Parametric Optimization of Compression Ignition Engine using Palm Seed Biodiesel: A Review

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Abstract— There are so many environmental and pollution problems today. Fuels prices are also increasing day by day. In this scenario it is needed to find an alternative fuel for internal combustion engines which is producing less pollution and are lower in price. Several alternate fuels are tried by various researches. An experimental study has been carried out for palm seed biodiesel blended with diesel used in a single cylinder diesel engine. Palm. Palm seed biodiesel presents a very promising scenario of functioning as alternative fuels to fossil diesel fuel. The properties of these can be compared favourably with the characteristics required for internal combustion engine fuels especially direct injection (diesel) engine. In this work, literature review for the use of palm seed biodiesel as fuel for compression ignition machine is provided. From the literature review, it is obtained parametric optimization of compression ignition machine using palm seed biodiesel can be done using various blends.

Key words: Diesel engine, Palm oil, Palm seed Biodiesel, Biofuels, Blending, Performance and Emission characteristics, Compression Ratio

I. INTRODUCTION

A. *Problem Definition*

Today diesel engines are widely used in world. Price of Petrol is increasing day by day. Needs of emission control from Gasoline engines are also increasing every day. At this time these reasons and better fuel efficiency, has increased used of diesel as fuel. These reasons have guided the researchers to find alternate fuel which can be used as biodiesel.

Now a days, there are problems about climate change is rising day by day. So we have to concern issues about climate change, have to give assurance about energy security, and we have to ensure that there is least damage to environment by the fuels we use. Today 65 % of total air pollutions is caused by emissions from vehicles. So these things are leading to find alternative fuels.

But these alternative biofuels are lacking behind in giving proper performance and efficiency. Vehicle speed obtained by these fuels are comparatively much lesser than gasoline or pure diesel. Sometimes emissions problems are also encountered in these biodiesels. So this leads us to do parametric optimization of biodiesels to find better performance and efficiency with least pollution, maintenance and good vehicle speed.

II. LITERATURE REVIEW

A. *Research Papers on blending:*

Saiban et al. (1997) studied about kinetic model for cloud-point blending of diesel fuels. They said that the accurate measurement and prediction of cloud points are essential in evaluating or designing processes associated with the longer-chain hydrocarbon fractions of crude oil. [1]

Benajes et al. (2015) did research on Effects of direct injection timing and blending ratio on RCCI combustion with different low reactivity fuels. They said the effects of the direct injection timing and blending ratio on RCCI performance and engine-out emissions at different engine loads using four low reactivity fuels: E10-95, E10-98, E20-95 and E85 (port fuel injected) and keeping constant the same high reactivity fuel: diesel B7 (direct injected) is investigated. Their results are suggesting that the valuable higher diesel amount is required to achieve a steady combustion using E85. This fact leads to higher NOx levels and unacceptable ringing intensity. [2]

Lapuerta et al. (2015) made research on molecular interactions in blends of alcohols with diesel fuels. They said that the alcohols such as ethanol and 1-butanol have an increasing interest as fuel components for diesel engines because of their oxygen content and their possible renewable origin. However, the stability and volatility of alcohol blends are affected by the molecular interactions depending on the nature of the base fuel they are blended with. This effect is well known in ethanol–petrol blends, where the presence of alcohol increases the vapour pressure in a non-ideal manner. [3]

Mofijur et al. (2015) had study on effect of biodiesel-diesel Blending on physico-chemical properties of biodiesel produced from Moringa oleifera. The aim of their study was to study the physical and chemical properties of Moringa oleifera biodiesel and its blends of 10%-90% by volume with petro-diesel. They came on conclusion that the fuel properties such as KV, D, CV, CP, PP, CFPP and FP increases with blending ratio either linearly or exponentially as applicable & CV decreases with blending ratio. Finally, the empirical models of fuel properties are proposed. [4]

Semion et al. (2015) made investigation on a comparison of ethanol and methanol blending with gasoline using a 1-D engine model. They said that ethanol and methanol are good alternative fuels because of their availability in liquid form and due to their better combustion properties. Results show that blending of alcohol and gasoline fuels, decreases brake power and increases brake specific fuel consumption. [5]

Abdullah et al. (2016) studied about a blending rule for octane numbers of PRFs and TPRFs with ethanol. They conveyed that for an octane booster in commercial gasoline fuels, ethanol can be used and is actually widely used. Its oxygenated nature reduces harmful emissions. However, the non-linear octane response of ethanol blending with gasoline fuels is not completely understood due to unknown intermolecular interactions in such blends. In general, when ethanol is blended with gasoline, the Research Octane

Number (RON) and the Motor Octane Number (MON) non-linearly increase (synergistic) or decrease (antagonistic), and the non-linearity depends on the composition of the base gasoline. [6]

Krutof et al. (2016) studied about Blends of pyrolysis oil, petroleum, and other bio-based fuels. They came to conclusion that there is possibility of using blends of compatible biofuels in low quality fuel applications. They also suggested blending of vegetable oils, biodiesels and pyrolysis oil with petroleum oils. Addition of alcohol also shows good result as per their study. They also said that the miscibility of the oils is poor due to density difference. [7]

Moser et al. (2016) had study on fuel property enhancement of biodiesel fuels from common and alternative feedstocks via complementary blending. They came to know that complementary blending was efficient at improving fuel properties such as cold flow, oxidative stability, and kinematic viscosity. Specifically, the cold flow properties of CSME, CTME, PME, and SME were enhanced through blending with FPME and MFME. [8]

Storch et al. (2016) did investigation on soot formation of spark-ignited ethanol-blended gasoline sprays with single- and multi-component base fuels. They came on result that soot can be formed in the front because of droplet type combustion and soot volume fraction results give confirmation about increasing sooting tendency of E20 in comparison with pure isooctane. [9]

Wei et al. (2016) studied on preparation of commercially applicable slurry fuels from rapid hydrogasification char by blending with coal. They concluded that both RH chars were having very poor slurryability mainly owing to the microporous and capillary structures of particles and the high water holding capacity, in sharp contrast to the properties of the parent coals and the char obtained from a common slow pyrolysis. This work thereafter aimed at making a commercially usable water slurry by using the blends of RH char and YY coal. [10]

B. Research papers on Palm seed biodiesel

Halim et al. (2009) did research on continuous biosynthesis of biodiesel from waste cooking palm oil in a packed bed reactor: Optimization using response surface methodology (RSM) and mass transfer studies. Their results show great agreement compatibility between mass transfer model and the experimental results obtained from immobilized lipase packed bed reactor operation, which shows that in this case the Fatty Acid Methyl Easter yield was mass transfer controlled. [11]

Soetaredjo et al. (2011) made research on KOH/bentonite catalysts for transesterification of palm oil to biodiesel. They found that a heterogeneous catalyst KOH/bentonite can be used as a solid based catalyst for biodiesel production via transesterification of palm oil. The catalyst synthesized with 25% KOH loading give the best performance for biodiesel production. The operating condition to produce the highest yield of biodiesel is: reaction time 3 h, amount of catalyst 3%, methanol to oil ratio 6, and the reaction temperature at 60 °C. [12]

Shahbazi et al. (2012) did investigation on biodiesel production via alkali-catalyzed transesterification of Malaysian RBD palm oil – Characterization, kinetics model. They found that Potassium and sodium hydroxide can be used as catalysts in this reaction at temperature of 60 °C in a stirred tank reactor with 600 rpm stirring. Gas chromatography is used to determine the fatty acid methyl ester (FAME) contents in the produced biodiesel. Yield of reaction which was carried out with KOH as a catalyst is of higher value than the reaction when NaOH is used as a catalyst. Important fuel properties of produced biodiesels are obtained and compared with petro diesel and the ASTM standards which indicate that the biodiesel with acceptable quality is synthesized experimentally. [13]

Silalertruska et al. (2012) studied on environmental sustainability assessment of palm biodiesel production. They observed that life cycle assessment is revealing lower values of environmental impact potentials of biodiesel as comparing with conventional diesel. They made recommendations are for improving environmental performance of palm biodiesel and for securing the long-term availability of crude palm oil supply with a view towards sustainable palm biodiesel production. [14]

Liaquat et al. (2013) did research on impact of palm biodiesel blend on injector deposit formation. They are saying that during short term engine operation, renewable fuels derived from vegetable oils, are capable of providing good engine performance. In more extended operations, some of the same fuels can cause degradation of engine performance, excessive carbon and lacquer deposits and actual damage to the engine. [15]

Shuti et al. (2014) researched on Feasibility study of various sulphonation methods for transforming carbon nanotubes into catalysts for the esterification of palm fatty acid distillate. They came to conclusion that the sulphonated MWCNTs used as catalysts could represent a breakthrough technology for biodiesel production, which warrants further study. [16]

Siregar et al. (2014) made investigation on a comparison of life cycle assessment on oil palm and physic nut as feedstock for biodiesel production. They came to know that the produced palm oil biodiesel has higher GWP value than Jatropha curcas biodiesel. Utilization of agrochemical, in form of fertilizer and plant protection, generate significant contribution to environmental impact of biodiesel production and after production is stabilised, CO2 emission of diesel fuel decreases. [17]

Johari et al. (2015) researched on the challenges and prospects of palm oil based biodiesel in Malaysia. They found that higher feedstock values, engine compatibility, fuel subsidies and crude oil prices are challenges in developing biodiesel as fuel. Technological innovations and efficient conversion techniques which eliminate the need for chemicals or water, catalysts and higher blends of biodiesel will improve the profitability and sustainability of biodiesel production. [18]

Mathiarasi et al. (2016) studied on optimization, kinetics and thermodynamic studies on oil extraction from Daturametel Linn oil seed for biodiesel production. They concluded that Daturametel Linn biodiesel is appropriate alternative to petroleum diesel with recommended fuel properties as per specified standards. [19]

Mosarof et al. (2016) did research on optimization of performance, emission, friction and wear characteristics of palm and calophyllum inophyllum biodiesel blends. They showed that average NO emissions of diesel were lower

than those of biodiesel blends. The maximum amount of NO emissions was found from CIB30 at approximately 337.2 ppm at 2400 rpm engine speed. PB10 and PB20 produced lower amounts of NO emissions compared to other biodiesel blends. [20]

C. Research Papers on Parameters

Bayraktar et al. (2008) did study on the performance parameters of an experimental CI engine fueled with diesel–methanol–dodecanol blends. They said that the fuel–air equivalence ratio of diesel–methanol blend decreases with the increasing methanol amount. The blend of 15% methanol results in a leaning of about 18% in the fuel–air mixture. Methanol causes improvement in engine effective power. The maximum improvement of about 7% in Ne was obtained with the blend of DM10. [21]

Dhole et al. (2014) researched on mathematical modeling for the performance and emission parameters of dual fuel diesel engine using hydrogen as secondary fuel. They observed that analysis of variance (ANOVA) of the experimental results at 95% confidence level reveals that the developed models are significant. Comparison of experimental output with those predicted by the developed models show close proximity having high correlation coefficients R2 for the various response variables as per their observation. [22]

Sakthivel et al. (2014) had study on comparative analysis of performance, emission and combustion parameters of diesel engine fuelled with ethyl ester of fish oil and its diesel blends. They came to conclusion that mean brake thermal efficiency decreases with increase in blend ratio by about 1.8%, 6.4%, 11.3% and 12.4% compared to diesel and HC and CO emissions decrease by 21% whereas CO2 emission slightly increases by 1.2% than diesel due to better oxygen content of biodiesel. [23]

Bari et al. (2015) studied about performance and emissions of a compression ignition engine run with biodiesel using guide vanes at varied vane angles. They observed that using guide vanes can improve the performance and reduce the emissions of a CI engine run with biodiesel and the 35° vane angle is found to be the optimum vane angle over all as it is found to be the optimum angle in both simulation and experimental results. [24]

Awad et al. (2016) made investigation on the effect of adding fusel oil to diesel on the performance and the emissions characteristics in a single cylinder CI engine. They found that alcohol, as an alternative fuel, has attracted the attention of many companies and researchers worldwide. They said that the fusel oil is an alcohol-based fuel collected as a by-product from the fermentation of alcohol. Hence, this experimental study compared fusel oildiesel blended fuel F20 (20% vol fusel oil and 80% vol diesel) with pure diesel in a single cylinder four-stroke CI engine. [25]

Balki et al. (2016) did research on optimization of the operating parameters based on Taguchi method in an SI engine used pure gasoline, ethanol and methanol. They showed that the estimated results obtained from Taguchi's test design are compatible with the confirmation experiments within the 95% confidence interval. This shows that the design of an experiment with Taguchi method is usable to define optimum working conditions in internal combustion engine tests. Moreover, because the number of experiments with this method decreases about 89%, it provides a high time saving. [26]

Channapattana et al. (2016) researched on optimisation of operating parameters of DI-CI engine fueled with second generation bio-fuel and development of ANN based prediction model. They said that ANN model based on multi-layer perception is developed to predict the performance and emissions using the experimental data. As it becomes a consequence of multi-objective optimisation of maximising the performance and minimising the emissions of the engine, in this work, the optimum combination of the operating parameters is decided by carrying out multi-objective optimisation using GA tool. [27]

Masjuki et al. (2016) did research on Study of production optimization and effect of hydroxyl gas on a CI engine performance and emission fueled with biodiesel blends. They saw that depletion and environmental impacts of the fossil fuel are the major concerns to think about the alternative energy sources to reduce the load on petroleum fuel. They also said that from different alternative fuels, biodiesel as well as hydroxyl gas (HHO, also known as Oxyhydrogen gas) are renewable, recyclable and non-polluting fuel. [28]

Nemati et al. (2016) researched on exergy analysis of biodiesel combustion in a direct injection compression ignition engine using quasi-dimensional multi-zone model. They found that the in-cylinder peak pressure decreases by 0.37%, 0.57%, 1.25%, and 3.42% owing to lower heat release resulting from lower LHV of biodiesel. Moreover, because of shorter ignition delay due to higher cetane number of biodiesel fuel, and lower volatility due to higher viscosity, the mixture of air and fuel during ignition delay is lower than that of diesel fuel hence the peak pressure decreases. [29]

Taghizadeh et al. (2016) studied about the effect of added ethanol to diesel fuel on performance, vibration, combustion and knocking of a CI engine. They said that ethanol is a renewable fuel in different countries, which is produced from plant, sugary and starchy biomass. Ethanol as an important additive to gasoline and diesel fuel can improve the engine performance and reduce emissions. They observed that with increasing the ethanol concentration more than 8% in diesel fuel, ignition delay rises and engine operates irregularity. In other words, the pressure changes are increased inside the cylinders and knocking is occurred. [30]

III. CONCLUDING REMARKS

- Most of the literature review results indicate that the emission of nitrogen oxide (NOx) is higher when Palm seed oil introduce in engine as a fuel and few indicates Nitrogen oxide (NOx) reduction also.
- Rather than directly use the biodiesel of any content used by blending with diesel provides more promising results.
- Both edible and non- edible oils of different contents blended with diesel can be used as a working fluid in IC Engine effectively.
- Possibility of using palm biodiesel with diesel in some proportion, thus reduce dependency on fossil fuel.

Reduce emissions than the diesel engines, hence saved atmosphere.

- The experimental work under this project includes analysing the effect on performance and emission engine by changing load by using different blends of diesel-Palm seed oil. To suggest best blend based on above results as an optimum blends.

IV. SCOPE OF THE WORK

Extensive study on EGR with this experiment can be performed.

- Palm biodiesel can be checked for better performance of diesel engine with or without changing the other performance parameters of engine.
- By changing different blend proportion and parameters it can be used for finding best optimized result by using Palm biodiesel-Diesel blend in CI engine.
- By using blending of more than one alternative fuel can also be useful in I C engine for finding out the optimized results.
- One can also be used this blend with some additives for much improved performance characteristics.

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