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"REVIEW OF METHANOL BIODIESEL FOR THERMAL PERFORMANCE, EMISSION AND COMBUSTION CHARACTERISTICS IN CI ENGINE"

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ABSTRACT

As the price of petroleum oil reaches a new high, the need of developing alternate fuels has become acute. Alternate fuels should be economically attractive in order to compete with currently used fossil fuels. Biodiesel, produce by the transesterification of vegetable oils or animal fats with simple alcohols and catalyst attracts more and more attention recently. Biodiesel is clean burning diesel alternative and has many attractive features including renewability, biodegradability, non toxicity and low emission. The aim of the present review is to study the biodiesel production from transesterification process, effect of reaction parameters on conversion of biodiesel yield and its combustion, performance and emission characteristics. It observes that the base catalysts are more effective than acid catalysts. Biodiesel is a notable alternative to the widely used petroleumderived diesel fuel since it can be generated by domestic and non domestic sources such as soybeans, coconuts, rapeseeds, Jatropha, Karanja, rubber seed, Mahuaa, waste frying oil, etc. and thus these reduces dependence on diminishing petroleum fuel from foreign sources. The problems with substituting triglycerides for diesel fuels are mostly associated with their low volatilities, high viscosities and polyunsaturated character. The main purpose of the transesterification process is to lower the viscosity of the oil. Over a number of years, the work of exploring different biodiesel as an alternative to diesel fuel has been carried out worldwide. The performance of biodiesel is closed to petroleum diesel fuel. The brake power of biodiesel fuel is approximately equal to diesel, while the specific fuel consumption is higher than that of diesel. The combustion characteristic of biodiesel fuels is similar to petroleum diesel fuel and blends provide small ignition delay, higher ignition pressure, and higher ignition temperature and peak heat release. The emission from the biodiesel is comparatively less to diesel except NOx.

Key Words: *Alternative fuels, Biodiesel, Emmision, Combustion, CI Engine.*

I. INTRODUCTION

From 1973 to 2004 the global primary energy consumption increased from 252 to 463 billions MJ. In addition, high emissions of CO2, NOx, SO2 and particulate matter (PM) are produced during fossil fuel use, generating environmental problems. These facts have converged in the search of renewable energies, such as biofuels. The lack of conventional fossil fuels, their increasing costs and rising emissions of combustion-generated pollutants will make bio-based fuels more attractive . Due to the rise in price of petroleum products, especially after the petrol crisis in 1973 and then the Gulf War in 1991, geographically reduced availability of petroleum and more rigorous governmental regulations on exhaust emissions, many researchers have studied alternative fuels and alternative solution methods.

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Impact Factor : 4.256

II. Bio Fuels

Biofuels are the most effective and efficient form of renewable energy. They can be easily extracted from the biomass, and they are biodegradable and are environment friendly. Their combustion is almost similar to fossil fuels, and they produce less toxic compounds. The biomass absorbs carbon dioxide from the atmosphere, and when they are used as energy source, they release the carbon dioxide back into the atmosphere.

2.1 CNG as diesel engine

Natural gas is one of the most important energy carriers today because it is available in large quantities and its reserves are of the same magnitude as the crude oil reserves. CNG/NG, is a Mixture of hydrocarbons in gaseous form, consists of approximately 80-90% of methane along with some percentage of ethane, propane, nitrogen . A gaseous form of natural gas, clearly has some Substantial benefits compare to petrol and diesel.

2.2 Biodiesel Production

Oil can be extracted from a variety of plants and oil seeds. It is estimated that about 3 million hectares plantation is required to produce oil for 10% replacement of diesel.

2.3 Methanol as diesel engine fuel

Methanol in diesel results faster-premixed combustion leading to higher combustion temperature, which causes higher NOX emissions in the engine exhaust emission? Before going for the commercial use of diesel–Methanol blends with high Methanol content, it is important to find a method to reduce the NOX emission. Many techniques are evaluated to allow the use of diesel and Methanol in compression ignition engines. But most commonly used techniques are alcohol fumigation, dual injection, alcohol-diesel fuel emulsion and alcohol-diesel fuel blends. Surfactants reduces the interfacial tension in a liquid medium and homogenizing the E-diesel blend, enhances engine performance and reduces ignition delay and exhaust emissions.

Properties	Unit	Diesel	Methanol
Molecular formula	-	$C_{14}H_{30}$	CH_3OH
Molecular weight	g	198.4	32.04
Cetane number	-	51	3
Research octane number	-	15–25	136
Boiling point	K	453–643	338
Liquid density	kg/m^3	840	796
Lower heating value (LHV)	MJ/kg	42.5	19.5
LHV of stoichiometric mixture	MJ/kg	2.85	2.68
Heat of evaporation	MJ/kg	243	1100
Auto-ignition temperature	K	503	736
Stoichiometric air-fuel ratio	-	14.6	6.45
Viscosity (at 40 °C)	cSt	4.59	0.65
Carbon content	%	85	37.5
Hydrogen content	%	15	12.5
Oxygen content	%	0	50

Table 1. Fuels properties

2.4 Nanoparticles

Nanofluids are made up of nanoparticles and are made by using metals, oxides, carbides and carbon nanotube. Most commonly used base fluids are oil, water and ethylene glycol. At present nanofluids are used in many applications because of their different properties, such as heat transfer, microelectronics, fuel cells, hybrid-powered engines, engine cooling, chiller units, refrigerators, machining and boiler flue gas temperature reduction. Nanofluids unveil superior thermal conductivity and the convective heat transfer co-efficient as compared with base fluids. Alcohols are alternate renewable fuels for diesel fuel with some additives which can enhance the desirable properties of the fuel. Alcohols can

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Impact Factor : 4.256

be produced in rural areas by the availability of forest products as raw materials. The absences of sulfur content in alcohols no sulfur dioxide emission from engine exhaust. This can be overcome by large-scale production of Methanol with the help of government sectors and private firms with government funding. Biodiesel is a good source of renewable energy and can be produced by various methods and materials.

Type of Fuel	Standard Specifications	
	US	EN
Ethanol	ASTM4806 ASTM5798	EN 15376 [1]
Methanol	ASTM D5797 [2]	EN 228-2008 (E) [3]

Table No. 2 Standard Specifications

II. LITERATURE REVIEW

[1] Mohit Raj Saxena, Rakesh Kumar Maurya, Prashant Mishra *et al* (2021) ., Effect of methanol on performance, combustion, and emission characteristics of conventional CI-engine . The soot and nano-particle emission from the methanol fueled CI-engine, which is one of the main emission legislation. It has observed that the utilization of methanol in CI-engine has the potential to improve the performance with a significant reduction in NOx, CO, soot, and nano-particle emissions in comparison to neat diesel operation. unburnt HC emission reduces for methanol- diesel blended fuel operation whereas HC emissions are higher for methanol diesel dual-fuel operation.

[2] Mani Ghanbari, Lotfali Mozafari-Vanani , Masoud Dehghani-Soufic, Ahmad Jahanbakhshi *et al* (2021), The interaction of variables on the emission and performance of the diesel engine was investigated . The maximum values of brake power and torque were obtained as 42.82 kW and 402.8 N.m for nanoparticle concentration of 160 ppm and engine speed of 1000 rpm, respectively. Also, the minimum BSFC, CO and HC were measured as 207.21 gr/ kWh, 1.15% and 9%, respectively. The maximum values of CO2 and NOx were recorded as 11.76% and 1899 ppm for nanoparticle concentration of 160 ppm and engine speed of 1000 rpm, respectively.

[3] Murat Kadir Yesilyurt (2020), Contrary to the lower-chain alcohols higher alcohols have an encouraging candidate for future diesel engine diesel fuel and biodiesel in the CI engine for extracting the characteristics of performance, emissions. Results shows that brake specific energy consumptions for diesel fuel, B20, B20Hp20 and B100 were found to be at 8.78 MJ/kWh, 8.90 MJ/kWh, 8.85 MJ/kWh, 8.94 MJ/kWh, and 10.29 MJ/kWh, respectively at 100% load while the maximum brake thermal efficiency values were obtained as 40.81%, 40.46%, 40.67%, 40.27%, and 35.00, respectively. At 100% load, the peak heat release rate for B20, Hp20 and B20Hp20 were found to be at 37.53 J/deg, 37.80 J/deg and 37.91 J/deg, oxygenated additive into the diesel fuel and biodiesel fuel blend caused to decreasing CO and unburned HC emissions while increasing CO_2, O_2, and NO_X emissions as compared to diesel fuel.

[4] Upendra Rajaka, Prerana Nashineb, Tikendra Nath Vermaa, Upendra Rajaka, Prerana Nashineb, Tikendra Nath Vermaa *et al* (2020) , The performance, combustion and emission analyses showed that of the injection timings with higher injection pressure of 220 bar. Brake thermal efficiency , exhaust temperature and pressure rates . Specific fuel consumption and ignition delay period results increased up to 3.3%, 8.2% and BTE reduced up to 3.03% when the spirulina microalgae blend was increased to 20% at the higher load. lower nitrogen oxides emission by 4.9%, particulate matter emission by 20.7% as well as lower smoke by 5.4%, but CO_2 emissions increased for all loads.

[5] Mandeep Singh, Sarbjot Singh Sandhu *et al* (2020), The biodiesel blends perform better at part load and high load in comparison of low load condition. 5.58% in brake thermal efficiency and 7.88% in brake specific fuel consumption were observed for AB20 at high load condition. reduction in exhaust emissions were observed at part load and high load up to 30% blending of argemone biodiesel in diesel. At low load, less NOx emissions, higher HC and CO emissions were observed for all biodiesel-diesel blends. Also, nochange in ignition delay was observed up to 20% blending of argemone biodiesel in diesel. AB30 and AB50 blends show a longer ignition delay in comparison of other

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tested blends. heat release rate was found at all the test conditions except low load for AB20 blend. 20% blending of argemone biodiesel can be used in engine to attain higher thermal efficiency with a penalty of higher NOx emissions. 30% blending of argemone biodiesel can be used to achieve almost similar brake thermal efficiency as that of petroleum diesel with less penalty of NOx emissions as imposed by AB20.

[6] Mehmet Akcay , Ilker Turgut Yilmaz , Ahmet Feyzioglu et al (2020) , Effect of hydrogen addition to a compression ignition engine fueled with the diesel fuel-waste cooking oil biodiesel blend on the engine performance, exhaust emissions was examined experimentally. The hydrogen was added to the intake air at the flow rates of 10, 20, 30 and 40 lpm. The exhaust gas temperatures and cylinder pressures with hydrogen addition. The NOx and total hydrocarbon emissions decreased with the hydrogen addition until 30 lpm at 40 and 60 Nm engine load for all hydrogen additions. While CO_2 and O_2 emissions decreased with the hydrogen addition.

[7] Oyetola Ogunkunle , Noor A. Ahmed *et al* (2020), Performance and emission analysis of a diesel engine was conducted on a diesel engine, operated under different operating conditions, using varied Parinari polyandra biodiesel blends. Exhaust emissions, hydrocarbons, carbon dioxide, carbon monoxide, sulphur dioxide, and nitrogen oxides were measured. B10 was found to be the optimal blend in improving the engine performance in terms of speed, power and thermal efficiency. B30 demonstrated stable performance for diesel engine. The emissions from biodiesel blends combustion were found to be lower than that of diesel, except nitrogen oxides. High percentage reduction of greenhouse gases, carbon monoxide and carbon dioxide observed 81.7% and 65.7%.

[8] Raghvendra Gautam, Saket Kumar et al (2020), In this study, biodiesel is produced from tallow oil and blended in different ratios , 10%, 20% and 30% as B10, B20 and B30 with diesel and used as an engine fuel to compare combustion and performance. In-cylinder pressure, rate of pressure rise, mean gas temperature, heat release rate, brake power, specific fuel consumption, brake thermal efficiency and torque. Results showed that engine performance parameters support the use of biodiesel and its blends as fuel , brake power values of diesel and biodiesel blends , B30 is 1.7% specific fuel consumption was higher in the case of biodiesel blends because of its lower heating value relative to diesel.

[9] Youssef A. Attai , Osayed S. Abu-Elyazeed, Mohamed R. ElBeshbeshy, Mohamed A. Ramadan and Mohamed S. Gad *et al* (2020) , An experimental study of engine's performance, emissions and combustion characteristics using biodiesel blended with gas oil in volumetric ratios of 0, 10, 25, 50, 75, and 100% at different loads was performed. Increase of CBD percentage in the blend led to a reduction in engine's thermal efficiency, cylinder pressure, net heat release rate,and smoke emission. The exhaust gas temperature, specific fuel consumption, unburned hydrocarbon, CO, and nitrogen oxide emissions were increased with the increase of CBD ratio. Biodiesel showed the maximum increase in specific fuel consumption by 10% and the thermal efficiency was decreased by 10.5% about pure diesel. Smoke emissions were decreased for CBD100 by 12% about gas oil.

[10] Rodica Niculescu , Adrian Clenci and Victor Iorga-Siman *et al* (2019), The Investigation has been investigated the impacts of biodiesel use on engine operation. The addition of alcohols such as methanol and ethanol is also practised in biodiesel–diesel blends, due to their miscibility with the pure biodiesel. Alcohols improve the physico-chemical properties of biodiesel–diesel blends, which lead to improved CI engine operation.

[11] Arkadiusz Jamrozik, Wojciech Tutak, Renata Gnatowska and Łukasz Nowak *et al* (2019) This investigation experimental examinations of a CI engine with a dual fuel system, in which co- combustion was performed for diesel and two alcohol fuels with energy contents of 20%, 30%, 40% and 50%. The presence and increase in the share of methanol and ethanol used for co- combustion with diesel fuel causes an increase in ignition delay and increases the heat release rate and maximum combustion pressure values. A larger ignition delay is observed for co-combustion with methanol. Based on changes in the coefficient of variation of the indicated mean effective pressure and the function of probability density of the indicated mean effective pressure.

ISSN : 2455-9679
Impact Factor : 4.256

[12] Oyetola Ogunkunle , Noor A. Ahmed *et al* (2019) , The effective power conversion from biodiesel combustion and emission impact on the environment has been investigated adoption has been captured according to production rate, the economic feasibility of diesel engines that are suitable for biodiesel with little or no modification. With the progress made so far by many researchers to establish biodiesel as a viable engine fuel, coupled with the ability to eradicate environmental issues like global warming and sustainability.

[13] Upendra Rajak , Tikendra Nath Verma et al (2019) , The slightly higher piston force and increased with compression ratio as well as sauter mean diameter with first, second and third generation biodiesel-diesel blend compared to diesel. Spray tip penetration was found to be slightly lower by increasing CR and higher for first, second and third generation fuels compared to diesel. An effective reduction of soot emission is observed with the biodiesel blend for Karanja by 6.1% , jatropha curcas by 25.9% and spirulina by 5.59%.

[14] Kass et al. (2018) conducted emission test using diesel ethanol blends on a 5.9 liter diesel engine, results show that CO emissions and total hydro carbons emissions decreases from 4-5%.

[15] Mohamed Nour et al. (2017), performed a study using rapid compression machine under CI conditions. From the results, it is observed that MMethanol/water blends with diesel fuel increases the ignition delay in premixed combustion phase causing higher heat release rates as compared with neat diesel fuel.

[16] Miqdam Tariq Chaichan et al. (2017) used aqueous alumina nanofluids additive in diesel engine. Results shows that complete combustion of fuel blend and high heatgenerated in the combustion chamber BTE increased by 5.5%, fuel consumption reduced by 3.94% due to oxygen enrichment by the addition of aqueous alumina nanofluids. Exhaust emissions like NOX, CO and HC are reduced and the values are lower than the diesel fuel.

[17] Qibai Wu et al.(2017) conducted tests by using three kinds of biofuel blends (biodiesel, biodiesel with ethanol and biodiesel, ethanol and 30 ppm aluminum nanoparticles) and results revealed that the addition of aluminum nanoparticles

[18]. S. S. M. Mostafa et al studied the feasibility of biodiesel produced from microalga Spirulina platensis according to the standard methods of analysis (ASTM) and compared to Egyptian petro-diesel. The obtained results reported that with the increase of biodiesel concentration in the blends; the viscosity, density, total acid number, initial boiling point, calorific value, flash point, cetane number and diesel index increase. While the pour point, cloud point, carbon residue and sulfur, ash and water contents decrease.

[19] S. H. Yoon et alperformed experimental investigation to find out the fuel properties of soybean biodiesel such as specific gravity, density, and viscosity of diesel and soybean biodiesel fuel in the temperature range from 0 to 200 °C. Paper reported that, the specific gravity of biodiesel fuel increased with the increase of the blending ratio of biodiesel and gradually decreased as the fuel temperature increased linearly. Also the density values are correlated as a function of blend ratio and temperature.

[20] Ramalho et.al used a poultry feedstock for production of biodiesel and studied the thermo-physical properties of biodiesel at low temperature. Modulated Temperature Differential Scanning Calorimetry was used to understand the physical meaning of properties as Cold Filter Plugging Point , Pour Point and Cloud Point of biodiesel.

III. CONCLUSION

The steep rise of demand of petroleum based fuel is because of rapid and fast industrialization of automotive sector. There are limited reserves for petroleum based fuels. These limited reserves are located in the certain regions of the world. Therefore the countries those are not having the sufficient stock of petroleum based fuel, are facing the problems of increase cost of fuel which mainly due to the cost involved in the import of the petroleum based fuel. Hence it is required to find out and investigate the other resources of the alternative fuels, which can be produced from nearby and locally available sources such as Alcohol. Biodiesel blends are prepared in any proportion with diesel to usein a

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conventional diesel engine. By using biodiesel in an engine there is a significant reduction in the harmful pollutants in the environment. This paper reviews the production, properties, performance and emission analysis of different feedstock of blends of biodiesel and experimental work carried out . In conventional compression ignition engines, up to 95% and 25% diesel can be replaced by methanol through fumigation and blending, respectively. Higher latent heat of vaporization of alcohol led to lower peak in-cylinder pressure and NOx; however, it negatively affects thermal efficiency and hydrocarbon and carbon monoxide emissions. Fumigation of alcohol requires modifications in the existing engine, whereas blending needed surfactants or additives to produce stable alcohol–diesel blends. High injection pressure and late direct injection, methanol–diesel blends have shown lower emissions and proved their potential as a suitable replacement for ethanol–diesel blends from the components durability perspective.

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