International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 04 | Apr 2022 www.irjet.net p-ISSN: 2395-0072

A Review on Performance and Emission analysis of 4-Stroke Diesel Engine using Blend Diesel.

Shubham[1], Pankaj kumar[2]

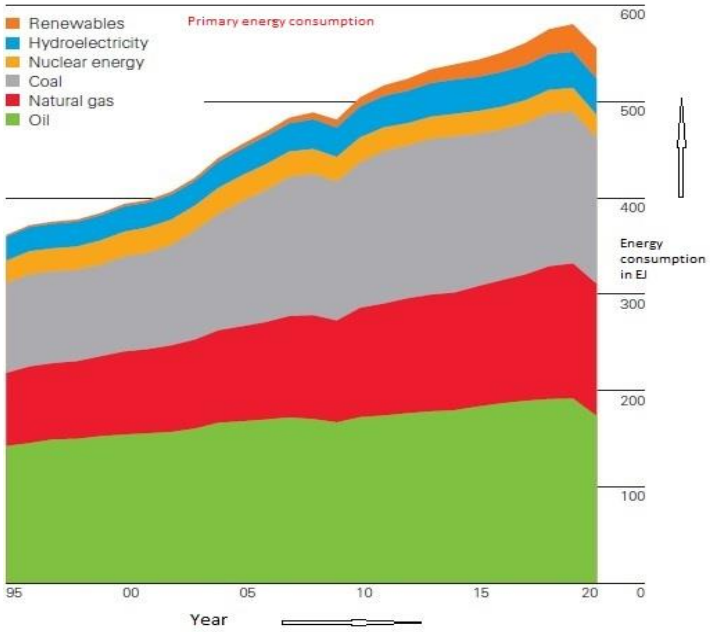
[1]*Department of Mechanical Engineering, B.I.T Sindri, India.*
[2]*Associate Professor*

Abstract - *The most of the energy required in the world is come from fossil fuel which is around 85% of primary source of energy mainly coal, petroleum, natural gas. In this era human being live in a world in which machine play an important role in daily life work to perform. So growing population of human being and the dependence on machinery equipment increases the demand of energy drastically. To full fill this demand the use of fossil fuel increase continuously. The main drawbacks with fossil fuel is, its limited quantity and its combustion which effect on human health and environment. Today the world faces a challenging problem called climate change which restricted the use of fossil fuel. So Bio fuel can be alternative of fossil fuel. In transportation, agriculture, power generation sector mostly based on petroleum and diesel fuels, in this field we can use biodiesel. Biodiesel can reduce the use of fossil fuel because biodiesel is non-toxic, biodegradable, renewable source of energy i.e. biodiesel use as a sustainably and environment friendly. It can be used in IC engine without much modification directly or by blending with diesel at different proportion. In this paper we review various biodiesel feedstock like, Rapeseed, soyabean oil, Mahua oil etc. and their performance and emission analysis on four stroke diesel engine. Most of the study suggest that 20% blend biodiesel give the best case scenario in term of engine performance as well as exhaust emission analysis.*

Key Words: **Biodiesel, Break thermal efficiency(BTE), Break specific fuel consumption(BSFC), Hydrocarbon(HC), Carbon mono-oxide(CO), Oxide of nitrogen(NOx), Calophyllum inophyllum(CI)**

1.INTRODUCTION

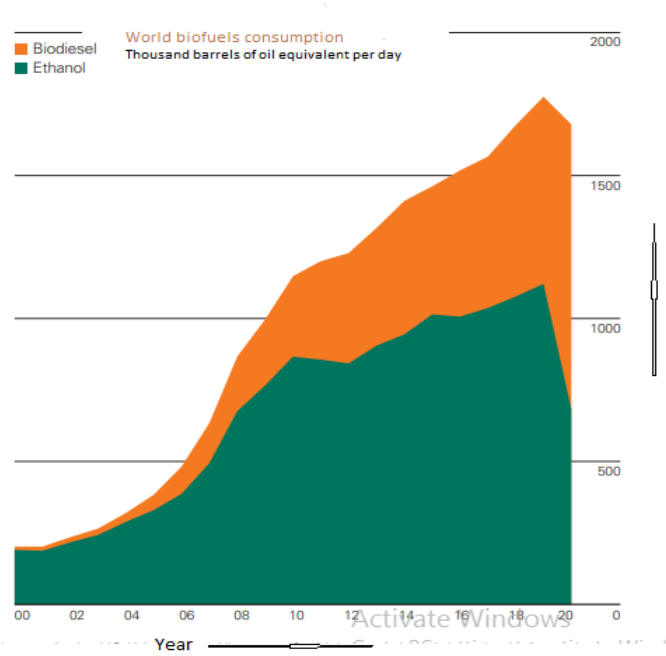
Energy consumption of the world is increasing drastically due to the rise of population and the dependence on machinery equipment. Today world is facing two major problems one is energy security and second is climate change. For our energy security we heavily dependent on fossil fuel which is shown in fig 1. The problem with fossil is that its limited stock and adverse effect on climate change. To resolve our problem we have to switch our energy source.



Primary energy consumption of world [1]

1.1 Current scenario of energy

According to international energy agency the major portion of energy around 82% of primary energy consumption is hold by fossil fuel (i.e. 31.2% by oil, 27.2% by coal, 24.7% by natural gas) other sources like nuclear power 4.3% and hydro power is 6.9% [1]. The energy consumption from fossil fuel is continuously rises which is indicated by fig.1. It decreases in last some year due to pandemic which is not a general condition i.e. it continue rise in future. For country like India where 85% of crude oil is imported. In 2019-20, diesel(HSD+LSD) accounted for the highest consumption share (38.9%) followed by petrol/motor Spirit (14.0%), LPG (12.3%), Petroleum Coke (10.1%), Naphtha (6.7%). The import of crude oil increases continuously from 189.43mmt in 2014-15 to 226.95 in 2019-20. Which is not good sign [2]. So to tackle with the problem of climate change and energy security, researchers are very much interested in biofuel (i.e. alternative option of petrol and diesel) which reduces the emission of harmful gases as well as a provide the renewable energy source. Biodiesel is a good alternative fuel. Governments also promote its, due this its uses is continuously increases fig 2.



Use of biofuel (Biodiesel, Ethanol) in world [1]

2.BIODIESEL

Biodiesel is an alternative diesel fuel derived from vegetable oils or animal fats. The main components of vegetable oils and animal fats are triglycerides known as ester of fatty acid attached to glycerol [3,4]. It can be use in existing diesel engine by blending with diesel. The properties of biodiesel are very close to diesel with lower emissions of harmful gasses. Biodiesel has higher cetane number, provides better lubricity, and low sulphur content than diesel fuel, which makes it a smart substitute for existing diesel engine. Varieties of feedstock have used to produce the biodiesel. The 20% blends of biodiesel with diesel shows satisfactory engine performance and reduced emissions of CO, HC and smoke as compared to diesel fuel [5,6].

2.1 Feedstock of biodiesel

In the recent time researchers shows their interest in the alternative fuel because of limited fossil fuel and environmental concern [7,8]. There are two type of oil one edible and other is non-edible. Non-edible have advantage corresponding to edible because non-edible may have toxic in nature [9]. Advantage of non-edible oil is that it does not affect food cycle [6]. Unproductive area of lands and alongside of roads and fields can be used for the non-edible crops. It gives flexibility to people to use less fertile land effectively which help rural area for their uplifting from poverty and it is sustainable also. Researchers prefer non-edible oil for sustainable biodiesel production [10-14]. There are varies biodiesel feedstock that we can use like rapeseed oil, soyabean oil, calophyllum inophyllum, mahua oil, jatropha oil, palm oil, pongamia pinnata etc.

3.Method of production of biodiesel

3.1 Transesterification

In this process reaction between triglycerides of oil and alcohol happen in the presence of catalyst and product of reaction is biodiesel and glycerol [15]. In transesterification process catalyst is used to increase the rate of reaction and improve quality. In higher amount of free fatty acid in oil the yield efficiency of reaction is lower [16,17]. So for oil having free fatty acid(FFA) less than 2% we use homogeneous base catalyst (KOH and NaOH). In oil having FFA greater than 2%, esterification process is necessary to obtained higher yield and to prevent soap formation issue in transesterification process [21]. For FFA>2% acid catalyst is used like H_2SO_4.

3.1.1 Base Catalyst Transesterification

In this process the reaction between oil and alcohol(methanol) happen in the presence of base catalyst like NaOH, KOH etc [21]. The reaction temperature should be 50 to 60^0C i.e. not above the boiling point of methanol. Simultaneously stirring of solution take place which increase the rate of reaction. Around 1 hr is taking place to complete the reaction. After that solution is left for 12 to 24 hr during this the glycerol settle down and biodiesel float upper side [19,20,21].

3.1.2 Acid Catalyst Transesterification

In this process, two stage is happened first happen with acid catalyst and the product of 1st reaction is go through base catalyst. In this process the alcohol will reacts with oil using acid catalyst and produces the biodiesel and water, the water must be removed immediately because the water will lead to the formation of soap while in base catalyst transesterification process. Here 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 [22,23,24]

Propertie of varies biodiesel production feedstock oil.

BIODIESEL	Calorific value(MJ/Kg)	Density(kg/m^3)	Viscosity(cst)	Flash point^{o}c	Cetain no.	ref
Rapeseed	37-38	874-885	4.6-4.8	140-148	53-54	25,26,27
Soyabean	36-38	870-875	3.9-3.99	128-130	54-56	28
CI	37-39	867-869	4.6-4.9	140-160	39-52	30,31
Mahua	42-43	870-883	5.38-5.6	156-175	51-52	32,33
Jatropha	39-41	871-882	401-5.3	125-162	48-58	35,36

4.Performance and emission analysis of above biodiesel feedstock

4.1For rapeseed oil biodiesel

The break thermal efficiency(BTE) decreases as blend percentage of rapeseed oil biodiesel is increases and at full condition the best comparable BTE with pure diesel is at 20% of biodiesel blend [25,26]. The calorific values of the rapeseed oil biodiesel blends were lower than diesel and it decreases with increase in the percentage of biodiesel in the blend [25]. Break specific fuel consumption increases as blend % increases and it is higher than diesel [26]. At full load condition the emission of hydrocarbon and carbon monoxide for blend biodiesel is less than pure diesel. But NO_X emission is higher than diesel engine because increase in exhaust gas temperature [25,26].

4.2 For soyabean oil biodiesel

For soybean oil biodiesel the bsfc is higher than pure diesel. NO_x is higher than diesel. CO, HC and smoke opacity is lower for biodiesel compare to diesel [28]. For most of the perameter the 20% soyabean biodiesel with diesel give best result like BTE is higher, fuel consumption lower than diesel [29].

4.3 For Calophyllum inophyllum(CI) or Punnia oil biodiesel

The BTE is increases with load upto 75% and then decrease but it is less than diesel. The BTE is increase when we added amount of n-octanol from 10% to 50% in CI biodiesel and at 50% amount of n-octanol in CI biodiesel give BTE comparable to pure diesel. smoke opacity and hydrocarbon of CI biodiesel is lowest and it is increases with blend % of octanol and for diesel it is higher then all. NO_x emission of CI biodiesel is higher diesel [30]. The BTE efficiency decrease with increase blend %of CI biodiesel in diesel. BSFC, CO_2 and NO_x is lowest for diesel and by increasing blend % it is increases. HC, CO and smoke opacity highest for diesel and by increasing blend% all are decreases [31].

4.4. For mahua oil biodiesel

BTE of pure biodiesel and their different blend in diesel is less than diesel. The lower % of blend of biodiesel in diesel give higher BTE and as increasing blend % decrease the BTE [32]. We can increase the BTE of pure mahua biodiesel by increasing the % of additive. [33]. BSFC is greater for pure biodiesel and their blend with respect to diesel. By increasing the % of biodiesel in diesel the BSFC if increasing [32]. Bsfc of pure mahua biodiesel is decrease by increasing the % of additive [33]. The emission of CO is almost double for pure mahua biodiesel as compared to diesel at full load condition. The NO_x and smoke emission of pure biodiesel and their blend compare to diesel [32].

4.5. Jatropha oil biodiesel.

The BTE of jatropha biodiesel and its blend is lower than diesel. And by increasing the % of biodiesel in diesel also decreases the efficiency. BTE efficiency of jatropha biodiesel and their blend frist increase with break power and then decrease [34,35]. BSFC of blend biodiesel is lower than diesel. And by increasing the %of biodiesel in diesel increases the bsfc[34,36]. HC and CO emission less than diesel. And by increasing blend % of biodiesel decreases the CO and HC emission at maximum speed [34]. NO_x emission higher for biodiesel blendand by increasing the speed of engine the NO_x emission decrease bled and diesel both. [34,35]

Conclusion

Many research is going on biodiesel. It is attractive topic for biodiesel. Because it gives advantage over conventional fuel to reduces the emission from engine. It is economical, and renewable as well. Many country promote the blending of biodiesel and set different target. So the demand of biodiesel is continuously rising. We can produce biodiesel from edible oil, non-edible oil or waste chicken fat or waste oil. Production of biodiesel from non-edible oil and waste oil is best for production because in case of edible oil biodiesel production, it disrupted the food cycle. In most of the biodiesel blending the lower % of blending of biodiesel (like 20%)give the better result.

REFERENCES

[1] BP Statistical review of world energy 2021 https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf

[2] https://mopng.gov.in/files/TableManagements/MoPNG-Annual-Report-combined.pdf.

[3] Kulkarni MG, Dalai AK. Waste cooking oil an economical source for biodiesel: a review Industrial& Engineering Chemistry Research 2006;45:2901-13

[4] Muhammad Farooq ,AnitaRamli b, Abdul Naeemc; Renewable Energy 76 (2015) 362e368

[5] Tapanes NCO, Gomes Aranda DA, De Mesquita Carneiro JW, Ceva Antunes OA. Transesterification of Jatropha curcas oil glycerides: theoretical and experimental studies of biodiesel reaction. Fuel 2008;87:2286–95.

[6] Divakara BN, Upadhyaya HD, Wani SP, Laxmipathi Gowda CL. Biology and genetics improvement of Jatropha curcas L.: a review. Appl Energy 2010;87:732–42

[7] Kannan M, Karthikeyan R, Deepanraj B and Baskaran R (2014) Feasibility and performance study of turpentine fueled DI diesel engine operated under HCCI combustion mode, Journal of Mechanical Science and Technology, ***28*** *(2), pp.729-737*.

[8] Deepanraj B, Sankaranarayanan G, Senthilkumar N and Pugazhvadivu M (2017) Influence of dimethoxymethane addition on performance, emission and combustion characteristics of the diesel engine, International Journal of Ambient Energy,38,pp.622-626

[9] Ahmad A, Yasin N, Derek C, Lim J. Microalgae as a sustainable energy source for biodiesel production: a review. Renew Sustain Energy Rev 2011;15:584–93

[10] Gui MM, Lee K, Bhatia S. Feasibility of edible oil vs. non-edible oil vs. waste edible oil as biodiesel feedstock. Energy 2008;33: 1646–53.

[11] Silitonga A, Masjuki H, Mahlia T, Ong HC, Chong W. Experimental study on performance and exhaust emissions of a diesel engine fuelled with Ceiba pentandra biodiesel blends. Energy Convers Manage 2013;76: 828–36

[12] Syers JK, Wood D, Thongbai P. The proceedings of the international technical workshop on the feasibility of non-edible oil seed crops for biofuel production. Mae Fah Luang University, Chiang Rai, Thailand; 2007

[13] Mustafa B. Potential alternatives to edible oils for biodiesel production – a review of current work. Energy Convers Manage 2011;52: 1479–92.

[14] Vedharaj S, Vallinayagam R, Yang W, Chou S, Chua K, Lee P. Experimental investigation of kapok Ceiba pentandra oil biodiesel as an alternate fuel for diesel engine. Energy Convers Manage 2013;75:773–9.

[15] Ayush Kumar Raghuvanshi; C P Singh, International Journal of Scientific and Research Publications, Volume 4, Issue 10, October **2014**

[16] Ramaraju A; Ashok Kumar T. V, ARPN Journal of Engineering and Applied Sciences, VOL. 6, NO. 4, APRIL 2011.

[17] B.K. Venkanna; C. Venkataramana Reddy, Bioresource Technology 100 (2009) 5122–5125.

[18] Sahoo PK, Das LM. Process optimization for biodiesel production from jatropha, karanja and Polanga oils. Fuel 2009;88: 1588–94

[19] AtulDhar; Roblet Kevin; Avinash Kumar Agarwal, Fuel Processing Technology 97 (2012) 118–129.

[20] S.S. Ragit; S.K. Mohapatra; K. Kundu; Prashant Gill, biomass and bioenergy 35 (2011) 1138-1144

[21] D. Subramaniam; A. Murugesan; A. Avinash, International Journal of Energy and Environment (IJEE), Volume 4, Issue 5, 2013, pp.859-870.

[22] HwaiChyuanOng; H.H. Masjuki; T.M.I. Mahlia; A.S. Silitonga; W.T. Chong;TalalYusaf, Energy 69 (2014) 427-445.

[23] M. Canakci; J. Van Gerpen, American Society of Agricultural Engineers, VOL. 42(5): 1203-1210.

[24] A.S.Silitonga; HwaiChyuanOng; T.M.I.Mahlia; H.H.Masjuki; W.T.Chong, Energy Procedia 61 (2014) 480 –483.

[25] L. Anantha Raman, B. Deepanraj, S. Rajakumar, V. Sivasubramanian ,Experimental investigation on performance, combustion and emission analysis of a direct injection diesel engine fuelled with rapeseed oil biodieselFuel 246 (2019) 69–74

[26] Bhavin Mehta*, Dattatraya Subhedar, Gaurang Patel and Abhishek Swarnkar, "Experimental investigation of performance and emission characteristics of diesel engine with use of rape seed oil as biodiesel"IOP Conf. Series: Materials Science and Engineering 872 (2020) 012093

[27] Tomas Mickevicius, Stasys Slavinskas, "EFFECT OF BIOFUEL ON PERFORMANCE AND EMISSIONS OF DIESEL ENGINE". DOI: 10.22616/ERDev.2021.20.TF227

[28] Suresh Vellaiyan, "Combustion, performance and emission evaluation of a diesel engine fueled with soybean biodiesel and its water blends" Energy 201 (2020) 117633

[29] Deepali Bharti1, Pushpdant Jain, Bhupendra Koshti3 and Rajesh Nag. " Prediction of performance parameters of a four stroke diesel engine. xperimented with blends of vegetable oil biodiesel".IOP Conf. Series: Materials Science and Engineering 1136 (2021) 012013

[30] B. Ashok, K. Nanthagopal, Vivek Anand, K.M. Aravind, A.K. Jeevanantham, Saravanan Balusamy." Effects of n-octanol as a fuel blend with biodiesel on diesel engine characteristics" Fuel 235 (2019) 363–373

[31] Bibin Chidambaranathan, Seenikannan P, and Devan PK. "Performance, emission, and combustion characteristics of a direct injection diesel engine using blend of punnia oil biodiesel and diesel as fuel"Thermal Science Year 2020, Vol. 24, No. 1A,pp.13-25

[32] S. Savariraj, T. Ganapat hy,and C. G. Saravanan. "Experimental Investigation of Performance and Emission Characteristics of Mahua Biodiesel in Diesel

Engine" International Scholarly Research Network, ISRN Renewable Energy, Volume 2011, Article ID 405182,6pages

[33] Swarup Kumar Nayak, Bhabani Prasanna Pattanaik "Experimental Investigation on Performance and Emission Characteristics of a Diesel Engine Fuelled with Mahua Biodiesel Using Additive" Energy Procedia 54 (2014) 569 – 579.

[34] M. Mofijur, H.H. Masjuki, M.A. Kalam, A.E. Atabani, "Evaluation of biodiesel blending, engine performance and emissions characteristics ofJatropha curcas methyl ester: Malaysian perspective" Energy 55 (2013) 879e887

[35] M.S. Gad, A.S. El –Shafay. "Assessment of diesel engine performance, emissions and combustion characteristics burning biodiesel blends from jatropha seeds" S0957-5820(20)31893-0

[36] Bhupendra Singh Chauhan, Naveen Kumar, Haeng Muk Cho. "A study on the performance and emission of a diesel engine fuelled with jatropha biodiesel oil and its blends" Energy 37 (2012) 616e622