A Review: Production & Performance of Biodiesel

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Abstract— As per environmental concern and availability of fossil fuel there is need to be found an alternative fuels. According to the literature review it is found that there are many advantages and limitations of biodiesel to replace petroleum-based diesel. We can use pure biodiesel in conventional diesel engine but its performance is poor than conventional diesel. By making blends with diesel we can improve properties of biodiesel to get the optimum result. CO, HC emissions are lower for biodiesel but NOx emission is higher as compare to diesel.

Key words: Biodiesel

I. INTRODUCTION

Now a day's energy demand by whole world is rapidly increasing. Fossil fuels such as Petroleum oil, coal and natural gas are important resources for energy production.

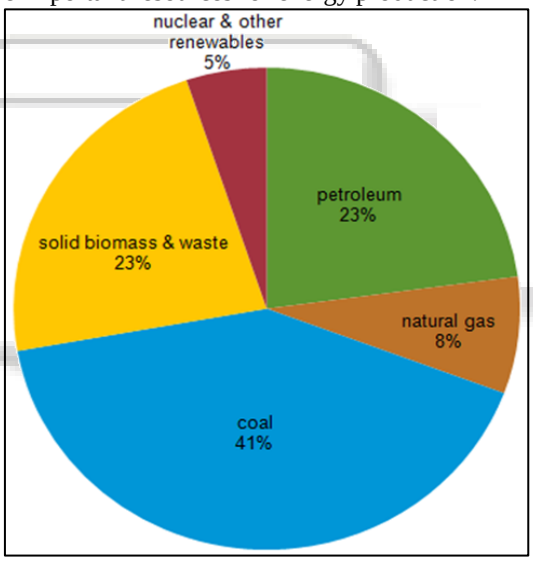

Fig. 1: Total Energy Consumption in India.

India is the 4th largest energy consuming country. As compared to develop countries per capita consumption of India is less. Coal is largest source in India. Due to continuous utilization of fossil fuel, rapid depletion of its reserves and environment degradation is observed. The solution to this problem would be to determined alternative source. Biodiesel is one of the best alternatives to fulfill energy demand. Biodiesel can be employed in IC engine without any modification. Biodiesel can be produce by using vegetable oil, animal fat, alcohol, catalyst, etc.

Advantages of biodiesel are, it is biodegradable, renewable, zero carbon emission and does not produce hazardous toxic gases. According to Ames mutagenicity tests, cancer risk is reduced up to 90%.

The properties of biodiesel are almost similar to diesel fuel. Biodiesel is storage safer due to its high flash point.

Engine efficiency increases as biodiesel is blended with diesel fuel. A chemical reaction called 'Transesterification' is used to convert vegetable oil into biodiesel to produce ethyl ester or methyl ester. Vegetable oils are palm seed oil, Cotton seed oil, Soybean oil, Sunflower oil, Olive oil, Karanji oil, Jatropha etc. Waste cooking oil can be used to produce biodiesel instead of fresh vegetable oil because it's easy availability and cheap price.

II. LITERATURE REVIEW

In this paper we have reviewed work of various authors in the field of biodiesel as an alternative resource.

Dr. B. Karunanithi et. al. discussed on "Transesterification of waste vegetables oil." Transesterification of waste cooking oil is done by using methanol in presence of potassium hydroxide catalyst. Environmental protection agency collect the waste vegetable oil form various restaurants and destroy it in a suitable way, because it contains large amount of fatty acid. We can use fresh vegetables oils as well as waste vegetables oils. We prefer waste vegetable oil because it is available in market at cheap price. Transesterification process in which, we can produce fatty acid esters by separating glycerol. Fatty ester oil is also known as biodiesel. Waste vegetable oil is filtered to remove the unwanted particles. Then it heated at certain temperature such as 120^0C for 30 to 45 minutes to remove moisture and heating is done by using electric heater. The process is done in three steps, in 1st step, diglycerides is produced from triglycerides. In 2nd steps, monoglyceride is produced form diglycerides and in the last step, glycerides are optioned. Formation of ester takes a place during this all reactions.

$$\text{Triglycerides+R'OH=Diglycerides+R'COOR}_1$$
$$\text{Diglycerides+R'OH=Monoglyceride+R'COOR}_2$$
$$\text{Monoglyceride+R'OH = Glycerides+ R'COOR}_3$$

Vegetable oil containing less amount of sulphur, hence it is less harmful for environment. [1]

They worked on performance of single cylinder, 4 strokes, water cooled and variable compression ratio diesel engine running at default set compression ratio 17.5 using Jatropha biodiesel blends (B10 to B50 with increment of 10). For same blends engine was run for 3 different loading conditions as high, medium and low and reading was taken after the steady state condition was reached. Results obtained were, for low and medium loading condition fuel consumption remains lower for diesel than biodiesel blends. Fuel consumption for B20 at high load condition was lowered. B20 blend at medium load has higher efficiency (19.82%). They conclude that biodiesel with lower blend ratio (B20) can be used for diesel engine without modification. [2]

Biodiesels were produced from waste fish oil, hazelnut oil, rapeseed oil and waste cooking oil. Pure

biodiesel without making blends with diesel fuel were used in a diesel engine and few important chemical and physical properties of fuel were found. Single cylinder, 4 strokes and air cooled engine was use to carried out tests. First tests were started with diesel fuel until the engine reached to the operating temperature. Engine was loaded with the hydraulic dynamometer to adjust the specified engine speeds and engine was run at full open accelerator position. After reaching certain speed, engine was not loaded more and reading was recorded. At fully open accelerator position, engine was loaded, till four speeds in the range of 1000 rpm to 2500 rpm were obtained. Results of this report are for all biodiesel torque and power values were decreased. For biodiesel average BSFC values were increased as compared to diesel. NOx values and exhaust emission temperature were higher for biodiesel but CO, CO_2 and HC emissions from biodiesel were lower than that of diesel fuel. [3]

They researched on Biodiesel produced from palm oil is used by making its blends i.e. B0, B10, B20, B30. Asingle cylinder, four strokes engine was run using diesel fuel until a steady state condition was reached. After that, biodiesel blend was used to carry out tests. The engine was operated with load variation from no load to full load condition at 1500 rpm. They concluded, flash point, kinematic viscosity and density of biodiesel were higher than that of diesel. Brake power and brake thermal efficiency of all test fuels increased as the load increased but BSFC decreased with increased in load. CO, HC and NOx emission of all blends decreased as compared to diesel. B30 showed better performance compared to other blends. [4]

Paper discusses on Biodiesel produced by using used vegetable oil. In this research density, kinematic viscosity, calorific value and flash point were measured. Density of biodiesel is 0.87 g/cm^3. Biodiesel is safe for transport because it has higher flash point (179^{o}C) than petro-diesel. The calorific value of biodiesel was 7813 kcal/kg and viscosity was 5.9 centistokes at 30^o. Maximum yield of this biodiesel was 94%. Methyl ester of used vegetable oil can be used as diesel as its properties are similar to that of diesel. By using used cooking oil collected from shop selling fritters, production cost of biodiesel can be reduced. [5]

In this research work they were studied to evaluate the best method for the production of biodiesel. Biodiesel was produced from vegetable cooking oil. The tests were carried out with dynamometer on I.C engine to analyze its performance with diesel fuel and biodiesel blends. Blends were B5, B20, B50 and B100. CO emissions were reduced up to 44% using biodiesel B100 compared to diesel. Result shows reduction of NOx emission. Biodiesel production using cooking oil is best solution to the problem of improper disposal of used oil. [6]

In this paper, they discussed about performance of four stroke four cylinder direct injection diesel engine on neat RME and its 5%, 10%, 20% and 30% blends with diesel fuel. They used Karanja for production of biodiesel. Torque decreases with increasing in percentage of biodiesel. Brake specific fuel consumption decreases with increases in compression ratio. They also conclude that diesel with 20% of biodiesel can safely blended at any of the compression ratio and speed. [7]

They made biodiesel by using cashew nutshell liquid; B10 to B20 range of biodiesel is used. Engine is started at no load and feed control was so adjusted that can attain the rated speed and steady state condition. Engine was loaded gradually to keep the speed within the permissible range. Two cylinder, air-cooled, constant speed, direct injection diesel engine is used. Output parameters checked in this paper were break specific fuel consumption, engine power, CO, HC, NOx emission. [8]

In this paper, they discussed about performance of single cylinder, four strokes, direct injection air cooled engine and electric dynamometer is used. Biodiesel is produced by waste cooking oil. Fuel consumption and load were measured, after the engine reached the stabilized condition. Output parameters considered are break specific fuel consumption, engine power and CO, HC and NOx emission. 5.5 gram potassium hydroxide and 100ml methyl alcohol were used for esterification of 250ml of sunflower oil. Blends used are B5 to B20 of which B20 gives result as that of diesel engine. They conclude that fuel consumption increases as the biodiesel content in the fuel rise due to its lower heating value. [9]

Discussion on performance of single cylinder four stroke water cooled engine with dynamometer, load cell and temperature sensors are used. B0 to B20 blends are used in which brake thermal efficiency, BSFC, emission of NOx, HC and CO, smoke capacity and exhaust gas temperature are the output parameters. Extraction method used was transesterification.CO, HC and NOx emissions are found less. [10]

They discussed about performance of single cylinder four stroke engines. They use blend B10 to B100 and check output parameter like brake specific fuel consumption, brake thermal efficiency, HC, CO and NOx emission. They conclude that fuel consumption is increased due to high density and viscosity of biodiesel. [11]

Triglycerides (vegetable oils/animal fats) and their derivatives are used to produce biodiesel. Vegetable oil has high flash point and its kinematic viscosity varies from 30^{0}C to 40^{0}C temperatures, so we cannot use vegetable oil as fuel. Due to above phenomenon some problems takes places, 1stpoor atomization due to high viscosity, 2nd heavy smoke emission due to the incomplete combustion. To avoid such type of problem we have to modify the properties of vegetable oil and formed biodiesel. [12]

They have discussed on performance of engine at various compression ratio. Biodiesel burns like petroleum oil. It is made from vegetable oil or animal oil. Vegetable oil or animal oil contains Triacylglycerols. This is combination of fatty acid and glycerol. Biodiesel produce from vegetable oil or animal fat. Properties are evaluated by varying various parameters like reaction time, KOH and molecule ratio. Temperature is kept constant i.e.60^0. The properties of biodiesel are compared on the basis of minimum viscosity, maximum viscosity and maximum fatty acid content. They got better result at molecule ratio 5:1, 0.5% KOH and reaction time was 60 minutes. BP of diesel was higher as compared to biodiesel. BP is decreased by increasing percentage of biodiesel due to the low heating and calorific value. [13]

They have discussed about various parameters related to engine performance. First they studied the effect of

biodiesel on torque and power of 2 cylinder diesel engine. For test purpose they use blends B0 to B50. At the end of test they founded that the torque and power give similar to the diesel fuel. (I.e. Torque=64.2Nm at 2400 rpm, power=18.12 kW at 3200 rpm). After that they studied on fuel consumption on same blends. They found that B-30 blend give less consumption of fuel (0.61%) and b-10 gives more consumption of fuel (4.1%). Later they studied on Exhaust emissions and the test result shows that the value of CH and HC gases coming from exhaust are decreased. From this paper we concluded that the engine performance of diesel fuel and this blend are nearly equal. [14]

In this paper they have studied the effect of mixture of emulsified biodiesel with 4, 6 & 8% of water contents. The mixture were prepared to be used as fuel in a 4 cylinder DI compression ignition engine and find the performance indicator such as brake power(BP), brake specific fuel consumption (BSFC) & brake thermal efficiency (BTE) and emissions such as NOx & PM. When they took the test at different load condition they saw that as load increases brake power also increase in all blends. The results were compared to B5 biodiesel (blend of 95% diesel & 5% palm oil biodiesel).At low load with 4% water ratio, BSFC decrease by 12.75%. With 6% water ratio, BSFC decrease by 1.5%. At 8% water ratio BSFC increase by 17.19%. This is more than B5. Also they have studied on emission parameters, by using water in emulsified biodiesel, the NOx gas emissions decreases (i.e 73.87%) and PM decreases by 20%. They conclude that no major differences between the engine BP and BTE measured for all emulsified biodiesel compared to B5 at high load. BSFC increases with increasing water ratio. The NOx & PM emission were decrease at by 8% because of water. [15]

III. Conclusion

The results of this report are summarized as follows:

1) Transesterification is best, suitable and preferred method of making biodiesel.
2) Biodiesel has high flash point. Thus it is safe to store.
3) All the biodiesel blends have higher brake thermal efficiency than that of diesel at high load.
4) CO, HC, CO_2 and NOx emission is reduced by using biodiesel.
5) NOx emission decreases as blend ratio increases at all loads.
6) Fuel consumption remains lower for diesel as compared to biodiesel at low and medium loading conditions.
7) B20 and B30 blends show better performance than other blends.

qConcluding the reviews of researchers we select waste cooking oil for our further research work. For production of biodiesel waste cooking oil is better option as it is easily available in market and cheaper in cost. We will try to obtain better result and to reduce NO_x emission.

Reference

[1] Dr. B. Karunanithi, K. Bogeshwaran, Manasa Tripuraneni discussed on. "Bio-Diesel from Waste Cooking Oil". IJMER, Volume 2, Issue 5, Sep-Oct 2012, pp.3857-3860.
[2] Sagar Chaudhari, Maulik Modi, Tushar patel and Gaurav Rathod. "Performance of Small Capacity Compression Ignition Engine using Jatropha Biodiesel Blends". IJRET Volume: 5, Issue: 3, March 2016; eISSN: 2319-1163; pISSN: 2321-7308.
[3] Rasim Behcet, Huseyin Aydin, Cumali llklic, Selman Aydin and Bahattin lscan "Diesel Engine Application for Evaluation of Performance and Emission Behavior of Biodiesel from Different Oil Stocks" AIChE 2014.
[4] Jalpit B. Prajapati, Parth R. Panchal, Tushar M. Patel. "Performance and Emission Characteristics of C.I. Engine Fuelled with Diesel- Biodiesel Blends".IOSR-JMCE; Vol 11, Issue 3; 2014.
[5] Nabanita Banerjee, Ritica Ramakrishnan and Tushar Jash. "Biodiesel production from used vegetable oil collected from shops selling fritters in Kolkata". Energy Procedia, 54, 2014, 161-165.
[6] Adeilton Fernandes, Alexandre Tadeu Simon and Carlos Roberto Camello Lima. "Study of the environment and technical performance of a diesel engine with the alternative use of biofuel obtained from the reutilization of vegetable oil". Procedia CIRP, 7, 2013, 335-340.
[7] Mohammed EL Kassaby, Medhat A. Nemit allah. "Studying the effect of compression ratio on an engine fuelled with waste oil produced biodiesel /diesel fuel". AEJ, 52, 1-11, Jan 2013.
[8] Balachandar.K, Shantharaman.P.P. "Performance and characteristics of biodiesel by using compression ignition engine" volume 2, issue 1, April 2015.
[9] Wail M. Adaileh and Khaled S. AIQdah. "Performance of diesel engine fuelled by a biodiesel extracted from waste cooking oil". Energy procedia 18, 2012, 1317-1334.
[10] ShyamPandey, Amit Sharma and P.K Sahoo "Experimental investigation on the performance and emission characteristics of a diesel engine fuelled with ethanol and jatropha based biodiesel blends". IJAEP, volume 4, issue2, pp.341-353, saptember 2012.
[11] B.M.Gitte, Sayyed Siraj and H. M. Dharmadhikari. "Performance and emission characteristics of diesel engine fulled with biodiesel and its blends". iJERT volume 2,issue 10,ISSN:2278-0181, October 2013.
[12] R. B. Sharma, Dr. Amit Pal, and JuhiSharaf. "Production of Bio-Diesel from Waste Cooking Oil". IJERA, ISSN: 2248-9622, Volum 3, Issue 6, Nov-Dec 2013, pp.1629-1636.
[13] Jaspreetsingh and Harpreetsingh. "Extraction and optimization of biodiesel produced from waste cooking oil and comparing the performance and emission characteristics with diesel at different compression ratio". IJERT, ISSN: 2278-0181, Volum3, Issue8, August2014.
[14] B. Ghobadian, H. Rahimi, A. M. Nikbakht, G. Najafi and T F Yusaf. "Diesel engine performance and exhaust emission analysis using waste cooking biodiesel fuel with an artificial neural network". Renewable energy, 34(4). pp.976-982. ISSN 0960-1481
[15] W. N. Maawa, R Mamat, G Najafi, O Majeed Ali, and Aziz. "Engine performance and emission of compression ignition engine fuelled with emulsified Biodiesel-water". ICMER 2015.

