Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 03, March-2018

Performance Analysis on PCCI Engine with Duel Fuel Mode Condition

[1*] P. Karthik Selvan,
[1]Assistant Professor,
Department of Automobile Engineering,
K.L.N. College of Engineering
Pottapalyam- 630612, Sivagangai, Tamil Nadu, India

[2*] R. Tamil Vaanan
[2]U.G. Scholar
Department of Automobile Engineering,
K.L.N. College of Engineering
Pottapalyam- 630612, Sivagangai, Tamil Nadu, India

[3*] P. K. Dhinesh
[3]U.G. Scholar
Department of Automobile Engineering,
K.L.N. College of Engineering
Pottapalyam- 630612, Sivagangai, Tamil Nadu, India

[4*] M. Karthick@Vinayakakumar
[4]U.G. Scholar
Department of Automobile Engineering,
K.L.N. College of Engineering
Pottapalyam- 630612, Sivagangai, Tamil Nadu, India

Abstract **- To modify conventional IC engine into PCCI to increase performance with reduction of smoke and efficiency by using dual fuel mode (petrol and diesel) . In which PC stands for premixed combustion and CI stands for stratified charge. This project has a combination of a both SI and CI engine thus increasing performance and reducing emission. Other similar combustion concepts, which can be considered as the extension of HCCI, are Low Temperature Combustion (LTC) and Stratified Charge Compression Ignition (SCCI). In modified engine without power reduction NOx and smoke are reduced by varying the injection process. The proportional of diesel and petrol fuels is mixtures of ratio will varying under various load condition. In this engine starting in primary (diesel) fuel and acceleration in PCCI action (diesel+petrol).**

The petrol is injected by MPFI injector and this injector is controlled by separate ECU circuit .The flame propagation phase is modeled by solving the transport equation for flame surface density equation in extended coherent flame model for 3 zones. A sector model of the engine cylinder is taken to avoid expensive computational resources. Standard k-ε model is used for modeling the turbulent flow in the cylinder. The engine to be tested and smoke analyzed using five gas analyzer.

Keywords: Pcci, Dual Fuel Mode, ECU, MPFI Injector, Ignition Delay, Pilot Injection, Eddy Current Dynamometer

1. INTRODUCTION

1.1 Internal Combustion Engines (IC Engines)

The internal combustion engine (IC Engine) is a heat engine that converts heat energy (chemical energy of a fuel) into mechanical energy (usually made available on a rotating output shaft). Mainly used as 'prime movers', e.g. for be the propulsion of a vehicle i.e., car, bus, truck, locomotive, marine vessel, or airplane. Other applications include stationary saws, lawn mowers, bull-dozers, cranes, electric generators, etc

1.2 Homogeneous Charge Compression Ignition (HCCI) Combustion Engine

In HCCI mode of combustion, the fuel and air are mixed prior to the start of combustion and the mixture is auto-ignited spontaneously at multiple sites throughout the charge volume due to increase in temperature in the compression stroke.Compression Ignition (CI) and Spark Ignition (SI) combustionare two primary technologies with established use in automobilesector. SI and CI engines use fossil fuels and both have their own merits and demerits.The characteristic feature of traditional SI engine flame propagation for combustion.

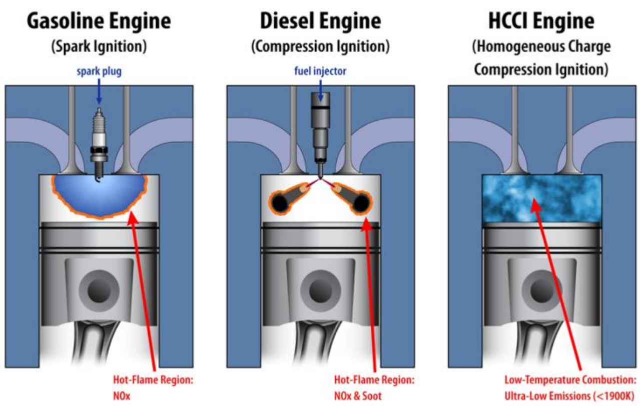

Fig:-1.1 Comparative Schematic diagram of Gasoline, Diesel and HCCI engines

Homogeneous Compressed Charge Ignition (HCCI) is a form of internal combustion in which well-mixed fuel and oxidiser are compressed to the point of auto ignition.HCCI combines characteristics of conventional gasoline engine and diesel engines.Gasoline engine combine homogeneous charge (HC) with spark ignition (SI), abbreviated as HCSI.Diesel engines combine stratified charge (SC) with compression ignition (CI), abbreviated as SCCI.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 7 Issue 03, March-2018

1.3 Premixed Charge Compression Ignition

Premixed charge compression ignition (PCCI) combustion for diesel engines is receiving increasing attentions in recent years, because it is capable of providing both high efficiency and extremely low particulate emissions. Unlike conventional diesel combustion, PCCI combustion mode uses early in-cylinder fuel injection to avoid soot emissions. However, due to the low volatility and high ignitability of diesel fuel, several technical barriers, such as mixture preparation and control of combustion phasing, must be overcome before the commercialization of diesel PCCI engine.In the PCCI combustion strategy, fuel can be introduced into the combustion chamber through port fuel injection, early direct injection, or late direct injection. Port fuel injection and early direct injection often suffer from incomplete fuel vaporization and fuel spray impingement on the cylinder walls, which causes high levels of hydrocarbon and carbon monoxide emissions as well as fuel/oil dilution Strategies to reduce fuel-wall impingement explored in the past include the use of narrow spray cone angle injectors. Late direct injection avoids fuel-wall impingement and provides good control over combustion phasing.

As per recent survey, the diesel engine is highly used more than the petrol engines in India. The diesel engine has high part load efficiency.All the commercial vehicles use diesel engine.By using diesel engine, it increases part load efficiency and also smoke increases.Hence the smokeis reduced by biodiesel, but by inducing biofuel we can reduce only 5% of totalcommercial vehicles.By using the PCCI engine, we can change the 75% of total commercial vehicles. Introducing the PCCI engine, we can easily alter the petrol and diesel engine to turn into PCCI engines.

2. EXPERIMENTAL DESCRIPTIONS

Fig:-2.1 Sample Diesel and Petrol fuel

Fig:-2.2 Experimental engine setup of PCCI

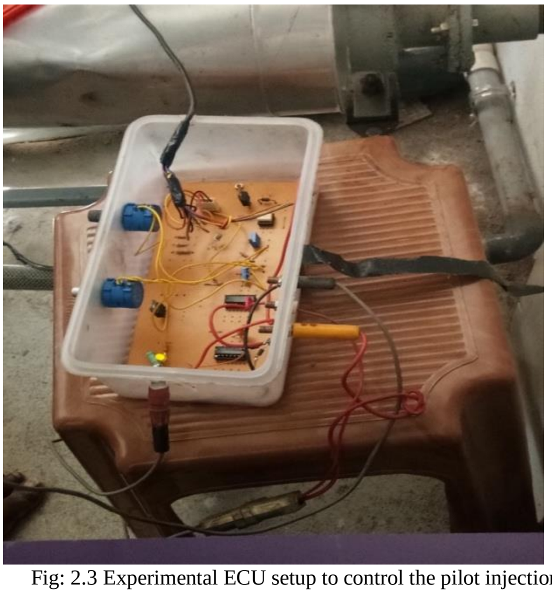

Fig: 2.3 Experimental ECU setup to control the pilot injection (Petrol).

This is Four stroke, Single cylinder vertical water cooled diesel Engine. Manual circuit setup for pilot injection.In this circuit we would control the percentage of petrol to be injected.For example: Diesel (80%), Petrol (20%). This circuit is connected with MPFI injector and secondary fuel tank.

2.1 Testing Method

- Main fuel – Diesel(Injected by injector)
- Pilot fuel – Petrol(Injected by MPFI injector)
- Petrol Injected at intake-manifold(near intake valve)
- Controlled by ECU circuit
- Performance and Emission measurements are calculated and taken.

Dual fuel is used namely petrol and diesel.For storing the fuels, we use separate fuel tanks.Governor is used to control the main fuel, when the load is reduced.By apply the load, eddy current dynamometer is used.Ignition delay occurs at 23° before TDC in main injector.

2.2 Testing Conditions

Various proportional ratio's of fuels are used.

Condition-1: Ratios of diesel (90%) and petrol (10%).

Condition-2: Ratios of diesel (80%)

and petrol (20%).

3. Calculation

3.1Diesel (90%) and petrol (10%):

Load – 25%

1. Brake power (BP)

$$= \frac{2\pi N (W\times 9.81)}{60 \times 1000}$$

= 1.31 Kw

2 Indicated Powers (IP)

$$= \frac{(IMEP)\ 10^{5} LAN/2}{60000}$$

= 2.92 KW

3. Total fuel consumption (TFC) $= \frac{10 \times 10^{-6}\ m^3 \times \text{Density of diesel}}{t}$

=0.46 Kg/h

4.Specific Fuel consumption (SFC) $= \frac{TFC}{BP}$

= 0.35kg/kWh

5.Mechanical Efficiency (η_M) $= \frac{BP}{IP} \times 100$

= 44.84 %

6.Brake Thermal efficiency (η_{BT}) $= \frac{BP}{TFC \times CV} \times 100$ [cv = 43,500 kJ/kg]

= 24.83 %

7. **Indicated Thermal efficiency** (η_{IT}) $= \frac{IP}{TFC \times CV} \times 100$

= 55.38 %

3.2Diesel (80%) and petrol (20%):

Load – 25%

1. Brake power (BP) $= \frac{2\pi N (W\times 9.81)}{60 \times 1000}$

= 1.33 Kw

2. Indicated Powers (IP) $= \frac{(IMEP)\ 10^{5} LAN/2}{60000}$

= 3.01 KW

3. Total fuel consumption (TFC) $= \frac{10 \times 10^{-6}\ m^3 \times \text{Density of diesel}}{t}$

= 0.35 Kg/h

4.Specific Fuel consumption (SFC) $= \frac{TFC}{BP}$

= 0.27 kg/kWh

5.Mechanical Efficiency (η_M) $= \frac{BP}{IP} \times 100$

= 44.12 %

6. Brake Thermal efficiency (η_{BT}) $= \frac{BP}{TFC \times CV} \times 100$ [cv = 43,500 kJ/kg]

= 31.83 %

7. **Indicated Thermal efficiency** (η_{IT}) $= \frac{IP}{TFC \times CV} \times 100$

= 72.16%

4. RESULT AND DISCUSSION:-

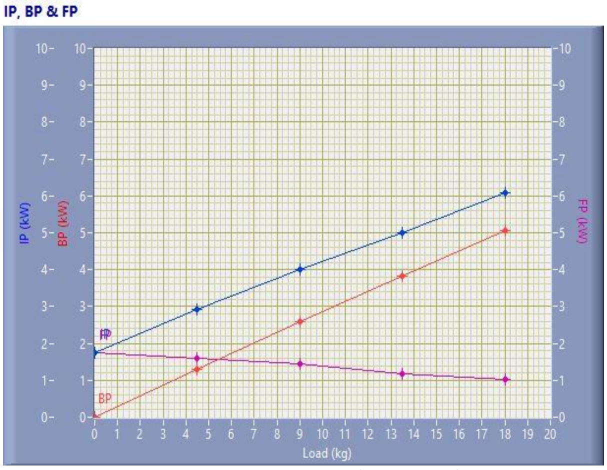

Fig:-4.1 Graphical representation of ip,bp and fp Vs Load

The reduction of peak pressure for Diesel was due to the cooling effect produced by the bio Petrol which reduces the combustion temperature which in turn decreases the peak pressure of the combustion.

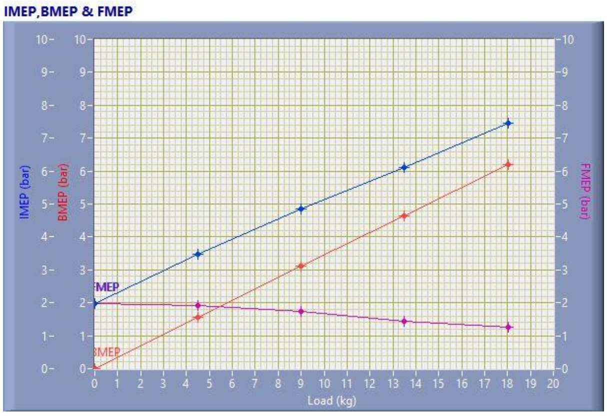

Fig:- 4.2 Graphical Representation of IMEP,BMEP and FMEP Vs Load

The Carbon monoxide emission was less in Petrol fuel PCCI operation when compared with the diesel fuel PCCI. This may be due to the higher oxygen concentration in the bio ethanol which results in oxidation of the carbon monoxide.

Fig:- 4.3 Graphical Representation of Indicated Thermal efficiency and Brake Thermal efficiency Vs Load

Reduction in the oxides of nitrogen may due to the reduction of operating temperature when the engine is run in PCCI mode.

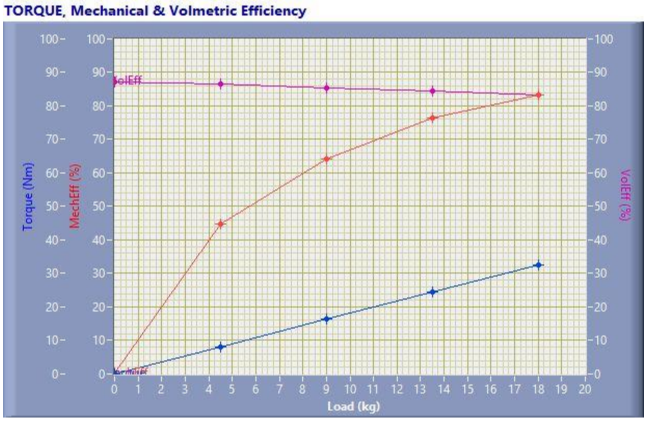

Fig:- 4.4 Graphical Representation of Torque, Mechanical and Volumetric efficiency Vs Load

The exergy efficiency of Diesel PCCI operation and Petrol PCCI operation are higher compare to conventional diesel operation due to presence of oxygen concentration. Because of the improved combustion of diesel blends at higher loads, the exhaust gas availability was increased.

5. CONCLUSION

A high efficiency, gasoline-fueled PCCI engine represents a major step beyond HCCI engines for heavy duty vehicles. The PCCI mode engine possesses the merits of both HCCI and SCCI engine. PCCI engines have the potential to match or exceed the efficiency of Diesel and Petrol fueled CIDI and HCCI engines without the major impact on fuel-refining capability. Port fuel injection (PFI), in-cylinder direct injection and PFI combined with direct injection strategies among others are employed for homogeneous mixture preparation. However, in HCCI engine it has difficulty in combustion phasing control, misfire at low and knocking at high loads, cold start problem, difficulty in homogeneous mixture preparation, high rate of pressure rise and high level of noise, high level of HC and CO emissions etc. Hence this demerits can be overcome by the PCCI engine. The combustion characteristics of PCCI would potentially enable the use of emission control devices. In addition, for heavy duty vehicles, successful development of Diesel and Petrol fueled PCCI engine is an important alternative strategy in the event that CIDI and HCCI engines cannot achieve feature NO_x and PM emission standards.

REFERENCES

[1] H. Zhao, HCCI and CAI Engines for the Automotive Industry, Woodhead Publishing Limited, Cambridge, UK, 2007.

[2] F. Zhao, T. N. Asmus, D. N. Assanis, J. E. Dec, J. A. Eng, and P. M. Najt, “Homogeneous charge compression ignition (HCCI) engines,” SAE Publication, 2003. View at Google Scholar

[3] R. H. Stanglmaier and C. E. Roberts, “Homogeneous charge compression ignition (HCCI): benefits, compromises, and future engine applications,” SAE Paper 1999-01-3682, 1999. View at Google Scholar

[4] M. Shahbakhti, Modeling and experimental study of an HCCI engine for combustion timing control [Ph.D. thesis], University of Alberta, 2009.

[5] A. Hakansson, CA50 estimation on HCCI engine using engine speed variations [MSc thesis], Lund University, 2007.

[6] O. Erlandsson, "Early swedish hot-bulb engines—efficiency and performance compared to contemporary gasoline and diesel engines," SAE Paper 2002-01-0115, 2002. View at Google Scholar

[7] S. H. Jo, P. D. Jo, T. Gomi, and S. Ohnishi, "Development of a low-emission and high-performance 2-stroke gasoline engine (NiCE)," SAE Paper 730463, 1973. View at Google Scholar

[8] S. Onishi, S. H. Jo, K. Shoda, P. D. Jo, and S. Kato, "Active thermo-atmosphere combustion (ATAC)—a new combustion process for internal combustion engines," SAE Paper 790501, 1979. View at Google Scholar

[9] M. Noguchi, Y. Tanaka, T. Tanaka, and Y. Takeuchi, "A study on gasoline engine combustion by observation of intermediate reactive products during combustion," SAE Paper 790840, 1979. View at Google Scholar

[10] K. Tsuchiya, S. Hirano, M. Okamura, and T. Gotoh, "Emission control of two-stroke motorcycle engines by the butterfly exhaust valve," SAE Paper 800973, 1980. View at Google Scholar

[11] P. Duret and J. F. Moreau, "Reduction of pollutant emissions of the IAPAC two-stroke engine with compressed air assisted fuel injection," SAE Paper 900801, 1990. View at Google Scholar

[12] P. Duret and S. Venturi, "Automotive calibration of the IAPAC fluid dynamically controlled two-stroke combustion process," SAE Paper 960363, 1996. View at Google Scholar

[13] Y. Ishibashi and Y. Tsushima, "A trial for stabilizing combustion in two-stroke engines at part throttle operation," in Proceedings of the IFP International Seminar, Editions Technip, Rueil-Malmaison, France, 1993.

[14] M. Asai, T. Kurosaki, and K. Okada, "Analysis on fuel economy improvement and exhaust emission reduction in a two-stroke engine by using an exhaust valve," SAE Paper 951764, 1995. View at Google Scholar

[15] Y. Ishibashi and M. Asai, "Improving the exhaust emissions of two-stroke engines by applying the activated radical combustion," SAE Paper 960742, 1996. View at Google Scholar