International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 04, April-2019

Production of Biodiesel from Simarouba Glauca using Mixed Base Catalyst and its Performance Study on CI Engine

Dr. Uday Kumar P A
Department of Mechanical Engineering, SRSIT, Bangalore, India.

Girish N
Department of Mechanical Engineering, SRSIT, Bangalore, India.

Kiran Kumar J
Department of Mechanical Engineering, SRSIT, Bangalore, India.

Sai Vamshi D S
Department of Mechanical Engineering, SRSIT, Bangalore, India.

Vinod K G
Department of Mechanical Engineering, SRSIT, Bangalore, India.

Umesh Raju Rathod
Department of Mechanical Engineering, SRSIT, Bangalore, India.

Abstract:- **The growing industrialization and motorization of the world has led to a steep rise for the demand of petroleum-based fuels. Petroleum based fuels are obtained from limited reserves. Therefore, those countries not having these resources are facing energy/foreign exchange crisis, in the main because of the import of crude oil. Hence, it is necessary to appear for different fuels which might be made from resources out of there regionally among the fuels, like alcohol, biodiesel, vegetable oils etc. Biodiesel is a fatty acid alkyl ester which is renewable, biodegradable and non toxic fuel which can be derived from any edible & non edible oil by Transesterification process. One of the popularly used non edible biodiesel in India is simarouba oil methyl ester (SOME). In the present investigation, simarouba oil based methyl ester (biodiesel) is produced by using mixture of Sodium hydroxide and Disodium ortho Phosphate, a mixed base catalyst by transesterification process. Experiments were conducted for Injection pressure (IP) of 200bar, keeping compression ratio (CR) of 17:1 as constant to study the performance and emission characteristics of a TAF-1, Kirloskar make, direct injection, Four Stroke single cylinder petro-diesel engine using blends of simarouba methyl esters with petro-diesel on a 10, 20, 30 and 100% volume basis, respectively. In this process the performance study and emission test is done.**

Keywords- Biodiesel, Mixed base catalyst, Simarouba Gluca, Transestercation, Performance, emissions.

1. INTRUDUCTION

Energy is taken into account as a critical issue for economic process, social development and human welfare. Since their exploration, the fossil fuels continued as the major typical energy supply with increasing trend of modernization industrialization, the planet energy demand is additionally growing at quicker rate. To manage the increasing energy demand, majority of the developing countries import fossil oil with the exception of their endemic production. This puts extra burden on their home economy. there are limited reserves of the fossil fuels and the world has already faced the energy crisis of seventies concerning uncertainties in their supply. Fossil fuels are presently the dominant internationally supply of carbon dioxide emissions and their combustion is stronger threat to wash atmosphere. Increasing manufacture, growing energy demand, limited reserves of fossil fuels and increasing environmental pollution have jointly necessitating the exploring of some alternative to the conventional liquid fuels, vegetable oils have been considered as appropriate alternatives due to conventional liquid fuels, vegetable oils have been considered as appropriate alternative due to their prevalent fuel properties. It was thought of as feasible option quite earlier. However despite the technical feasibleness, vegetable oils as fuel could not get acceptance, as they were more costlier than crude fuels. This led to the retardation in scientific efforts to investigate the further acceptability of vegetable oils as alternate fuels.behind, due to numerous factors as stated above created resumed interest of researchers in vegetable oils as substitute fuel for diesel engines.

2. LITERATURE SURVEY

Liquid fuels from renewable resources are biodegradable and inexhaustible. In this regard vegetable oils having their physical and combustible characteristics close to diesel fuel may stand as immediate candidate substitute for alternative fuel to reduce its dependence on imports. The rural development ministry, government of India hopes to introduce biodiesel for industrial use particularly for automobile terribly presently. Bio-diesel is already in use in Italy, Brazil, US, Malaysia and Japan just that it’s made from different natural sources in different places. In India biodiesel will be produced from oil-bearing trees available.

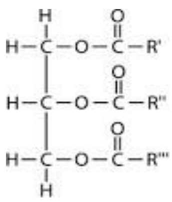
Mishra S.R :- Simarouba seeds contain about 40 % kernel and kernels content 55-65% oil. The amount of oil would be 1000 – 2000 kg/ha/year for a plant spacing of 5m X 5m. It was used for industrial purposes in the

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 04, April-2019

manufacture of soaps, detergents and lubricants etc. The oil cake being rich in nitrogen(7.7 to 8.1%), phosphorus (1.07%) and potash (1.24%) could be used as valuable organic manure. Simarouba was a rich source of fat having melting point of about 290C. The major green energy components and their sources from Simarouba were biodiesel from seeds, ethanol from fruit pulps, biogas from fruit pulp, oil cake, leaf litter and thermal power from leaf litters, shell, unwanted branches etc. The transesterification of Simarouba glauca oil by means of methanol in presence of Potassium hydroxide catalyst at less than 65 0 C. The viscosity of biodiesel is nearer to that of the diesel. Simarouba glauca oil consists of 96.11 % pure triglyceride esters.

3. PRIMARY STUDY OF OIL

Vegetable oils are generally composed of triglycerides whose molecular structure are branched and complex. Figure shows the structure of a typical triglyceride molecule. On the another hand, diesel consists of straight chain molecular structure. Vegetable oils have comparably energy density, cetane number, heat of vaporization, and stoichiometric air/fuel ratio with mineral diesel fuel. The large molecular sizes of the element triglycerides ends in the oils having higher viscosity compared there with of mineral diesel fuel. The problem of viscosity has an adverse effect on the combustion of vegetable the fuel, such as spray atomization, consequent vaporization, and air/ fuel mixing. But vegetable oils have oxygen molecules present in them.



Structure of a typical triglycerides molecules

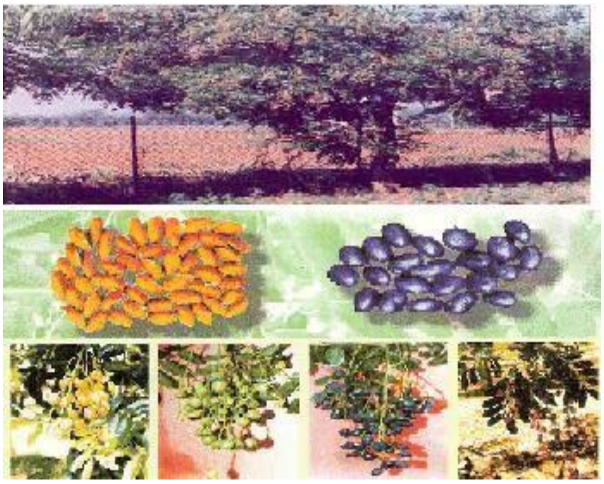


Fig.1 simarouba gluca seeds

Fig.2 simarouba gluca oil

Simarouba Glauca, is associate non edible oil seed bearing tree, that's compatible for warmth, humid, tropical regions. Its cultivation depends on rain distribution, water holding capability of the soil and sub-soil wet. it's fitted to temperature vary of 10 to 40oC. the tree is currently found in numerous regions of India. It is fully grown on waste tracts of marginal, fallow lands of Southern india. Simarouba saplings are durable in nature and might survive below every type of piece of ground, and soils with some depth for the roots to penetrate.

4. EXPERIMENTAL INVESTIGATION

Transesterification is a chemical reaction used for the conversion of vegetable oil/Seed oil to biodiesel. In this process vegetable oil is chemically reacted with an alcohol like methanol or ethanol in presence of a catalyst like NaOH. After the chemical reaction, various components of vegetable oil break down to form new compounds. The triglycerides are converted into alkyl esters, which is the chemical name of biodiesel. If methanol is used in the chemical reaction, methyl esters are formed, but if ethanol is used, then ethyl esters are formed. Both these compounds are Biodiesel fuels with different chemical combinations. In the chemical reaction alcohol replaces glycerin.

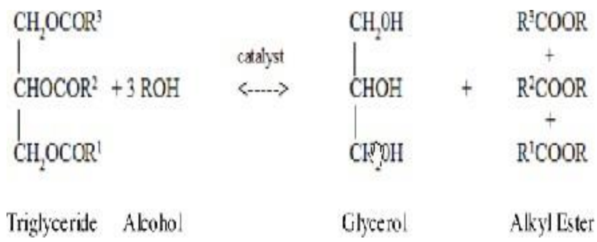


Fig .3 Transestrification reaction

Where R1, R2, R3, are the palmitic acid, oleic acid, linoleic acid, arachidic acid, linolenic acid of the simarouba seed oil in the flask was heated on a heating mantle with a mechanical stirrer arrangement. Measuring the Free fatty acid content in the oil, Heating the oil up to 65ºC.Adding required amount of Sodium Hydroxide and methanol. Heating the solution using a magnetic stirrer for 2 hours. Keeping the oil for settling process in a settling funnel for five hours. After settling methanol is

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 04, April-2019

recovered from the solution through distillation. Once the glycerol layer settled down, the methyl ester layer, formed at the upper part of the container, was transferred to another vessel after that, a washing process to clean some unreacted extra methanol and catalyst was carried out, using distilled water and blown air. Then, a distillation process at about 110c was applied for removing the water contained in the esterified simarouba gluca oil.

Fig .4 Transeterification set up

Fig.5 settling into separate funnel

Fig. 6 methanol recovery

5. PERFORMANCE EVALUTION

A diesel engine is an internal combustion engine that operates using the diesel cycle (named when Dr. Rudolph Diesel). Diesel engines have the highest thermal efficiency of any internal or external combustion engine, because of their compression ratio. The process feature of the diesel engine is that the use of the warmth of compression to initiate ignition to burn the fuel, which is injected into the combustion chamber throughout the ultimate stage of compression. This is in contrast to a petrol (gasoline) engine or gas engine, which uses the Otto cycle, in which a fuel/air mixture is ignited by a spark plug. The exhaust of automobiles is one amongst the

foremost contributors to the world's pollution downside. Recent research and development has made major Reductions in engine emissions, but a growing population and a greater number of automobiles mean that the problem can exist for several years to return. During the primary 1/2 the 1900s, automobile emissions were not recognized as a drag, mainly due to the lower number of vehicles. As the number of automobiles grew along with more power plants, home furnaces, and population normally.

6. RESULTS AND DISCUSSION

The experiments were conducted on a direct injection compression ignition engine for different brake power and different blends (Biodiesel-B10, B20, B30 and B100) of biodiesels. Analysis of performance like brake specific fuel consumption, brake thermal efficiency, Exhaust gas temperature and emission characteristics like hydrocarbon, oxides of nitrogen, carbon monoxide and carbon dioxides are evaluated. The biodiesel used is as per ASTM normal, there’s no modification within the engine. The experiment is carry off at continual compression ratio of 17.5:1 and continual injection pressure of 200bar by change brake power.

1. *Brake power, BP,*

$$= \frac{(2\pi NT)}{(60X1000)}$$

$$= \frac{(2\pi \text{ X } 1444 \text{ X } 28)}{60000}$$

$$= \mathbf{4.23\ KW}$$

2. *Total Fuel Consumption, TFC*

$$= \frac{(10 \text{ X } 3600 \text{ X S.g})}{(t \text{ X } 1000)}$$

$$= \frac{(10 \text{ X } 3600 \text{ X } 0.865)}{(25.66 \text{ X } 1000)}$$

$$= \mathbf{1.214\ Kg/\ Hr}$$

3. *Specific fuel consumption, SFC*

$$= \frac{TFC}{BP}$$

$$= \frac{1.214}{4.23}$$

$$= \mathbf{0.287\ Kg/\ KW\ hr}$$

4. Brake Thermal Efficiency, BTE

$$= \frac{(BP \times 3600 \times 100)}{(TFC \times C_V)}$$

$$= \frac{(4.23 \times 3600 \times 100)}{(1.214 \times 43500)}$$

= **28.84 %**

7. CONCLUSION

1. The yield obtained by using homogeneous catalyst is less (86% to 92%) because the formation of glycerin is more compared to heterogeneous catalyst. The use of mixed catalyst yields more biodiesel (920ml-950ml) and the catalyst will be used 4 to 5 times by the addition of NaOH.
2. SOME satisfies the important fuel properties as per ASTM specification of Biodiesel.
3. Engine performance with biodiesel does not differ greatly from that of petro-diesel fuel. The B30 shows good brake thermal efficiency in comparison with petro-diesel. A little increase in fuel consumption is usually encountered because of the lower calorific price of the biodiesel.
4. Most of the major exhaust pollutants such as HC is reduced with the use of biodiesel and the blend as compared to diesel. But NOX emissions increase when biodiesel fuelled with diesel as compared to conventional diesel fuel. This is one of the crucial drawback of biodiesel.
5. vi).Among the blends, B30 gives better results as Brake thermal efficiency, brake specific fuel consumption, Exhaust gas temperature, hydrocarbons, oxides of nitrogen, Carbon monoxides and Carbon dioxides without any modification in the petro-diesel engine.

vii).In view of the petroleum fuel shortage, B30 blend biodiesel can certainly be considered as a potential alternative fuel. The existing petro-diesel engine performs satisfactorily on biodiesel fuel without any significant engine modifications.

ix). Engine performance with biodiesel does not differ greatly from that of petro-diesel. The B20 shows good brake thermal efficiency in comparison with petro-diesel. A small increase in fuel consumption is commonly encountered due to the lower calorific value of the biodiesel.

8. REFERENCES

[1] Ramadhas A.S, Jayaraj S., Muraleedharan C., *"Use of vegetable oils as I.C. Engine fuel – A review."* Renewable Energy, Vol 29, pp. 727- 742, 2004

[2] Anil Duhan, Yeshwant Suthar., *"Effect of processing on seed oil of simarouba glauca (dc): an underutilized plant"*Vol-6, No.7, July 2011 ISSN 1990-6145

[3] Mishra S.R., Mohanty M.K., Das S.P., *"Production of Bio-diesel (Methyl Ester) from Simarouba Glauca Oil"* Vol. 2(5), 66-71 ISSN 2231-606X

[4] Ma F. and Hanna M.A.*"Biodiesel production: A review", Bio-resource Technol, 70, 1–15 (1999)*

[5] Gerpen J. V., *"Biodiesel processing and production",* Fuel Process Technol, 86,1097–1107 (2005)

[6] Joshi Syamsunder and Hiremath Shantha. 2000. *"Simarouba - A potential oilseed tree", Current Science. 78: 694-697.*

[7] Alcantra R., Amores J., Canoira L., Fidalgo E., Franco M.J. and Navarro A., *"Catalytic production of biodiesel from soybean oil, used frying oil and tallow",* Biomass and Bioenergy, 18(6), 515–27 (2000).