Optimization of Neem Biodiesel and Its Performance on CI Engine

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Abstract- *The use of fossil fuel is increasing now a days, because of which pollution problems are increases due to which it create health problems and has great impact on environment. So there is need of an alternative fuel which is to be used instead of diesel. The best alternative eco-friendly fuel which is developed from non-edible oil is biodiesel. In this paper, the biodiesel which is produced from neem seeds known as neem biodiesel is studied. The oil is extracted from the neem seeds and then followed by transesterification process. After that, the oil is settled and washed; the pure neem biodiesel is produced. Different blends are made from the produced biodiesel which are B10, B20, B30, B40, B50, B60, B70, B100. And finally the performance and emission testing analysis is carried out on four stroke CI engine. After this, the optimized biodiesel is found.*

Keywords- blends, neem oil, optimization, transesterification

I. INTRODUCTION

In the modern world, the demand for non-renewable energy sources is increasing day by day due to modernization and mechanization. Demand for electricity and enormous increase in the number of automobiles has resulted in greater demand for petroleum products. The increasing demand for the petroleum based fuels has led to oil crises in the recent times. Therefore attention has been focused on developing the renewable or alternate fuels to replace the petroleum based fuels for transport vehicles [1-3].

The use of non-edible oils as alternative fuels has been around for one hundred years when the inventor of the diesel engine Rudolph Diesel first tested peanut oil, in his compression-ignition engine [4]. Fossil fuels are still being created today by underground heat and pressure; they are being consumed more rapidly than they are being created. Insufficient quantities or unreasonable price of petroleum fuels deeply concerns us whereas the renewable energy is a promising alternative solution because it is clean and environmentally safe Due to petroleum fuel, Pollution and accelerating energy consumption have already affected equilibrium of the earth's landmasses and biodiversity [4].

Energy can be broadly divided in two types which are Renewable and Non-renewable energy resources. The energy sources which are available free of cost ,abundant in nature and eco-friendly are known as Renewable Energy sources whereas the energy sources which are available in less quantity and are causing problem to environment are called Non-renewable energy sources, they are mostly produced from fossil fuel. Renewable energy sources include solar, wind, tidal energy as these are all eco-friendly and available in large amount, research is done on large scale in this sector. While on the other hand the non- renewable energy includes fuel made from fossil fuel (petrol, diesel, oil etc.), wood, coal etc. as this are causing pollution and are also not available in more quantity , there is a need of finding an alternative fuel. The best alternative fuel is Biodiesel. In this paper biodiesel made from neem oil is discussed.

Biodiesel-

Biodiesel is a fuel which is obtained from edible and non-edible oil. Edible oil (Vegetable oil) cannot be directly used in the diesel engine for its high viscosity, high density, high flash point and lower calorific value. So it needs to be converted into biodiesel to make it consistent with fuel properties of diesel [1].Same is in the case of non-edible oil. In this paper the biodiesel is prepared from the non-edible oil i.e. neem seeds.

Actually Biodiesel can be defined as a fuel composed of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, used in compression ignition engines. The most common process for biodiesel production consists in a trans-esterification reaction in which a triglycerides source (vegetable oil or animal fat) reacts to a short chain alcohol (methanol or ethanol) in catalyst presence [2]. The most commonly catalyst used are potassium hydroxide and sodium hydroxide. The byproduct formed is glycerine which can also be used in ointment and soap industry. The very basic reaction for production of biodiesel is

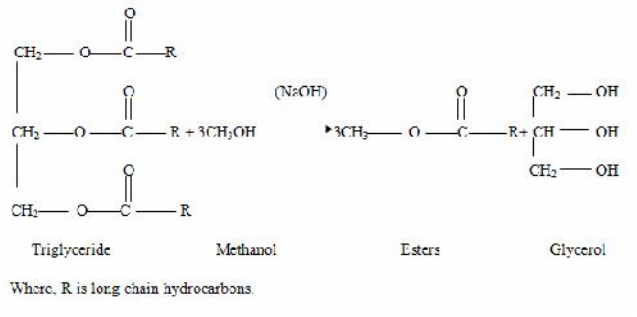


Fig 1. Reaction

Biodiesel can also be produced from oil such as chicken fat, undi, soyabean, castor etc. But this paper is thoroughly discussed about the Neem Biodiesel which produced from neem seeds by following the trans-esterification process. The purpose of using neem oil is very simple because it is having near about same characteristics and also economical.

Biodiesel refers to a family of products made from vegetable oil or animal fats and alcohol, such as methanol or ethanol, called mono alkyl esters of fatty acids. Study shows that, on the mass basis, biodiesel has an energy content of about 12% less than petroleum based diesel fuel. It reduces unburned hydrocarbons (HC), carbon monoxide (CO), and increase oxides of nitrogen (NOx) than diesel-fueled engine. It is a domestic, renewable fuel for diesel engine derived from natural oil like Neem oil. Biodiesel is environment friendly liquid fluid similar to conventional diesel fuel in engine tests, the power and fuel consumption [5].

II. LITERATURE REVIEW

Md. Hasan Ali et.al Studied that Recently energy scene of fossil fuel, renewable energy sources such as biodiesel, bioethanol, biomethane, and biomass from wastes or hydrogen have become the subjects of great interest, this reduces the consumption of fossil fuel. For these reasons they are known as “alternative fuels”. Vegetable oil cannot be directly used in the diesel engine for its high viscosity, high density, high flash point and lower calorific value. So it needs to be converted into biodiesel to make it consistent with fuel properties of diesel. Biodiesel production is a valuable process which needs a continued study and optimization process. The seeds of Neem contain 30-40 % oil. This report deals with biodiesel obtained from Neem oil which are mono alkyl esters produced using ‘Transesterification’ process.

Solange A. Quintella et.al studied that Ethanol can be environ- mentally advantageous over methanol because it can be obtained from renewable sources whilst methanol is usually derived from mineral sources,it is more frequently used as reagent in biodiesel production. Mesoporous silica catalyst was evaluated in the ethanolysis of soybean oil.The reaction was performed using the molar ratio ethanol:soybean oil of 20:1 at inert atmosphere (N2) at 343 K with 1wt% of catalyst mass relative to total oil mass added to the reaction mixture. The reaction was evaluated for ethyl ester conversion after 6 h. comparing well with previous reports for methanolysis of soybean oil. Moreover, lixiviation of the active phase was not observed, thus excluding the contribution of the homogeneous catalysis to the studied transesterication process.

M.M.K.Bhuiya et.al discussed that the depletion of fossil fuel reserved on extensive level produces harmful emission causing environmental issues. Hence considerable attention has been given to alternative sources such a biodiesel.the second generation biodiesel include non-edible vegetable oils. Waste cooking oil as well as animal fats. This study introduces second generation biodiesl to be use as biodiesel feedstocks. Several aspects of the feedstocks are reviewed and discussed in this paper.

Mustfa Balat et.al studied that,the inventor of diesel engine Rudolf diesel first tested penutoil as a biodiesel in his compression ignition engine as an alternative fuel.In 1970 it was discovered by the scientist that,viscosity of vegitable oil can be reduse so that it can perform as a diesel fuel in modern engine.Cansiderable effort have been made to develope vegitable oil derivatives that approximate the properties and performance of the hydrocarbon based diesel fuel.Biodiesel production is a very modern and technological area for researchersdue to relevance that is wining every day because of the increase in the petroleum price and environmental advantages.

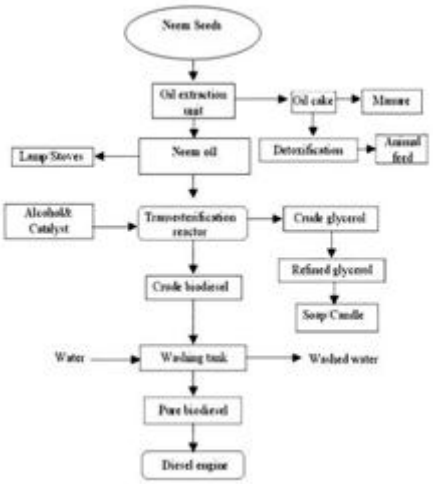
Mallikappa D.N et.al discussed that Engine tests were conducted on a double cylinder, direct injection, compression ignition engine. From the engine tests, it is observed that the brake power increases (by 70% approximately) as load increases. Brake specific energy conversion decreases (by 25e30% approximately) with increase in brake power. Brake thermal efficiency increases with higher brake power and emission levels (HC, CO, NOX) were nominal up to 20% blends.

Myung *G.J.*et.al.studied that crude canola oil shows the negative effect due to it contains about 100-300 ppm of phospolipids. negative effect like poor performance, impure quality of fuel affects the overall performance of the engine. So it is necessary to avoid this effects by using the two step enzymatic process. Two step enzymatic process were carried

out for efficient production of biodiesel.By using this process all the negative effect were reduced as per requirement. Two step enzyamatic process involved degumming and transesterification. In this study, two-step enzymatic processes (degumming and transesterification) were carried out for the production of biodiesel from CCO. Degumming of CCO was performed using phospholipase A2 as a degumming reagent. By carrying this process the phospolipids contain was reduced.

C.S CHEUNG et.al studied that waste cooking oil was used as a biodiesel production. From this waste cooking oil biodiesel was produces and different blends were created eg. B20,B50 And B100. Experiments were conducted with five engine loads, corresponding to brake mean effective pressures of 0.165, 0.33, 0.496, 0.661 and 0.753MPa at a constant speed of 1800rpm. The results show that biodiesel leads to reduction of HC, CO and particulate mass concentrations and number concentrations but an increase in NOx. After testing this biodiesel on a 4 cylinder diesel engine the result show that this biodiesel lead to reduction of HC,CO but increase in NOx

III. METHODOLOGY



Flow chart

In transesterification process, alcohol is reacted with non-edible oil in the presence of appropriate catalyst. Generally, ethyl or methyl alcohol is used to produce ethyl or methyl esters. When the reaction is completed, two distinct layers of liquids i.e., ethyl or methyl ester and glycerine appear and they separate out.The glycerine is refined and disposed of for further use. The crude biodiesel is also refined and alcohol is separated from it which is reused in the cycle.The technology of biodiesel production includes transesterification of oils (triglycerides) with alcohol which gives biodiesel which is chemically-known as fatty acid methyl ester (FAME) as the main product and glycerol as the by-product [3].

1) Extraction of neem oil and production of biodiesel

Biodiesel is a mono- alkyl ester produced through trans-esterification processes. It is obtained from the transesterification of vegetable oil or animal fats. Transesterification reaction is the transformation of an ester, a triglyceride (vegetable oil) into another ester in the presence of acid or base as a catalyst. In the production of biodiesel, the products are mixtures of fatty esters (biodiesel) and glycerol. Following steps describe cleaning of neem seeds, extraction of neem oil and production of biodiesel.

2) Cleaning of Neem Seeds

The first step in obtaining oil from neem for Bio-diesel is to remove the seed-coat and husk in a process referred to as De-hulling. In developing countries, hard objects are used to crack the shells are popular. Once the nuts are cracked, the oil-bearing seeds are cleaned and dried. Seed cleaning involves the removal of the seed coat and the separation of the chaff. Seed drying can be done by placing the seeds under the sun or by heating carefully on the fire for a short while. Once this is done, the next step is to begin the crucial extraction process.

Neem seeds Neem Kernel Neem drying

Fig 2. Drying process

3) Method of Neem oil Extraction

Extraction with ram press and expeller are referred to as cold pressing extraction. Expellers are the most popular oil extraction Engines. They are designed into small output devices that can cater for small scale extraction. Oil seed ram press is simply apiston inside a cage. With the seeds placed inside the cage, the piston can compress the seeds and force out the oil. Sometimes the operating force of the ram can be from a manual pump lift [6].

Preparation of blends-

Different blends were prepared

B10: 10% neem biodiesel and 90% diesel by volume.
B20: 20% neem biodiesel and 80% diesel by volume
B40: 40% neem biodiesel and 60% diesel by volume.
B50: 50%neem biodiesel and 50% diesel by volume.
B60: 60% neem biodiesel and 40% diesel by volume.
B70: 70% neem biodiesel and 30% diesel by volume.
B100:100%neem biodiesel and 0% diesel by volume.

IV. RESULTS

Comparing the properties of Diesel, Neem Oil, Neem Biodiesel

Sr.No	Test Description	Ref. Std. ASTM	Reference		Diesel	Neem Oil Biodiesel Blends						
			Unit	Limit	B00%	B10%	B20%	B30%	B40%	B50%	B60%	B70%
1	Density	D1448	gm/cc	0.800-0.900	0.830	0.835	0.842	0.846	0.850	0.856	0.859	0.866
2	Calorific Value	D6751	MJ/Kg	34-45	42.50	42.20	42.05	41.90	41.60	41.26	41.10	39.50
3	Cetane Number	D613	-	41-55	49.00	49.41	49.46	49.52	42.56	49.66	49.78	49.83
4	Viscosity	D445	mm^2/sec	3-6	2.700	-	-	-	-	-	-	4.22

REFERENCES

[1] Mohammad Md. Hasan Alia**,** Md. Rowsonozzaman Rubelb-"Biodiesel from Neem oil as an alternative fuel for Diesel engine" International Conference on Thermal Engineering,Procedia Engineering ,2013, pp.625 – 630.

[2] Solange A. Quintella , Rosana M.A. Saboya a, Davi C. Salmin -"Transesterification of soybean oil using ethanol and mesoporous silica catalyst." Renewable energy ,2012,pp.136-140.

[3] M. M. K. Bhuiya , M. G. Rasula, M. M. K. Khan-"Second generation biodiesel: Potential alternative to edible oil-derived biodiesel" International conference on Applied energy, Energy Procedia , 2014, pp.1969-1972.

[4] Mustafa Balat , Havva Balat-"A critical review of bio-diesel as a vehicular fuel." Energy Conversion and Management , 2008, pp.2727-2741.

[5] Mallikappa D.N., Rana Pratap Reddy , Ch.S.N. Murthy - "Performance and emission characteristics of double cylinder CI engine operated with cardanol bio fuel blends."Renewable energy , 2012, pp.150-154.

[6] Myung Gwi Janga,, Deog Keun Kimb, SoonChul Parkb- "Biodiesel production from crude canola oil by two-step enzymatic processes". Renewable Energy, 2012, pp. 99-104.

[7] C.S. Cheung, X.J. Man, K.W. Fong and O.K. Tsang.- "Effect of waste cooking oil biodiesel on the emission of diesel engine". International conference on combustion and Energy utilisation, Energy Proccedia , 2015, pp. 93-96.