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Performance Characteristics of PCCI Engine using Biodiesel

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Abstract:

However, these engines produce a lot of emissions, including nitrogen oxides (NOx), soot, and to a lesser extent hydrocarbons (HC), carbon monoxide (CO), and carbon dioxide (CO2). Among these emissions NOx and soot are cause more effect on human life and the environmental pollutions. To reduce these emissions which are coming from the engine cylinder after the end of combustion process some combustion strategies are introduced. The pre-mixed charge compression ignition (PCCI) concept, which is utilised to emit low levels of NOx and unburned hydrocarbon (UHC) while boosting thermal efficiency, is one of the alternative combustion strategies. To found the performance characteristics of the engine

Keywords — Biodiesel, PCCI, Nano particles.

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I. INTRODUCTION

The PCCI engines give improved combustion performance due to the homogenous combustion of the air-fuel charge, and as there is no external ignition in a PCCI engine, the homogeneous mixture of fuel is squeezed takes place [1]The fuel is self-igniting at this stage due to the uniform mixture temperature and pressure, which causes simultaneous auto-ignition at numerous locations throughout the whole combustion chamber. The secondary fuel in this PCCI engine is injected with intake air at the same time as the main fuel. To prepare premixed charge the high amount of secondary fuel injected at intake manifold and the charge is ignited by primary fuel[2].

The fuel which is generally in conventional I.C engines is replaced by biofuel which is having and it can be obtained from biomass and it will cause emits less amount of NOX [3]. Biofuels are having high flame speed which will reduce ignition lag/delay and combustion duration which helps in complete combustion quickly in PCCI mode of operation and which increases heat release rate [4].The biofuels are basically two types which are low viscosity fuels and high viscosity fuels. The most used biofuels are biodiesel and bioethanol.The best examples of high viscous fuels are vegetables oil, these high viscous fuels are not directly used in I.C engines, it will cause injection, nocking, [4]etc. Coconut oil and pine oils are best examples of low viscosity fuels and it's have greater cetane number. The quantity of bioethanol share is directly proportional to the brake thermal efficiency of the engine.

That is the brake thermal efficiency increases with ethanol. The addition of bio ethanol will result in a decrease in heat of combustion, which will lower NOX and smoke emissions.

In this PCCI engine, the cotton seed the biodiesel is extracted by transesterification process and Diethylether (DEE) is used as a secondary fuel which is having low autoignition [5]. In blend can be made by adding 20% of (DBD-1, DBD-2 & DBD-3).Among these three blends, DBD-2, DBD-3 blends have lower NOx level at all loads, the average reduction of NOx 29.5%, 22.2% reduced due high value of latent heat of vaporization of fuel by increasing quantity of Diethyether (DEE), and also it can emits lesser HC (15% reduced compared with diesel engine) because of the DEE fuel having more amount of O2 which increase the combustion rate. DBD-3 blend has 10% reduction in the CO emission than diesel engine, and the smoke emissions also reduced 50% for DBD-3 blend other than two blends. The brake thermal efficiency increased by 8.5%than diesel engine [6].

In this PCCI engine, the primary fuel is cotton seed biodiesel, which is pumped directly into the engine's cylinder. The secondary fuel, n-butanol, is made and is combined with diesel[7]. The mix CS50Bu50 (Bu50PFI-CS50DI) is the most effective at reducing NOx and soot emissions of all of these blends. Caused by n-butanol port fuel injection, NOx emissions were lowered by 15%, and soot production was reduced by 68% compared to diesel engines [8]. Additionally, the BSFC of the CS50BU50 mix is lower than those of other blends (2% lower than diesel). CO and UHC both experienced 10% and 25% decreases. The thermal efficiency of the brakes decreased by 2% when n-butanol was added compared to a typical diesel engine. With increments of 2% n-butanol in PFI, the mechanical efficiencies remain constant at 67%[9].

In this investigation the ethanol fuel was supplied to intake air at 40oC and injected into intake manifold of PCCI engine. The test was conducted at different ratios of ethanol at varying engine load conditions of 1, 2, 3 and 4 bar brake mean effective pressure. The ethanol is used to obtain homogeneous combustion and lower the emissions. The results obtained from the test experiment, the maximum fuel energy supplied by ethanol is 28%, 13% at low load and high load conditions respectively. The high colling effect produced by the ethanol is reduces the NOx emissions at low loads and the colling effect increased with ethanol quantity.By adding 4ml & 10ml ethanol is reduces 43% & 78% of NOX emissions at low loads than diesel engine and with increasing ethanol quantity HC & CO emissions are reduced [5]. In PCCI engine operation, wheatgerm oil is used as a primary fuel which is extracted from cold processing process with supercritical CO2 extraction, and the secondary fuel is the bio-ethanol which is supplied to the intake air at intake manifold into atomization spray. This experiment used 10%, 20%, and 30% compositions of wheat germ oil and bioethanol (WBE-1, WBE-2, WBE-3). Due to the cooling impact of the rising percentage of bioethanol, NOX emissions at 30% bioethanol energy share are shown to be lower than diesel engine at all load circumstances. At a 30% energy share for bioethanol compared to other energy shares, CO and HC emissions are minimal. The combustion rate increases along with the percentage of bioethanol. For a 30% energy share, smoke emissions are modest, and at full load, they are much lower at 67%. The increase in premixed combustion rate causes BTE to rise to 29.14% at 30% energy share bioethanol input [10].

The biodiesel produced from calophyllum-inophyllum oil is combined with diesel and used as a fuel for diesel engines. Additives use multi-walled carbon nanoparticles and cerium oxide nanoparticles. Among the blends, BCM reduces CO emissions to 50% for BCM20 and NOx emissions by 40.6%. BTE is raised by 17.9% for blend BCM20 while smoke emissions are reduced by 54.32% [9].

this experiment dual fuel diesel engine is tested by adding nanoparticles as an additive. Nanofluid is prepared by adding aluminium, cerium and silica nanoparticles in the proportions of 25, 50 and 100 PPM into methanol separately and this nanofluid is injected through direct injection with diesel fuel to form NMF (nanofluid-methanol-diesel blend)by varying methanol in three compositions 10%,20% and 50%respectively at all loads.However, the NOx emissions are reduced for aluminia and ceria nanoparticles at higher than silica nanofluid. And by adding the nanoparticles CO, HC and smoke are reduced upto 40% for methanol-diesel i.e: methanol-NMF blends [11].

According to the aforementioned literacy study, the engine is operated in PCCI mode to increase performance and decrease emission characteristics. Nitrogen oxide levels are higher in PCCI mode than in normal engine mode. Introduce the nanoparticle into the fuel to reduce emissions. Fuels can be made more engine-efficient and their emission characteristics are reduced by adding nanoparticles [12].

II. MATERIALS AND METHODS

A. Outline of Oil

Scarcity of oil resources and that its extraction method is pollution-free because it has no negative effects on the environment. Additionally, it is estimated that 13.5 million tonnes of tyres are scrapped annually around the world, with nearly 1 million tonnes of tyre scrap being available in India each year as a result of the use of a large number of vehicles in the country. There are several uses for the crude oil that is recovered from worn tyres, including use as fuel in large businesses like steel and glass production.

B. Pyroloysis Oil

Fast thermal degradation of biomass without oxygen is known as pyrolysis. The pyrolysis process, which is carried out at temperatures between 700 and 1000 oC [13], produces gases, biofuels, and char. The pyrolysis technique is used to obtain the oil from the used tyre oil. The processes of feeding, reaction, and condensation are carried out in this process. The tyre is then broken into bulk pieces, and these bulk pieces are fed through a conveyor belt to a compressive shredder where they are reduced to little pieces. Fire the fuel in the burning room to produce heat and the fuel may be diesel, LPG etc [14].

The fuel that was induced in the small pieces of tyre through uniform heating is evaporated, and this vapour state fuel will go to the cyclone to remove the char in the vapour, which is followed by condensation in which the vapour is converted to liquid fuel and is collected in the oil tank [15]. The uncondensed gas is then supplied to the burner and is used as a burning fuel. The pyrolysis scheme is depicted in fig. 1.

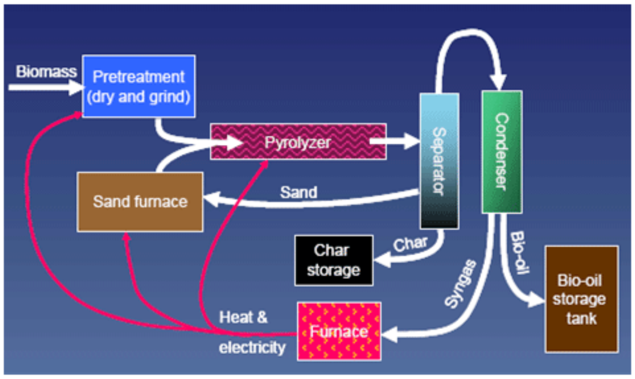


Figure 1: Pyroloysis Process

III. FUELS PREPARATIONS

C. Tested Fuels

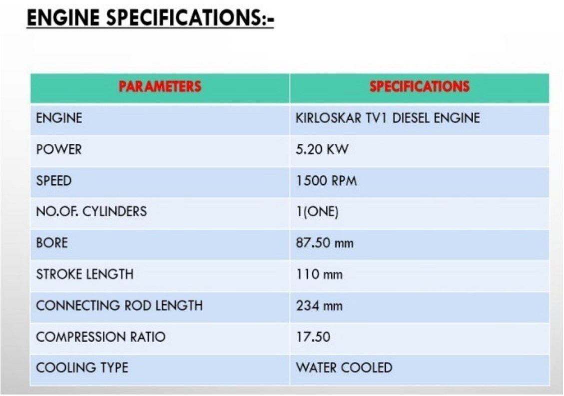
Dual fuel was used when running the engine. Two different tanks were used in the dual fuel mode; one was the major fuel tank and the other was the secondary fuel tank. Waste plastic oil was used as the primary fuel, while pentanol was used as the secondary fuel. The pyrolysis-extracted waste plastic oil was used to create B20 fuel mixes. Pentanol was used as a secondary fuel at various amounts of 10%, 20%, and 30%, respectively. In this case, Cuo/Zno nanoparticles were utilised at a constant dosage of 50 ppm. With the use of an ultrasonicator, the 50 pmm nanoparticle was blended with the primary fuel's waste plastic oil. [16]

D. Adding Of Nanoparticles By Ultrasonictor

The nanoparticles are used in this process is supply additional amount of oxygen in order to improve combustion rate of the engine. the nanoparticles used in this experiment are Cuo/Zno in the range of 50 ppm.The ultrasonicator is used for adding nanoparticles with blend composition the ultrasonicator [17] having lid and tray in which the blend composition will poured and the time will be set by the operator by using button and the temperature will be set to certain value.Then push the heating button to supply the heat and vibration button to supply ultrasonic vibrations due to the vibrations produced by the sound the nanoparticles are uniformly mixed with blend composition.

e. Experimental Setup

This experiment uses a single four-stroke constant speed premixed charge compression ignition engine with direct injection, and the engine specifications is given in table 1



ENGINE SPECIFICATIONS:-

PARAMETERS	SPECIFICATIONS
ENGINE	KIRLOSKAR TV1 DIESEL ENGINE
POWER	5.20 KW
SPEED	1500 RPM
NO.OF. CYLINDERS	1(ONE)
BORE	87.50 mm
STROKE LENGTH	110 mm
CONNECTING ROD LENGTH	234 mm
COMPRESSION RATIO	17.50
COOLING TYPE	WATER COOLED

TABLE I : ENGINE SPECIFICATION

IV. RESULTS AND DISCUSSIONS

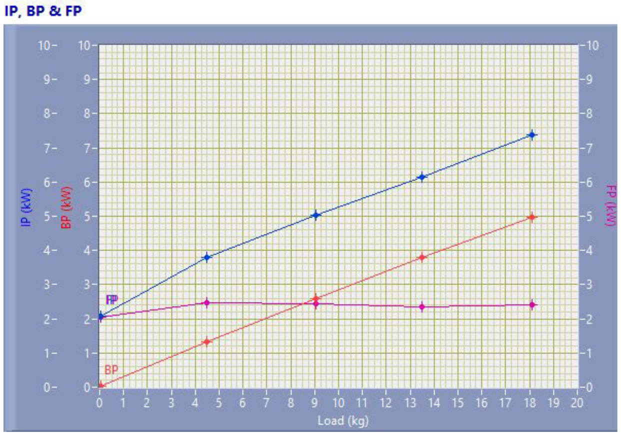


Figure 2: Load Vs BP &FP

The Load vs BP, FC shows in the figure 2. The fuels blends B2O with nanopartcles are shows the greater values when compared with the diesel. The other fuels blends its drastically reduced. Due to incomplete combustion.

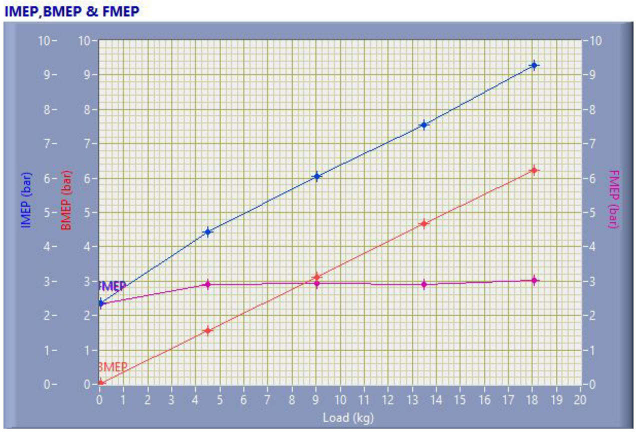


Figure 3: Load Vs IMEP, BMEP &FMEP

The Load vs BP, IMEP, BMEP & FMEP shows in the figure 3.While load is increasing the all three parameters are also increased. The fuels blend B20 with 10 ppm of nanoparticles shows in better results when compared with the diesel fuels.

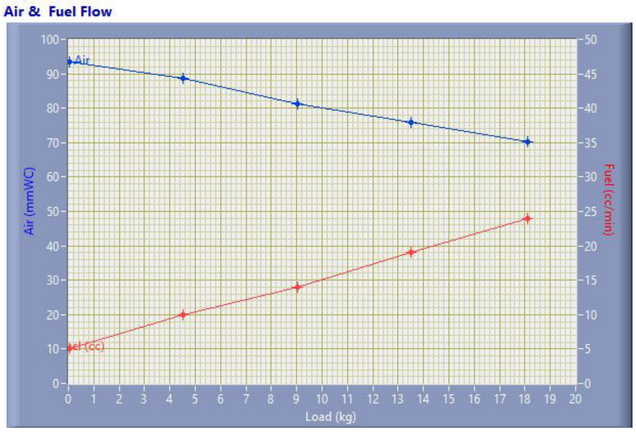


Figure 4: Load Vs Air & Fuel Flow

The Load vs Air & Fuels Flow shows in the figure 4. While load is increasing the air flow is decreased. While increasing the load the fuels flows are increasing in PCCI engine The fuels blend B20 with 10 ppm of nanoparticles shows in better results when compared with the diesel fuels.

Figure 5: Load Vs IE & BTE

The Load vs IE & BTE shows in the figure 5. While load is increasing IE is decreased. While increasing the load the BTE are increasing in PCCI engine The fuels blend B20 with 10 ppm of nanoparticles shows the highest BTE by 12.32% when compared with diesel fuels.

Figure 6: Load Vs SFC, Fuel Consumption

The Load SFC & Fuel Consumption shows in the figure 6. The BSFC is inversely propulsion to the BTE. While load is increasing SFC is decreased. While increasing the load the Fuel Consumption are increasing in PCCI engine The fuels blend B20 with 10 ppm of nanoparticles shows the highest BTE by 5.42% when compared with diesel fuels[18-19].

V. CONCLUSIONS

The performance was carried out in the PCCI engine with biodiesels and nano particles

The BP of fuels blends B2O with nanopartcles are shows the greater values when compared with the diesel.

In the air fuels flows The fuels blend B20 with 10 ppm of nanoparticles shows in better results when compared with the diesel fuels.

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