INVESTIGATING THE BIOFUELS AS A REPLACEMENT OF CONVENTIONAL FUELS

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***Abstract*: As the energy demand increases demand of fossil fuel increases which results in depletion of fuel day by day. Biodiesel is the most suitable and promising alternatives for conventional fuels. Since last two decades researcher is rigorously doing work to increase the use of biofuels in place of conventional petro-diesel fuels. This work basically includes the review of different biofuels, their production and properties.**

***Keywords*: biofuel, review, method, production technique**

1. Introduction

The energy needs of the world are increasing rapidly. The large increase in the number of automobiles in recent years has resulted in greater demand for petroleum products. The increase in energy demand, decrease in petroleum-based fuel reserves, increase in pollution caused by them and increasing fuel prices have focused attention on alternative sources of energy. With crude oil reserves estimated to last for few decades, there has been an active search for alternate fuels. Such alternative fuels in use today are bio alcohols, hydrogen, natural gas and biodiesel. Among the various alternate fuels under consideration; biodiesel derived from vegetable oils, is the most promising alternative fuel to Petroleum Based Diesel Fuel (PBDF) due to the following reasons (Ramadhas et al 2004). The esters of vegetable oils and animal fats are known collectively as biodiesel, a renewable alternative fuel that has been shown to be a direct replacement for PBDF in Compression Ignition (CI) engines. The technical, definition of biodiesel is "A fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100, and meeting the requirements of ASTM D 6751" (NBB 2006). At present, India is producing only 30% of the total petroleum fuels required. The remaining 70% is being imported. It is an astonishing fact that mixing of 5% bio-diesel fuel to the present PBDF can save about Rs. 4000 crore every year. It was estimated that India will be able to produce 60 million tons of bio-diesel per annum by the end of 2030 that can be blended to the extent of 30-40% with diesel. (Abdul Kalam A.P.J. 2006 & 2007). The planning commission of India has launched a bio-fuel project in 200 districts from 18 states in India. It has recommended two plant species, viz. Jatropha curcas and Pongamia for biodiesel production (Report of Planning Commission on 'bio-fuel' 2003). The recent auto fuel policy document states that bio-fuels are efficient, eco-friendly and 100% natural energy alternative to petroleum fuels.

2. Energy demand

Global fossil fuel consumption stands next to population from the year 1900 to 2050. Consumption of energy is increasing worldwide in various procedures for a variety of purposes. The aggregate of consumption is directly proportional to a society's growth. Today developing countries are prospering through economic reforms and are becoming technologically advanced. In India, freight and passenger transportation bags a big deal in energy consumption in the transport sector. However, road transport is the most recurrently used means of transport, followed by rail and then air. Lastly, a very small quantity of energy is used for water ways transport. Diesel and motor gasoline epitomise 90% of the final energy disbursed in the transport sector, while jet kerosene epitomise 8% and electricity 2%. India is prosperous in coal production and richly gifted with renewable solar energy, wind energy, hydro energy and bio energy, its hydrocarbon reserve is 0.8 billion tones (at the end 2015) which are really very small (0.5 percent of world's reserve). India is counted for 10.88 % of entire principal utilization of energy in region of Asia-Pacific and 3.83 % of world major energy utilization in 2008. The energy utilization per capita remains little as 510.0 KGOE (Kilogram of oil equivalent) differentiated with an average of energy consumption of 1820.0 KGOE in 2006. Indian economy is influencing the world and has to extensively use energy to sustain its growth.

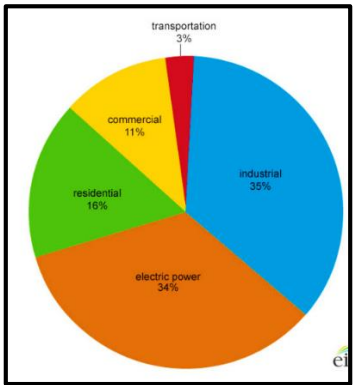

Fig.1 Consumption (% of total) in India

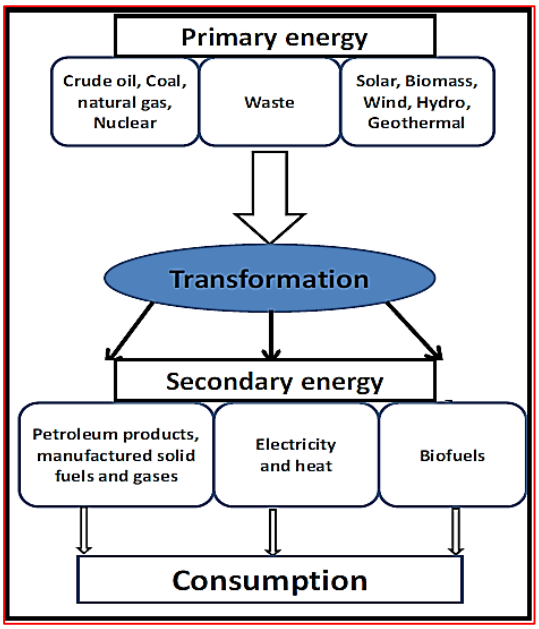

Fig.2 Primary and secondary energy types

3. Bio diesel

Biodiesel is one of the promising alternate fuels because of the compatible nature of the fuel in diesel engines, suitability in technology for the production and cost effectiveness when associated to petro-diesel, etc. Chemically, biodiesel is composed of mono alkyl esters of long chain fatty acids that are derived from triglyceride vegetable oils or animal fats. The general representation of the structure of biodiesel showing the ester functional group and fatty acid alkyl chain is shown in figure 1.6.

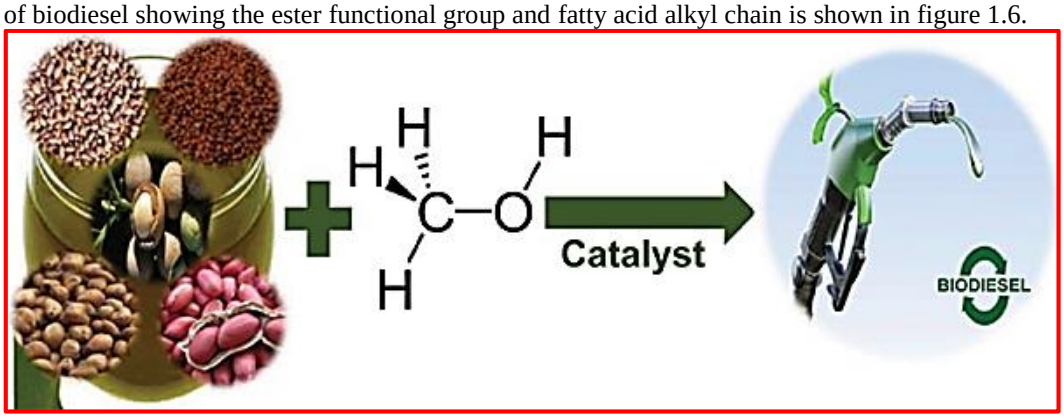

Fig.3 General structure of biodiesel

R indicates the alkyl chain of the lower alcohol component. When R = CH3, the biodiesel is termed as fatty acid methyl ester (FAME). Thus, biodiesel is an oxygenated fuel which is derived from renewable triglyceride lipids and consists of mainly mono alkyl esters. The oil from plants like jatropha, Pongamia, rice bran, neem, karanja, soyabean, cotton seed, have been used as biodiesel and are under research.

4. Existing research work

1. **Saravan *et.al* [2019]** This study had demonstrated the enactment and emission physiognomies of a variable compression ratio diesel engine (VCRDE) employing the dual biodiesel. The dual biodiesel employed was a assortment of Rapeseed (RA) and Mahua biodiesel (MU) in equivalent ratio by volume. The investigation had accompanied underneath altered load circumstances with constant engine speed of 1500 rpm. The biodiesels adopted here were organised by transesterification process and fashioned one new biodiesel (RM) with mingling of Rapeseed biodiesel and Mahua biodiesel by equal ratio (1:1). The performance assessment was done for 100% RA, 100% MU and different RM blends such as BL20, BL40, BL60 and BL80, along with diesel.
2. **Vinoth *et.al* [2019]** In this study the biodiesel derived from new line different vegetable oil esters like Jatropha, Karanja, Mahua and Neem oil were new line compared with diesel. The Performance, Emission and Combustion new line characteristics of different vegetable oil esters in single cylinder compression new line ignition engine were compared with Diesel. The main aim of our study is the theoretical and experimental comparison of performance, emission and combustion characteristics of new line biodiesel using esters of Jatropha, Karanja, Mahua, and Neem with diesel. New line Performance properties - Break thermal Efficiency and Brake Specific Fuel new line Consumption.
3. **Devarajan *et.al* [2018]** This work had investigated the experimental study for examined the operational physiognomies of a neat neem oil methyl ester (BD100) along with silver oxide nano-particles with a metal-based additive in several ratio

fractions. Silver oxide nano-particle was mixed into 100% of BD100 at 5 and 10 ppm. The experimental examination on diesel engine had showed that the addition of silver oxide nano-particles to BD100 resulted in enhancement of brake thermal efficiency (BTE) with a reduction in brake specific fuel consumption (BSFC).

4. **Novianto *et.al* [2018]** This research is consistent with the concept of public policy implementation that sets factors that affect the implementation of the public policy such as communication, resources, disposition and bureaucratic structures. According to the model of Van Meter and Van Horn, these four factors together influence each other toward implementation's performance. This study found that the renewable energy policy (M) scenario influenced the successful implementation of subsidy policy (Y).
5. **Tuccar *et.al* [2017]** In this study, they had concluded the accessibility of pomegranate seed oil biodiesel (POB) employing as an substitute fuel in diesel engines then appraise engine enactment and emission physiognomies of pure hydrogen enriched POB by means of diesel engine. For this persistence, the intake manifold of the tested engine was adapted and hydrogen enriched intake air was abounding throughout the experimentations. Physical properties of POB and its blend with diesel fuel were also strongminded. It had been unstated that high viscosity and density values of POB fuel can be remunerated by mingling it with diesel fuel. The drawback instigated by low cetane number value of POB, can be abolished by diesel addition.
6. **verma *et.al* [2016]** investigated that process of bio diesel production mainly depends on five process parameters such as free fatty acid content, molar ratio of alcohol to oil, concentration and type of catalyst, reaction temperature and reaction time. In general, methanol and ethanol are frequently recycled alcohol for bio diesel production in presence of alkaline catalysts like sodium and potassium hydroxides. The work had exposed that for optimum bio diesel production reaction temperature should be in range of 50–60 °C, molar ratio of alcohol to oil should be in range of 6–12:1 with the use of an alkali catalyst partaking optimum concentration 1% by weight and the optimal reaction time for transesterification process is around 120 min.
7. **Jundika *et.al* [2016]** The objective of this paper is to provide an overview of the palm oil industry, review technologies available to process oil palm and palm oil residues into biofuel, and to summarise the challenges that should be overcome for further development. The paper also discusses the research and development needs, techno-economics, and life cycle analysis of biofuel production from oil-palm and palm-oil wastes. Over the last decades, the palm oil industry has been growing rapidly due to increasing demands for food, cosmetic, and hygienic products. Aside from producing palm oil, the industry generates a huge quantity of residues (dry and wet) which can be processed to produce biofuel. Driven by the necessity to find an alternative and renewable energy/fuel resources, numerous technologies have been developed and more are being developed to process oil-palm and palm-oil wastes into biofuel. To further develop these technologies, it is essential to understand the current stage of the industry and technology development.
8. **selvam *et.al* [2015]** examined that the combustion of vegetable oils was completely recycled as a carbon dioxide (CO2) as the oil is extracted from plants. Table 2.2 lists out the numerous types of vegetable oils with their properties. It specified that the viscosity of vegetable oils is somewhere around 11 – 17 times more than that of diesel. The heating values of vegetable oil was around 37 – 40 MJ / kg whereas, it is 42.8 MJ / kg for diesel. Vegetable oil has very high flash point more than 200 °C, and found to be an alternative fuel in conventional diesel engine. Usages of vegetable oil is not advisable during winter owing to its higher pour and cloud point compared to diesel. In addition, vegetable oils reduce the ignition delay because of its high cetane number. Furthermore, long time storage is not suggested for these fuels owing to their high iodine value thereby increasing its oxidation rate.
9. **Debnath *et.al* [2014]** deduced that most efficient and reliable energy conversion devices available till date are diesel engines. In the beginning of the last century people were eager to use low cost diesel engines. Emulsified fuel is also a new technique which could be effective. Two fluids that are not miscible are mixed together. People have done a lot of research on water and diesel emulsion. The emulsions prepared with animal fat, methanol, ethanol and few studies with emulsified biodiesels have also been reported. The present paper attempts to accumulate most of these studies under a single shed. Efforts have been made to analyze the numerous studies on emulsified fuel both qualitatively and quantitatively. This paper gives an insight to the types of emulsion, their characteristics, and the method of preparing a qualitative emulsion, followed by the review of their performance, combustion, emission and spray characteristics when run in a diesel engine. Eventually, some of the important points have been addressed based on the elaboratereview on the indigenous literature.
10. **Karthick *et.al* [2014]** Analyze combustion and exhaust emissions with castor nuts and ethylene blends in a fully engineered diesel engine with a properly engineered cylinder. Parameters were measured for two different compression ratios. The compression ratio was reduced from 17.5 to 16.8: 1, increasing the plate size of the piston. The purpose of the reduced compression ratio is to reduce the cylinder temperature. Various mixtures such as J20, J17 + DEE3%, J16 + DEE4%, J15 + DEE 5% were used for the machine experiments. The experimental results show that the BTE of the higher and higher load at higher load was 30.31% for the J17 + DEE 3%, which was 7.3% higher than diesel. . NOx emissions decrease as the compression ratio decreases, but combustion consumption increases the NO volume by 10% due to the high amount of ketone. Thus, the reduction in compression ratio and the use of biodiesel provide the NOx value almost the same as diesel, which controls a 10% increase in ADS, which still produces less smoke than exhaust gas.
11. **Silitonga *et.al* [2013]** had synthesized Ceiba bentandra methyl ester using acid catalyst-sulphuric acid and alkaline catalyst-sodium hydroxide. They have suggested that blending biodiesel with diesel will improve the properties such as viscosity, density, flash point, calorific value and oxidation stability.

12. **Sangeeta *et.al* [2013]** stated that usage of straight vegetable oil (SVO) directly into diesel engine as fuel creates various problems. The main problems is due to higher viscosity of SVOs compared to diesel oil. Owing to higher viscosity, incomplete combustion, poor fuel atomization and deposits in the combustion chamber occur. To utilize vegetable oils as diesel fuel substitute's potential methods like heating, dilution, blending, emulsification and transesterification may be employed.
13. **Mishra *et.al* [2013]** used simarouba glauca oil to produce bio diesel by transesterification with methanol in the presence of KOH as a catalyst. To produce simarouba oil methyl ester, optimization of reaction parameters such as catalyst concentration, alcohol to oil molar ration, temperature and rate of mixing were done. Under optimal conditions 94-955 of methyl esters from simarouba oil is yielded. Comparison with ASTM and DIN EN 13214 was made for essential fuel properties of methyl esters of simarouba oil (biodiesel). At 400C, 4.68 cst viscosity and 1650C flash point were found. The obtained results denote tranesterified oil properties were very close to diesel properties.
14. **Lohan *et.al* [2013]** produced bio diesel from in-edible oils like Jatropha, Neem, Karanja, Mahua, Simarouba oil. Their work had presented the current status, deliberates the future projection and scrutinizes the critical constraints and impediments in India to the path of development of Indian bio diesel program. Their work also offers recommendations and alternative policy possibilities so as to permit the sequencer to accomplish its intentions. The belongings of bio diesel on engine enactment i.e. brake power, brake thermal efficiency, specific fuel consumption and substantial decrease in particulate matter (PM), hydrocarbons (HC), carbon monoxide (CO) and oxide of nitrogen (NOx) were also swotted.
15. **Atabani *et.al* [2013]** studied on non-edible oil resources for biodiesel production, their advantages, oil extraction techniques and properties. Biodiesel from non-edible would play a role in using the waste land areas. The physical and chemical properties of biodiesel produced from non-edible feed stock such as jatropha, Pongamia and Madhuca are within the limits of ASDM and DIN EN specifications.
16. **Bhupendra *et.al* [2012]** Conducted a study comparing the performance characteristics and biodiesel emissions obtained from castor oil in dual-fuel diesel engines with basic diesel output. The estimated parameters of efficiency and emission are: BTE, BSFC, power output, CO, CO2, HC, NOx and smoke opacity. Jatropha methyl ester BTE and its diesel were lower than diesel, and BSFC was originate to be higher. However, HCS and smoke were found to be lower in biodiesel than in pumpkin oil. NOx emissions in bio digester and their mixtures are higher than diesel emissions.
17. **Mahla *et.al* [2012]** They had studied on three blend ratios of 5%, 10% and 20% of ethanol with 95%, 90% and 80% of diesel respectively. The commercial diesel fuel and anhydrous ethanol were used for the preparation of different blends. Pure diesel fuel was used as base fuel for ethanol-diesel blends in this study. Different diesel- ethanol fuel blends were kept for 24 hours and they showed some sort of phase separation in the blends which had more than 5 % ethanol, by volume.
18. **Durairaj *et.al* [2012]** researched with crude Jatropha Curcas oil to produce bio diesel in two steps. Free fatty acid content of Jatropha Curcus was converted into bio diesel by acid transesterification in the first step. By maintaining 9:1 molar ratio of methanol to oil, 1% w/w of oil of H2SO4 and 60°C temperature for one hour of reaction time reduces free fatty acid to 1.12%. The mixture was tolerable to settle at least for 2 hours after the completion of reaction, and the top layer of methanol-water mixture was unconcerned. Alkali catalyzed transesterification is employed as second step using 5.41:1 molar ratio of methanol to oil and 0.55% w/w ratio of catalyst to oil for producing bio diesel from the product of the first step at 60°C. The maximum yield of 93% w/w of Jatropha Curcus bio diesel was produced which was more than the bio diesel yield (80.5%).
19. **Out *et.al* [2012]** They had conducted the experiment on effects of blending on the properties of biodiesel fuels. The objective of this study was to quantify the changes in selected properties after transesterification and blending with diesel fuel using cashew, rubber and egunsi seed oils. The results obtained showed that properties such as flash points, acid and iodine values reduced while others like cetane number increased with blending. Blending can hence be used to modify the properties of biodiesels.
20. **Rahman *et.al* [2011]** experimented with Jatropha oil for the production of bio diesel. Jatropha curcas grows to be a wild hardy plant, a renewable non-edible plant found in arid and semi-arid regions on degraded soils having low moisture and fertility. 50 – 60% of oil is found naturally in the seeds of Jatropha. Transesterification process is employed in this study to convert oil in bio diesel for performance evaluation in diesel engine.

5. Conclusion

Through literature survey it is found that now a day's world is facing a severe problem of depletion of fossil fuel and with the excess use of conventional fuels global warming and environment degradation are the main issue. Finding alternative resources for the accomplishment of energy requirement is the priority in today's research work. Different types of non-conventional fuels are used to reduce the consumption of conventional fuels and also to reduce the amount of different harmful gases that are produced after the combustion of conventional fuel. Different bio-fuels like karanja oil, jatropha oil and many others are also used. Manly for heavy duty power generation diesel engines are used which emits carbon mono oxide, nitric oxide, carbon-di-oxide and many others. With use of bio-diesel emission of harmful gases get also reduced. Bio-fuels are blended with conventional diesel at different proportion to increase the performance and other properties of fuel.

References

[1] Sunarno, J. N., Prasertsan, P., Duangsuwan, W, Cheirsilp, B., & Sangkharak, K. (2019). Biodiesel derived crude glycerol and tuna condensate as an alternative low-cost fermentation medium for ethanol production by Enterobacter aerogenes. Industrial Crops and Products, 138, 111451. doi:10.1016/ j.indcrop.2019.06.014.

[2] Vinoth B, Sundarapandian S (2019), "Experimental and theoretical investigation of performance emission and combustion characteristics of diesel engine using bio", hdl.handle.net/10603/253949 Diesel engine Engineering and Technology, Engineering, Engineering Mechanical.

[3] M, Ravi, K, Vijayakumar K C (2019),” Experimental exploration on di CI engine characteristics fuelled by diesel bio diesel blends with biogas in dual fuel mode”, http://hdl.handle.net/10603/232825.
[4] Yuvarajan Devarajan, Dinesh Babu Munuswamy, Arulprakasajothi Mahalingam (2018);” Influence of nano-additive on performance and emission characteristics of a diesel engine running on neat neem oil biodiesel”, Environmental Science and Pollution Research September 2018, Volume 25, Issue 26, pp 26167–26172.
[5] Novianto, F., Noor, I., & Indah Mindarti, L. (2018). Renewable energy policy scenarios as implementation moderation of fuel subsidy policy in Indonesia. Foresight. doi:10.1108/fs-05-2018-0054.
[6] Charusiri, W., & Vitidsant, T. (2017). Response Surface Methodology Optimization of Biofuels Produced by Catalytic Pyrolysis of Residual Palm Oil from Empty Fruit Bunch over Magnesium Oxide. JOURNAL OF CHEMICAL ENGINEERING OF JAPAN, 50(9), 727–736. doi:10.1252/jcej.16we306.
[7] Puneet Verma & Sharma, MP 2016, ‘Review of process parameters for bio diesel production from different feedstocks’, Renewable and Sustainable Energy Reviews, vol. 62, pp. 1063-1071.
[8] Chetankumar Patel, Sanghoon Lee, Nachiketa Tiwari, Avinash Kumar Agarwal, Chang Sik Lee & Sungwook Park 2016, ‘Spray characterization, combustion, noise and vibrations investigations of Jatropha bio diesel fuelled genset engine’, Fuel, vol. 185, pp. 410-420.
[9] Jundika C. Kurnia, Sachin V. Jangam, Saad Akhtar, Agus P. Sasmito, Arun S. Mujumdar et.al (2016),” Advances in biofuel production from oil palm and palm oil processing wastes: A review”, Biofuel Research Journal 9 (2016) 332-346.
[10] Fayyazi, E, Ghobadian, B, Najafi, G, Hosseinzadeh, B, Mamat, R & Hosseinzadeh, J 2015, ‘An ultrasound-assisted system for the optimization of bio diesel production from chicken fat oil using a genetic algorithm and response surface methodology’. Ultrasonics Sonochemistry, vol. 26, pp. 312–320.
[11] Biplab Debnath,K 2014, ‘Thermodynamic analysis of a variable compression ratio diesel engine running with palm oil methyl ester’,Energy Conversion and Management vol.65, pp.147-154.
[12] Sunilkumar R, Kumbhar and Dange H M, “Performance Analysis Of single Cylinder Diesel Engine, Using Diesel Blended with Thumba Oil”, International Journal of Soft Computing and Engineering (IJSCE), 4, (2014) 24-30.
[13] Atabania, AE, Silitonga, AS, Irfan Anjum Badruddina, Mahliaa TMI, Masjukia, HH & Mekhilefd, S 2012, „A comprehensive review on biodiesel as an alternative energy resource and its characteristics“, Renewable and Sustainable Energy Reviews, vol. 16, no. 4, pp. 2070-2093.
[14] Mishra, SR, Chaterjee, S, Mohanty, SK, Senapati, MN & Panigrahi, N 2013, ‘Bio dieselProduction from Simarouba glauca oil using CaOand KOH Catalysts: A comparative study,’ IJSER, vol. 4, no. 12, pp. 147- 151.
[15] Sangeeta Kanakraj, Savita Dixit & Rehman, A 2013, ‘Development of blends of degummed Linum usitatissimum seed oil with diesel: as a potential resource for diesel engine’ International Journal of Advanced Research, vol. 1, pp. 43-48.
[16] Lohan, SK, Ram, T, Mukesh, T, Ali, M & Arya, S 2013, ‘Sustainability of bio diesel production as vehicular fuel in Indian perspective,’ Renewable and Sustainable Energy Reviews, vol. 25, pp. 251-259.
[17] S. Gomasta and S.K. Mahla (2012),” An Experimental Investigation of Ethanol Blended Diesel Fuel on Engine Performance and Emission of a Diesel Engine”, International Journal on Emerging Technologies 3(1): 74-79(2012).
[18] Bojan, SJ & Durairaj, SK 2012, ‘Producing Bio diesel from High Free Fatty Acid Jatropha Curcas Oil by A Two Step Method-An Indian Case Study’, Journal of Sustainable Energy & Environment, vol. 3, pp. 63-66.
[19] Galadima, A., Garba, Z.N., Ibrahim, B.M., Almustapha, M,N., Leke, L., Adam, I.K. 2011. Biofuels Production in Nigeria: The Policy and Public opinions. Journal of Sustainable Development, 4(4),22-31.
[20] Kazimosdafijur Rahman & Mohammad Mashud (2011), ‘Bio diesel From Jatropha Oil as an Alternative Fuel for Diesel Engine’, vol. 10, no.