A COMPREHENSIVE REVIEW ON KARANJA OIL AS AN ALTERNATIVE FUEL FOR DIESEL ENGINE

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Abstract: The strict emission laws, deteriorating environmental conditions, the depletion of oil reserves and the increasing price of petroleum fuels have forced the world to find alternatives fuels. Biodiesel, the promising alternative fuel can be used in diesel engines with little or no modifications. The properties of biodiesel are similar to those of diesel fuels. It can use as a fuel in diesel engine by blending with diesel The use of non-edible oil is more beneficial as compared with edible oil. Various non-edible oil seeds like Jatropha, Karanja, Neem etc. are widely available in India. Among them, Karanja has a potential to be used for the production of biodiesel. Karanja, are multipurpose non-edible plants can be cultivated on any type of soil such as degraded forests, boundaries of roads and irrigation canals. Its seeds contain 27–39% of the oil. This paper provides a comprehensive review on the important contributions of researcher work on Karanja oil and its blend as alternative fuel for diesel engine .The performance parameters evaluated include brake specific fuel consumption, brake thermal efficiency and emission parameters of karanja bio diesel and its blends are described. It is observed that Karanja oil can be used as alternative fuel for diesel engine.

Keywords: Biodiesel, karanja, non-edible oil, diesel engine.

1. INTRODUCTION

The concept of use of biodiesel in diesel engines is not a new. Rudolph Diesel tested vegetable oil as the fuel for his engine. Biodiesel have become more attractive recently because of their environmental benefits and the fact that they are made from renewable resources. Biodiesel can be produced from variety of plant oils both edible and non-edible. Biodiesel is briefly defined as the monoalkyl esters of vegetable oils or animal fats[1]. Biodiesel is the best candidate for diesel fuels in diesel engines. Biodiesel burns like petroleum diesel as it involves regulated pollutants. The main advantages of biodiesel as diesel fuel are its portability, ready availability it is non-toxic, biodegradable, environmental friendly, has high flash point and can be blended with diesel since the characteristics are similar. When the vegetable oil is used as fuel in diesel engine, it does not cause any major problem. The transesterification process has proved as one of the best method to achieve the same. Biodiesel can be produced from various vegetable oils. The vegetable oil is edible plant oils such as groundnut, rapeseed, soybean, sunflower, mustard etc. and the non-edible plant oils such karanja oil, cotton seeds, jatropha mahua etc. There is tremendous demand of edible oil as food. The non-edible oil is easily available in many parts of the world and are very economical compared with edible oils. The use of non-edible oils will help solve fuel crises problem and reduced the pressure on edible oils and also reduced the current competition of oil for food and for fuel.

2. WHY KARANJA?

In India, non-edible oils like karanja oil and jatropha oil are available in abundance, which can be converted to biodiesel.Karanja can be cultivated on any type of soil such as unproductive lands and degraded forests, irrigation canals, boundaries of roads and

cultivation of this plant is easy [16]. This plant required minimum water.Karanja is medium sized tree almost like neem tree and is found throughout India Figure.1 shows karanja tree.

Figure.1 Karanja plant

Karanja tree has got much importance with excellent medicinal properties and multiple use.Karanja wood is commonly used as fuel wood as well as can be used in agricultural implements. The fruits and sprouts, along with the seeds are used in many traditional remedies. It is use for medicine purposes. The oil of the Karanja or Pongam is used in pharmacy and in agriculture. [15] The oil extracted from karanja seed has pays much attention as alternative fuels for diesel engine. The karanja seed are as shown in Figure 2.

Figure.2 Karanja seed

3. ENGINE PERFORMANCE

Many researchers have carried out experimental investigations to study the performance characteristics of engines running with karanja oil and its blends.The performance of karanja oil blends is compared with engine running with diesel. Performance parameters include brake specific fuel consumption, thermal efficiency and emission parameters of karanja bio diesel and its blends are summarized as follows.

P.K. Srivastava et.al [2] conducted the performance test using methyl ester of karanja oil as fuel in a diesel engine to study its performances and assess its suitability as an alternate fuel for diesel engine. It is observed that thermal efficiency of methyl ester is slightly less than that of the diesel. The brake specific fuel consumption is slightly higher as compared to diesel. The thermal efficiencies are higher with 5%, 10%, 20% and 30% blending of biodiesel by volume as compared to 100% biodiesel. The exhaust gas temperature of methyl ester is higher as compared to diesel and blends.

Also, HC, CO and NOx emissions found slightly higher for all blends than diesel. It is observed that almost all properties of the methyl ester of karanja oil are quite similar to those of the diesel oil. Hence it may be concluded that methyl ester of karanja oil can be used as an alternative fuel for diesel engine.

S. Bajpai et al [3] have blended 5%, 10%, 15% and 20% of pure Karanja oil with diesel. The kinematic viscosity of oil was 27.84 cSt at 40°C.The test were carried out over the entire range of engine operation and engine performance parameters such as fuel consumption, thermal efficiency, exhaust gas temperature, and exhaust emissions. A fuel blend of 10% karanja oil (KVO10) showed higher brake thermal efficiency at a 60% load. Similarly, the overall emission characteristics were found to be best for the case of KVO10 over the entire range of engine operation. They have recommended to use 10% blends of Karanja oil with diesel as a fuel for the diesel engine without any major modifications.

B. Baiju et al [4] Identified that major problem of using neat Karanja oil as a fuel in a diesel engine are its high viscosity. They have used ethanol and methanol as alcohol to produce karanja oil ethyl esters and karanja oil methyl esters. The viscosity of both esters was within the limit of biodiesel standards. Results show that methyl esters produced slightly higher power than ethyl esters. Exhaust emissions of both esters were almost identical. These studies show that both methyl and ethyl esters of Karanja oil can be used as a fuel in compression ignition engine without any engine modification. Among the blends, methyl esters show better performance and emission characteristics, At full load, diesel emits higher NOx as compared to both esters. However, at part load, 10–25% higher NOx emissions observed for all blends of esters.

P.K. Sahoo et al [5] has performed experimentally the practical applications of biodiesel in a single cylinder diesel engine. In the study, Jartopha, Karanja and polanga non-edible methyl esters and their blends(B20,B50,B100, Diesel) with diesel were used as fuels to evaluate the performance and emission characteristics. The results reveals that the maximum increase in power is observed for 50% jatropha biodiesel at rated load. smoke emission is reduced for all biodiesels and their blends compared to diesel at rated load. The result shows that biodiesel from unrefined Jatropha, Karanja and Polanga seed oil is quite suitable as an alternative to diesel. However they suggested that more research on the fuel property, long-term run and wear analysis.The present analysis reveals that biodiesel from unrefined Jatropha, Karanja and Polanga seed oil is quite suitable as an alternative to diesel.

Avinash Kumar Agarwal, K. Rajamanoharan[6] In this study, Karanja and its blend with diesel was used as fuel in C.I. Engine. They conducted experimental investigation of performance and emission of karanja oil and its blend(10%,20%,50% and 75%) diesel in a single cylinder agricultural diesel engine. The results shows that Significant improvements have been observed in the performance parameters of the engine as well as exhaust emissions, when lower blends of Karanja oil were used with preheating and also without preheating The results of the experiment in each case were compared with baseline data of mineral diesel. The gaseous emission of oxide of nitrogen from all blends with and without preheating are lower than mineral diesel at all engine loads. Karanja oil blends with diesel (up to 50% v/v) without preheating as well as with preheating can replace diesel for operating the CI engines giving lower

emissions and improved engine performance. Fuel preheating in the experiments for reducing viscosity of Karanja oil and blends has been done by a specially designed heat exchanger, which utilizes waste heat from exhaust gases.

Kamal Kishore Khatri ,Dilip Sharma[7] have designed an experimental setup to reduce the viscosity of the fuel by blending Karanja oil with Petro-Diesel and preheating the Karanja-Diesel blend.Experiments are performed using Petro-Diesel and preheated Karanja-Diesel blend (in ratio 40:60 by volume) on constant speed direct injection C.I. engine. The effect of injection timing on the preheated Karanj-Diesel blend is investigated On the basis of results obtained, the optimal injection timing is determined for Karanj-Diesel blend, which is found to be 19º BTDC. It is found that substitution of Diesel oil by Karanj oil to the extent of 40% is best possible in the temperature range of 55-60 ºC as the viscosity of blend becomes equal to that of pure Diesel. Therefore, it may be concluded that preheating and blending of the vegetable oils with diesel, together can reduce the problems of straight vegetable oils drastically making it useful substitute for diesel fuel.

P. V. Rao[8] have studied the effect of properties of Karanja methyl ester on combustion, and NOx (oxides of nitrogen) emissions of a diesel engine. The properties of the karanja methyl ester such as viscosity, density, bulk modulus, calorific value, iodine value, cetane number, saturation% and oxygen% are considered for the study. The engine tests were on single cylinder, four-stroke, stationary, water cooled, constant rpm diesel engine conducted with karanja methyl ester (with and without preheating), and baseline fossil diesel. The peak pressures and peak heat release rates for methyl ester was slightly higher than diesel fuel.It was observed that, at full load the oxides of nitrogen emissions of karanja methyl ester are increased by 6%. A significant reduction in oxides of nitrogen emission is observed with preheated methyl ester.

Avinash Kumar Agarwal, AtulDhar[9]. In this experimental study, performance, emission and combustion characteristics of Karanja oil blends (K10, K20, K50 and K100) with mineral diesel were investigated in unheated conditions in a direct injection CI engine at different engine loads and constant engine speed (1500 rpm). Fuel consumption and thermal efficiency are relatively inferior for all Karanja oil blends compared to mineral diesel. The HC emissions decreased. NOx emissions were higher and smoke opacity was lower for all blends compared to diesel. They have recommended to use 20% blend with diesel in a diesel engine higher concentration blends are not suitable as alternate fuels in unmodified diesel engines.

Bhupendra Singh Chauhan, Naveen Kumar[10] The objective of this study is to compare the performance, emissions and combustion characteristics of biodiesel derived from non-edible Karanja oil. The performance parameters evaluated in this study includes brake thermal efficiency of Karanja biodiesel with different compositions at 5%, 10%, 20%, 30% and 100% with mineral Diesel. BTE was about 3 to 5% lower with Karanja biodiesel and its blends with respect to diesel. The unburned hydrocarbon, CO, CO_2 and smoke were lower with Karanja biodiesel fuel. However, NOx emissions of Karanja biodiesel and its blend were higher than Diesel. The results from the experiments suggest that biodiesel from non-edible oil like Karanja and its blends with diesel could be a potential fuel for diesel engine and play a vital role in the near future especially for small and medium energy production.

Atul Dhar, Avinash Kumar Agarwal[11]have tested 10%, 20% and 50% blends of Karanja oil (viscosity-35.98 cSt) with diesel in the diesel engine Effect of Karanja biodiesel (Karanja oil methyl ester) and its blends on engine performance, emissions and combustion characteristics in a direct injection compression ignition (DICI) engine of a medium size utility vehicle with varying engine speed and load has been investigated. Maximum torque attained by 10% and 20% Karanja oil methyl ester blends were higher than mineral diesel, while higher biodiesel blends produced slightly lower torque. The brake specific fuel consumption for lower Karanja oil methyl ester blends was comparable to mineral diesel however brake specific fuel consumption increased for higher biodiesel blends. The brake specific fuel consumption for lower Karanja oil methyl ester blends was comparable to baseline mineral diesel however brake specific fuel consumption increased for higher biodiesel blends. At lower engine loads, higher biodiesel blends have lower brake thermal efficiency than mineral diesel. At higher engine loads, brake thermal efficiency of all Karanja oil methyl ester blends was almost same as mineral diesel. The 20% blend of Karanja oil with diesel shows satisfactory engine performance.

Mohammed Takase a, Ting Zhao[12] have focus on the use of non-edible resources Neem, karanja, rubber and jatropha are evergreen multipurpose non-edible plants that are widely available and can be grown in diverse socio-economic and environmental conditions. This study was therefore undertaken to explore the multipurpose of these four non-edible tree plants. Among the highlights of this expatiate review include oil as feedstock for biodiesel, the need for non-edible feedstocks, neem, karanja, rubber, jatropha and their value chains, methods of modifying oil to biodiesel, factors affecting biodiesel production, application of the selected non-edible seed biodiesels to engines for performance and emission characteristics and the outlook From the study, these four multipurpose non-edible tree plants (neem, karanja, rubber and jatropha) there- fore show great potentials as non-edible biodiesel feedstock that can ensure sustainable bioenergy production

L. Karikalan and M. Chandrasekaran[13] have carried experimental analysis to evaluate the performance and emission characteristics of a compression ignition engine fuelled with dissimilar compositions of karanja biodiesel and its blend at 5%, 10%, 20%, 25%, 50%, 75% and 100% with mineral diesel. HC, CO, CO_2 and smoke were measured, found lower with karanja biodiesel fuel. However, NOx emissions of karanja biodiesel and its blend were higher than diesel. The combustion analysis was done using peak cylinder pressure and heat release rate with respect to crank angle. The peak cylinder pressure and heat release rate was lower for karanja biodiesel. Results confirm that the performance of the engine fuelled with karanja biodiesel and its blends with diesel fuel is by and large comparable with pure diesel.

Rupesh L. Patela,,C.D. Sankhavarab[14] have taken review of karanja oil as fuel for diesel engine. Karanja trees can grow on sides of roads, canal and boundary portion of agricultural lands with minimum care. Its seeds contain 27–39% of the oil. Transesterification, Pyrolysis, Micro emulsion and Blending are four primary methods for the production of biodiesel. The 20% blend of Karanja oil methyl ester (KOME) with diesel (B20) is the most optimized blend for a diesel engine. The Brake thermal efficiency (BTE) and Brake specific fuel consumption (BSFC) of B20 is comparable to diesel. Emissions of CO, HC and smoke are reduced and NOx is increased with increasing blending of Karanja oil methyl ester with diesel.

4. CONCLUSION

This paper provides a comprehensive review on the important contributions of researcher work on karanja oil and its blend with diesel.The study includes preparation of biodiesel from karanja and its application as fuel to diesel engine. Most of the researcher concluded that no modification is required in diesel engine if we blend karaja oil with suitable percentages. Some researcher have suggested little modification such as to reduce viscosity of karanja oil small heat exchanger can be used which can exchange heat of exhaust gas of engine. The overall conclusion is that karanja oil diesel blend is suitable as alternative fuel for diesel engine. The performance of engine with blend fuel (20% karanja methyl ester and 80% diesel) was found to be better than the other blend fuels for which brake thermal efficiency and brake specific fuel consumption are almost close to diesel. Further study is requiring for long term storage of karanja oil diesel blend, Reduction of NOx emission and engine wear.

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