

# A Review Paper on Blending of Fuel for Increasing the Performance and Emissions Characteristics of Engine

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## Abstract

The factor to be considered while designing a new combustion process are , higher compression ratio, lean homogeneous air fuel mixture, complete and instantaneous combustion, which lead to HCCI. HCCI is a clean and efficient combustion process. The main objective of the HCCI engine to achieve the high compression ratio. HCCI combustion is the potential to work with high thermal efficiency, low fuel consumption, and extremely low NO<sub>x</sub> and PM emission. Alternative fuels including methane/hydrogen blend, methane/syngas blend to Improving of HCCI engine performance, reducing the pollutant emission, increasing the output energy. For use of the ethanol fuelled HCCI engine to BTE increasing with increasing the charged temperature, exhaust gas temperature decrease with increase intake air temperature. HCCI operating range higher efficiency is found at higher engine load and lower engine speed, and low NO<sub>x</sub> and CO emission. For use of hydrogen and Natural gas in diesel HCCI engine to Reduce NO<sub>x</sub>, CO, PM emission, fuel consumption And Increasing engine efficiency by 13% to 16%. For CNG/Biodiesel duel fuel mode is more suitable especially high engine load for high thermal efficiency, lower combustion, improving the break thermal efficiency and lower rate of emission. Finally The Experiment is conduct to blend of palm-oil bio-diesel and CNG in HCCI engine. To derive objective by executing work for use of bio-fuels is waste cooking oil from palm oil blending with diesel fuel. The bio-diesel has been produced via trans-esterification process.

**Keywords: Homogeneous Charge Compression Ignition Engine, Diesel, Palm Oil, Bio-Diesel, CNG, Performance and Exhaust Emission**

## I. INTRODUCTION

The internal combustion engine is the key to the modern society. There are two types of the IC engine namely the Spark Ignition (SI) engine and the Compression Ignition (CI) engine. Petrol and Diesel are at present the principle fuels for SI and CI engines. The IC engine is known to be one of the major sources of air pollution in the environment. And mainly responsible to global warming issues. The IC engine is known as one of the major sources of air pollutants in the environment. Bio diesel is capable of solving the problem of fuel supply in a decentralized fashion and simultaneously reduces environment related problems. HCCI engines are being actively developed because they have the potential to be highly efficient and to produce low emissions. HCCI engines can have efficiencies close to those of diesel engines, with low levels of emissions of NO<sub>x</sub> and PM.

## II. LITERATURE REVIEW

In 2016, V.E. Kozlov, I.V. Chechet, S.G. Matveev, N.S. Titova, A.M. Starik [1] 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% H<sub>2</sub> content, syngas with the composition CO/H<sub>2</sub> =25/75 and methane/synthesis gas blend with 50% synthesis gas 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% H<sub>2</sub> 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: CH<sub>4</sub>/H<sub>2</sub>=50/50 and CH<sub>4</sub>/CO/H<sub>2</sub>=100/ 25/75. The minor value of CO<sub>2</sub> emission can be achieved by using synthesigas or CH<sub>4</sub>/H<sub>2</sub> =20/80 as a fuel.

In 2014, A.AzizHairuddin , TalalYusaf , AndrewP.Wandel [2] 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 of them. The HCCI engine has low emissions levels of NO<sub>x</sub>, 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.

In 2016, Rakesh Kumar Maurya, Nekkanti Akhil [3] 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 2009, Mingfa Yao, Zhaolei Zheng, Haifeng Liu [4] In present paper HCCI combustion has been drawing the considerable attention due to high efficiency and lower nitrogen oxide (NO<sub>x</sub>) and particulate matter (PM) emissions. there are still tough challenges in the successful operation of HCCI engines, such as controlling the combustion phasing, extending the operating range, and high unburned hydrocarbon and CO emissions. the combustion mode design will be become one of the most interesting topics in the future. To realize the high efficiency and clean combustion in the complete engine operational range, In the end, the optimization of fuel economy and emissions can be reached to the complete engine operational range through an optimum combustion mode design.

In 2014, Sina Voshtani, Masoud Reyhanian, Mohammadali Ehteram, Vahid Hosseini [5] In present paper HCCI Combustion has the potential to work with high thermal efficiency, low fuel consumption, and low NO<sub>x</sub> 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 H<sub>2</sub> content in RG. However, in higher RG percentages, the CO mass concentration becomes more effective than H<sub>2</sub> 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 H<sub>2</sub> mass fractions in the combustion mixture were examined. When H<sub>2</sub> was lower than 10%, the amount of H<sub>2</sub> in the combustion mixture had a significant effect on SOC and the effect of CO mass fraction could be ignore.

In 2011, Alberto A. Boretti [6] In present paper to the traditional spark ignition (SI), premixed, gasoline-like and compression ignition (CI), diffusion, Diesel-like operation of internal combustion engines, premixed, homogeneous charge, compression ignition (HCCI) operation propose to improve the fuel conversion efficiency and reduce the pollutant formation. Then lean burn limit with large A/F ratio and peak burn limit with small A/F ratio. The Design of 12.8L inline six cylinder turbo charged directly injected heavy duty truck diesel engine fuelled with hydrogen. Injection may occur in the jet ignition pre-chamber before the main chamber fuel is injected and mixed with air, and the engine then operates Diesel-like. Injection may occur in the jet ignition pre-chamber after the main chamber fuel is injected and mixed with air and the engine then operates gasoline-like. Finally, if no injection occurs in the jet ignition pre-chamber, the engine operates HCCI-like. Theoretically up to 20% of this exhaust energy can be recovered. Exhaust back pressure also increasing the pumping losses. The additional cooling of the exhaust gases reduces the effectiveness of exhaust after treatment systems. At low engine loads the converted energy available downstream of the turbine is not enough to compensate for back pressure losses and the efficiency deteriorates. Increase in maximum power output about maximum speed, where otherwise the power output sharply reduces. The better efficiency of the power turbine translates in a better recovery of the exhaust energy. Results of simulation on a compression ignition Diesel Truck engine converted to hydrogen provide better than Diesel brake efficiencies at same BMEP outputs. Operating HCCI/gasoline-like, the hydrogen engine may have even better fuel efficiencies when permitted by the limits on peak pressure and maximum  $\lambda$ .

In 2016, S.V. Khandal, N.R. Banapurmath, V.N. Gaitonde, S.S. Hiremath [7] In present paper CI engines operated in conventional CI, CRDI and HCCI Modes. decreases NO<sub>x</sub> emission at the expense of smoke, HC and CO emissions. HCCI mode of engine operation reduces NO<sub>x</sub> and smoke emissions because of lower in-cylinder temperature inside the CC but with higher HC and CO emissions. 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 [8] 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 [9] 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 [10] 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 [11] 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 NO<sub>x</sub> emission than conventional mode. CNG/biodiesel experienced much higher NO<sub>x</sub> emission than CNG/diesel, about 36%.

In 2016, Harisankar Bendu, B.B.V.L. Deepak, S. Murugan [12] 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 2008, A. Tsolakis, A. Megaritis, D. Yap [13] In present paper documents the application of exhaust gas fuel reforming of two alternative fuels for biodiesel and bio-ethanol in internal combustion engines. The benefits of exhaust gas fuel reforming have been demonstrated by adding simulated reformed gas to a diesel engine fuelled by a mixture of 50% ultra low sulphur diesel (ULSD) and 50% rapeseed methyl ester (RME) as well as to a homogeneous charge compression ignition (HCCI) engine fuelled by bioethanol. a reduction of NO<sub>x</sub> emissions was achieved without considerable smoke increase. REGR addition to the biodiesel fuelled engine resulted in lower smoke emissions compared to engine operation with standard EGR. The biodiesel fuel consumption was lower by 3% compared to operation without REGR.

In 2016, Rakesh Kumar Maurya, Nekkanti Akhil [14] 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<sub>2</sub> and CH<sub>4</sub>. A detailed hydrogen combustion reaction mechanism with NO<sub>x</sub> 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, NO<sub>2</sub> and N<sub>2</sub>O are formed at 1800 K (onset of NO<sub>x</sub>) N<sub>2</sub>O 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 NO<sub>x</sub> 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 [15] 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% NO<sub>x</sub> 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 [16] 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 2014, G. Sakthivel, G. Nagarajan, M. Ilangkumaran, Aditya Bajirao Gaikwad [17] In present paper A single cylinder compression ignition engine was operated successfully using biodiesel–diesel blends and the performance, emission and combustion characteristics were evaluated and compared with that of diesel fuel.

- 1) Mean brake thermal efficiency decreases with increase in blend ratio compared to diesel.
- 2) HC and CO emissions decrease
- 3) NO<sub>x</sub> was observed to decrease uniformly for all blends of diesel–biodiesel blends
- 4) Peak pressure and rate of pressure rise are lower with biodiesel as compared to diesel and decreases with increasing blend ratio
- 5) Biodiesel produces lower heat release rates as compared to diesel during the premixed combustion phase. The main reason for this is shorter ignition delay.

In 2015, Ali M.A. Attia, Ahmad E. Hassaneen [18] 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 2007, Russ Winfried, Meyer-Pittroff Roland, Dobiasch Alexander, Lachenmaier-Kolch Jurgen [19] In present paper The use of plant and waste oils as fuel is possible. Both engines (adapted to triglycerides or not) show a good performance regarding the exhaust gases. The catalytic conversion of NO<sub>x</sub> and CO is possible with triglycerides as with diesel. Regarding the emissions catalytic systems should be preferred. The injection of urea leads to a decrease of the emissions, but is not feasible in mobile engine systems (e.g. cars, HGV etc.).

### III. CONCLUSION

For study above literature review it is important to note that combustion process has almost the same or even better ignition and combustion properties in comparison to the reference diesel fuel. The factor to be considered while designing a new combustion process are , higher compression ratio, lean homogeneous air fuel mixture, complete and instantaneous combustion, which lead to HCCI. HCCI is a clean and efficient combustion process. The main objective of the HCCI engine to achieve the high compression ratio. HCCI combustion is the potential to work with high thermal efficiency, low fuel consumption, and extremely low NO<sub>x</sub> and PM emission.

So following thing is expected. Increasing the power, Break thermal efficiency, Brake Mean Effective Pressure and decreasing the exhaust emission, torque, specific fuel consumption.

Then Improvement the HCCI performance and reducing the pollutant emissions.

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