Capability of biodiesel as an alternative fuel- A Review

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***Abstract*- Energy is considered as one of the most important factors for economic and industrial growth. The increasing industrialization and motorization of the world has led to a increasing demand of an petroleum products. Increasingly important due to diminishing petroleum reserves and the environmental consequences of exhaust gases from petroleum-fuelled engines. Biodiesel fuel produced by alcoholysis of edible, non-edible and waste cooking oil is viewed as a promising renewable fuel source. Diminishing petroleum reserves and increasing environmental regulations have made the search for renewable fuel. Biodiesel offers a great choice. It is mainly derived from vegetable oils, animal fats and algae. In this paper detail review of various experimental studies on Biodiesel and its characteristics are discussed.**

***Index Terms*- biodiesel, transesterification.**

I. INTRODUCTION

Biofuel is a nonpolluting, locally available, accessible, sustainable, and reliable fuel obtained from renewable sources. The fractions of biomass that have been used and are still enjoying renewed attention as feedstock for production of liquid biofuels are from agricultural sources, like: lipids, simple sugars and polysaccharides sources [1]. There are different processes which can be applied to synthesize biodiesel such as direct use and blending, micro emulsion process, thermal cracking process and the most conventional way is transesterification process. This is because of the fact that this method is relatively easy, carried out at normal conditions, and gives the best conversion efficiency and quality of the converted fuel [2].

Biodiesel is an alternative fuel made from renewable biological sources such as vegetable oils both (edible and non-edible oil) and animal fats According to the US standard specification for biodiesel (American Society for Testing and materials (ASTM) 6751), biodiesel is defined as a fuel comprised of mono alkyl esters of long chain fatty acids from vegetable oils or animal fats . The dominant bio-diesel production process, namely transesterification, typically involves the reaction of an alkyl-alcohol with a long chain ester linkage in the presence of a catalyst to yield mono-alkyl esters (bio-diesel) and glycerol .

Production of Biodiesel by Transesterification :

Generally, biodiesel is produced by means of transesterification. Transesterification is the reaction of a lipid with an alcohol to form esters and a byproduct, glycerol. It is, in principle, the action of one alcohol displacing another from an ester, referred to as alcoholysis (cleavage by an alcohol). In Transesterification mechanism, the carbonyl carbon of the starting ester (RCOOR1) undergoes nucleophilic attack by the incoming alkoxide (R2O−) to give a tetrahedral intermediate, which either reverts to the starting material, or proceeds to the transesterified product (RCOOR2). Transesterification consists of a sequence of three consecutive reversible reactions. The first step is the conversion of triglycerides to diglycerides, followed by the conversion of diglycerides to monoglycerides, and finally monoglycerides into glycerol, yielding one ester molecule from each glyceride at each step. The reaction is represented in equation 1. The reactions are reversible, although the equilibrium lies towards the production of fatty acid esters and glycerol. This reaction proceeds well in the presence of some homogeneous catalysts such as potassium hydroxide (KOH)/sodium hydroxide (NaOH). Depending on the undesirable compounds (especially FFA and water), each catalyst has its advantages and disadvantages. Sodium hydroxide is very well accepted and widely used because of its low cost and high product yield. The most common alcohols widely used are methyl alcohol and ethyl alcohol.

Among these two, methanol found frequent application in the commercial uses because of its low cost [3].

$$\text{Triglycerides} + \text{ROH} \rightleftharpoons \text{Diglycerides} + R^1COOR$$

$$\text{Diglycerides} + \text{ROH} \rightleftharpoons \text{Monoglycerides} + R^2COOR$$

$$\text{Monoglycerides} + \text{ROH} \rightleftharpoons \text{Glycerol} + R^3COOR$$

Equation 1 Chemistry of transesterification

The fuels of bio-origin can provide a feasible solution to this worldwide petroleum fuel crisis. Gasoline and diesel-driven automobiles are the major sources of greenhouse gas (GHG) emission. Researchers around the world have explored several alternative energy resources having the potential to quench the ever-increasing energy thirst of today's population. Biodiesel from vegetable oils is emerging as a potential substitute for diesel to be used in IC engines. The Ministry of Petroleum & Natural Gas, Govt. of India has taken several measures for enhancing exploration and exploitation of petroleum resources, apart from developing the distribution and marketing of petroleum products. There was an increase by 7.15% in production of total petroleum products, including fractionators, during 2012–13 compared to the year 2011–12. This calls to improve the alternative resources for continuous feed of demand of energy. Large-scale biodiesel production from edible oil is negatively impacting India due to competition with food crops creating economic imbalances. A possible solution to overcome this problem is to use non-edible oil. The main feedstocks for biodiesel production from non-edible oils are Jatropha, Pongamia and Polanga etc. Eucalyptus Oil is also one the non-edible oils which can be a potential source for biodiesel due to its large availability in India [4].

Biodiesel can replace fossil fuel as a "clean energy source". It can protect the environment by reducing CO_2, SO_2, CO, HC.The carbon cycle of Biodiesel is dynamic through the photosynthesis process. Plants absorb CO_2, which is more than those discharged by the biodiesel combustion process. Thus, using biodiesel can more effectively reduce the emission of CO_2, protect the natural environment and maintain the ecological balance, compared to the use of fossil fuel .The emission of SO_2 in the combustion process of biodiesel is much lower than normal diesel oil because of the low sulfur content in it. Thus, the use of biodiesel instead of normal diesel oil will effectively reduce acid rain, which represents a serious threat to the environment and human infractructure in forms of acidification of soil, surface and ground water forest and vegetation damage, and increased corrosion of buildings and historical monuments made from calcium containing stones. Furthermore, CO, HC and particulate matters will be less discharged, because ester compounds in biodiesel contains oxygen promoting clean burning. Using biodiesel can also reduce air pollution. The use of biodiesel in a conventional diesel engine results in a substantial reduction of hydrocarbons, aromatic hydrocarbons, carbon monoxide, alkenes, aldehydes, ketones, and particulate matter. Nitrogen oxide emissions are slightly increased if the engine management remains unchanged. However, this can be optimized using special software and biodiesel sensors. Using biodiesel decreases solid carbon fraction particulate matter and eliminates the sulfate fraction. Increasing the percentage of biodiesel blended with petroleum diesel fuel progressively eliminates sulfates. Biodiesel works well with new technologies such as catalysts, particulate traps, and exhaust gas recirculation. Soy biodiesel reduces carbon dioxide by 78 percent on a life cycle basis. In addition, diesel engine exhaust from biodiesel was found to have a lower mutagenic potential than that from conventional diesel fuel. This effect is believed to result from a lower content of polycyclic aromatic hydrocarbons in the particle emission of biodiesel, Biodiesel is the first alternative fuel that has fully completed the health effects testing requirements of the Clean Air Act.34 [5].

This is a good alternative to improve the waste cooking oil which is a water contaminant and a health problem in many countries. Initially the two oils were characterized by density, viscosity, iodine index, saponification index and free fatty acids percentage, where the results were consistent with those reported in the literature. Subsequently the mixture between 0% and 20% of waste cooking oil with castor oil was conducted. The transesterification was performed under the conditions previously defined: temperature 60 ° C, molar ratio of 6 mol of methanol / 1mol of oil, catalyst potassium hydroxide (KOH) at 1% w/w with respect to oil. The highest yield was 99% for 85% mixture of castor oil and 15% waste cooking oil, since the results of the other mixtures used were up to 89% yield. The results obtained in gas chromatography showed an average composition of 97.6 of methyl esters. The calorific value was 36,645 J / g for the 85% blends of castor oil and 15% waste cooking oil, it was found that the above mixture was the best of all blends made. Through this work it is concluded that it is possible, from a technical point of view, to use the mixture of castor oil and waste cooking oil for biodiesel production, which can reduce costs in the production of biodiesel from castor oil [6].

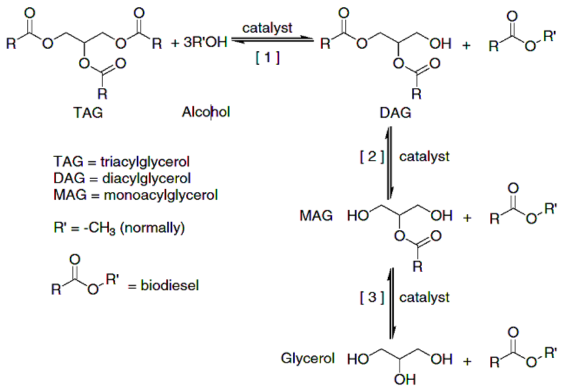
This demand promoted the emergence of biofuels among which biodiesel is considered to be the most accepted and best alternative for the depleting energy resources. Many methods like transesterification, BIOX process, super critical process etc., have been employed to produce biodiesel more efficiently from variety of sources like edible oils, non edible oils and algal oil etc. Biodiesel is environment friendly, non toxic, biodegradable, renewable as well as a neat biofuel and hence plays a significant role in meeting the energy demands [7].

There are various types of raw materials are used for production of biodiesel such as Jatropha, Karanja, Moha, Undi, Castor, Jojoba, Cottonseed etc. An non-edible oil seeds and various vegetable oils including Palm oil, Soya bean oil, Sunflower oil, Rapeseed oil and waste vegetable oils. It can be used in diesel engine with no modifications. It is simple to use biodegradable, nontoxic and having low emissions. In India, edible vegetable oils are in short supply and India needs to import 45% of total requirements (600,000 tons) per year, to bridge the gap. Used cooking oil is practically not available, as it is used till the end due to shortage. In many developed countries vegetable oilsare in excess of their local requirements of edible oils. They have to dispose of these oils and converting these to Biodiesel as fuel is best option for them for disposal [8].

II.EXPERIMENTEL REVIEWS

The *Jatropha curcas* fruits were collected around Tanke in Ilorin and Omu – aran both in Kwara State, Nigeria. The fruits were dried, dehulled to obtain the seed, the seed was separated from the seed coat and dried, undesired impurities were removed by hand-picking. The seed was prepared for extraction by grinding using a laboratory mortar and pestle to. The bulk of the oil was extracted using by soaking the grinded seed in a container with petroleum ether and left for 3 days, the extraction process was repeated 3 times for proper extraction. The fossil diesel used was purchase at Mobil Filling Station, Taiwo Road, Ilorin, Kwara State. 450 ml of the oil was pour into the reactor and heated to 450C to improve the oil's mixability with the alcohol. This catalyst concentration level was achieved by dissolving 4.1g of potassium hydroxide (KOH) in 100 ml of the alcohol and the mixture was stirred for twenty minutes to form potassium alkoxide. The resulting solution was added to the oil in the reactor and the entire content was brought to a temperature of 550C and then held at this temperature for an hour. The reactions product mixtures were allowed to separate into phases by standing for eight hours in a separating funnel so as to separate glycerol from the biodiesel. 5 ml of acetic acid was added to the biodiesel followed by washing with water to and was allowed to stand for eight hours in a separating funnel. The denser soapy mixture was carefully drained from the bottom of the separating funnel leaving behind the biodiesel. The biodiesel obtained was dried in an oven at 100°C for 1 hr and the volume determined. Results show the percentage oil yield of Jatropha curcas seed and biodiesel gotten from the oil are 39.7 and 80.2 respectively. The biodiesel yield of the oil is also low and The carbon residue of the biodiesel 0.2% was higher compared to 0.050max documented. This could be due to the contaminant which might have entered the sample during the heating to evaporate the oil. The carbon residue of the diesel fuel from table 4 is higher compared to biodiesel. This implies that diesel fuels will form a higher deposits compared to that of biodiesel in engines [1].

In this review, the processes of biodiesel production by transesterification and factors affecting biodiesel production are also addressed. The process of transesterification brings about drastic change in viscosity of the vegetable oil. The high viscosity component, glycerol, is removed and hence the product has low viscosity like the fossil fuels. The biodiesel produced is totally miscible with mineral diesel in any proportion.



Bio diesel production by transesterification [2]

Flash point of the biodiesel is lowered after transesterification and the cetane number is improved. The yield of biodiesel in the process of transesterification is affected by several process parameters which include; presence of moisture and free fatty acids (FFA), reaction time, reaction temperature, the biodiesel production is strongly affected by parameters such as molar ratio of alcohol, reaction temperature, reaction time and catalyst concentration. Hence, this paper concentrates on the development of economically viable as well as ecofriendly substrates for biodiesel production and briefly discusses the factors that affect the biodiesel production [2].

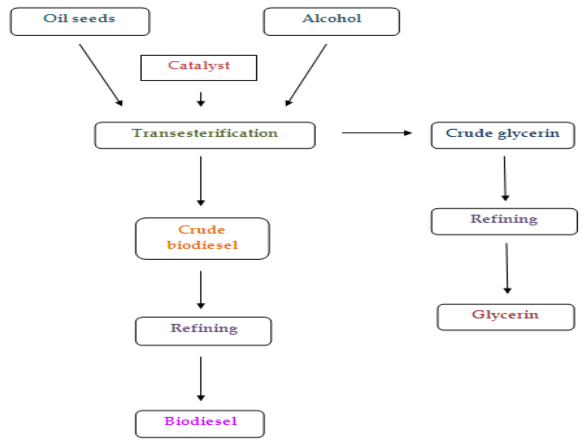
Biodiesel is an important alternative transportation fuel and it possess properties like renewability, biodegradability, non-toxicity and environmentally friendly benefits. Biodiesel can be produced from different feedstock containing fatty acids such as animal fats, edible oils, non-edible oils, and waste cooking oils and by products of the refining vegetables oils. Transesterification is a commonly employed method for its production. The purpose of this method is to reduce the viscosity of oil or fat using acid or base catalyst in the presence of methanol or ethanol. Transesterification with alkali catalyst (KOH and NaOH) is more economical than acid catalyst and enzyme catalyst. The biodiesel production is strongly affected by parameters such as molar ratio of alcohol, reaction temperature, reaction time and catalyst concentration [3].

In this paper effort has been made to find out feasibility of biodiesel obtained from eucalyptus oil and its impact on diesel engine. Higher viscosity is a major issue while using vegetable oil directly in engine which can be removed by converting it into biodiesel by the process of transesterification. Various fuel properties like calorific value, flash point and cetane value of biodiesel and biodiesel–diesel blends of different proportions were evaluated and found to be comparable with petroleum diesel. The result of investigation shows that Brake Specific Fuel Consumption (BSFC) for two different samples of B10 blend of eucalyptus biodiesel is 2.34% and 2.93% lower than that for diesel. Brake Thermal Efficiency (BTE) for B10 blends was found to be 0.52% and 0.94% lower than that for diesel. Emission characteristics show that Smoke Opacity improves for both samples, smoke is found to be 64.5% and 62.5% cleaner than that of diesel. Out of all blends B10 was found to be a suitable alternative to conventional diesel fuel to control air pollution without much significant effect on engine performance. On comparing both samples, biodiesel prepared from sample A of eucalyptus oil was found to be superior in all aspects of performance and emission [4].

This paper reviews the history and recent developments of Biodiesel, including the different types of biodiesel, the characteristics, processing and economics of Biodiesel industry. The application of biodiesel in automobile industry, the challenges of biodiesel industry development and the biodiesel policy are discussed as well. Biodiesel can replace fossil fuel as a “clean energy source”. It can protect the environment by reducing CO2, SO2, CO, HC. The carbon cycle of Biodiesel is dynamic through the photosynthesis . Plants absorb CO2, which is more than those discharged by the biodiesel combustion process. Thus, using biodiesel can more effectively reduce the emission of CO2, protect the natural environment and maintain the ecological balance, compared to the use of fossil fuel. The emission of SO2 in the combustion process of biodiesel is much lower than normal diesel oil because of the low 927ulphur content in it. Thus, the use of biodiesel instead of normal diesel oil will effectively reduce acid rain, which represents a serious threat to the environment and human infractructure in forms of acidification of soil, surface and ground water forest and vegetation damage, and increased corrosion of buildings and historical monuments made from calcium containing stones. Furthermore, CO, HC and particulate matters will be less discharged, because ester compounds in biodiesel contains oxygen promoting clean burning. In conclusion, biodiesel production is set to rise drastically in the coming years. Biodiesel offers the promise of numerous benefits related to energy security, economics, expansion of the agriculture sector and reduction of pollutant emission. Despite its many advantages as a renewable alternative fuel, biodiesel presents a number of problems that must be resolved before it will be more attractive as an alternative to petroleum diesel [5].

In this paper blends containing 0%, 5%, 10%, 15%, 20% and 100% of waste cooking oil in castor oil were trans-esterified to obtain biodiesel. The reactions were performed in duplicate A calorific pump IKA C 2000 (IKA, Ireland) was used for this test. Close to 1 gram samples were weighed and placed in the glass of the pump where combustion takes place. Oxygen is used at a pressure of 350 psi. Biodiesel was obtained from blends of castor oil and waste cooking oil by transesterification. The results obtained in this work showed that the yield, for blends of castor oil with waste cooking oil, were up to 92.66%, being the mixture of 85% castor oil and 15% waste cooking oil that obtained the greater yield (99.89%). In addition the calorific value obtained for this mixture is 36645 J/g being the highest with respect to the other mixtures evaluated and there is no greater difference with respect to the biodiesel obtained entirely from waste cooking oil. In terms of costs it can be said that the castor oil is above the waste cooking oil 70%, and with the blends it reduces the cost of the biodiesel to 30% less compared to if only castor oil were used. With this work, it can be concluded that it is possible to integrate the waste cooking oil into productive processes to obtain biodiesel from castor oil, and reduce the costs of the biodiesel generated. In addition, it will be possible to integrate used cooking oil into a production process without continuing to generate impacts on the environment [6].

Biodiesel feedstocks require some conversions to meet their regulatory standards. Primarily used technologies for the conversion of vegetable oil, microalgal oils and other crops are Using the oil directly, Blending or mixing with petro-diesel, Formation of Micro-emulsion by utilizing alcohol or any solvent, Pyrolysis, Transesterification etc. Among these the most widely used process is transesterification. Biofuels like biodiesel are renewable, eco-friendly and non-toxic energy. Biodiesel is similar to petroleum diesel in its properties but biodiesel emits very less amount of CO2, 928sulphur and particulates compared to petroleum resources.



Production of biodiesel [7]

It can be produced by a simple transesterification process using acid or base catalyst or enzymes as catalyst. Enzymatic transesterification process using lipases gave high yield of biodiesel but because of the high cost of lipases, enzymatic transesterification is not much followed. But catalytic transesterification has several problems like removal of catalyst and product purification etc., so non catalytic transesterification such as BIOX process, supercritical process have become the most preferable method for biodiesel production [7].

From this paper we can conclude that day by day energy consumption in India increases and the resources of petroleum products are decreases. Hence it is necessary to find out an alternative fuel. The biodiesel is only one fuel that can be replaced to diesel fuel and it can be used in diesel engine with none or very minor engine modification. Biodiesel and diesel fuel blends may prove an alternative option as diesel fuel in the future because they are renewable resources and less polluting. The leading crops for production of biodiesel are palm, jatropha, castor, rapeseed etc. The oil extraction from jatropha is more a compared to other seeds. But in India castor seed is widely available and oil extracted from castor is 48%. So it is effectively used for production of biodiesel in India [8]

III CONCLUSION

This work has provided a comprehensive literature review of the previous research work carried out in past years on production of biodiesel from edible, non-edible and waste cooking oil. An effort has been made to comprise all the important contributions and highlighting the most pertinent literature available for investigating the feedstocks of biodiesel. Biodiesel has attracted wide attention in the world due to its renewablity, biodegradablity, non toxicity and environmentally friendly benefits. Biodiesel is similar to petroleum diesel in its properties but biodiesel emits very less amount of CO2, sulfur and particulates compared to petroleum diesel. It can be produced by a simple transesterification process using acid or base catalyst or enzymes as catalyst. Recent studies show that microalgae are the best and an ever green source for biodiesel production as microalgae has many advantages over other conventional sources.

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