A Review on Performance of Hybrid of Thumba and Waste Vegetable oil.

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ABSTRACT

The research activities from past two decades have been vigorously done in the area of alternate fuel for CI engine and still it is going on. The rapid industrialization and motorization aims a serious threat to the draining of petroleum resources, also developing countries consuming huge amount of energy by fossil fuels for their development that also affects on depletion of fossil fuels. Due to depletion of fossil fuel and environmental concern has promoted to look over the bio fuel as an alternative fuel source. Many investigations and studies revealed that the oils from the vegetable origin can be successfully implemented to the existing CI engines without any major hardware modification and still further research is necessary to find a fuel resource from a waste recovery point of view. In this regard, generally biodiesel has obtained from vegetable oil and animal fat that have been considered as a promising alternate fuel. The research regarding blends of Diesel and single biodiesel have done already. Very few works have been done with combination of two different biodiesel blends with diesel (i.e. Hybrid fuel) and left a lot of scope in this area. Therefore waste cooking oil and thumba can be used as a potential alternative fuel. This paper reviews the production, potential, characterization, and engine performance of the waste cooking oil and thumba biodiesel through the experimental work carried out in various part of the world.

Keywords: - *biofuel, Thumba, Waste Cooking Oil, Hybrid Fuel, etc.*

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1. INTRODUCTION

World's energy consumption has increased continuously since decade, because the world population is increasing and the economies of developing countries are expanding rapidly. Also, increasing industrialization, growing energy demands, limited reserves of fossil fuel and increasing environmental pollution have joined necessitated exploring some alternative of conventional petroleum fuels. Energy is the prime mover of economic growth and is vital to the sustenance of a modern economy. Future economic growth mainly depends on the long-term availability of energy from sources that are affordable, accessible and environmental friendly. Also, the source and supply of primary energy sources like coal, oil and natural gas seem to decrease to a critical point. The petroleum fuels are one of the major sources of energy are currently the dominant global source of CO_2 emissions, greenhouse gases and global warming.

The rise in petroleum prices and increase in environmental pollution jointly have create a necessity to find renewable alternatives to conventional petroleum fuels. Among the biofuels, vegetable oils like jatropha oil, karanja oil, castor oil, cottonseed oil, neem oil, manhua oil, thumba oil, palm oil, soybean oil, sunflower oil etc. are being explored as promising alternative to hydrocarbon based fuels to fulfil the future energy needs. Vegetable oils can be used as alternative fuels because they are biodegradable, non-toxic and significantly reduce pollution. Vegetable oils and their derivatives as diesel engine fuels lead to substantial reductions in Carbon monoxide, smoke and particulate emissions. Vegetable oils have approximately 90% heating value of mineral diesel due to higher oxygen content. One of the main problems of vegetable oil use in diesel engines is high viscosity than that of mineral diesel due to which problems occur in pumping and atomization, ring sticking, carbon deposits on the piston, cylinder head, ring grooves, etc. Therefore, a reduction in viscosity is of prime importance to make vegetable oils a suitable alternative fuel for diesel engines. The problem of high viscosity of vegetable oils can be resolved in several ways, such as preheating the oils, blending or dilution with other fuels, transesterification and thermal cracking or pyrolysis. One of the possible methods to overcome the problem of high viscosity is blending of vegetable oil in proper proportions with diesel. It is a fact that biodiesel is a safer, more economical and infinitely more environmentally friendly than the conventional petroleum diesel.

2. THUMBA (Citrulluscolocyntischord)

Thumba is the plant which is non edible vegetable oil plant, mainly grows in rain fed parts of Rajasthan and Gujarat. It is a creeper and grows well in sandy soil. Comparing with Jatropha, Thumba plant with small crop cycle and various uses can play a pivotal role for the process of Indian rural economy. Scientific name of Thumba is Citrullus Colocynthisschard. Citrullus colocynthisschard is a species of family Cucurbitaceae, citrullus genus native to Turkey. Commonly it is called as 'Bitter apple' (in English), Thumba, (in Marathi), Indrayan (in Hindi). It is short period crop grown naturally within 45-55 days wild in Indian arid zone (Western Rajasthan). Thumba is planted/ grown naturally in rainy season and its fruits / seeds are available in winter. It has annular and rough stem, rough leaves that are 3-7 lobed, 5-10cm long in middle, flowers are monoleceios and have yellow rounded fruit. This plant leaf may be used as fodder in summer for animals, when there is a very high scarcity of regular fodder crops. The average yield is about 2500-3500 kg of seeds/ ha. With minimum inputs. Seeds contains 12-20% of golden yellow- brown oil. Deoiled cake has a great importance in organic fertilizer industry. Currently all extracted oil is consumed by saponification industries, and local soap industries. Thumba contains 50% oil and up to 35% protein. It can tolerate annual; precipitation of 250-1500mm and an annual temp of 14.8 to 27.8^0 C. it also grows from sea level up to 1500 meter above sea level on sandy loam, sub desert soils, and sandy costs with a pH range between 5.0 and 7.8. The plants grows in tropical deserts, wet forests as well as cool temperature moist regions.

Since it is available in large amount at low cost and it is non edible hence it can be used for biofuel.

3. WASTE VEGETABLE OIL

Presently, wide open research is going on to replace the petroleum diesel by a non-petroleum. Product which is friendly and cost effective and efficient. The United States Energy Information Administration predicted in 2006 that world consumption of oil will increase to 98.3 million barrels per day (15,630,000 m^3/d) (mb/d) in 2015 and 118 million barrels per day in 2030. With 2009 world oil consumption at 84.4 mb/d, [2] reaching the projected 2015 level of consumption would represent an average annual increase between 2009 and 2015 of 2.7% per year. In June, BP provided an intriguing update to its global oil reserves estimates in the company's yearly review of energy statistics. It raised its reserve estimate by 1.1% to 1687.9 billion barrels-just enough oil to last the world 53.3 years at the current production rates. According to the Institute of Mechanical Engineers, there are 1.3 trillion barrels of proven oil reserve left in the world's major fields, which at present rates of consumption should last 40 years However, the organization also emphasizes that by 2040, production levels may be down to 15 million barrels per day-just 20% of what we currently consume. By that time, it is probable that the world's population will be double what it is today and much more industrialized. Used cooking oil causes severe environmental problems, "a litre of oil poured into a water course can pollute up to 1000 tanks of 500 litres". It's feasible to demonstrate the contamination with the dumping of these oils to the main water sources. The oil, which reaches the water sources, increases its organic pollution load, to form layers on the water surface to prevent the oxygen exchange and alter the ecosystem. The dumping of the oil also causes problems in the pipes drain obstructing them, creating odours, and increasing the cost of waste water treatment. For this reason, has been necessary to create a way to recover this oil and reuse it. Also due to the wear and tear resulting in sewer pipes may cause overflows of the system, generating diseases that can cause mild stomach cramps to diseases potentially fatal, such as cholera, infectious hepatitis and gastroenteritis, due to the sewage contains water which can transport bacteria, viruses, parasites, intestinal worms and moulds. Vegetable oil and its methyl esters are the prominent candidates for alternative diesel fuels. These fuels are now under its initial stage of commercialization they are technically feasible and economically competitive as compared with convectional diesel fuel.

Used cooking oils/waste cooking oils/waste frying oil and fat residues from meat processing may be used as raw materials, which are obtained after repetitive frying of the food products. Previously the waste vegetable oil was used as an ingredient in animal feed but, it was banned by European Union due to animal health hazards. The disposal of waste cooking oil is a problem since, it contaminates water resource and blocks the drainage systems. So, using it as an alternative fuel is therefore found most suitable solution not only for disposal but also to manage the fuel crisis. In

Some instances, the waste cooking oils are used to manufacture soaps and detergents but a major volume of waste cooking oil is discharged to environment.

4. LITERATURE REVIEW

Sunilkumar R. Kumbhar, et al [1] investigates the performance analysis of single cylinder diesel engine, using diesel blended with thumba oil. Depletion of non-renewable source of energy (fossil fuels like petroleum, coal and natural gas) many researches are always looking to find an alternative source of renewable energy. One such alternative to diesel fuel is biodiesel, because they are environmental friendly, biodegradable, renewable and sulphur free. In this research the engine used is single cylinder diesel engine with bore diameter of 87.50 mm, and stroke length of 110 mm, with power developing capacity of 3.5 KW power generation capacity at full speed, the CR should be varied between 12 to 18. The thumba biodiesel blends used for the testing are B10, B20, B30, B40, B50 & B100 and compared them with performance of B00 (i.e. pure diesel). Biodiesel blends of B10% (i.e. Diesel 90% & biodiesel 10% by volume) and B20% (i.e. Diesel 80% & biodiesel 20% by volume) gives better BTE and lower BSFC than other biodiesel blends. The blends of B10% and B20% gives better emission characteristics than other blends and closer to diesel values. CO, HC, CO_2 of B100 of Thumba biodiesel showed less emission percentage/ppm, for NOx emission B10 and B20 of Thumba, biodiesel showed less emission ppm.

Chavan S. B., et al [2] perform and study transesterification process on thumba seeds for production of thumba oil as a biofuel. As demand of fossil fuel increasing day by day so it is necessary to found alternative for those fossil fuel. The very much known way to replace fossil fuel was bio diesel, and many more researches are going on production and testing of biofuel as an alternative of diesel fuel. The thumba is plant which was grown in hot region like Rajasthan and grown up within short time of 45-55 days in monsoon season. So the production of thumba seed should be possible in large hectares of land in future, now there will most of researches done on biodiesel production and performance but thumba is one which could be preferred in future biodiesel. There is a best source as a raw material that is Citrullus Colocynthisschard (Thumba) oil for biodiesel production. Their study is focused on the collection of seeds and oil extraction then proceed for biodiesel production with molar ratio 8:1, KOH were 0.75wt%, temperature 65^0C, reaction time 90 minutes were used and testing of parameters as per ASTM 6751 standards. The physical properties like acid value, density, Calorific value, Flash point, Fire point and Moisture, Viscosity of Thumba methyl ester (TME) were 0.42,0.870gm/cc, 37.00MJ/Kg, 1640c, 1720c and 0.02%, 4.78 Cst found. From their study it is concluded that, TME may works as a sustainable feedstock for biodiesel production that is equivalent to fissile fuel as per ASTM 6751.

Jaspreet Singh, et al [3] done a work on extraction and optimization of biodiesel produced from waste cooking oil and comparing the performance and emission characteristics with diesel at different compression ratios. In this research work they use bio fuel prepared from waste cooking oil and comparing their performance and emission characteristics with pure diesel fuel. The three different types of blends B10, B20 and B30 are used to perform trial on four stroke CI engine. The biofuel was prepared by transesterification process and conduct a trial on single cylinder, four stroke CI engine at various compression ratios of 12, 14 and 16. By this testing they calculate BP (Brake Power), BSFC (Brake Specific Fuel consumption), BTE (Brake Thermal Efficiency) and exhaust gas concentration including oxides of nitrogen, sulphur, HC and CO. The calorific value of optimized waste cooking oil biodiesel was lower than diesel fuel. The flash and fire point of waste cooking oil biodiesel were determined to be 154^oC and 160^oC respectively which are higher than diesel fuel. The experimental results also showed that the smoke emissions were reduced for all biodiesel mixtures and hydrocarbon (HC) and NOx emissions of B10 blend is lowest among all. There is a slight increase in the carbon monoxide (CO) emission for the B10 blend as compared to B20 and B30. From this research study it is conclude that, B10 blend of waste cooking oil biodiesel act as best alternative fuel among all tested fuel at full load condition.

Adeilton Fernandes, et al [4] studied the environmental and technical performance of a diesel engine with the alternative use of biofuel obtained from the reutilization of vegetable oil. In this research study they used the blends of vegetable oil with pure diesel in the proportion of B5, B20, B50 and B100 and compare their technical and emission performance with the pure diesel which is done on single cylinder VCR engine. They also compare the power producing ability of each blend and then compare them with diesel fuel, by varying the toque and then speed subsequently and observed that B100 is shows loss in BP production by 6% as compared to the pure diesel fuel and BSFC slightly increasing. B5, B20 similarly behaves like diesel with minor deflection in the performance, in the speed range of 1600-2200 rpm speed B20 performance is better. From above study, it is conclude that there is definitely reduction in emissions of CO, CO_2, $NO_{X,}$ and $SO_{X,}$ by improving density, additives, and stoichiometric balance of that vegetable oil biofuel. As we know it is not possible to use the vegetable oil as a bio fuel because it’s edible and due to limited availability, then we can use waste cooking oil for bio fuel production because, it has a great impact in terms of soil and water contamination if it is disposed of in an incorrect manner.

David K. Chirchir, et al [5] carried a review on the performance and exhaust emissions characteristic of a diesel engine running on waste vegetable biodiesel oil. Now worldwide use of diesel in large quantity is the big concern for the future as fossil fuels are used because of their large power production capacity. We know that diesel also having greater fuel economy and lower hydrocarbons (HCs) and carbon monoxide (CO) emissions than gasoline fuel, however, emissions of particulate matter (PM), nitrogen oxides (NOx), sulphur oxide (SOx), polycyclic aromatic hydrocarbons (PAHs) and exhaust odour from diesel engines have always been of great concern. So there is need to find alternative for diesel with minimizing harm to the environment as global warming increasing day by day so better option is coming out and that is vegetable oils as we discuss in above research paper review [10] its edible so the better option is comes out is waste cooking oil, but because of high viscosity and low volatility affecting the atomization and spray pattern of fuel leading to incomplete combustion, severe carbon deposits, injector choking and piston ring sticking. By transesterification process we develop the biofuel made by raw material as waste cooking oil. By this study it is conclude that, biofuel can reduce carbon monoxide, carbon dioxide, hydrocarbon, particulate matter and sulphur oxide emission with slightly increased brake specific fuel consumption but increases the nitrogen oxide emission. To reduce NOx emission in the exhaust, it is necessary to keep combustion temperature under control using exhaust gas recirculation technique.

B. De, at al [6] studied the performance and emission characteristics of vegetable oil blends with diesel in a direct injection variable compression ignition (CI) engine. There has been growing interest in alternative fuels like vegetable oils, biodiesels, biogas, LPG, CNG to provide a suitable diesel oil substitute for internal combustion engine. Vegetable oils, because of their agricultural origin, due to less carbon content compared to mineral diesel are producing less CO_2 emissions to the atmosphere. It also reduces import of petroleum products. This experimentation is carried out on I.C. engine laboratory single cylinder, four-stroke VCR, direct injection diesel engine to analyze the performance and emission characteristics of pure diesel and prepared biofuel for comparing with pure diesel. The readings are taken out for the compression ratio of 16, 17 and 18 varying the load from idle to rated load of 3.7 kW. These results are calculated at constant speed, and various loads of that engine (i.e. 10%, 30%, 50%, 70% and 90% of rated speed). By above study is conclude that, thermal efficiency, exhaust gas temperature and emission parameters such as NO_x and co at CR of 18 for the blends containing up to 30% (by volume) jatropha oil is close to that of diesel fuel. But with the increase of jatropha oil concentration in the blends increasing the exhaust gas temperature and emission parameters like NO_X, co and decreases the thermal efficiency of the engine.

A.M. Liaquat, et al [7] studied the application of blend fuels in a diesel engine. In this experimentation study they use four samples of blends including diesel prepared by pure diesel, jatropha oil biofuel and waste cooking oil biofuel. The blends to be tasted are as follows, B00 (100% diesel fuel), B5 (5% jatropha biodiesel and 95% diesel fuel), B10 (10% jatropha biodiesel and 90% diesel fuel) and B10 (J5W5, i.e. 5% jatropha biodiesel, 5% waste cooking oil and 90% diesel fuel) respectively. Engine performance test was carried out at 100% load keeping throttle 100% wide open with variable speeds of 1500 to 2400 rpm at an interval of 100 rpm and then emission tests were carried out at 2300 rpm at 100% and 80% throttle position. By this study the overall result comes out is, the average torque reduction compared to B00 for B5, B10 and B10 (i.e. J5W5) was found as 0.63%, 1.63% and 1.44% and average power reduction was found as 0.67%, 1.66% and 1.54% respectively. Average increase in BSFC compared to B00 was observed as 0.54%, 1.0% B10 and 1.14% for B5, B10 and B10 (i.e. J5W5) respectively. In case of engine exhaust gas emissions, compared to B00 average reduction in HC for B5, B10 and B10(i.e. J5W5) at 2300 rpm and 100% throttle position found as 8.96%, 11.25% and 12.50%, whereas, at 2300 and 80% throttle position, reduction was as 16.28%, 30.23% and 31.98% respectively. Average reduction in CO at 2300 rpm and 100% throttle position for B5, B10 and B10(i.e. J5W5) was found as 17.26%, 25.92% and 26.87%, whereas, at 80% throttle position, reduction was observed as 20.70%, 33.24% and 35.57%. Similarly, the reduction in CO_2 compared to diesel fuel for B5, B10 and B10(i.e. J5W5) at 2300 rpm and 100% throttle position was as 12.10%, 20.51% and 24.91%, whereas, at 80% throttle position, reductions was observed as 5.98%, 10.38% and 18.49% respectively. However, some NO_X emissions were increased for all blend fuels compared to B00. In case of noise emission, sound level for all blend fuels was reduced compared to B00. It can be concluded that B5, B10 and B10 (i.e. J5W5) can be used in diesel engines without any engine modifications However, B10 (i.e. J5W5) produced some better results when compared to B10.

K. Srithar, et al [8] investigated the performance of Diesel engine on mixing of two biofuels blended with diesel fuel. As mentioned in paper by author very few researches done with performance analysis of diesel engines by using mixture of two bio-fuels blend with diesel fuels, and that lefts lot of scope for research in this area. This study brings out an experiment on diesel engine by using feedstock of pongamia pinnata oil & mustard oil blended with diesel fuel in various six ratios (B10, B20, B30, B40, B60 & B80). In this Study they examine the effect of biofuel on performance of single cylinder diesel engine and exhaust emissions with constant speed of 3000 rpm. Break thermal efficiency (Π_{BTE}) of blend B10 was higher than diesel. The emission of smoke, hydro carbon, and nitrogen oxide of dual bio fuel blend was slightly higher than the pure diesel but, temperature of exhaust gases lower than diesel. Therefore from this paper it is conclude that the blends of mixture of two bio-fuels blend with diesel fuel (pongamia pinnata oil & mustard oil) with mixing ratio of B10, B20 & B30 would be used as an alternative fuel for diesel in diesel engine.

Sushma.S, et al [9] studied the production and performance of hybrid bio diesel (Dairy Waste Scum and Karanja) on single cylinder diesel engine. In this research, the general motive to reuse of dairy waste scum and seeds of karanja for bio diesel production and perform a trial on single cylinder diesel engine (i.e.CI engine). For this research firstly they produced the hybrid biodiesel for conduct a test on CI engine with compression ratio of 17.5, the hybrid term indicates that they blend the hybrid biodiesel that means equal amount of two separate feedstocks are mixed up and blended with the diesel. Suppose on biodiesel ratio of B20 trial is to be carried out on single cylinder diesel engine then total 20% biodiesel was tested on this engine but, in that 20 % bio diesel the dairy waste oil and karanja oil was in equal quantity of 10% each is to be mix. The BTE of B10 is very close to that of diesel fuel at full load condition, by increasing the load of the engine, the BTE also increases for all the tested blends. The specific fuel consumption of biodiesel and its blends at all loads is higher than diesel fuel, As the load increases, BSFC decreases for all bio fuel blends. From all this they conclude that, Cost of biodiesel can be reduced by using low cost raw material like dairy waste scum oil, karanja and can be further reduced by adopting mass production, with solving dairy disposal problem and help to growing economy.

K.Vijayaraja, et al [10] did a detailed study on the performance and emission characteristics of the CI engine using various bio diesel blends prepared by the mango seed oil at various ratios and compared them with performance and emissions of the CI engine by pouring pure diesel in it. The methyl ester of mango seed oil is blended with diesel in a single cylinder, four stroke vertical and air cooled Kirloskar diesel engine. The some results of performance and emission characteristics occur by using mango seed biofuel blends of B00, B25, B50, B75 & B100 are, The brake thermal efficiency, unburned hydrocarbon and smoke density are observed to be lower in case of mango seed biofuel blends than diesel. BSFC increases as percentage of biofuel increases in the blends. The emission of NO_x is nearer to the diesel fuel when B25 blend is used but it increases as % of biofuel increases. From this study, it is concluded that optimized blend is B25 with respect to performance, emission and combustion characteristics for all loads compared with diesel and it could be used as alternative fuel in a single cylinder direct injection diesel engine without any modifications and thereby saving 25% of the precious neat diesel fuel.

Bobade S.N., et al [11] study and prepared methyl ester (biodiesel) from jatropha curcas linn oil. Need to find alternative for diesel is they are renewable, safe and non-polluting and by considering top priority in view of the uncertain supplies and frequent price hikes of fossil fuels in the international market. As per this paper, biodiesel (fatty acid methyl ester) which is derived from triglycerides by transesterification, has attracted considerable attention during the past decade as a renewable, biodegradable and nontoxic fuel. This process has therefore been widely utilized for biodiesel fuel production in number of countries. As the acid value of Jatropha curcas oil is high, so that we have to reduce it by the process of esterification followed by transesterification. The methyl ester produced by this way gives the good result. The present study deals with transesterification of jatropha curcas oil which gives > 83% of methyl ester and > 17% of glycerol using molar ratio 6:1 (methyl alcohol to oil) and 0.5wt % of sodium hydroxide at 65^0C for 90 minutes and allowed to settle overnight. As per ASTM 6751(American Standards For Testing and Material) the properties like density, viscosity, flash point, cloud point and pour point have been carried out for the fuel quality of Jatropha oil methyl ester (i.e. JOME).

5. CONCLUSION

From above review paper, we observed Biodiesels are considered as good alternatives to diesel. Biodiesel is prepared by using 'Transesterification Process', which is widely used for preparation of the biodiesel and it can be used by mixing of two different biodiesels (i.e. Hybrid Methyl Ester) in engine. Thus, Biodiesel offer the advantages to be used in existing diesel engine without engine modifications and works without any disturbance. It is an alternative fuel and can reduce carbon monoxide, carbon dioxide, hydrocarbon, particulate matter and sulphur oxide emission with slightly increased brake specific fuel consumption but increases the nitrogen oxide emission. To reduce NOx emission in the exhaust, it is necessary to keep combustion temperature under control.

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