IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

VARIOUS BIODIESEL PRODUCTION METHODS – A REVIEW

Rahul K. Bawane[1*], Rohit Sonawane[1], Shubham Walunj[1], Shubham Pharate[1], Chetan Rakshe [1]

Department of Mechanical Engineering, Pimpri Chinchwad College of Engineering and Research, Ravet, Pune (MS) India 412101.

Abstract: *Biodiesel is now become the key source for renewable energy. Generally used feedstock for biodiesel production is edible oils as they are easily available and their yield is also more. Certain factors are affecting on biodiesel production are production methodology, cost and requirement of equipment, Properties of the raw material. Transesterification Process is mostly used for biodiesel production because it is less costly and simplicity of equipment. Blending is used but it is in small scale only because it requires engine modification when used in the large scale. Engine parameters like brake specific fuel consumption and brake thermal efficiency increases when blends are used. Microemulsion and pyrolysis are also the methods used from many years but due to complexity in the processes they are avoided. Microemulsion is thermodynamically stable process.*

Keywords: **Biodiesel, Production, Blending, Micro-emulsion, Transesterification, Pyrolysis**

1. INTRODUCTION

World oil reservoirs are now speedily decreasing due to their high use in industries or for human needs. Therefore lots of research is going on to find the substitute fuels. Further now a day's increase in oil prices and pollution from vehicles has stimulated a lot of curiosity in exploring new choices. Due to exhaustion of these non-renewable energy sources there is negative impact on the developing as well as on the developed countries also. Pragmatic approach is to be the use of alternative fuel which must be technically feasible, available and meet pollution standards. Biodiesel, a harmless fuel and sustainable, can be used without any large engine modifications in the current diesel engines. [1]

Biodiesel is used in the CI engines along with the blends to reduce the pollutants and it also increase engine life due to the lubricative properties and high combustion characteristics. Biodiesel is the mono alkali ester derived from the animal fats or vegetable oils. Edible vegetable oil for biodiesel production may lead to a food shortage hence is not sustainable alternative. [2]

In 2019, Indonesia ,United States and Brazil were the largest biodiesel production countries in the world, with a total production of 7.9 , 6.5 and 5.9 billion L. respectively, followed by Germany (3.8 billion), France (3 billion), Argentina (2.5 billion), and the India has only 0.2 billion litre's. In Indonesia, the contribution of renewable energy sources in the national energy mix in 2025 is targeted to be 25%, and bioenergy including biodiesel is expected to contribute 5% to those energy needs. [3]

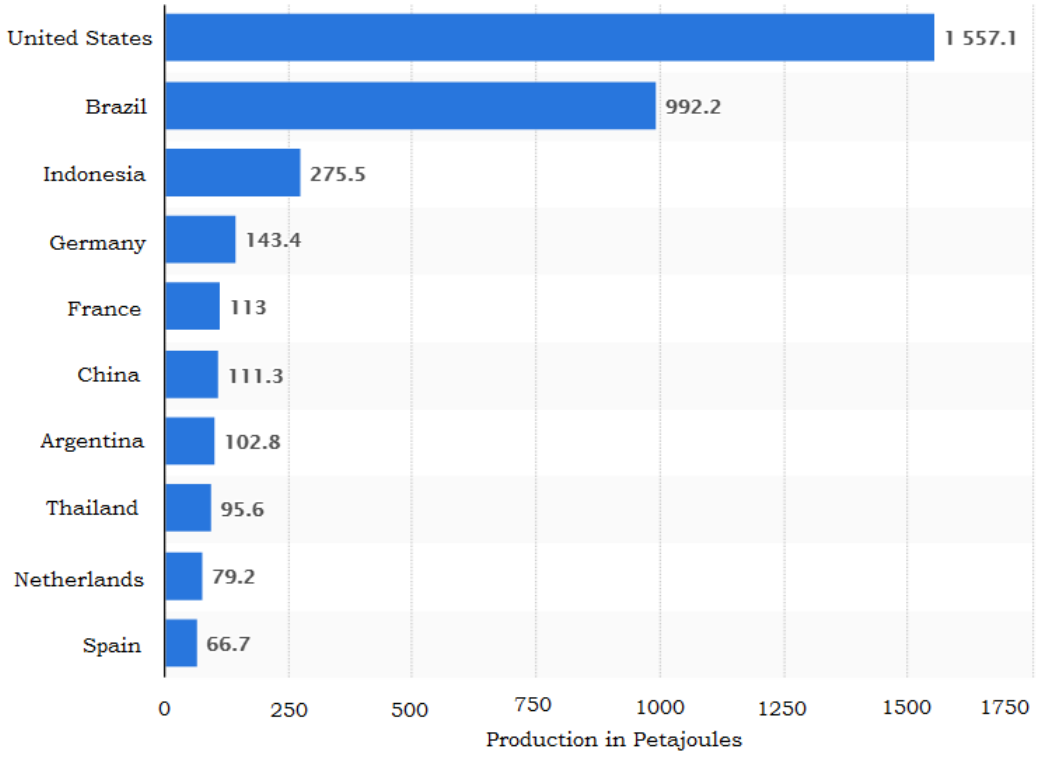


Figure1. Leading biodiesel producers worldwide in 2019

2. CLASSIFICATION OF BIODIESEL

Mainly there are three major kinds of biodiesel on the basis of raw material used in the production of biodiesels i.e. First-generation, Second-generation and Third-generation Biodiesels.

2.1 First-generation biodiesels

These are mainly manufactured from food crops such as wheat, beet, corn which contains high sugar and starch, further it is fermented into bioethanol. But now a day's they are produce from vegetable oil or animal fats using standard technology. Common first-generation biofuels include biogas, biodiesel, vegetable oils, syngas, bioalcohols, solid biofuels.[4-5]

2.2 Second-generation biodiesels

These are produced from supportable or non-food feedstocks such as as cellulosic biofuels and waste biomass (stalks of wheat and corn, and wood), waste cooking oils.[2] Examples of Second-generation biodiesels are biohydrogen, biomethanol, Dimethylformamide, Bio-Dimethylester, Fischer-Tropsch diesel, biohydrogen diesel, mixed alcohols and wood diesel.[6-7]

2.3 Third-generation biodiesels

These are mostly produced from extracting oil of algae hence known as "algae fuel" or "oilage". Algae has high growth rate and gives better production of fats. They gives almost 10 to 15 high yield than the second generation biodiesels.[8]

By using higher technology in the production Fourth generation biodiesels are formed.

3. FEEDSTOCK FOR BIODIESEL PRODUCTION

3.1 Edible oils for biodiesel production:

Almost 95% of biodiesel is produced from edible vegetable oils. Commonly used of these oils are palm oil, soybean oil, coconut oil, rapeseed oil and sunflower oil due to their high availability.[2,9-10]

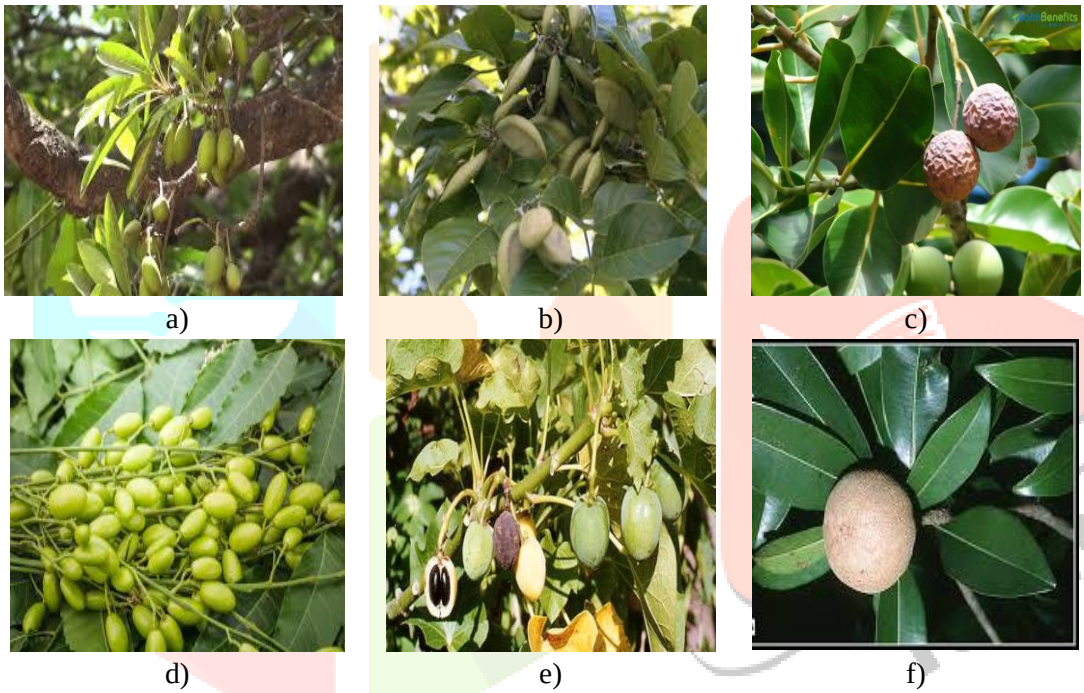
Edible oil for biodiesel production may lead to a food cricis hence is not sustainable alternative. To overcome this limitation the non-edible oil feedstock's are used for the production of biodiesel.

a) b) c) d)

Figure 2. Edible Oils Such as a)Palm Tree, b)Coconut Tree, c)Soybean Seeds , d)Sunflower for Biodiesel Production

3.2 Non-edible oils for biodiesel production:

These oils include polanga (Calophyllum oil), jatropha, karanja, jojoba, rice bran oil, mahua oil,. neem, linseed, microalgae, tobacco, waste cooking oil, animal fats, activated sludge lipid and rubber seed oils, and are also used for biodiesel production.[1,11-12]



a) b) c)

d) e) f)

Figure 3. Non-Edible Oil Feedstock such as a) Mahua, b) Karanja, c) Polanga, d) Neem, e) Jatropa, f) Rubber For biodiesel Production

3.3 Animal Fats for Biodiesel Production:

Different animal fats, as Beef tallow, pork lard, yellow grease, waste salmon, melon bug, sorghum bug, chicken fat and by-products from fihi oil were used for biodiesel production.[13]

4. BIODIESEL PRODUCTION METHODS

4.1 Direct use or Blending:

A. Rajalingam , et.al, The animal fat and vegetable oil used as a fuel in direct injection engines because they possesses good heating value and it may give a good amount of power. But in direct injection engines it has some problems, to overcome that modification is required. To eliminate this type of costly problems the alternative fuel sources are directly blended with conventional fossil fuels. Due to this blending technique there is reduce in the fuel consumption and is also improves fuel quality. The bio oil and diesel blends will be in different ratio like 10:1, 10:2, 10:3, etc.[1,2]

CI engines do not require any modifications, for blends of up to 30% biodiesel blended in diesel fuel. NOx, smoke, and Particulate matter emissions lowered, the improvement of Hydrocarbons and CO emissions depends on the type of fuel blend and on the engine operating parameters. Engine parameters like brake specific fuel consumption and brake thermal efficiency increases when blends are used.[14-15]

4.2 Micro-emulsion:

Thermodynamically stable, isotropic liquid mixtures of oil, water and surfactant (compounds that lower the surface tension of a liquid, the interfacial tension between two liquids) is known as Microemulsion. [16] By the use of this process problems in the atomization properties of oil, viscosity of oil get solved. alcohol increases the volatile property of oil and reduces the smoke. Cetane number will also improved by the alkyl nitrate. microemulsion process used to get a good spry property when injected into the engine by nozzle. However if the microemulsified diesel is used the problems like incomplete combustion, carbon deposit and nozzle failure may arrive in the diesel engine. [1, 2, 17]

Waste cooking oil is treated with fatty acid by esterification and then mixture is mixed with ethanol and butan-2-ol which further gives the Microemulsion based biofuel. [18]

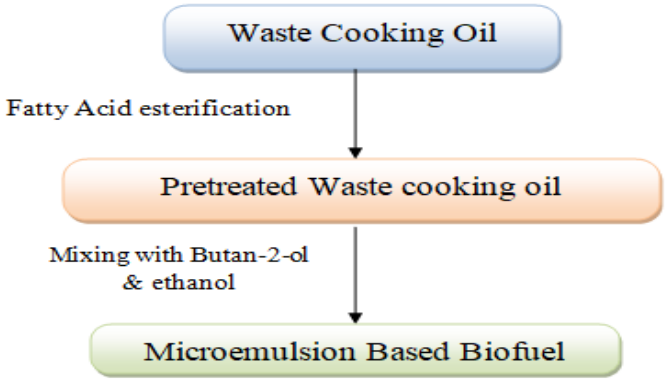


Figure 4. Micro-emulsion technique [18]

Micro-emulsions are generally transparent and they are thermodynamically stable under certain conditions. According to Winsor , there are four types of micro-emulsion based on phases exists.

4.2.1 Oil-in- water Micro-emulsion or Winsor I: Oil-in-water micro-emulsion in which a portion of oil is solubilized by surfactant. And microemulsion is in equilibrium with excess oil phase. [19-22]

4.2.2 Water-in-oil Micro-emulsion or Winsor II: water-in-oil micro-emulsion in which a portion of water is solubilized by surfactant and microemulsion is in equilibrium with excess water phase. [19-22]

4.2.3 Bi-continuous Micro-emulsion or Winsor III : Both oil and water are solubilized by surfactant and is often assumed to be bi-continuous because it is in equilibrium with excess oil and water. [19-22]

4.2.4 Single phase homogeneous mixture or Winsor IV : In single phase homogeneous mixture, water and surfactants are homogenously mixed. [19-22]

4.3 Transesterification Process

Transesterification or alcoholysis is the method in which non-edible oil is allowed to chemically react with alcohol with the help of catalysts. It is commonly used because of its simplicity and low cost .[17]

The catalysts used in this process are acidic , basic or enzymatic catalysts. reactions are often catalyzed by the addition of a base and acid. Bases can catalyze the reaction by removing a proton from the alcohol, thus making it more reactive, while acids can catalyze the reaction by donating a proton to the carbonyl group, thus making it more reactive. Common catalysts for transesterification include sodium hydroxide, potassium hydroxide, and sodium methoxide.[12,23-24]

Alcohol is treated with vegetable oil in the presence of catalyst in transesterification process, commonly, 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 appears and they separate out. The glycerine is refined and disposed of for next use. The crude biodiesel is refined and alcohol is separated from it is reused in the further cycle. transesterification of oils (triglycerides) with alcohol gives biodiesel i.e. fatty acid methyl ester (FAME) as the main product and glycerol is the by-product. triglyceride is converted into diglyceride, monoglyceride, and lastly, glycerol is converted. transesterification reaction depemds on methanol/oil molar ratio, catalyst concentration, reaction temperature and reaction time are checked for high biodiesel conversion and quality.[25]

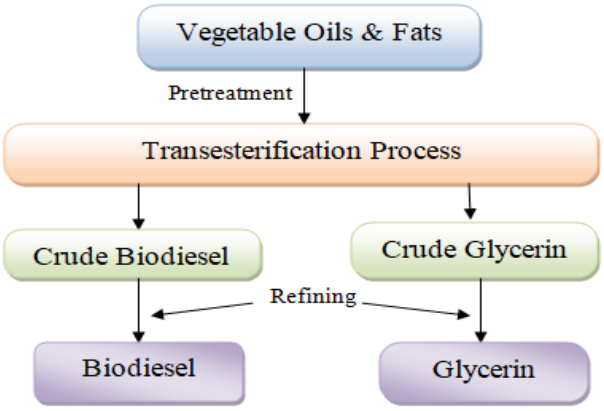


Figure 5. Basic Transesterification Process[12]

Generally, there are two types of Transesterification Process,

4.3.1 **Base catalyst transesterification process:** In this stage of process potassium Hydroxide (KOH), sodium hydroxide (NaOH) and sodium methoxide are used as a catalyst. It is a reaction base catalyst between alcohol and oil.[17,26]

4.3.2 **Acid catalyst transesterification process:** In this stage phosphoric acid or sulphuric acid is used as a catalyst. The product obtained from acid catalyst is use to produce biodiesel through base case catalyst transesterification process.[26]

4.4 Thermal cracking (pyrolysis)

Thermal decomposition of biomass occurring in the absence of oxygen is known as pyrolysis. Pyrolysis technology has the potential to produce bio-fuel with high fuel-to-feed ratios. Therefore, pyrolysis is an effective method in converting biomass into bio-fuel during recent years. In pyrolysis Method organic matter is very complex and consists of simultaneous and successive reactions when organic material is heated in a non-reactive environment. In this process; thermal decomposition of organic components in biomass starts at 250 °C–450 °C and goes up to 700 °C–800 °C in the absence of oxygen [27]

Pyrolysis method has following Advantages:-

- It is Renewable fuel for boiler, engine, turbine, power generation and industrial processes;
- Low cost;
- Utilisation of second generation feed-stocks and waste materials;
- Storability and transportability of liquid fuels;
- High energy density compared to atmospheric biomass gasification fuel gases;

Oil Fat by using catalyst undergoes the thermal cracking Process and after vaporization of liquid . condensate is formed and it is the biodiesel.[1,2,27]Catalysts used in this process are zeolites , alumina and redmud.[1,2] The reaction time for pyrolysis process is around 3 to 6 hours.[28]

Pyrolysis product distribution depends on reaction parameters like temperature, heating rate, reactant particle size and starting biomass.[29]

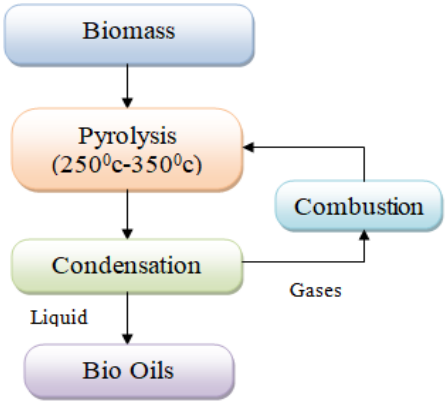


Figure 6. Pyrolysis Method [27]

5. CONCLUSION

Biodiesel is now become the key source for renewable energy. Generally used feedstock for biodiesel production is edible and non-edible oils. they are easily available and their yield is also more. Certain factors are affecting on biodiesel production are production methodology, cost and requirement of equipment, Properties of the raw material. Transesterification Process is mostly used for biodiesel production because it is less costly and simplicity of equipment. The highest yield of single feedstock biodiesel from palm oil achieved 90.87%. Blending is also used but it is in small scale only because it requires engine modification when used in the large scale. Microemulsion and pyrolysis are also the methods used from many years but due to complexity in the processes they are avoided.

REFERENCES

[1] *A. Rajalingam , S. P. Jani , A. Senthil Kumar and M. Adam Khan, "Production methods of biodiesel", Journal of Chemical and Pharmaceutical Research , **(2016)***

[2] *Alemayehu Gashaw, Tewodros Getachew, Abile Teshita Mohammed, "A Review on Biodiesel Production as Alternative Fuel" , Journal Of Forest Produc Ts & Industries, 2015, 4(2), 80-85 Issn:2325–4513(Print) ISSN 2325 - 453x (Online) **(2015)***

[3] *Ian Taseo, " Leading Biodiesel Producers Worldwide in 2019", Review article on stastista.com, **(2020)***

[4] *Yaser Dahman,Cherilyn Dignan, Asma Fiayaz, Ahmad Chaudhry, "An introduction to biofuels, foods, livestock, and the environment" , DOI: 10.1016/B978-0-08-102426-3.00013-8 **, (2019)***

[5] *Yaser Dahman, Kashif Syed, Sarkar Begum, Pallavi Roy, Banafsheh Mohtasebi, "Biofuels: Their characteristics and analysis" , DOI: 10.1016/B978-0-08-102426-3.00014-X **(2019)***

[6] *Sampa Saha, Arun Sharma, Srijita Purkayastha, Kalpana Pandey, Shaifali Dhingra,"Bio-plastics and Biofuel: Is it the Way in Future Development for End Users?" , DOI: 10.1016/B978-0-12-813140-4.00014-5 , **(2018)***

[7] *M. M. K. Bhuiya, M. G. Rasula, M. M. K. Khana, N. Ashwathb, A. K. Azada, M. A. Hazrat, "Second Generation Biodiesel: Potential Alternative to-edible Oil-derived Biodiesel" , DOI: 10.1016/j.egypro.2014.12.054 ,**(2015)***

[8] *Firoz Alam, Saleh Mobin and Harun Chowdhury, "Third generation biofuel from Algae" , DOI: 10.1016/j.proeng.2015.05.068 , **(2015)***

[9] *Mustafa Balat, "Potential alternatives to edible oils for biodiesel production – A review of current work" , DOI: 10.1016/j.enconman.2010.10.011 , **(2010)***

[10] *A. Gnanaprakasam, V. M. Sivakumar, A. Surendhar, M. Thirumarimurugan, and T. Kannadasan, "Recent Strategy of Biodiesel Production from Waste Cooking Oil and Process Influencing Parameters: A Review" , DOI: 10.1155/2013/926392 **, (2013)***

[11] *Abul Kalam Mohammad Aminul Islam, Sri Rizki Putri Primandari and Zahira Yaakob, "Non-Edible Vegetable Oils as Renewable Resources for Biodiesel Production: South-East Asia Perspective" , DOI:10.5772/intechopen.73304 **(2017)***

[12] *Khandelwal Shikha and Chauhan. Y. Rita, "Biodiesel production from non edible-oils : A Review" , Journal of Chemical and Pharmaceutical Research, 2012, 4(9):4219-4230 **(2012)***

[13] *Gokul Raghavendra Srinivasan, Ranjitha Lingam,"Comprehensive Study on Biodiesel Produced from Waste Animal Fats-A Review" , DOI: 10.3923/jest.2018.157.166* ***(2018)***

[14] *Rodica Niculescu , Adrian Clenci and Victor Iorga-Siman, "Review on the Use of Diesel–Biodiesel–Alcohol Blends in Compression Ignition Engines ", DOI:* ***10.3390/en12071194*** ***(2019)***

[15] *Jayashri N Nair, J. Deepthi, K. Siva kalyani, "Study Of Biodiesel Blends And Emission Characteristics Of Biodiesel" , International Journal of Innovative Research in Science, Engineering and Technology, Vol.2 , Issue 8****(2013)***

[16] *Madhav and D. Gupta , "A Review On Microemulsion Based System" , DOI: 10.13040/IJPSR.0975-8232* **,** *Vol. 2(8): 1888-1899* ***(2011)***

[17] *Ifeanyichukwu Edeh, "Biodiesel Production as a Renewable Resource for the Potential Displacement of the Petroleum Diesel" , DOI:10.5772/intechopen.93013* ***(2020)***

[18] *Plaban Bora, Jutika Boro, Lakhya Jyoti Konwar,Dhanapati Deka, "Formulation of microemulsion based hybrid biofuel from waste cooking oil – A comparative study with biodiesel" , DOI: 10.1016/j.joei.2015.07.001* ***(2015)***

[19] *Ashwini Jadhav, Abhijeet Daundkar, Deepak Morale, Nikhil Bhujbal, Dr.Sandip Kshirsagar: Review on: Microemulsion a Novel Approach for Drug Delivery", Int. J. Pharm. Sci. Rev. Res., 52(2), Article No. 11, Pages: 60-65* ***(2018)***

[20] *Rasvendra Rajput, Vikas Kumar, Shaweta Sharma, "Microemulsions: Current Trends In Sustained Releasedrug Delivery Systems" , International Journal of Pharma Professional's Research | Vol. 9| Issue 3 ,* ***(2016)***

[21] *Pranjal Kumar Singh, Mohd. Kashif Iqubal, Vikesh Kumar Shukla, Mohd. Shuaib Microemulsions, " Current Trends in Novel Drug Delivery Systems", Journal of pharmceutical , Chemical and biological sciences, 1(1):39-51****(2014)***

[22] *Shehzad Ahmed and Khaled Abdalla Elraies, "Microemulsion in Enhanced Oil Recovery", DOI:10.5772/intechopen.75778* ***(2018)***

[23] *J.M. Marchetti, V.U. Miguel, A.F. Errazu, "Possible methods for biodiesel production" , DOI: 10.1016/j.rser.2005.08.006* ***(2005)***

[24] *Konfo Tétédé Rodrigue Christian ,C. Pascal Agbangnan,"Comparative Study of Transesterification Processes for Biodiesel Production (A Review)" , Montcho Papin S. et al./ Elixir Appl. Chem. 120 ,51235-51242 ,* ***(2018)***

[25] *M. M. K. Bhuiya, M. G. Rasula, M. M. K. Khana, N. Ashwathb, A. K. Azada, M. A. Hazrata, "Second Generation Biodiesel: Potential Alternative to Edible Oil-Derived Biodiesel", DOI: 10.1016/j.egypro.2014.12.054 ,****(2015)***

[26] *Ulf Schuchardt , Ricardo Sercheli and Rogério Matheus Vargas,"Transesterification of Vegetable Oils: a Review", DOI: 10.1590/S0103-50531998000300002* ***(1998)***

[27] *Mohammad I. Jahirul, Mohammad G. Rasul, Ashfaque Ahmed Chowdhury and Nanjappa Ashwath: Biofuels Production through Biomass Pyrolysis —A Technological Review ,DOI:* ***10.3390/en5124952*** *,* ***(2012)***

[28] *M. A. Mohamed1, A. M. Hashim, O. S. Abu-Elyazeed, H. A. Elsayied,"Biofuel Production from Used Cooking Oil Using Pyrolysis Process", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 5 Issue XI ,* ***(2017)***

[29] *Renato Cataluña Veses, Instituto de Química, Universidade Federal do Rio Grande do Sul, Porto Alegre, RS, Av. Bento Gonçalves: Bio-Oil Production by Thermal Cracking in the Presence of Hydrogen ,DOI: 10.4172/2090-4541.1000194 ,* ***(2015)***