ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Biodiesel as an alternate fuel for CI Engine – A Review

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ABSTRACT

Depletion factors of fossil fuels and dependency with foreign source and increasing in constraint in emission norms need for an alternate fuel in CI engine. Biodiesel was found to be better alternate for diesel engine. Higher viscosity unfavoured the oil as straight fuel in diesel engine. Since biodiesel is derived from the vegetable oil, animal fats and its feedstock. Transesterification process was found easiest and better extraction of biodiesel. This paper study the performance and emission characteristics of CI engine fuelled with different biodiesel blends. Transesterification process using methanol as solvent and KOH as catalyst was found more feasible in majority of oil. Lower calorific value, higher viscosity leads to improper atomization and reduces the brake thermal efficiency and increase the specific fuel consumption with increase in blends to diesel fuel. CO, HC and smoke was found significant reduction due to more oxygen content in blended fuel. No_x was found higher than diesel fuel. Overall performance and emission Characteristics CI engine fuelled with biodiesel and its blend is very close to diesel. Biodiesel is better alternate for diesel engine.

KEY WORDS: CI Engine, Biodiesel, fuel.

1. INTRODUCTION

Due to depletion of fossil fuels and increase in demands leads to need an alternate fuel which can be effectively substituted by biodiesel derived from edible oil, non-edible oil, feedstocks of animals and animal fats. Because of high viscous content vegetable oil can be used as straight fuel. In order to increase the viscosity of fuel it is converted into biodiesel. Transesterification process is one of viable method to extract the biodiesel from edible oil and non-edible oil. Biodiesel extraction process was affected by free fatty acid conditions. When free fatty acids condition lead to more than 1% by volume needed two step transesterification process. First step with acid catalyst etherification and second step process with base catalyst. Most of biodiesel derived from the vegetable oil (edible oil and non-edible oil) fulfilled the performance and emission characteristics of CI engine. Biodiesel of all oils having an issue on viscosity and leads to poor combustion. This can be rectified by blending with diesel, alcohol like ethanol, methanol, buatanol, propanaol etc ether compounds like di methyl ether, diethyl ether etc. so blending of fuel lead to decrease in viscosity and better atomization for combustion.

Algae oil: Microalgae oil has feasible development in recent years because oil content and fast growing rates. Microalgae biodiesel can be easily extracted from the one step transesterification process by using methanol and NaOH as calatyst. Most of reviewer use the biodiesel blended diesel as fuel for CI engine. Low cetane value of microalgae oil biodiesel was decrease in Brake power with increase in blend ratio. Butanol as additive also decrease the brake power and torque. Lower calorific value of biodiesel with additive of butanol increase the fuel consumption. Extra oxygen present in the biodiesel reduces the CO emission by enhancing proper combustion. Lower heating value of Microalgae biodiesel was reason for the lower emission of NO_x. Excess content in oxygen content in microalgae biodiesel lead to increase in NO_x but addition of butanol decrease the NO_x because of its lowering temperature effect. Additional oxygen content in the microalgae biodiesel and with additives of butanol cause less smoke opacity.

Beef Tallow oil: Beef tallow oil methyl ester was prepared from the one step transesterification process with methanol using KOH as catalyst. Density of fuel was found higher than diesel. SFC was increase with increase in load of the engine. SFC was decrease in increase in blend ratio. Brake thermal efficiency was decrease with increase in blending ratio due to high viscosity lead to poor atomization and lower heating value of the fuel. Exhaust gas temperature was found lower in higher speed and higher in lower speed this is because of poor atomization and longer combustion period. HC emission was lower at medium loads and higher at no load and peak loads.

Cashew nut shell oil: Straight cashew nut shell oil as fuel lead to incomplete combustion due to high viscosity. Camphor oil is promising blend for cashew nut shell oil because of flow viscous. Blending of camphor oil with cashew nut shell oil reduces the viscosity of fuel and leads to good atomization. Because of good atomization, increase in brake thermal efficiency. Blending of camphor oil with straight cashew nut oil decrease the Specific fuel consumption. Cashew nut oil as straight fuel leads to incomplete combustion and because of it increases in exhaust temperature.

Honge oil: Honge oil methyl ester have better brake thermal efficiency subjected higher compression ratio. Brake thermal efficiency increase with increase in injection pressure because of higher temperature. But at to high injection pressure because of high velocity and smaller droplet lead to poor atomization and reason for lower thermal efficiency. At higher compression ratio and lower injection timing have good thermal efficiency. Good thermal efficiency was obtained for higher compression ratio, higher injection pressure and lower injection timing because

of good atomization and uniform mixing and good premixing. Smoke density was found less for higher compression ratio, higher injection pressure and lower injection timing. Higher compression ratio, higher injection pressure and lower injection timing leads to lower HC, CO and increase in NO_x emission because of lower physical delay.

Kapok Oil: Kapok oil methyl ester was produced from the transesterification process using KOH as catalyst and methanol as solvent. some researcher done two-step process for transesterification for producing kapok methyl ester, acid etherification using sulphuric acid as catalyst and methanol as solvent and base etherification using methanol as solvent and KOH as catalyst. Kapok oil methyl ester have better in-cylinder pressure and higher heat release rate when coated with partially stabilized zirconia (better durability and poor thermal conductivity). Lower heating valve and shorter ignition delay of higher blend of Kapok methyl ester with diesel lead lower peak pressure for both coated and uncoated engine. Higher blend ratio has lower brake thermal efficiency for higher blend ratio have lower calorific valve and leads to higher specific fuel consumption for uncoated engine and heat trap and oxygen content in the fuel in engine because of coating leads lower specific fuel consumption. Coating provides better insulation and oxygen content increase the brake thermal efficiency and in mean time lowers heating value and higher viscosity result lower brake thermal efficiency in higher blending ratio. For lower blend ratio have low viscosity compare to higher blend ratio lead to better combustion and result I lower HC and CO emission. Because of higher combustion temperature and oxygen result in higher NOx emission.

Mango seed oil: Mango seed oil methyl ester was prepared using transesterification process having methanol as solvent and KOH as catalyst. BSFC was found increased with increase in blending ratio (Mango seed oil methyl ester +Diesel). Brake thermal efficiency was higher for lower blending ratio and very close diesel. Poor atomization of mango seed oil methyl ester result in longer and poor combustion, but lower Exhaust gas temperature. At lower load co emission was found higher because of incomplete combustion (insufficient time for combustion). At higher load condition CO emission was found lower because of complete combustion. Mango seed oil methyl ester have shorter ignition delay compare diesel because of higher cetane number and favour for higher NOx emission and lower HC emission. Lower carbon content and higher oxygen content of biodiesel leads to lower smoke emission. Anti-oxidant like Pyridoxine Hydro Chloride (PHC) addition to fuel leads to reduction in NO_x increase in HC and emission.

Moringa oleifera oil: Moringa oil methyl ester was produced from two step transesterification process. In acid etherification, methanol as solvent and sulphuric acid as solvent was used. In base etherification, methanol as solvent and KOH as catalyst are used. Brake power is decreased with increase in blending ratio lower heating value and higher viscosity of biodiesel leads more specific fuel consumption. Higher oxygen content in blended fuel over diesel leads to lower CO emission.

Eucalyptus oil: Methyl ester of eucalyptus oil was produced from the transesterification process using methanol as solvent and KOH as catalyst. Brake specific fuel consumption was higher for higher blend this is because of lower calorific valve and higher viscosity and high degree of unsaturation in biodiesel. Brake thermal efficiency was found increase with increase in blending ratio and decrease with increase in heating valve. At higher loading conditions brake thermal efficiency for all blends to be increased. Smoke intensity was found at lower blend ratio. B10 at lower load. B10 was found significance (10% Eucalyptus oil methyl ester + 90% diesel).

Hazelnut kernel oil: Hazelnut kernel oil methyl ester was produced from transestefication process by methanol solvent and KOH as catalyst. Brake thermal efficiency was increase in increase load, by the addition of hazelnut methyl ester biodiesel was found to be decrease in increase in blending ratio. Since B20 has good performance behavior closely to diesel. All the blended fuel has more BSFC than diesel fuel. Exhaust temperature was directly proportional to load. Lower blend exhaust temperature was higher because of longer combustion effect. Higher blending ratio result lower exhaust temperature because deterioration of combustion and oxidizing of fuel. CO emission was increase with increase in load. CO emission was decrease with increase oxygen content of fuel when more methyl ester is added. But for higher blended CO emission was found increasing because of increase in viscosity because of lower mean temperature of biodiesel, NO_x was found decreased. More oxygen content of methyl ester or higher blended fuel reduces the smoke formation and leads to lower smoke emissions.

Citrus Sinensis oil: Citrus Sinensis oil methyl ester was prepared from transestefication process having methanol as solvent and NaOH as catalyst. Lower Cetane number of blended fuels result incomplete combustion. Because of incomplete combustion brake thermal efficiency and torque was found reduced than diesel fuel. Higher blended diesel fuel has reduction CO emission because of oxygen enrichment in the blended fuel. NO_x was found higher for biodiesel because of the local high flame temperature and more oxygen content.

Turpentine oil: Turpentine oil is combination of hydrocarbon isomers. So turpentine oil was easy to blend with diesel and it can be used as fuel for CI engine. Specific fuel consumption was found higher for higher blended fuel than diesel fuel. This is because of higher viscosity, higher specific gravity and lower cetane number. Since Specific fuel consumption was inversely proportional to break power. Brake thermal efficiency was increase with increase in loads for all blended fuel this is because of low heat loss and increase in power more fuel consumption leads lower

thermal efficiency for all blended fuel. Better combustion of turpentine oil and its diesel blend leads to lower exhaust temperature than diesel. Since Turpentine oil and blended diesel fuel was partially oxygenated will reduce the soot formation and smoke opacity. HC and CO emission was reduced to Turpentine oil volume basics addition to diesel fuel. This is due to higher oxygen content.

Trout oil: Trout oil methyl ester was prepared using methanol as solvent and KOH as Catalyst in transesterification process. Since biodiesel has 10% of oxygen content by weight supports for better combustion than diesel leads increase in brake power and better torque. More blended fuel is supplied than diesel fuel results in higher torque and brake power. Brake specific fuel consumption was higher to blended fuels than diesel fuel because of lower heating value. At lower brake thermal efficiency was higher at lower speed for blended fuels because it lower heating value and at higher speed brake thermal efficiency was found lesser than diesel fuel for blended fuel because of reduction in heat loss and increase in power for diesel fuel. CO emission was found lesser for blended fuel because of its higher oxygen content throughout all speed conditions. NO_x emission was found higher throughout all speed conditions. Exhaust gas temperature was found closer to diesel fuel for blended fuel at lower speed conditions. But it was found higher for blended fuel at speed conditions. HC and smoke was found lesser for blended fuel than diesel fuel because of its oxygen content.

Tobacco seed oil: Tobacco seed oil methyl ester oil methyl ester was produced from transesterification process by methanol solvent and Noah as catalyst. Tobacco seed oil methyl ester contains 11% of oxygen by weight and leads to complete combustion, so he blended fuel have high brake power and torque. Brake Thermal Efficiency of blended fuel is slightly higher than diesel. For higher blended fuel brake thermal efficiency was slightly less than diesel because of lower heating value and higher viscosity. Because of complete combustion of blended fuel CO, HC and soot emissions are lower than diesel fuel. NO_x emission for blended fuel was slightly higher than diesel fuel at partial and full load condition due to high oxygen content, peak combustion temperature and longer duration for combustion process. The rich mixture is supplied at full load condition and more amount of oxygen content in the fuel is the reason for higher NO_x emission at full load condition.

Pine oil: Because of higher heating value pine oil can be directly used as fuel for CI engine. Additional of pine oil with diesel increases the brake thermal efficiency. 100% pine oil as fuel will reduce CO emission level more than blended fuel [pine and diesel] because of enrichment of oxygen in pine oil. At lower load condition emission of CO, HC is higher than the diesel fuel and higher load condition CO, HC emission of blended fuel is lesser than diesel fuel. At lower load condition NO_x was found lesser than the diesel and at higher load condition NO_x emission of blended fuel is higher than the diesel. The smoke density was lower by increasing the blend of pine oil on volume basis.

Almond oil: Almond oil methyl ethyl ester was prepared from transesterification process using methanol as solvent and potassium acetate as catalyst. Viscosity was found to be 4.89 cSt which is 10% higher than diesel fuel. Cetane number was found to be 49.11 which is very closer to diesel fuel. Lower calorific valve higher viscosity leads to higher SFC and lower brake thermal efficiency than diesel. Lower cetane number increase the premixing time of almond oil methyl ester reason for lower exhaust temperature. Almond biodiesel blends contain more oxygen content and reduce the CO and HC with increase in torque. Longer premixed combustion period leads lower gas temperature and reduce the No_x emission than diesel fuels. For small sized direct injection constant speed engines, the optimum operating parameters combination was found as compression ratio of 19:1 with injection pressure of 240 bar and injection timing of 27°bTDC.The heat release rate is reduced for methyl ester of pungam oil blended fuel PME20 compared to diesel.

2. CONCLUSION

Since most of the biodiesel have common behavior with respect to properties of blends, blending ratio, loading conditions and its emissions are summarized. Brake thermal efficiency was found lesser and specific fuel consumption was found lesser than diesel because of lower calorific valve and poor atomization of fuels.

- Exhaust Gas Temperature was found higher for biodiesel because longer premixed Combustion.
- Co, and HC and found lesser than diesel because of more oxygen content present in the blended fuel.
- No_x was higher than diesel because of more oxygen content and good combustion of blended fuel.
- Since No_x was found higher than diesel but having brake Thermal efficiency very close to diesel and significant reduction in Co, HC and Smoke was found with biodiesel and its blended fuel. So, biodiesel can be best alternate for CI engine.

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