

Experimental Study on Performance of P-HCCI Engine using Biodiesel Mixture

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Abstract— This paper represents the performance of single cylinder HCCI Engine using Biodiesel Mixture. The Homogeneous charge compression ignition (HCCI) combustion is a new trend alternative technology to current engine combustion systems. Many inventions in PHCCI is being worked out to use it as a method to reduce exhaust emissions and also fuel economy. The quality of homogeneous mixture of air and fuel is the key feature of HCCI combustion. HCCI has the characteristic nearly eliminate NO_x emissions while increasing efficiency as in diesel engine. HCCI adapts a pre mixture of gas-phase fuel and air being burned spontaneously and entirely by an auto ignition process. Homogeneous Charge Compression Ignition (HCCI) engines promises a high thermal efficiency combined with low levels of NO_x and PM emissions. The purpose of this study is to analyze the effect of alternative fuel when used in the HCCI engine combustion process. The experiments were conducted in a modified single cylinder water-cooled diesel engine. In this experiment we use diesel and bio-diesel Mixture as the fuel at different milli second injection.

Key words: Homogeneous Charge Compression Ignition (HCCI), PHCCI, Diesel, CI Engine, Emission, Biodiesel Mixture

I. INTRODUCTION

Because of the reduction of petroleum of reserves and air pollution emerged from exhaust emissions, there have been great efforts to use alternative fuels in diesel engines for substitution diesel fuel. Known petroleum reserves are limited and will eventually destroyed. Biomass energy technologies are use waste or plant matter to produce energy with a lower level of greenhouse gas emissions than fossil fuel sources. The biofuel economy will grow rapidly during the 21st century. The biofuel economy, and its related bio refineries, will be shaped by many of the same forces that shaped the development of the hydrocarbon economy and its refineries over the pastcentury.

Biodiesel is step by step gaining acceptance in the recent market as an ecofriendly fuel and the demand is expected to increase all at once as an alternative renewable energy source in the near future. The biggest difference between biofuels and petroleum feed stocks is oxygen content. Biofuels have oxygen levels of 10 to 45% while petroleum has essentially none, making the chemical properties of biofuels very different from those of petroleum. All have very low sulfur levels and many have low nitrogen levels. Biodiesel which has combustion characteristics similar to diesel and biodiesel blends has shorter ignition delay, higher ignition temperature and pressure as well as peak heat release compare to diesel fuel. Moreover, theengine power output and brake power

efficiency was found to be equivalent to diesel fuel. Biodiesel and diesel blends can reduce smoke opacity, particulate matters, un-burnt hydrocarbons, carbon dioxide and carbon monoxide emissions but nitrous monoxide emissions have slightly increased.

II. BIODIESEL MIXTURE AS AN ALTERNATIVE FUEL FOR IC ENGINE

Fuel Vaporizer is an external device consisting of heaters to vaporize the pilot fuel (diesel) so that it mixes homogeneously with air thereby forming a homogeneous mixture leading to uniform combustion. Diesel fuel has very low volatility and is highlyviscous. These two properties are the main drawbacks leading to formation of heterogeneous air-fuel mixture .In order to reduce the viscosity and increase the volatility of diesel, it has to be pre-heated to a certain temperature or vaporized so that vapors can mix easily with air leading to the formation of homogeneous mixture and in turn leading to homogeneous combustion.

Biodiesel is an oily liquid synthesized from fatty material. It has a light yellow color and mild odor and a bitter taste, it has many advantages such as: Renewable, it can be extracted from vegetable oil, Potential for Carbon Neutral lifecycle, simple to make, Non-toxic, Biodiesel is free from sulphur (< 0,001 %), the only alternative fuel that does not require engine modification or retuning, safer for storage and handling than petroleum diesel Emulsification,

- Pyrolysis,
- Dilution and
- Transesterification process.

Among these four methods, the transesterification is commonly used commercial process to produce clean and environment friendly Biodiesel. Methyl esters of used cooking oil, sunflower oil, rice bran oil, palm oil, soybean oil, Mahuaoil, Jetrophaoil,castor,karanj and coconut oil have been successfully tested on C.I. engines. In present research Biodiesel Mixture is use as an Alternative fuel. My Research I Used three vegetables Oils like Castor ,Karanj and Coconut to make Biodiesel Mixture

Fuel Properties	Diesel	Biodiesel Mixture
Density	0.860	0.890
Boiling point, °C	188-343	130
Kinetic Viscosity, cst	2-4	4.204
Calorific Value, kJ/kg	42,000	37,891
Flash point, °C	55	140
Autoignition Temp. °C	316	230
Cetane number	51	57

Table 1: Important properties of Biodiesel Mixture and diesel

III. REASONS TO MODIFY DIESEL ENGINES CONVERSION IN TO HCCIENGINE

- The problem of air pollution around the globe is real and serious, diesel exhaust emissions are a major source of pollution in most urban centers around the world and a major contributor to climate change. Trucks, buses, generators and ships burn millions of gallon of diesel fuel daily. Many countries are to alternative fuels to reduce diesel exhaust emissions, especially in urbancenters.
- Furthermore, as the price of crude oil continues to increase, the use of alternative fuel becomes increasingly economical and reduces the import burden of oil country like India.
- Price of diesel is low compare to petrol and has higher efficiency than petrol so people of the urban area are switched over to the diesel engine which make a serious problem in urban are to solve this problem higher efficient and economical operated Biodiesel fuelled diesel engine is required.
- Biodiesel is an alternative source if petroleum source is out of stocks
- HCCI Engine is give high power output compared to C I Engine also it used alternate fuel.

A. Modification Done To Convert Diesel Engine In To Hccienigne

- Heater installed on copperpipe
- Install heater in Intakemanifold
- Injector cut off System
- Data Acquisition Unit.
- Temperature Sensor Installation

IV. EXPERIMENTAL SET-UP

A. Experimental Engine Test Rig



Fig. 1: Actual experimental set-ups for modified engine (HCCI engine)

A vertical, single cylinder, water-cooled, four stroke, and high speed diesel engine has been used for the experiment. The technical specification of engine is as under:

Engine	Kirloskar AV1
Dynamometer	eddy current, water cooled
Bore (mm)	87.5
Stroke (mm)	110
Displacement (cm ³)	661
Compression ratio	17.5
RPM	1500
H.P.	5.2

Table 2: Properties of Diesel and Biodiesel Mixture.

V. BIODIESEL MIXTURE

- Biodiesel mixture means there is one or more vegetable oil use to making biodiesel.
- Mixture vegetable oil of castor, coconut and karanj to be use.
- The main objective of biodiesel mixture is to achieve good properties of biodiesel fuel which we desire. Biodiesel mixture name is CACOKAB. Means castor, coconut and karanj biodiesel.



Fig. 2: Castor seed2.Coconut seed3.Karanj seed

Fuel Property	Biodiesel Mixture	Diesel
Density Kg/m ³	0.890	0.860
Boiling point, °C	130	188-343
Kinetic Viscosity, cst	4.204	2-4
Calorific Value, kJ/kg	37,891	42,000
Flashpoint, °C	140	55
Auto ignition Temp. °C	230	316
Cetane number	57	51

Table 3: Properties of Diesel and Biodiesel Mixture.

A. Production of Biodiesel from Vegetable Oil

Because of high viscosity of vegetable oils and low volatility causes the atomization and spray patterns problems, leading to incomplete combustion and severe carbon deposits, injector choking and piston ring sticking.

The methods used to reduce the viscosity are:

- 1) Emulsification,
- 2) Pyrolysis,
- 3) Dilution
- 4) Trans esterification process.

Among these four methods, the trans esterification is commonly used commercial process to produce clean and

environment friendly Biodiesel. Methyl esters of usedcooking oil, sunflower oil, rice bran oil, palm oil, soybean oil, Mahua oil, Jetrophaoil,castor,karanj and coconut oil have been successfully tested on C.I. engines.In present research Biodiesel Mixture is use as an Alternative fuel. Production of Biodiesel from Vegetable Oil

VI. RESULTS & DISCUSSIONS

Engine performance parameters for conventional Diesel and Diesel-Biodiesel HCCI:

A. Effect of Load on Specific Fuel Consumption:

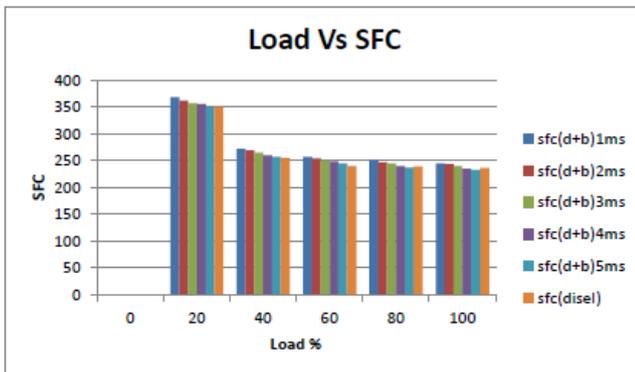


Fig. 5.1: SFCvs Load

Specific fuel consumption of Biodiesel injection decrease at gradual increase load but compare to diesel engine slightly increase

B. Effect of Load on volumetric Efficiency:

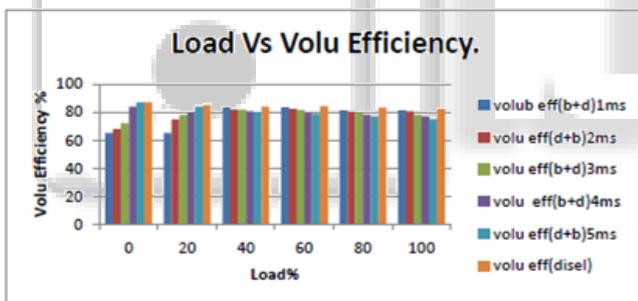


Fig. 5.2: Volumetric Efficiency vs load

Volumetric efficiency decrease at 0 to 20% load and after increase in high load.

C. Effect of Load on Exhaust Gas temperature:

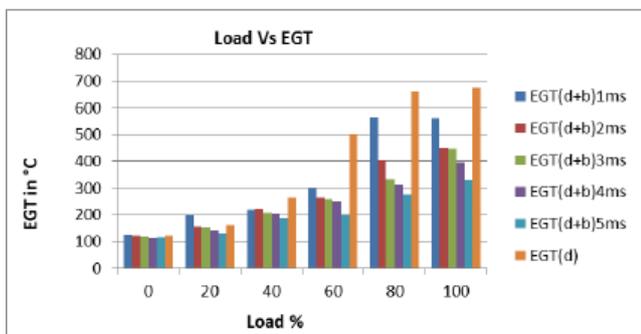
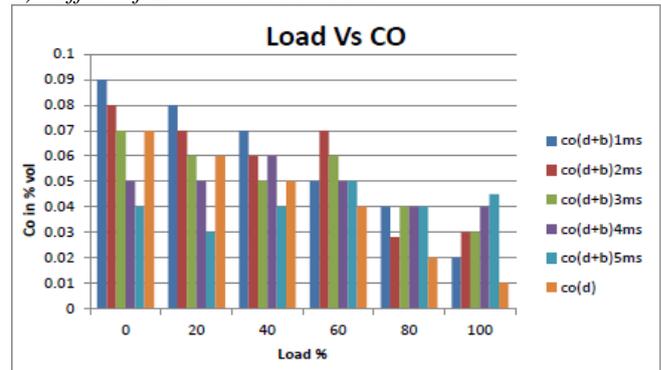


Fig. 5.3: Exhaust temp vs load

Exhaust gas temperature overall decrease in all load

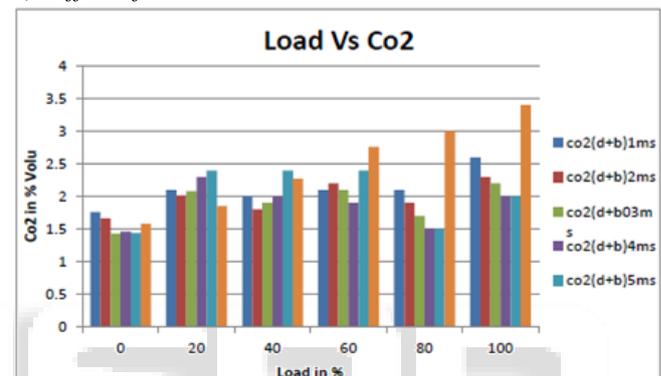
D. Engine emission parameters for conventional Diesel and Diesel Biodiesel HCCI

1) Effect of Load on co emission:



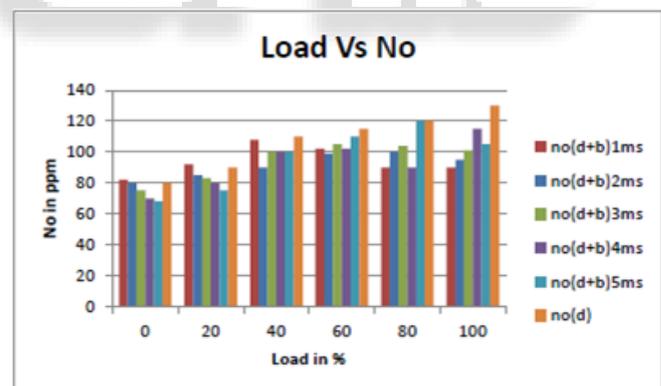
The co emissions are lower for high time in ms at 0 to 40% load and high load co maximum compare to C.I engine.

2) Effect of Load on co2 emission:



Carbon dioxide decrease at high load compare to C.I engine. But at low load gradually increase.

3) Effect of Load on No emission:



The NOx emissions are lower for diesel-biodiesel HCCI compared to theconventional diesel in the low load and high load.

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