Experimental Investigations on Homogeneous Charged Compression Ignition (HCCI) Engine

A.Renuka Prasad, Dr.Rakesh Bhandari, Donepudi.Jagadish

Abstract: ***The Homogeneous Charge Compression Ignition technique used both Spark Ignition and Diesel Compression engines. But, most widely used in Diesel Compression engines. The Homogeneous Charge Compression Ignition (HCCI) technique, are introduced for engines, the Emissions are HC, CO, NOx and PM are reduces. And, also advantages of technology are the Combustion is increases. This paper explains the four modes of tests performing on the engine. In the first mode, Diesel engine, No Turbo charge and No HCCI. In second mode, Diesel engine, Turbo charge and No HCCI. In Third mode, Diesel engine, Turbo charge and HCCI and final testing No Diesel engine, No Turbo charge and HCCI only.***

Keywords: HCCI engines, Combustion, Turbo charge, Hydro Carbons and NOx.

I. INTRODUCTION

The Internal Combustion(IC) engine play a vital role in the society. Most of the research works performed on the IC engines. Due to increase the performance and requirement for the society. The concept of the developing of Internal Combustion engines are increasing the Thermal efficiency, engine mileage and reduce the emissions of the engine [1-4]. When the Emissions are reduce from the Internal combustion engines, the environment pollution 35% is controlled in the World. And, also developing the combustion. When the rate of combustion increases the fuel injection quantity is increases. Basically, the engines are classified as two types: Internal Combustion (IC) and Spark Ignition (SI). These type of engines are using fossil fuels, such as Petrol and Diesel etc. Most of the IC engines are used for Transportation [5,6]. Present, the entire nation is depend on the Transportation of vehicles for Food Transportation, Equipment transportation etc. The alternative or another combustion process 'homogeneous charged compression ignition' engine (HCCI) is suggested that researchers in the replace of CI engines.

HCCI technology is developing technology for the increase of Thermal efficiency compared to Internal Combustion engines. It is the alternative technique for the next generation of engines. In this technique the fuel mixture (fuel+air) are entered in inlet of the engine. The type of mixture is known as Homogeneous mixture [7]. The Homogeneous mixture are compressed at the compression stroke, the combustion is started in the engines. The combustion is high compared to the IC engines.

Revised Manuscript Received on December 22, 2018.

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2. EXPERIMENTAL SET-UP

The test engine is used was a 5H.P. Kirloskar engine. The engine is modified as a HCCI Mode of engine, to determine the engine performance and emissions at different mode of operating conditions, from no load to full load or maximum load [8, 9]. The specifications of the engine are 4-stroke, water cooled, and Direct Injection (DI) type of engine. At the time of suction and compression strokes, in HCCI mode of engines, fuel supply system changes from direct fuel injection (DI) system to port fuel injection (PI) system [13,15]. Figure 2.1 shows the experimental setup of the engine.

Thermocouples are used to measure the exhaust gas temperature, coolant water temperature and intake air temperature of the engine. The exhaust emissions are Oxides of Nitrogen, Carbon monoxide, Hydrocarbons and Carbon dioxide measured with the exhaust gas analyzer apparatus. The Rope brake dynamometer is used to measure the speed of the engine and control the loads of the engine.

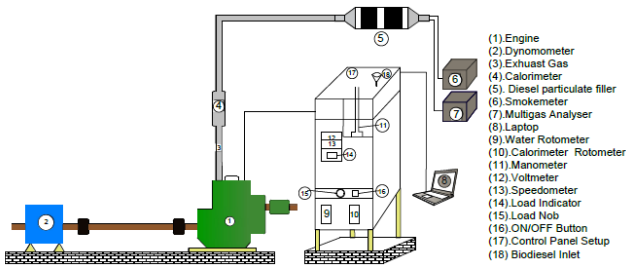

Fig. 2.1: Experimental Set-Up

3. RESULTS AND DISCUSSIONS

In this work find the Performance characteristics of normal Diesel (IC) engine and HCCI technology engine with varying the speed at different loads from min. load to maximum loads. Also, comparison of results gives some opinion on HCCI in terms of Improved/Decreased performance. The different performance parameters are Fuel consumption, Thermal efficiency, Volumetric efficiency and Emissions such as CO, CO2, O2 and NOx are measured [10] through exhaust gas analyzer. The following four tests are conducted on the HCCI technology engine.

Test 1: Diesel engine, No Turbo charge, No HCCI.
Test 2: Diesel engine, Turbo charge, No HCCI.
Test 3: Diesel engine, Turbo charge, HCCI.
Test 4: No Diesel engine, No Turbo charge and HCCI Only.

4. PERFORMANCE TESTS

The following tests are conducted on the HCCI Technology engine.

4.1 Basic Specific fuel Consumption

Fig. 4.1 shows the graph of Basic specific fuel consumption for CI engine and HCCI mode engine. From the graph, determined the HCCI mode of engine working through air-fuel mixture for all load conditions. And, also a increases combustion efficiency.

4.2 Brake Thermal Efficiency

Fig. 4.2 shows the graph of Brake thermal efficiency with vary the load. It can be determined that, fuel injection in the induction pipe resulted in increased fuel consumption.

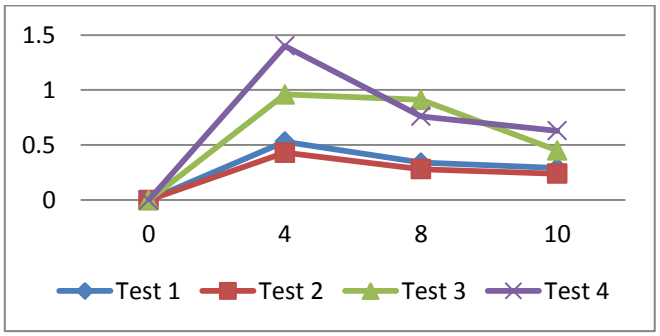

Fig. 4.1: Load Vs Basic Specific Fuel Consumption.

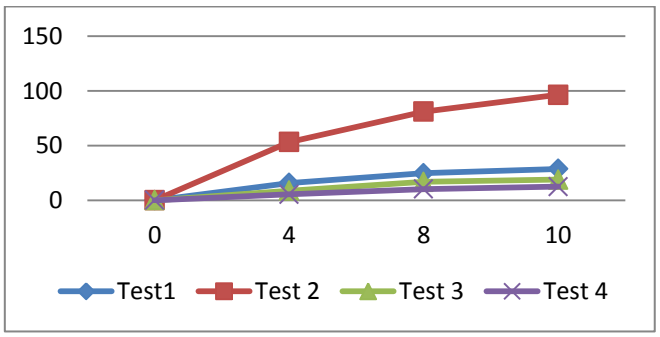

Fig. 4.2: Load Vs Brake Thermal Efficiency.

5. EMISSION TESTS

The following Emissions test are conducted on HCCI technology engine.

5.1 Oxides of Nitrogen

The Fig. 5.1 shows the drawn between of Oxides of Nitrogen and Load for CI and HCCI mode of engine it is shows that the Test 4 has contributions in reducing the emissions to certain extent. The reason is charge homogenization.

5.2 Hydro Carbon

Fig. 5.2 is between HC emissions and varying the load. It is observed that load increases the emissions by reducing the quality of combustion.

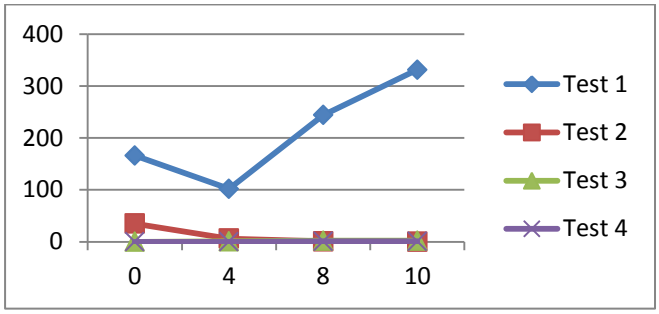

Fig. 5.1: Load Vs Oxides of Nitrogen.

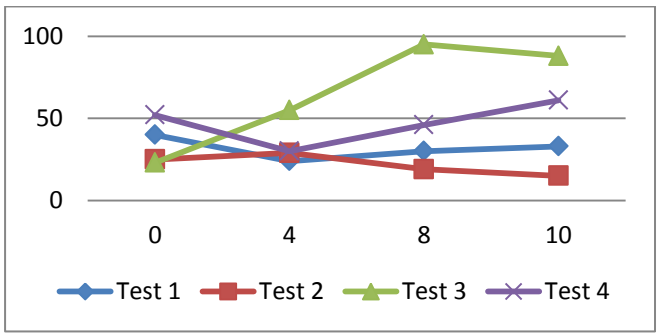

Fig. 5.2: Load Vs Hydro Carbons.

5.3 Opacity

The varying the load versus smoke Opacity is shown in Fig. 5.3. It is observed that the smoke increases with load increases as well with indirect injection of fuel.

Recent Developments (or) Features of HCCI

The recent developments on HCCI technology implemented companies are GM, Mercedes-Benz, Honda, and Volkswagen are implemented in HCCI mode of engines [11,12].

1. General Motors are ready to launch Opel Vectra and Saturn Aura are modified HCCI technology engines. Mercedes-Benz develops a prototype engine, with auto ignition type [14].
2. Volkswagen are developing expects them to be ready for launch in about 2020.

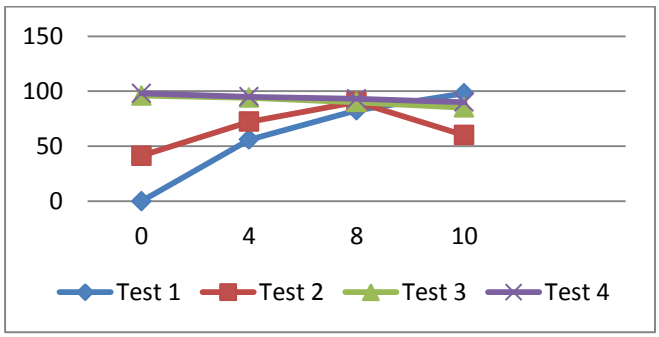

Fig. 5.3: Load Vs Opacity.

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6. CONCLUSION

The various mode of tests conducted on HCCI engine. The following performance and emission characteristics are observed.

1. The test has been made to convert the existing CI engine to work for HCCI engine.
2. The fuel has been introduced in the intake pipe to convert engine as prototype of HCCI engine' and the performance tests have been conducted.
3. The fuel efficiency is find to be lower with HCCI engine given to higher fuel consumptions when the fuel introduced in the intake pipe

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