesel and its diesel engine application: A review", Renewable and Sustainable Energy Reviews, Vol.14, pp.1999-2008, 2010.

[16] Swapnil D. Ambhore, P. E. Chaudhari and S. H. Barhatte, "Comparison of Performance and Exhaust Emissions of Jatropha, Palm and Calophyllum Inophyllum Biodiesel: A Review", International Journal of Current Engineering and Technology, MITCOE & DIAT, Pune, AMET-2017, IJCET INPRESSO Special Issue-7, 331-334, March 2017.

[17] Dipak Patil and Rachayya Arakerimath, "Performance characteristics and analysis of Jatropha oil in multi-cylinder turbocharge Compression Ignition Engine", International Journal of Engineering Research and Development, Vol. 1(10), pp.50-55, June 2012.

[18] Canaki M., Van Garpen J. H., "Comparison of engine performance and emissions for petroleum diesel fuel, yellow-grease biodiesel and soybean-oil biodiesel", Transactions of the ASAE, Vol. 46(4), pp. 937-944, 2003.

[19] Freedman B., Pryde E. H., "Fatty esters from vegetable oils for use as a diesel fuel", Transactions of the ASAE, pp. 117-122, 1982.

[20] Akintayo E. T., "Characteristics and composition of Parkia biglobbossa and Jatropha curcas oils and cakes", Bioresource Technology, Vol. 92, pp. 307-310, 2004.

[21] Geyer S. M., Jacobus M. J., Lestz S. S., "Comparison of diesel engine performance and emissions from neat and transesterified vegetable oils", Transactions of the ASAE, Vol. 27, Issue. 2, pp. 375-381, 1984.

[22] Gaurav Paul, Ambarish Datta and Bijan Kumar Mandal, "An Experimental and Numerical Investigation of the Performance, Combustion and Emission Characteristics of a Diesel Engine fueled with Jatropha Biodiesel", 4th International Conference on Advances in Energy Research 2013, ICAER 2013.

[23] Bhagwat Prasad Dwivedi, Ajay Singh & Samarjeet Bagri, Performance of CI Engine on Particulate Matter Ethanol Blending with Jatropha Oil In Variable Proportion- A Review, International Journal Of Engineering Sciences & Research Technology, Vol.7(3), pp.212-216, March, 2018.

[24] Mohammed EL-Kasaby and Medhat A. Nemit-allah, "Experimental investigations of ignition delay period and performance of a diesel engine operated with Jatropha oil biodiesel", Alexandria Engineering Journal, Vol. 52, pp.141–149, 2013.

[25] J. Sadhik Basha and R.B. Anand, "Performance, emission and combustion characteristics of a diesel engine using Carbon Nanotubes blended Jatropha Methyl Ester Emulsions", Alexandria Engineering Journal, Vol.53, pp.259–273, 2014.

[26] K. A. Abed, M.S. Gad, A.K. El Morsi, M.M. Sayed and S. Abu Elyazeed, "Effect of biodiesel fuels on diesel engine emissions", Egyptian Journal of Petroleum, Vol. 28, pp.183–188, 2019.

[27] A. Sanjid, H. H. Masjuki, M.A. Kalam, S M Ashrafur Rahman, M.J. Abedin, M.I. Reza and H.Sajjad, "Experimental investigation of palm-jatropha combined blend properties, performance, exhaust emission and noise in an unmodified diesel engine", 10th International Conference on Mechanical Engineering, ICME 2013, Procedia Engineering, Vol. 90, pp.397 – 402, 2014.

[28] Bhaskar Kathirvelu, Sendilvelan Subramanian, Nagarajan Govindan, Sampath Santhanam, "Emission characteristics of biodiesel obtained from jatropha seeds and fish wastes in a diesel engine", Sustainable Environment Research, Vol.27, pp.283-290, 2017.

[29] Saurabh Sharma, Rohit Singh, Mayank Mishra, Gaurav Kumar Mitra and Rakesh Kumar Gangwar, "Performance and Emission Analysis of Diesel Engine using Biodiesel and Preheated Jatropha Oil", International Journal of Current Research and Academic Review, Vol.2(6), pp. 229-239, June-2014.

[30] Devendra Vashist and Mukhtar Ahmad, "Statistical Analysis of Diesel Engine Performance for Castor and Jatropha Biodiesel-Blended Fuel", International Journal of Automotive and Mechanical Engineering (IJAME) ISSN: 2229-8649 (Print); ISSN: 2180-1606 (Online); Vol.10, pp.2155-2169, July-December 2014.

[31] M. Mofijur, H.H. Masjuki, M.A. Kalam and A.E. Atabani, "Evaluation of biodiesel blending, engine performance and emissions characteristics of Jatropha curcas methyl ester: Malaysian perspective", Energy, pp.1-9, 2013.

[32] D. Ramesh and A. Sampathrajan, "Investigations on Performance and Emission Characteristics of Diesel Engine with Jatropha Biodiesel and Its Blends". Agricultural Engineering International: the CIGR Ejournal. Manuscript EE 07 013, March, 2008.

[33] Amar Pandhare and Atul Padalkar, "Investigations on Performance and Emission Characteristics of Diesel Engine with Biodiesel (Jatropha Oil) and Its Blend", Journal of Renewable Energy Volume 2013, Article ID 163829, 11 pages.

[34] Bhupesh Sahu, Ajay Singh Paikra, Dilbag S. Mondloe and Himanshu Agrawal, "Performance and emission characteristics of diesel engine working on Jatropha Methyl Ester and its blends", International Research Journal of Engineering and Technology, Vol. 05 Issue: 02, 682-688, Feb-2018.