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Experimental Investigation on Single Cylinder Modified Compression Ignition Engine to Spark Ignition Mode

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Abstract: A lot of research has been going on in the field of modification of IC engine and work on dual fuel mode. Most of the modified engine can work on dual fuel mode, but they need to require a pilot fuel to start the working on another fuel. In this research work we modified single cylinder diesel engine that work on dual fuel mode without adding any pilot fuel and focus the performance and emission analysis of that modified engine working on gasoline and LPG at constant speed and same compression ratio 7.6 and compare the result with Diesel engine. Result show that the maximum brake thermal efficiency of modified engine using LPG fuel give higher efficiency then diesel engine but using petrol in modified engine its maximum efficiency will be 31% which is higher than diesel engine .Simultaneously reduction in HC and CO emission using LPG fuel and Brake specific fuel consumption also reduce.
Keywords: Modified, Dual Fuel, IC Engine, Pilot, LPG, Emission.

Introduction

Compressed ignition engine are the best choice for the small and heavy-duty application because of high fuel conversion efficiency. Petroleum product also causes a lot of problems major problems at the crisis and pollution which causes various hazardous problems. A lot of research has been conduct and going on to overcome these problems. Modified diesel engine work in dual fuel mode in which LPG used as a fuel in that converted engine it will reduce the NOx emission and power output with the part load will drop as compared to diesel fuel.[1] The LPG and natural gas are the best alternative choice to reduce the dependence on petroleum base liquid fuel with some extent, and also emit less pollutant that of diesel fuel.[2] Bio diesel are also the best alternative to use in diesel engine and comparative study of heavy alcohol and safflower base biodiesel with blended mixture use in four cylinder waters cooled diesel without modification and found that with increasing the blend of alcohol brakes thermal efficiency decreases and conversely fuel consumption increases, but while using heavy alcohol with biodiesel then brake thermal efficiency is improve and emission characteristic NOx, CO and HC Reduce within a limit. [3] With increasing the industries and transportation emission of harm full gases are also increases consistently that are the main causes of global warming and climate change much pollution emitted by diesel engine that can harm to human as well as environment therefore we should focus and keep it within specific limit. [4] Simulation on converted CI to SI engine conduct using CFD simulation using G-equation in bowl-in-piston found that with increasing methane number MN emit lower NOx while lowering MN increasing CO emission, and also found bowl-in-piston is better for combustion phenomenon as compared to type combustion head chamber. Natural gas also use, but it has high, self ignition temperature and therefore, high compression ratio need which would increase both flames speed and engine efficiency due to this natural gas is good to replace diesel in CI engine but due to higher ignition temperature it is difficult to control engine operation without adding modification [5,6].

"By converting diesel engines to run on LPG we can significantly reduce the problem of diesel pollution while also improving emissions of greenhouse gases" [1, 7, 8].CNG and Diesel are used in different blend conclude that at lower load CNG performance lower then 100% diesel operation but emission of CO2 is lower due to low ration of carbon and hydrogen and CO emission is higher due to low air fuel ratio [9].Various researches have been done and going on to convert compression ignition

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engine to spark ignition mode and will try to improve the performance and emission of the engine. In most of the research various type of fuels and blended are use but pilot fuel is used to start the engine after that switching the engine in alternate fuel mode. Aim of this work is to modify and study the performance and emission of the engine. Lee et al. [10] developed a multi-objective Non-dominated Sorting Genetic Algorithm II (NSGA-II) optimization of compression ignition engine parameters using biodiesel fuel and exhaust gas recirculation. The major intention of this approach was to correlate the performance features and response based on engine emissions. Carbon monoxide (CO) emission rate, power, engine, engine speed, engine load, average distance and speed were the performance measures employed to obtain good optimization capability and minimum emission rate. However, this approach required more time in determining the parameters.

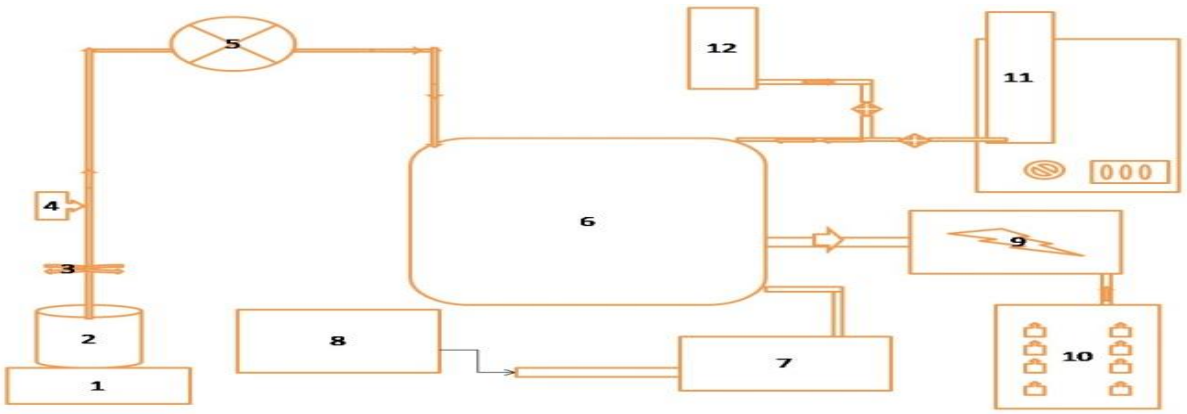
Multi-objective optimization of diesel injection parameters in a nat- ural gas/diesel reactivity controlled compression ignition engine was proposed by Motlagh et al. [11] to minimize exhaust emission and max- imize gross efficiency. Pressure rate, crank angle, and exhaust gas recir- culation ratio were the simulation measures evaluated to enhance the performance of the engine and high-pressure rise rate. A high percent- age of smoke was considered as the major drawback of this approach.

To minimize nitrogen oxides (NOx), soot emissions, and fuel effi- ciency Xu et al. [12] developed a computational optimization of the dual-mode dual-fuel concept through a genetic algorithm at different engine loads. Here, an enhanced fuel economy, minimum heat transfer loss and minimum soot emissions were obtained by evaluating certain performance measures like in-cylinder pressure, crank angle, in- cylinder temperature and energy fractions. The major drawback of this approach was low fuel efficiency

Experimental Setup and Procedure

Experimental work has been conducted on modified Single cylinder diesel engine. Modification are required to run diesel engine in dual fuel mode that is Petrol and LPG we need carburetor for the combustion of fuel instead of injector therefore we also make slightly some modification in head of that engine make Internal thread at 20^{o}angle in that place we insert spark plug to create spark. Mixture is also fitted at the top of engine that are use to run engine in LPG fuel it mix gas and air for the combustion. Kit has to be made that change the compression ratio according to the fuel use and start also without using any pilot fuel.

Block diagram Pictorial view of experimental setup shown



1-Weiging machine
2-LPG Cylinder
3-Control Valve
7-Calorimeter
8-Gas Analyzer
9-Generator

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4-Pressure Gauge 10-Load unit
5-Mixture for LPG 11-Petrol burette
6-Modified Engine 12-Diesel burett

Experimental Procedure

For experimentation 40cc fuel use and investigate the performance under various load and the emission analysis done with the help of AVL DIGAS 444N Gas Analyzer For the load set up use electric load 0 to 2 kW .In case of Gas mixture assemble at the top of the engine setup the provide proper mixture of LPG and air for the combustion in this experimental work both the fuel keep working in same compression ratio i.e.7.72 and with constant speed 1500rpm.Various temperature are to be noted with the help of temperature setup unit. Fuel supply can be maintained with the help of carburetor and mixture. Following observation and trail are to be observed. Observation made on diesel mode before conversion and on petrol and LPG after conversion modern and evaluates the performance and emission of that engine.

OBSERVATION

	Diesel CV 43000 kJ/kg	Petrol CV 45000kJ/kg	LPG CV 47000kJ/kg
Load W	0	0	0
BSFC (g/kWh)	-	-	-
Brake thermal efficiency (η_{bt})	-	-	-
Load W	0.25	0.25	0.25
BSFC (g/kWh)	1.4	3.42	4.05
Brake thermal efficiency (η_{bt})	6	2	1
Load	0.50	0.50	0.50
BSFC (g/kWh)	0.72	1.7	1.69
Brake thermal efficiency (η_{bt})	11	4	5
Load	0.75	0.75	0.75
BSFC (g/kWh)	0.50	1.06	0.96
Brake thermal efficiency (η_{bt})	16	7	7
Load	1.00	1.00	1.00
BSFC (g/kWh)	0.43	0.76	0.62
Brake thermal efficiency (η_{bt})	19	10	12
Load	1.25	1.25	1.25
BSFC (g/kWh)	0.34	0.54	0.44
Brake thermal efficiency (η_{bt})	24	14	17
Load	1.50	1.50	1.50
BSFC (g/kWh)	0.31	0.42	0.32
Brake thermal efficiency (η_{bt})	26	18	23

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Load	1.75	1.75	1.75
BSFC (g/kWh)	0.30	0.32	0.25
Brake thermal efficiency (η_{bt})	27	24	30
Load	2.00	2.00	2.00
BSFC (g/kWh)	0.27	0.24	0.20
Brake thermal efficiency (η_{bt})	30	31	37

RESULT AND DISCUSSION

The experiment was performed on the modified diesel engine result obtain and compare the result with the engine working on Diesel, Gasoline , LPG

Brake thermal efficiency

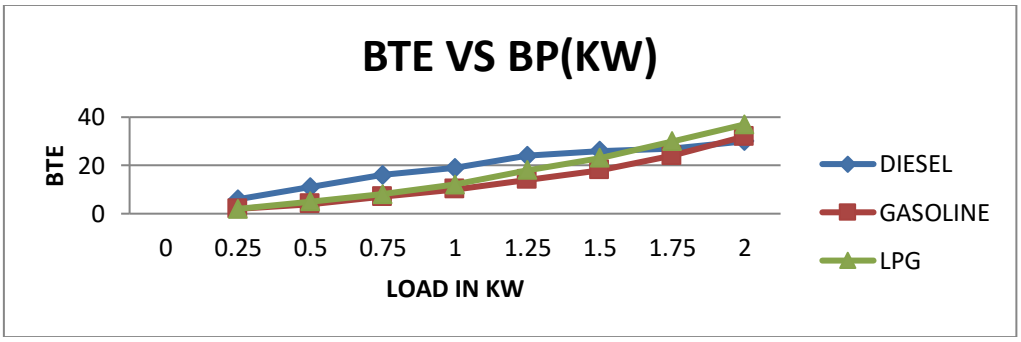

Figure 1 Brake thermal efficiency Vs Load

The plot of graph between brake thermal efficiency and load shown graph 1.Modified engine work on Petrol and LPG. Performance on LPG mode will improve with increasing load. Maximum brake thermal efficiency obtaining is 37% in case of LPG and 31% in case of Petrol fuel with compare result of modified engine to diesel engine they perform well. LPG enters the cylinder in a gaseous state it allow more proper mixing of fuel and air. Appropriate mixing means proper ignition and less fuel goes un burnt into exhaust, giving more thermal efficiency as compare to Diesel as well as Petrol.

Brake Specific Fuel Consumption

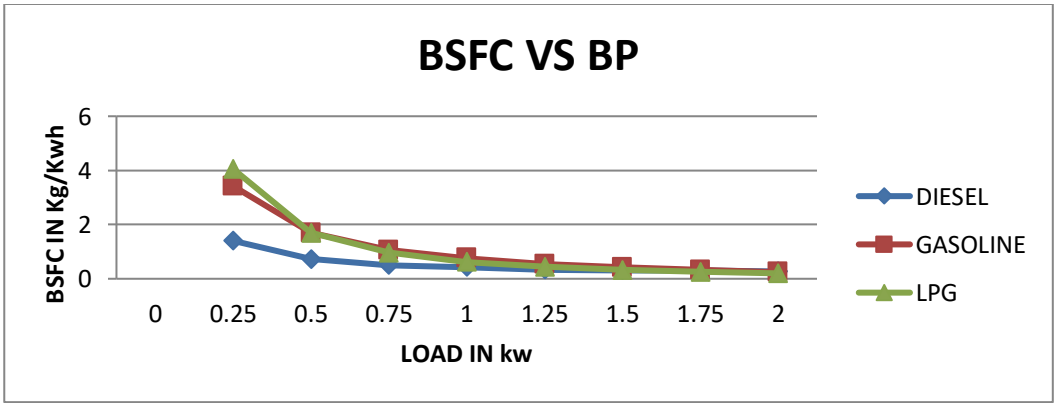

Figure 2 Brake Specific Fuel Consumption Vs Load

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The result for the variation in the brake specific fuel consumption (BSFC) is shown and found that BSFC suddenly drop with the 0Kw to 0.75Kw load. At full load BSFC in case of LPG is around 0.20kg/Kwh. From the figure clearly seen maximum BSFC obtain in case of petrol and diesel fuel is more but in case of LPG fuel BSFC will be decreases. At the same compression ratio at 7.6 brake specific fuel consumptions is low as compare to petrol and diesel.

CO Emission with Load

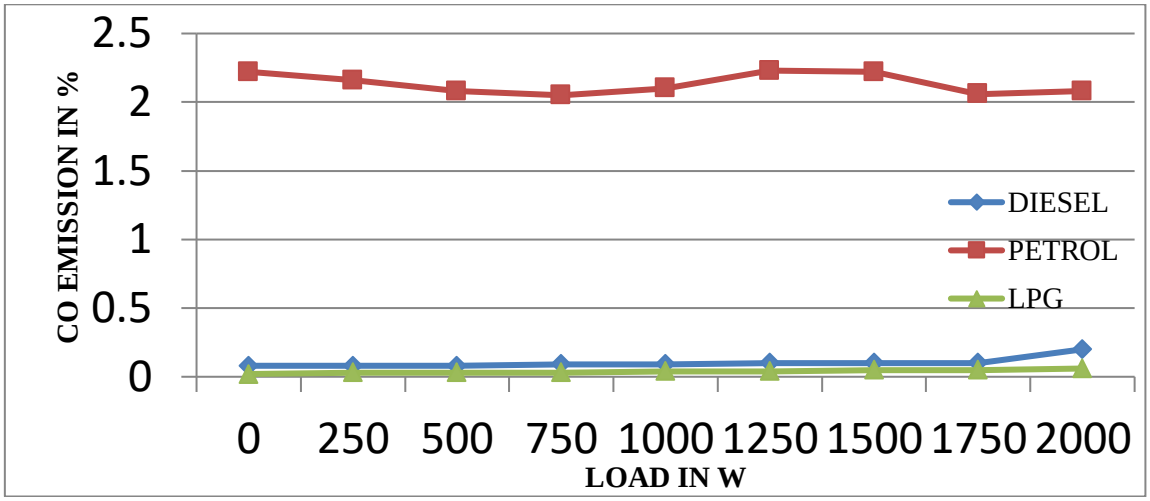

Figure 3 CO Emission with load

From the figure 3 it is clear that CO emission with LPG will be minimum and similar to diesel emission but in case of higher value of CO is obtain due to the incomplete combustion of air fuel rich mixture. Modified engine with LPG fuel CO emission will reduce with increases load in case of petrol high emission of CO is obtain at the same compression ratio that can be use to on LPG.

Hydrocarbon (HC) Emission

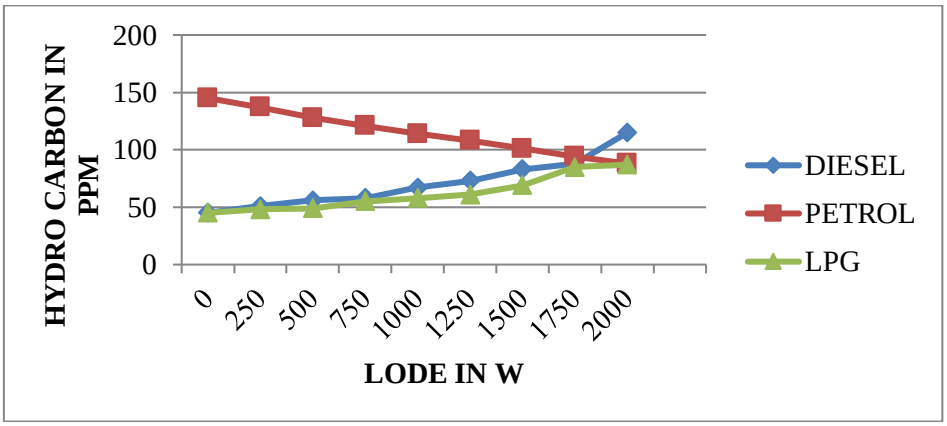

Figure 4 HC Emission Vs load

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From the figure 4 Hydro Carbon emission obtain will be higher in case of petrol fuel and lower in case of LPG fuel give over all emission of HC using LPG fuel is low that can be acceptable.

Conclusion

Performance and Emission characteristics are great influenced by fuel used in engine Experimental work shows that Brake thermal efficiency of LPG fuel operated modified diesel engine give higher efficiency about 37% and on petrol give 31%.LPG give the best result and its engine efficiency is more better as compare to diesel engine .Brake specific fuel consumption using LPG will be reduce that is the most important in the economical point of view. Modified engine using LPG also emits less pollutant as compare to gasoline fuel.

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