A Review Paper on Blends of Biodiesel to Study Performance and Emission Analysis of HCCI Engine.

Prof.V.M.Patel[1] Thakre Chetan G.[2]
[1]Assistant Professor [2]Student
[1]Department of Mechanical Engineering [2]Department of IC Engine & Automobile
[1,2]L.C.I.T., Bhandu, India

Abstract— Environmental concern and availability of petroleum fuels have caused interest in the search for alternative fuels for internal combustion engine. Many alternate fuels are tried by various researches. Based on literature review it is found that for diesel engine, Bio Diesel is most promising fuel. In this project works prospects and opportunities of utilizing palm oil-diesel blend ratio as fuel in HCCI engine is going to be studied by varying engine loads. Also based on experimentation an optimum blend and engine parameters are to be suggested for obtaining better performance and emission control. The properties of these can be compared favorably with the characteristics required for internal combustion engine fuels specially diesel engine. The experiment is to be done by using various engine load with various fuels like palm oil biodiesel-diesel and its blend at different proportion. To Improve the Performance and Emission Characteristics and Reduce the Pollutant emission. The experiment analysis such as engine performance like Break Thermal Efficiency, Fuel consumption, Specific Fuel Consumption, Break Power, Exhaust Emission to be finding out and Compared to Palm oil biodiesel and Diesel.

Keywords: HCCI Engine, Diesel, Palm Oil, Bio-Diesel, Performance and Exhaust Emission

I. INTRODUCTION

Homogeneous Charge Compression Ignition (HCCI) is a form of internal combustion in which well-mixed fuel and oxidizer (typically air) are compressed to the point of auto-ignition. As in other forms of combustion, this exothermic reaction releases energy that can be transformed in an engine into work and heat. HCCI combines characteristics of conventional gasoline engine and diesel engines. HCCI is characterized by the fact that the fuel and air are mixed before combustion starts and the mixture auto-ignites as a result of the temperature increase in the compression stroke. Optical diagnostics research shows that HCCI combustion initiates simultaneously at multiple sites within the combustion chamber and that there is no discernable flame propagation.

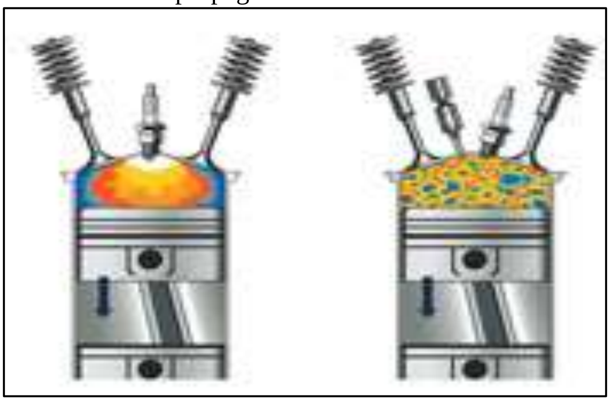

Fig. 1: Hcci Engine

II. LITERATURE REVIEW

In 2020, S. Raghuvaran , B. Ashok, B. Veluchamy, N. Ganesh [1] In present paper experimental study, engine performance and exhaust emissions were evaluated using palm oil biodiesel blends (PB10,PB20, PB30, PB40 and B50) and ordinary diesel as fuel. It is observed that the BSFC decreases sharply for all blends of fuel with the increase in load. Blends PB10 and PB20 are found to be the blends that give lower BSFC when compared to diesel. When compared to palm oil bio diesel blends (PB10, PB20) at all loads the conventional diesel fuel produces lowest thermal efficiency. At higher engine loads for PB20 (e.g., 1.1 kW), the HC emissions reduces about 50% in comparison with neat diesel fuel is noted. The CO emissions of PB 20 at load 0.3 Kw are less than ordinary diesel. The indication of incomplete combustion and wastage of part of the fuel supplied to the engine results in higher percentage of CO in exhaust. However, when compared to pure diesel, the NOx emission was decreased for PB10, PB20 and PB40. From the results of the experiments it is observed that lower palm seed oil–diesel blends for diesel engines is the one of the alternate fuel. Evaluation of the performance and exhaust emissions of the engine and shows that blend PB20 could be a substitute for diesel. It shows that the POME could be the suitable alternate fuel in a diesel engine instead of diesel fuel. It can be concluded that, the Brake power, BSFC, BTE, CO, NOx, and HC emissions predicted by artificial neural network model is accurate, fast and reliable.

In 2020, Jun Cong Ge, Ho Young Kim, Sam Ki Yoon, Nag Jung Choi, [2] As a reliable alternative fuel, palm oil biodiesel (POB) has great practical application value in diesel engines. To comprehensively investigate the performance, combustion and emission characteristics of POB and its blends in a CRDI diesel engine, a series of experimental conditions (such as EGR and pilot injection timing) were optimized With an increase in EGR rate from 0% to 10% to 20%, the peak of in-cylinder pressure and heat release rate (HRR) are gradually reduced, especially with reduced NOx emissions. The downside is that CO, HC, and PM emissions are slightly increased, but these shortcomings are significantly improved by adding POB to the diesel fuel. By observing the curves of in-cylinder pressure, HRR, mass fraction burned, and emission characteristics, it is seen that the pilot injection timing occurring at 34° CA BTDC is premature injection, which causes some fuel to hang on the cylinder wall and the piston head (wall wetting issues), resulting in failure to burn normally. Based on the engine performance and combustion characteristics, the diesel engine fueled with B30 blend fuel at a 10% EGR rate or with a pilot injection timing of 24° CA BTDC can effectively reduce PM emissions and simultaneously keep NOx emissions at low levels.

In 2019, Ganesh R. Gawale, G. Naga Srinivasulu [3] The experiments were carried out to assess the performance of ethanol/diesel dual fuel mode HCCI engine with a different mass flow rate of ethanol for varying load conditions. Also, experiment was carried out using a neem biodiesel blend (B20) instead of diesel with jet 90 in dual fuel mode HCCI engine for high load conditions. by the use of ethanol and diesel/biodiesel fuels with reduction of NOX, smoke opacity, and increased thermal efficiency. It shows that in-cylinder pressure reduces, and NOX and smoke opacity are reduced; conversely HC and CO emissions increase compared to neat diesel engine for all loads. Almost 65% of NOX and 88% of smoke opacity were reduced correspondingly. For low load condition, NOX emissions reduced by 86%, 79%, and 81% for 20%, 40%, and 60% engine load respectively; however ηT also reduced by 2%, 3%, and 1% correspondingly. however, HC and CO emissions increased to some extent. For load of 80% and 100%, ηT of E + D dualfuel mode HCCI engine increased by 3% and 1.5% respectively compared to neat diesel engine. The results show that HC and CO emissions were reduced; however NOX and smoke opacity increased little compared to E + D dual-fuel mode HCCI engine. From this study, it is concluded that dual fuel mode HCCI engine can replace the diesel fuel by ethanol as an alternative fuel with low NOX, low smoke opacity, and better fuel economy without penalty of brake power for higher load conditions.

In 2020, Murat Kadir Yesilyurt,, Mustafa Aydin [4] In the present study, a single-cylinder, four-stroke, air-cooled, naturally-aspirated, DI diesel engine coupled with a generator was operated with diesel fuel, cottonseed oil biodiesel-diesel fuel blend (B20), and ternary blends of diesel fuel-biodiesel-DEE. When the BTE outcomes were examined, the tested binary and ternary fuel blends showed lesser results as compared to the neat diesel fuel. It is noted to be that the increase of the concentration of DEE in the blend has led to increasing both the BSFC and BSEC in order to provide the fixed power output. The mean EGTs of the ternary fuel blends were slightly lower than that of diesel fuel while higher than that of the B20 binary blend. The average CO emissions of of B20DEE2.5 respectively lesser than that of diesel fuel. The average oxides of nitrogen emissions of the tested ternary blends were lower up to 8.84% than that of the pure diesel fuel. both the cottonseed oil biodiesel-diesel fuel blend and DEE-biodieseldiesel fuel blends could be evaluated for the compression-ignition engine applications out of any modifications on the engine. The engine test results showed that the DEE can be used to decrease exhaust emissions particularly the formation of NOX. However, these tested fuel blends ought to be tried under several engine operating conditions in further experiments. Besides that, thermodynamic, economic and environmental analysis can be conducted to obtain accurate results.

In 2016, V.E. Kozlov, I.V. Chechet , S.G. Matveev , N.S. Titova ,A.M. Starik [5] In present paper Analysis of the combustion and pollutant formation in the cylinder of HCCI engine operating on alternative fuels such as methane, methane/hydrogen blend with 50 and 80% H2 content, syngas with the composition CO/H2 =25/75 and methane/synthesisgas blend with 50% synthesisgas content was conducted with the use of 2D CFD and 0D single zone thermo chemical models and Improvement of HCCI engine performance, Reducing the pollutant emission. It was shown that the usage of methane-hydrogen blend with 80% H2 content as a fuel in HCCI engine allows one to increase the specific output energy Em by 50% and decrease the CO emission. The most promising fuel for HCCI engine among considered ones, providing both rather high output energy and appropriate emission of NO and CO, are the fuel blends with the composition: CH4/H2=50/50 and CH4/CO/H2=100/25/75. The minor value of CO2 emission can be achieved by using synthesis gas or CH4/H2 =20/80 as a fuel.

In 2014, A.AzizHairuddin, TalalYusaf, AndrewP.Wandel [6] In present paper The hydrogen-diesel combination in HCCI engines shows better results, while producing a higher efficiency compared to the single diesel mode and the natural gas–diesel mode. A higher BTE will help reduce the fuel consumption. The HCCI engine has low emissions levels of NOx, soot and particulates. If hydrogen is added to diesel-air mixture, knocking will take place once the energy ratio is more than 16%.where the highest temperature region will initiate instantaneous local combustion resulting in a local high heat release rate. Using a direct injection system see most requires few modifications, but care is required with the associated disadvantages. If port injection is to be used, one might have to install the atomizer and heater in the inlet port, which leads to additional costs. The main objective of the HCCI engine is to achieve a high compression ratio, which provides similar efficiency to the CI engine or better, with emissions levels at least as good as SI engines. Therefore, an optimized experimental method would be able to solve the HCCI engine problems, with the help of simulations.

In 2016, Rakesh Kumar Maurya, Nekkanti Akhil [7] In present paper Ethanol fuelled homogenous charge compression ignition engine offers a better alternative to achieving higher engine efficiency and lower emissions using renewable fuel. Present study computationally investigates the HCCI operating range of ethanol at different compression ratios by varying inlet air temperature and engine speed using stochastic reactor model. HCCI operating range for compression ratios 17, 19 and 21 are investigated and found to be increasing with compression ratio. Simulations are conducted for engine speeds ranging from 1000 to 3000 rpm at different intake temperatures (range 365–465 K). In HCCI operating range, higher efficiency is found at higher engine loads and lower engine speeds. HCCI operating range decreases with increase in engine speed with same operating limits.The combustion efficiency decreases with increase in engine speed in HCCI operating range. Maximum indicated efficiency obtained is around 50% for all the compression ratios. Emission was found very high for higher engine speeds in HCCI operating range.

In 2018, S.V. Khandal, N.R. Banapurmath, V.N. Gaitonde [8] In present paper HCCI engine powered with BDFs and H2 combination. HCCI engine powered with BDFs showed 2 to 3.4% lower BTE, 65 to 67% lower smoke, and 98 to 99% lower NOx emissions with HFER of 7% and EGR of 54% at 80% load as compared to CI mode. HCCI engine fuelled with BDFs resulted in about 11 times higher HC emissions with HFER of 7% and EGR of 54% at 80% load as compared to CI mode. It can be concluded that CI engine operation with BDFs and hydrogen provides complete freedom from use of fossil fuels. These fuels are renewable and biodegradable. CI engine powered with these fuels require appropriate hardware modifications. BDF powered CRDI engine yielded higher BTE and lower emissions compared to CI engine. BDF and Hydrogen was found to be a better option to operate the engine in HCCI mode to get improved BTE and lower exhaust smoke and NOx emissions.

In 2014, Sina Voshtani, Masoud Reyhanian, Mohammadali Ehteram, Vahid Hosseini [9] In present paper HCCI Combustion has the potential to work with high thermal efficiency, low fuel consumption, and low NOx and PM emission. The Blending of Natural gas and Reformer gas (RG). Experiment Performed were Modified Single cylinder CFR engine. It is found that the strength of the chemical effect is mainly dependent on H2 content in RG. However, in higher RG percentages, the CO mass concentration becomes more effective than H_2 in altering SOC. Experimental preparation has been implemented for a CFR engine to separately deliver CNG and RG into an engine. Various RG% blending ratios and a wide range of CO and H2 mass fractions in the combustion mixture were examined. When H2 was lower than 10%, the amount of H2 in the combustion mixture had a significant effect on SOC and the effect of CO mass fraction could be ignore.

In 2017, S. Gowthaman, A.P. Sathiyagnanam [10] in present paper to the specific fuel consumption of HCCI engine is much higher than conventional DI diesel engine. The rate of fuel consumed by the HCCI engine is depending on inlet charge temperature. The rate of fuel consumption is decreased with increasing the inlet air temperature. Brake thermal efficiency of the HCCI engine is depend on amount fuel consumed by the engine and amount of heat energy liberated from the charge during the combustion process. The 130 C inlet air charged HCCI engine has consumed less amount fuel and generated high efficiency compared to other charge temperature operated HCCI engine. The increases in brake thermal efficiency is 3% more than 90 C operated engine. The smoke density of the engine is depending on combustion temperature and present of air in the combustion process. The result indicated that the HCCI engine has lower NOx emissions. The exhaust emissions of CO and HC have been decreased with increasing the charge temperatures. During low load operations there is no major difference in HC emission. The temperature of 120 C and 130 C operated engine had lower CO emissions for all operating conditions, and having maximum reduction while engine running with minimum load conditions. The 150 C charge temperature operated HCCI engine has HC emission of 210 ppm for full load operation, in this case increased air temperature was reduced the HC emissions.

In 2016, S.V. Khandal, N.R. Banapurmath, V.N. Gaitonde, S.S. Hiremath [11] In present paper CI engines operated in conventional CI, CRDI and HCCI Modes. decreases NOx emission at the expense of smoke, HC and CO emissions. HCCI mode of engine operation reduces NOx and smoke emissions because of lower in-cylinder temperature inside the CC but with higher HC and CO missions. If achieving homogeneous mixture and auto ignition control in HCCI engines, first one reduces the soot emission by eliminating fuel rich regions and the second one improves the BTE. Dilution of charge extends the load range of HCCI engines by retarding the combustion process and it also improves the BTE. HCCI concept will become most suitable and acceptable future technology of efficient combustion.

In 2016, Harisankar Bendu , B.B.V.L. Deepak , S. Murugan [12] In present paper the performance and emission of the ethanol-fueled HCCI engine. The experimental results were also validated through generalized regression neural network (GRNN) prediction. The BTE increased with increase in the charge temperature and at 170°C a maximum BTE of 43% is found. While the exhaust gas temperature decreased with the increase in the intake air temperature. While the UHC and CO emissions were found to be higher.

In 2016, Ali Yousefzadeh, Omid Jahanian [13] In present paper these simplifications have been progressed to reach real-time response as the main nature of controlling target. In this study, a 3D CFD model coupled with detailed chemical kinetics has been modified to devise a brief relation between these controlling parameters and what really happens in combustion chamber. The model has been validated with experimental results in four distinct conditions. In high burning rate (approximately combustion in 5 crank angle degree) CNG-fueled HCCI engine, with high precision, the crank angle of maximum OH rate and maximum pressure rate mirrors the robust combustion phasing, named CA50. Hydroxyl radical behavior as robust parameter in combustion phasing reflects that it could be used for controlling strategies and may lead to better response time.

In 2014, M. Mohamed Ibrahim, A. Ramesh [14] In present paper at improving the performance and extending the load range of hydrogen fueled homogeneous charge compression ignition (HCCI) engine through charge temperature regulation and addition of carbon dioxide in order to control the combustion phasing. Intake charge temperature and equivalence ratio were varied from 130 °C to 80°C and 0.19 to 0.3 respectively. Experiments were performed on a single cylinder CI engine with a compression ratio of 16:1. The highest brake thermal efficiency was 24.2% at a BMEP of 2.2 bar (at an intake charge temperature of 80°C) where as it was only 21.5% with diesel operation at the same BMEP. The level of NO emissions were lesser than 0.38 g/kWh in the hydrogen HCCI mode whereas it was 8.5 g/kWh with diesel mode of operation. On the whole, hydrogen HCCI combustion is promising in terms of high thermal efficiency and low emissions.

In 2015, Ayatallah Gharehghani, Reza Hosseini , Mostafa Mirsalim , S. Ali Jazayeri ,Talal Yusaf [15] In present paper In this study, the combustion characteristics, performance and exhaust emissions of the RCCI (reactivity controlled compression ignition) engine dual fueled CNG (compressed natural gas)/biodiesel were investigated experimentally at various load conditions. The CNG/Biodiesel dual fuel mode had about 1.6% more gross thermal efficiency than the CNG/Diesel mode. The combustion loss of dual fuel modes were about 18.85% for CNG/biodiesel and 20.88% for CNG/diesel mode. Also, gross thermal efficiency of CNG/biodiesel case was approximately 2% higher than CNG/diesel case at 100% engine load. Dual fuel engine for either pilot fuels showed much lower NOx emission than conventional mode. CNG/biodiesel experienced much higher NOx emission than CNG/diesel, about 36%.

In 2016, Harisankar Bendu, B.B.V.L. Deepak , S. Murugan [16] In present paper In this research study, the ethanol-fuelled homogeneous charge compression ignition (HCCI) engine operating conditions were optimized based on its performance and emission parameters. For this purpose, a hybrid generalised regression neural network (GRNN)–particle swarm optimisation (PSO) model was designed to optimize three input parameters, including the charge temperature, engine load, and EGR rate. The optimum HCCI engine operating conditions for the general criteria were found to be 170 °C charge temperature, 72% engine load, and 4% EGR. This model took about 60–75 ms for HCCI engine optimization. The main advantage of the developed fitness function is that a user can define the weights as per the emission norms and fuel economy standards.

In 2018, Ali Turkcan, Mustafa Deniz Altinkurt, Gokhan Coskun, Mustafa Canakci [17] In this study, In-cylinder combustion process was simulated using a 3D-CFD model and simulation results were compared and validated with the experimental results. Experimental and CFD studies showed that HCCI combustion and emission characteristics can be controlled by changing the second injection timings and using alcohol-gasoline fuel blends. Calculated pressure curves and Pmax values generally agree well with the experimental results. MRHR values were obtained for all cases with approximately 10–20 J/°CA difference from the experimental results, except for E10 and M20 blends which have much lower MRHR values than that of experimental results. Increasing trend of CO emissions with respect to the second injection timings was captured, except 10% and 20% alcohol fuel blends. In the NOx emissions, general trend was determined between the experimental and CFD results. Both NO mass fraction and temperature distribution images show that NOx emissions formed in the areas where high temperature combustion occurred.

In 2016, Rakesh Kumar Maurya, Nekkanti Akhil [18] In present paper Hydrogen is a potential alternative and renewable fuel for homogenous charge compression ignition (HCCI) engine to achieve higher efficiency and zero emissions of CO, unburned hydrocarbons as well as other greenhouse gases such as CO_2 and CH_4. A detailed hydrogen combustion reaction mechanism with NOx consisting 39 species and 311 reactions was developed. A reduced hydrogen mechanism consisting 30 species and 253 reactions was developed for hydrogen HCCI combustion using directed relation graph (DRG) method through Lu &Law algorithm. It was found at lower temperature NO, NO2 and N2O are formed at 1800 K (onset of NOx) N_2O and NO are dominant and at higher temperatures NO is the only major emission specie. It was found that HCCI operating range shrinks with increase in engine speed and operating range expands with compression ratio increase. The maximum combustion efficiency in hydrogen HCCI combustion was observed to be 98%. Maximum thermal efficiency of 46% was observed for compression ratio 18 and 45% for compression ratio 16 and 17. It was also found that NOx emissions are highly dependent on engine load and minimal dependency on engine speed at all the compression ratios.

In 2010, M.A. Kalam, H.H. Masjuki, M.H. Jayed, A.M. Liaquat [19] In present paper the experimental study carried out to evaluate emission and performance characteristics of a multi-cylinder diesel engine operating on waste cooking oil such as 5% palm oil with 95% ordinary diesel fuel (P5) and 5% coconut oil with 95% ordinary diesel fuel (C5). Palm oil was found to be the best waste cooking oil to replace diesel.

1) Waste cooking oils such as, C5 and P5 reduce brake power by 0.7% and 1.2% respectively compared with B0.
2) C5 and P5 reduce CO by 7.3% and 21% respectively compared with B0.
3) C5 and P5 reduce HC by 23% and 17% respectively compared with B0.
4) C5 reduces by 1% and the P5 increases by 2% NOx emission compared with B0.

Therefore, palm and coconut oil do not have a negative effect on engine performance and emission

In 2014, Rasim Behçet , Recep Yumrutas, Hasan Oktay [20] In present paper effects of the FB25 and CB25 fuels produced from fish and cooking oils on engine performance and exhaust emissions were investigated so as to develop alternative fuels for the Diesel engines.

1) When the FB25 and CB25 fuels were used in the test engine, torque, brake power, brake thermal efficiency were slightly lower than those of diesel fuel while the brake specific fuel consumptions were higher.
2) CO and HC emissions reduced when the blend fuels of FB25 and CB25 in diesel engines.

In 2015, Ali M.A. Attia, Ahmad E. Hassaneen [21] In present paper Biodiesel from edible waste cooking oil (waste cooking oil methyl ester –WCOME) has been produced via trans-esterification process. While there was a range of blending ratio from B20 to B50 throughout the best engine environmental behaviour is attained.

1) Biodiesel production from waste cooking oil has economic benefits as its cost is the lowest almost among both alternative and conventional fuels.
2) The Brake Specific Fuel Consumption (BSFC) is increased with the increase of WCOME blending ratio in the blended fuels.
3) Best engine thermal efficiency is received at B20
4) Best engine emission characteristics are obtained at blending ratios around 30% in comparison with engine emissions fuelled by neat diesel fuel

In 2015, Chunhua Zhang, Han Wu [22] In present paper With the increase of the intake temperature, fuel air equivalence ratio, and engine speed, the maximum cylinder pressure and heat release rate are increased, the combustion phases also are advanced. Among all of the tested parameters, intake temperature is the most sensitive one to influence the methanol combustion characteristics. With the increase of the intake charge temperature and engine speed, the ignition timing (CA10 and CA50) are advanced while the combustion duration is shortened; while, with the increase of the equivalence ratio, the ignition timings are delayed and the combustion duration is shortened. The engine speed scopes change with operation conditions and the optimized speed where lowest cyclic variation obtained increases with equivalence ratio. Relative rich airefuel mixture is helpful to reduce the cyclic variation. The IMEP increases with the increase of intake charge temperature and fueleair equivalence ratio. Higher ITE usually corresponds to the short combustion duration. For the methanol HCCI engine in this work, high ITE can be obtained at CA50 near 7.5 CA while combustion duration is less than 11 CA.

III. Conclusion

From This Literature Review find the gap that, many research paper works on different bio-fuels with diesel fuel. So, tried to derive objective by executing work for use of bio-fuels is waste cooking oil from palm oil blending with diesel fuel for making to the palm oil bio diesel. The bio-diesel has been produced via trans-esterification process. The engine will operate under variable load condition. A total of three test fuels were selected for this investigation 100% Diesel fuel (B0), 10% Palm oil Biodiesel and 90% Diesel fuel (B10), 20% Palm oil Biodiesel and 80% Diesel fuel (B20), 30% Palm oil Biodiesel and 70% Diesel fuel (B30). Finally The Experiment is conduct to Diesel, blend of palm-oil bio-diesel & diesel mode in HCCI engine. Decided Process Parameter Exhaust Emission, Break Power, Break Thermal efficiency, Specific Fuel Consumption. Fuel Consumption

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