Experimental Investigation Of A High-Efficiency Engine With Ceramic-Coated Cylinder Head, Supercharger, And Scrt Emission Control

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ABSTRACT

The effect of thermal barrier coating (TBC) on the cylinder components like piston crown top, cylinder liner, cylinder head inside and valves . The thermal barrier coated engines are otherwise known as low heat rejection (LHR) engines. Due to the insulation of the cylinder wall the heat transfer through the cylinder walls to the cooling system is reduced which change the combustion characteristics of the diesel engine. To know the changes during combustion the steady-state LHR engines operation have been studied by applying either the first or second law of thermodynamics. The state of the art of the thermal barrier coating is the plasma spray Zirconia . In addition, other material systems have been investigated for the next generation of TBC. The study also focuses on coating method for Plasma Spray Zirconia (PSZ) to improve coating under high load and temperature cyclical conditions encountered in the real engine. The effect of insulation on engine performance, heat transfer characteristics, combustion and emission characteristics are studied and compared with standard (STD) diesel engine.

A supercharger is added to the engine to improve its performance and efficiency. Compared to other boosting options, superchargers offer very rapid response in intake manifold pressure and low exhaust system heat absorption. Therefore, superchargers can be used to improve low speed transient response in downsized and down sped engines. Superchargers have been also used to improve power and torque density in engines using over-expanded cycles, as well as in hybrid vehicle drive trains.

The fuel used is waste plastic pyrolysis oil (WPO) to reduce pollution Fast exhaustion of oil resources and increase in energy demand have focused the researchers to find alternate ways to produce high quality oils that could replace fossil fuels. The idea of waste to energy recovery is one of the promising techniques for managing the waste plastic. Waste plastics are attractive for energy conversion because of their high heat of combustion and bulk availability. Exponential rate of increase in plastic production happens in every year due to the wide range of plastic appliances in domestic as well as industrial purposes. The drastic increase in the plastics production naturally lead to large amount of plastic waste that endangers the environment because of their disposal problems

. The conversion of plastic to 2 high quality liquid oil through pyrolysis process is highly advisable as the oil produced has high calorific value than that of commercial fuel. This paper describes commonly used verities of plastics and potential of pyrolysis process to produce fuel using them.

KEY WORDS : LHR - Low Heat Rejection, TBC-Thermal Barrier Coating, PSZ-Plasma Spray Zirconia STD-Standard, HTP-High Temperature Polymer

1- INTRODUCTION

The influx of automobiles necessitated demand for energy. Present world is commonly facing the environmental degradation as well as fossil fuel depletion crisis. Fossil fuels are extremely limited energy resources. They are exhaustible resources of energy. There is an immediate need for the exploration of inexhaustible energy resources, which are important not only for energy security but also for environmental protection. The bio- origin fuels can give a better solution to the crisis. A century ago, Rudolf Diesel discovered diesel engine that determined the compression ignition engine fundamental principle by the utilization of peanut oil as a fuel. He also suggested the future fuel of the diesel engines would be vegetable oils.

Petroleum which was discovered later replaced vegetable oils. The research for renewable oils of bio - originis immediately desirable in the present context of the depletion of renewable energy resources. The bio-origin fuels are eco-friendly and can be substituted for the exhaustible energy resources. They are not yet all harmful to human health.

The post depletion of fuel resources caused to hike the fuel prices in international market which has been economically burdensome to the developing countries like India .The fuels of biological origin can decrease the pollution levels. Diesel fuel can be substituted by alcohols and vegetable oil which are renewable resources in nature . Alcohols and vegetable oils cause combustion problems .They are highly viscous and high with molecular weight and with low volatility. The process of trans esterification can be the solution to some extension converting crude vegetable oils in to biodiesels.

Plastic Fuel are not available in plenty with respect to user point of view; it is not a cost effective approach. The research outcome on the write-up is further elaborated to a specific application to give more value addition.

2 REVIEW OF LITERATURE

The documented indisputable fact is that around one third of energy supplied is lost through the coolant as well as other one third energy is wasted through mechanical friction and other unaccounted losses , thus for useful purposes leaving only a little more or about 33% energy utilization.

In the above scenario, during the last 10 or 20 years in engine research the major thrust has been on low heat rejection engine development. Such engines are considered appropriate for adapting renewable as well as alternative fuels which includes vegetable oils and alcohols because within the combustion chamber hot environment is provided by them. In diesel engines alcohols are not suitable for direct use as they have low cetane number as well as high heat of evaporation . In the same way , in diesel engines combustion problems are caused by vegetable oils due to their lower volatility and higher viscosity. Therefore, biodiesel is developed by chemical conversion (trans esterification) of vegetable oils for improving the cetane number as well as decreasing the high viscosity, molecular weight. The limitations associated with the biodiesel and vegetable oils to be utilized in diesel engine which includes the low heat rejection (LHR) engine.

For attaining LHR to the coolant numerous methods were adapted through low- thermal conductivity materials such as low-carbon steel, SS, superni (an nickel alloy) etc. utilizing ceramic coatings on cylinder head, liner and piston as well as by producing air gaps among piston as well as an other components .The earlier approaches result e din some issues such as shedding coatings after operation’s certain hours, whereas advanced approaches comprise the problem which joins two dissimilar metals for producing air gaps by the coating techniques’ advancements, one of the effective and simple approach is ceramic coating. Also, several crown materials along with various air gap thickness among crown as well as therefore piston body is utilized by several researchers. They have had had retarded or advanced injection timing in order to urge better output and a decrease in motor emissions from the manufacturer ' s suggested injection timings.

Several techniques were used to estimate the liner with various boundary situations piston temperature distribution , utilizing finite element approach through various researchers with several un certain ties as well as far from reality.

Various researchers were working with LHR engines as well as traditional engines with diesel as fuel with various combustion prototypes starting from the single zone to the multi zones. Never the less , there has been no systemic research with these engines on the other available renewable fuels ’ adaptability such as bio diesel as well as vegetable oil .

Since it has been described in chapter 1, performance assessment was carried out on high quality LHR combustion chamber engines that comprised of air gap insulated liner with superni insert, the piston with a superni crown and ceramic cylindrical head insulated ”byairgapwithwastefriedvegetablecookingoil’svario usoperatingconditions in basic form as well as with various engine parameters in biodiesel form. In components of high grade LHR engine , predictions of temperature distribution were performed with FEA as well as associated with experimental examinations . Zero – dimensional , multi–zone combustion model was undertaken on waste fried vegetable cooking oil ’s as well as its bio diesel utilization in LHR combustion chamber engine.

The subsequent topics were covered in the literature survey as well as described in brief regarding the examinations administered by several researchers in following paragraphs with in the specific field associated with the work.

Literature review is conducted on the following topics and subsequently research gaps are identified. Based on research gaps, objective or problem is formulated.

Manigandan Sekar et al., [1] Combustion and emission characteristics of diesel engine fueled with Nano catalyst and pyrolysis oil produced from the solid plastic waste using screw reactor, Pyrolysis method was used to extract the PO from the mixture of plastic waste and the chemical composition was analyzed using GC/MS. Having been found the chemical compounds in the PO, the P25A was added to improve the quality of Waste plastic oil (PO). A number of tests were conducted to find the effect of P25A blend and PO on the performance characteristics and emission characteristics. A single cylinder with 4 stroke engine was used to conduct all tests. The effect of the addition of P25A in PO was found better among other fuels. The P25A blend increased the BREAK THERMAL EFFICIENCY as the loads increased. Further,

the BSFC of the P25A blend was increased due to the enormous oxygen presence to improve the combustion process even in fuel rich zones. At the 5.3 BMEP, the combustion duration of the PO and P25A were 7% and 3% higher than neat diesel. The CFD code was typically helpful to predict the temperature to be maintained for the effective production of pyrolysis oil.

D. Damodharan et al., [2] Effective utilization of waste plastic oil in a direct injection diesel engine using high carbon alcohols as oxygenated additives for cleaner emissions. The raw data for engine performance and emissions recorded from the full factorial design matrix shown in Table 8 was used to develop regression models using RSM. A comparative evaluation between the effects of WPO was carried out based on the response surface plots. Finally an optimal combination of alcohol, injection timing and EGR was determined using desirability approach.

R.K. Singha et al., [3] Waste plastic to pyrolytic oil and its utilization in CI engine: Performance analysis and combustion characteristics. The utilization of crude PPO with diesel in different blend ratios shows an increase in exhaust emission while the variation is comparatively low when compared with 100% diesel. At high load, low oxygen content, delayed ignition, short combustion duration results in increased emission values whereas shows a good combustion characteristic for utilization as fuel in a diesel engine. The utilization of crude PPO with diesel blends up to 50% can be utilized in diesel engines with a minor loss in efficiency and with a small increase in exhaust emission when compared to 100% diesel fuel characteristics.

D. Damodharana et al., [4] Combined influence of injection timing and EGR on combustion, performance and emissions of DI diesel engine fueled with neat waste plastic oil. The present study investigated the combined influence of injection timing and EGR rates on characteristics of a DI diesel engine fueled with neat waste plastic oil (WPO) derived from mixed waste plastic via catalytic pyrolysis. The tests were conducted at the engine's rated power output and speed. The conclusions were drawn with reference to baseline engine fueled with diesel at its stock settings. Peak pressure and HRR for neat WPO reduced gradually with increasing EGR rates. The peak in-cylinder pressures and HRRs also dropped as the injection timing was delayed from 25°CA bTDC to 21°CA bTDC. BSFC of WPO injected at the early injection timing of 25°CA bTDC under 10% EGR delivered diesel-like fuel consumption. Otherwise BSFC of the engine suffered at higher EGR rates at all injection timings. BREAK THERMAL EFFICIENCY of WPO injected at the early injection timing of 25°CA bTDC under 10% EGR was found to be better than diesel by 5.1%. However BREAK THERMAL EFFICIENCY deteriorated at higher EGR rates at all injection timings. NOx decreased by 52.4%when the EGR rate was increased from 10% to 30% at 21°CA bTDC.

J. Thamilarasan et al., [5] A Investigation of plastic Pyrolysis oil performance on CI engine blended with magnesium oxide nano particle using Taguchi method. The ecologist faced a big challenge by abandoning the plastics used. In this paper, a single-cylinder air cooled direct injection diesel engine, the surplus of plastic oil and Magnesium oxide was experimented with diesel. The parameters affecting the engine were calculated as engine load, plastic and Magnesium oxide mixing ratio and pressure injection in the response to diesel engine output and emissions. The orthogonal array L9 was generated and evaluated using an SN ratio using the Taguchi process. The findings indicate that the plastic oil combination was the most dominant with its 10% rating. Technically, 10% of PPO can be rated as full load condition; Magnesium oxide mixes with diesel at an injection pressure of 220 bar.

S. Gopinath et al., [6] A review on influence of injection timing and injection pressure on DI diesel engine fuelled with low viscous fuel. This work was reviewed to summarize the effects on combustion characteristics, engine performance and emissions of waste plastics oil. Even though, there have always been uncertain trends for WPO combustion characteristics, engine performances and emissions accordant with the different tested engines, different operating conditions, the different measurement techniques or instruments, etc., the following conclusions could be drawn.

Amar Kumar Das et al., [7] Thermal balancing and exegetic performance evaluation of a compression ignition engine fuelled with waste plastic pyrolytic oil and different fuel additives. Heat balancing and energy analysis were performed using the experimental observations achieved from engine testing of a 4stroke diesel engine fuelled with WPO blended diesel along with ethanol and Nano graphene as additive. The following observations are enumerated as follows From the above results it is found that, addition of nano graphene improves the exergetic efficiency (by 14.18% with respect to diesel), which signifies that the engine could derive maximum higher useful work as compared to other fuel mixtures and thus improve overall thermodynamic efficiency. So it can be concluded that nano Graphene addition in WPO diesel blend found significant improvement in combustion in comparison with diesel and other fuel combinations. Hence it is regarded as better alternative for diesel without engine modifications.

R. Boopathi et al., [8] Performance analysis of plastic oil blend by changing the fuel injection timing in diesel engine. The viscosity and specific gravity (SG) of the plastic oil blend is found to be similar than all other fuels. Flash and fire point temperature of the plastic oil and its blend are higher than diesel. It implies that the alternative fuel to the transportation of plastic oil blends is easy for handling. Performance of the engine was superior at advancing the injection timing and it leads to lower

TABEL 3.1 : Properties of Test Fuels

BSFC and higher BREAK THERMAL EFFICIENCY at all engine loads. It has lower emission ofCO2, CO, HC and NOx were observed from advancing the injection timing. The performance of the P10D90 is found to be almost similar to diesel and the emission were considerably reduced by advancing the fuel injection timing. The 10% of the plastic oil blend with diesel has the similar to diesel and modified advance injection.

3-RESEARCH METHODS AND MATERIALS

3.1 Preparation of biodiesel

The chemical conversion of transesterification reduced viscosity four fold. Crude vegetable oil contains up to 70 % (wt.) free fatty acids. The methyl ester was produced by chemically reacting crude cotton seed oil with methanol in the presence of a catalyst (KOH). A two–stage process was used for the transesterification of the crude cotton seed oil [6]. The first stage (acid-catalyzed) of the process is to reduce the free fatty acids (FFA) content in cotton seed oil by transesterification with methanol (99% pure) and acid catalyst (sulfuric acid-98% pure) in one hour time of reaction at 55°C. Molar ratio of cotton seed oil to methanol was 9:1 and 0.75% catalyst (w/w). In the second stage (alkali-catalyzed), the triglyceride portion of the cotton seed oil reacts with methanol and base catalyst (sodium hydroxide–99% pure), in one hour time of reaction at 65°C, to form methyl ester (biodiesel) and glycerol. To remove un–reacted meth oxide present in raw methyl ester, it is purified by the process of water washing with air–bubbling. The properties of the Test Fuels used in the experiment were presented in Table-3.1. [90].

Property	Units	Diesel	Crude Vegetable Oil	Biodiesel	ASTM Standard
Carbon chain	----	C8–C28	C12–C20	C16–C24	-----
Specific Gravity at 30°C	---	0.84	0.90	0.87	ASTM D 4809
Kinematic viscosity at 40°C	cst	2.25	5.2	4.2	ASTM D 445
Lower calorific value	kJ/kg	42000	37500	37000	ASTM D 7314
Cetane Number	---	55	45	60	ASTM D 613
Preheated Temperature	°C	--	95	60	----

3.2 Introduction to plastic oil

Plastics are mould able polymers which can deform to a very high degree. They are a range of organic compounds which are mostly synthetic, derived from petrochemicals. Some plastics are also semi-synthetic in nature and can be made from renewable materials.

Plastics have found wide varieties of use in wide varieties of industries. They are most used in applications of piping, plumbing and vinyl siding. They are also used in automobiles, furniture and toy industries. Medical equipments have found a lot of uses for plastics.

Due to increase in human population, rapid economic growth and continuous urbanization; the use and production of plastics is also increasing very rapidly. Since plastics have a short lifespan of use, this also means that the plastic wastes are also increasing rapidly. Most of the plastics are non-biodegradable hence if they are dumped into the soil then they are going to stay in that area for hundreds of years and will render that piece of land useless for growing crops and even for the sake of urbanization. If plastics are dumped in the seas then they will float and follow the currents. It has led to accumulation of plastics in various areas of oceans. The accumulation is even as large as size of islands. This poses a threat to the sea life.

Disposal of plastic wastes is a big problem hence it has been recommended time and time again to recycle the plastic materials. Pyrolysis is one way to recycle the plastic material. The basis is that pyrolysis of plastic can be done to produce oil. This oil is then used as a fuel. The method of pyrolysis involves thermal degradation of plastic at different temperatures in the absence of oxygen. Plastic waste raw material is first obtained and then it is pre-treated in order to remain any material which is foreign to the process of conversion of plastic to fuel. In short, impurities are removed from the raw material.

Then the pre-treated raw material is grinded to the required size as desired before inputting the grinded raw material in the reactor, the pyrolysis chamber. The size should be proper so that the reaction is able to occur smoothly and efficiently.

The pyrolysis chamber is loaded with the grinded plastic along with a suitable catalyst in order to promote specific types of chemical reactions. The temperature of the reaction can range from 200-900C based on the quality of the liquid oil desired further down the line as a product. The grinded raw material first gets melted and then it gets vaporized. The vapours are then passed to condensers in series in order to condense it into a liquid. This liquid is the oil but it is further sent for the process of refining. This refined liquid is the desired oil which is used as a fuel. They are also put into category of bio fuels depending on the type of raw material selected. The oil is multipurpose in nature and can also be used in cars.

(i) (ii)

Figure 3.5: Laboratory experimental set-up

Figure : 3.11 Instrument To Checking The Density Of Fluid

Figure 3.12 Overall Set Up Of Experiment In Lords College Of Engineering & Tech

Figure 3.13 AVL 437 Smoke Meter PROB (Source : CBIT)

Figure 3. 14 : AVL 437 Smoke Meter (Source : CBIT)

Figure 3.15 : Overall Set Up Of Experiment (Source : CBIT College Of Engineering)

4-RESULTS & DISCUSSION

4.1 The variation of Break Thermal Efficiency with Break Mean Effective Pressure For Conventional Engine

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Fig.4.1 shows the variation of break Thermal Efficiency with Break Mean Effective Pressure for convention engine with test fuels. break Thermal Efficiency increased with Break Mean Effective Pressure up to 80% of the full load. This is due to improved fuel conversion efficiency and mechanical efficiency. Beyond 80% full load, break Thermal Efficiency decreased with test fuels. This is due to reduction of fuel conversion efficiency, mechanical efficiency, volumetric efficiency and oxygen fuel ratio. break Thermal Efficiency improved with advanced injection timing. This is due to improved atomization . The optimum injection timing for plastic fluid I is 31°bTDC. At recommended injection timing, break Thermal Efficiency decreased with plastic fluid , when compared with diesel. This is due to high viscosity and high duration of combustion of plastic fuel.

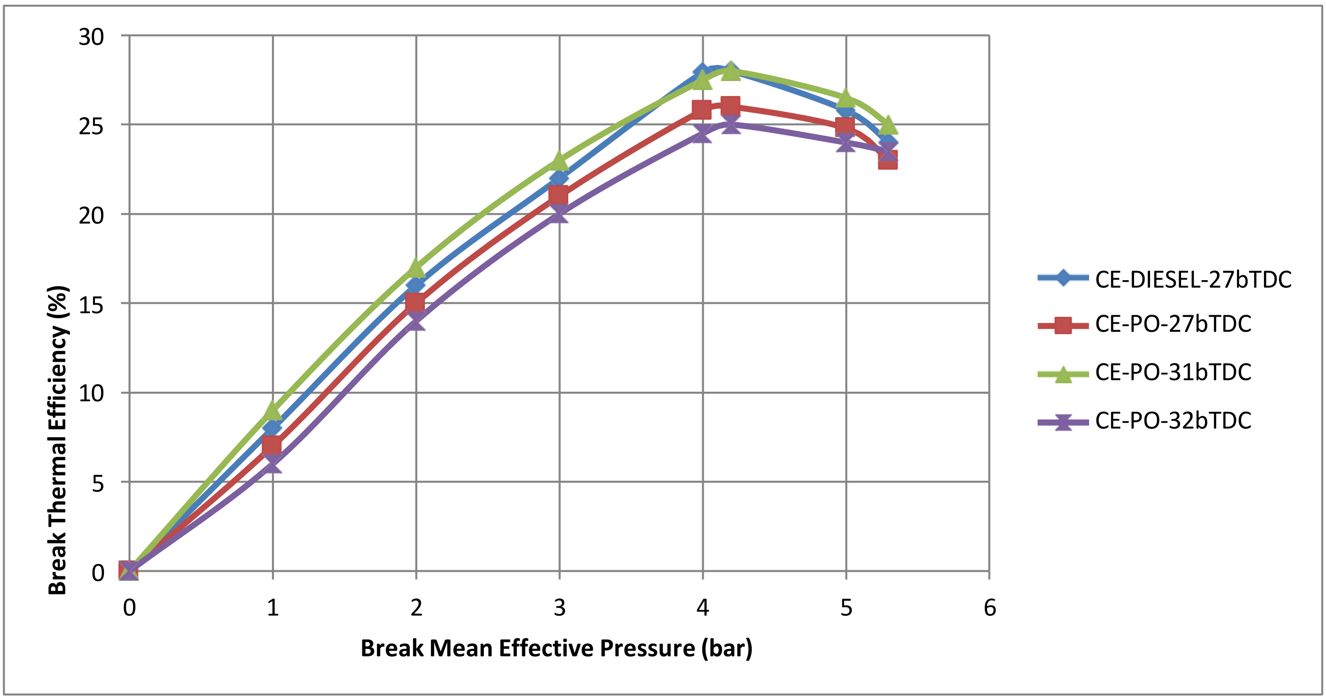


Figure : 4.1 The variation of Break Thermal Efficiency with Break Mean Effective Pressure For Conventional Engine

4.2 The Variation of Break Thermal Efficiency with Break Mean Effective Pressure for Low Heat

Rejection Engine .

Fig.4.2 shows the variation of Break Thermal Efficiency with Break Mean Effective Pressure for Low Heat Rejection Engine with test fuels. Break Thermal Efficiency increased with Break Mean Effective Pressure up to 80% of the full load. This is due to improved fuel conversion efficiency and mechanical efficiency.

Beyond 80% full load, Break Thermal Efficiency decreased with test fuels. This is due to reduction of fuel conversion efficiency, mechanical efficiency, volumetric efficiency and oxygen fuel ratio. Break Thermal Efficiency improved with advanced injection timing. This is due to improved atomization. The optimum injection timing for plastic fluid I is 29° b TDC. At recommended

y (%)

injection timing, Break Thermal Efficiency increased with plastic fluid. when compared with diesel. This is due to high heat release rate, reduction of ignition delay and faster rate combustion with hot environment maintained by Low Heat Rejection Engine. This is also due to turbulence of combustion created by torlite piston.

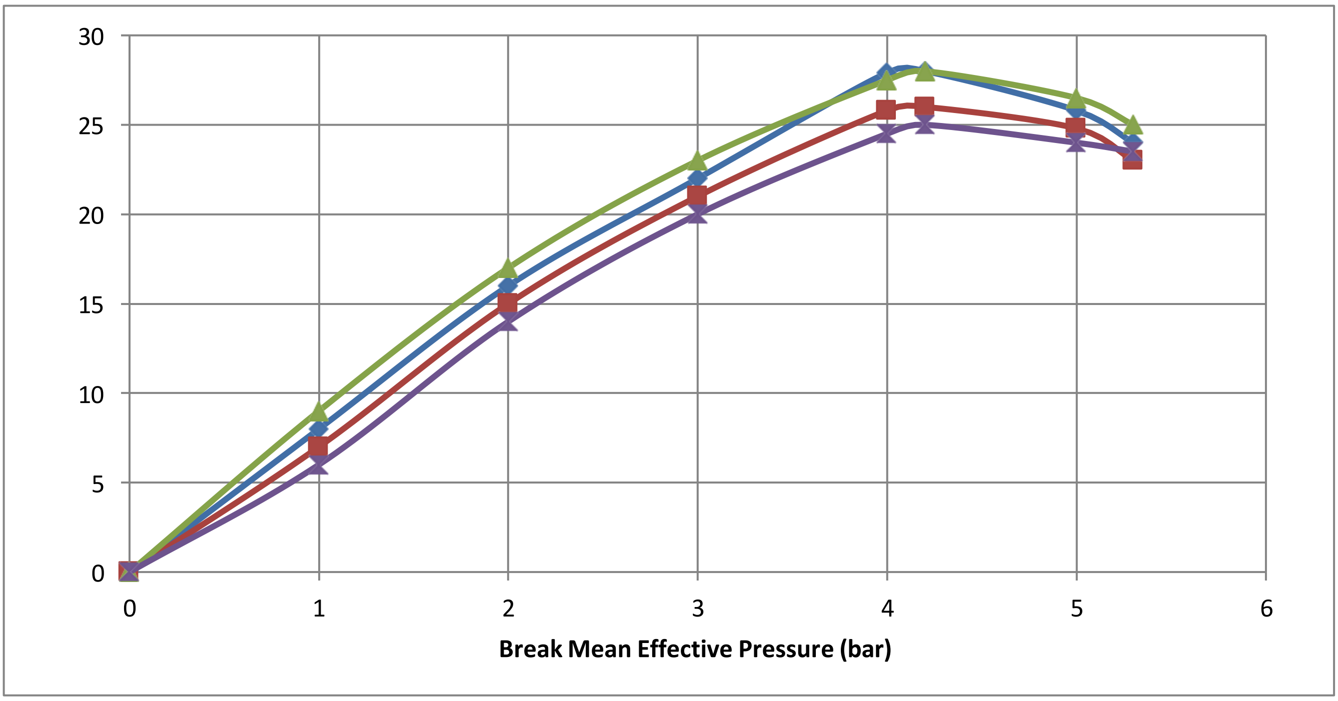


Figure : 4.2 Variation of Break Thermal Efficiency with Break Mean Effective Pressure for Low Heat Rejection Engine .

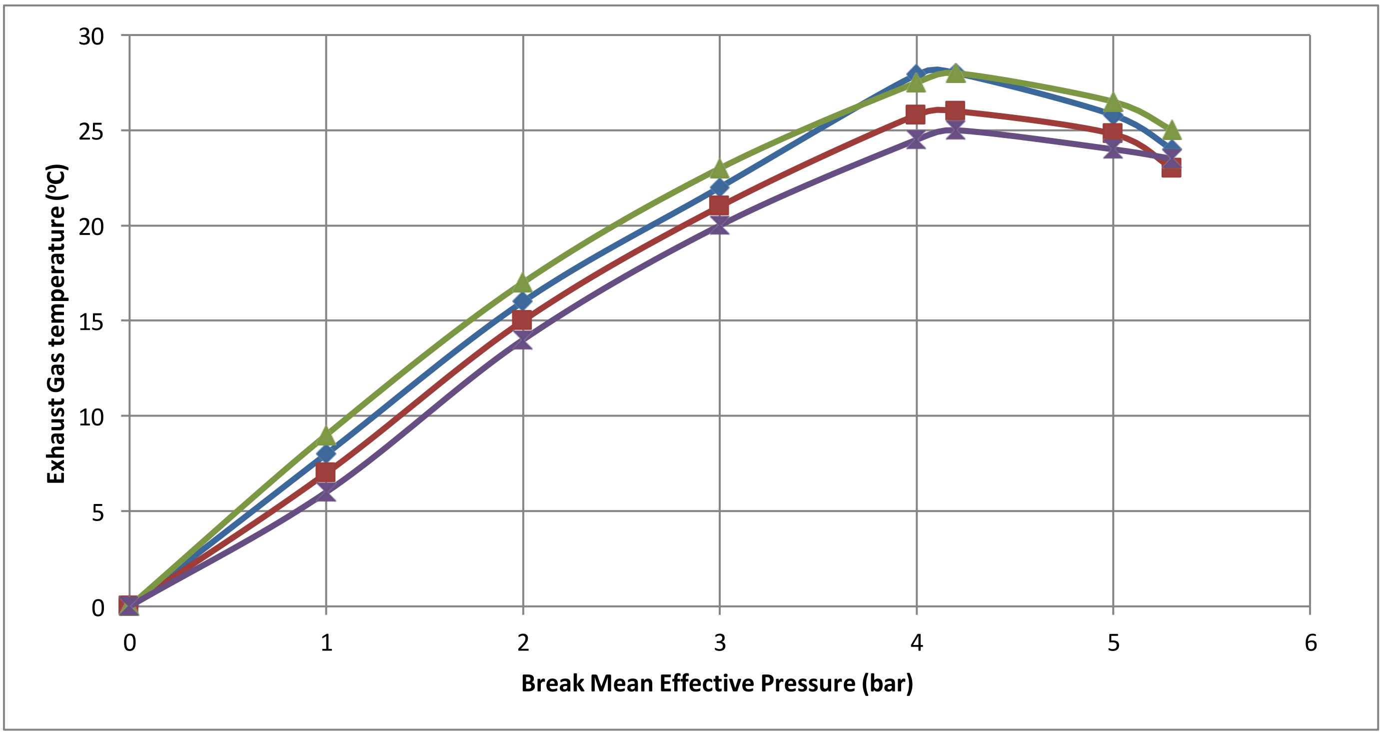
Figures 4.2 shows variation of break thermal efficiency with Break mean effective pressure for the different versions of the engine and recommended and optimum injection timing

The advance injection timing improved the performance of the engine due to improved. Automization characteristics, Low Heat Rejection Engine showed improved break thermal efficiency than conventional engine at recommendation and optimum Injection timing, this is due to improved heat released rate faster rate of burning and reduction of ignition delay.

Figure shows the variation of Exhaust gas temperature with Break mean effective pressure for different versions of engine at recommenced and optimum injection time

Exhaust gas temperature increase with increase in Break mean effective pressure at different operating condition. This is due to increase of gas temperature with increase of increase in mass fuel burning rate. Optimum injection timing reduce Exhaust gas temperature then recommended injection timing due to more expansion of combustion temperature LHR engine shows increase in Exhaust gas temperature due to provision insulation as heat contain in the system itself this is also due increase in turbulence of torlite piston which increase combustion temperature

4.3 The variation of Exhaust gas temperature with Break mean effective pressure for different versions of engine at recommenced and optimum injection time .



4.3 The variation of Exhaust gas temperature with Break mean effective pressure for different versions of engine at recommenced and optimum injection time

4.4 The variation of coolant load with break mean effective pressure for the different versions of the engine and recommended and optimum injection timing.

Figure 4.4 shows variation of coolant load with break mean effective pressure for the different versions of the engine and recommended and optimum injection timing.

Coolant Load increase of Break mean Effective pressure at different operating condition this is due to increase of gas temperature. Optimum injection timing Reduce the coolant load increase with advance injection timing with conventional Engine and reduce with Low Heat Rejection Engine this is due to increase of gas temperature with conventional engine and reduction of conventional engine with Low Heat Rejection Engine engine improve combustion Low Heat Rejection Engine engine show drastically reduction in coolant load then conventions engine due to the provision of thermal insulationn and also improve in combustion

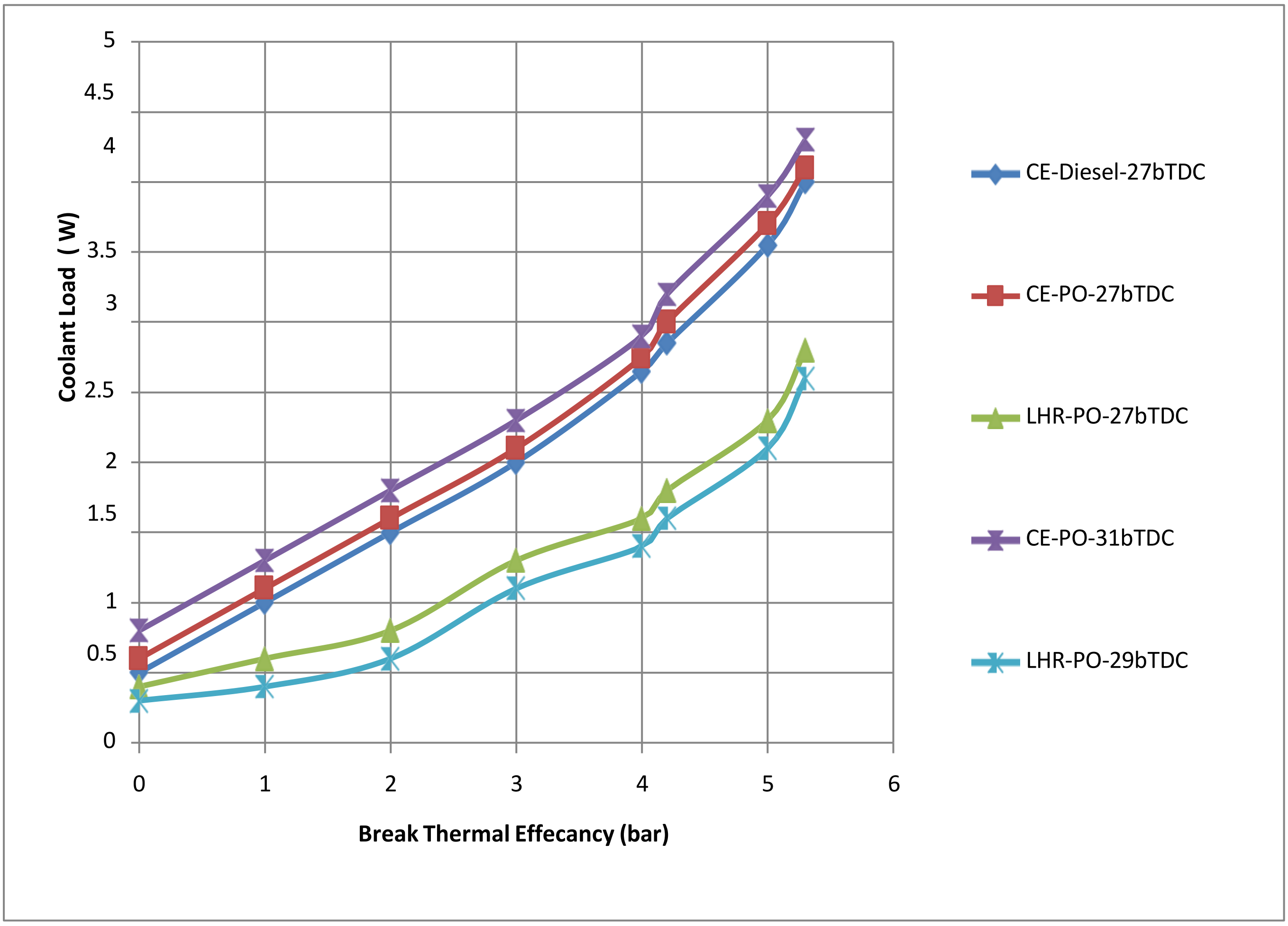


Figure 4.4 : variation of coolant load with break mean effective pressure for the different versions of the engine and recommended and optimum injection timing.

4.5 The variation of volumetric efficiency with break mean effective pressure for the different versions of the engine and Recommended and optimum Injection timing

Figures 4.5 Shows variation of volumetric efficiency with break mean effective pressure for the different versions of the engine and Recommended and optimum Injection timing .

Volumetric efficiency decrease with increase in Break mean effective pressure due to increase of gas temperature and increase of combustion wall temperature and also un burn fuel concentration at different operation condition of the engine advance injection timing increase volumetric high efficiency marginally for both version of the engine due to improve atomization characteristic Low Heat Rejection engine drastically reduce volumetric efficiency due to heating of air with hot insulated component of the Low Heat Rejection engine.

4.6 The variation. Of NOx with break mean effective pressure for the different versions of the engine and recommended and optimum Injection timing.

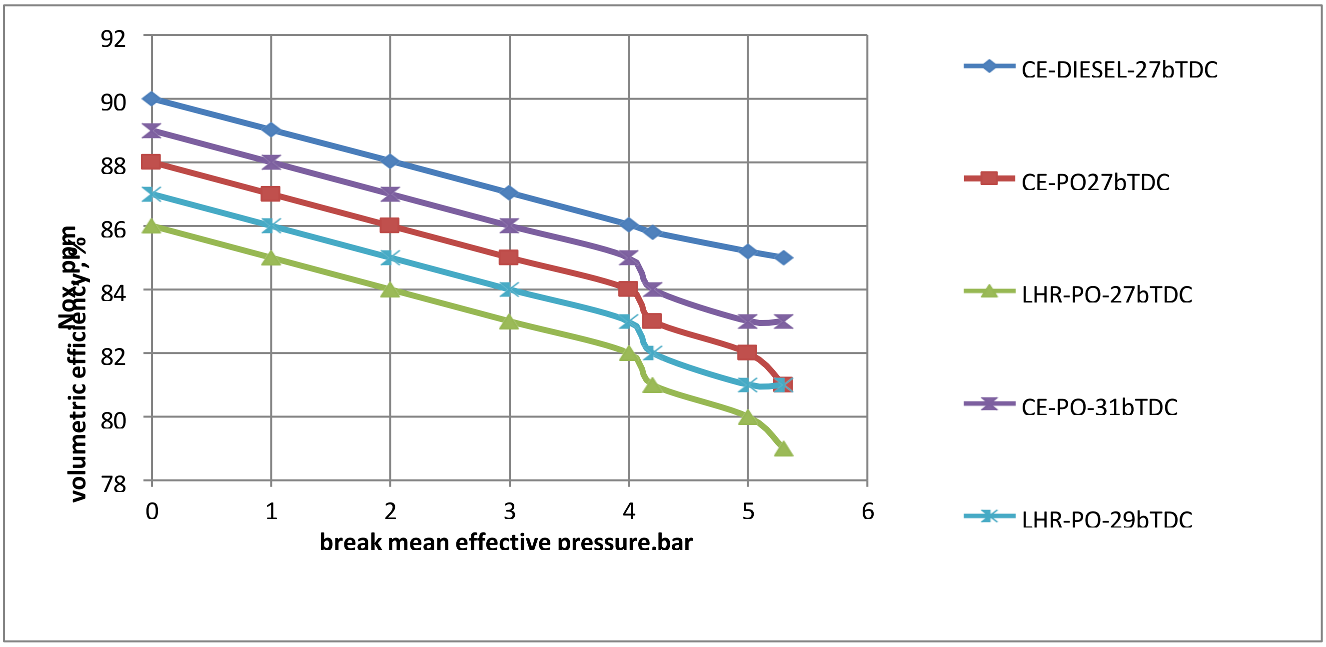


Figure 4.5 : variation of volumetric efficiency with Break mean effective pressure for the different versions of the engine and Recommended and optimum Injection timing .

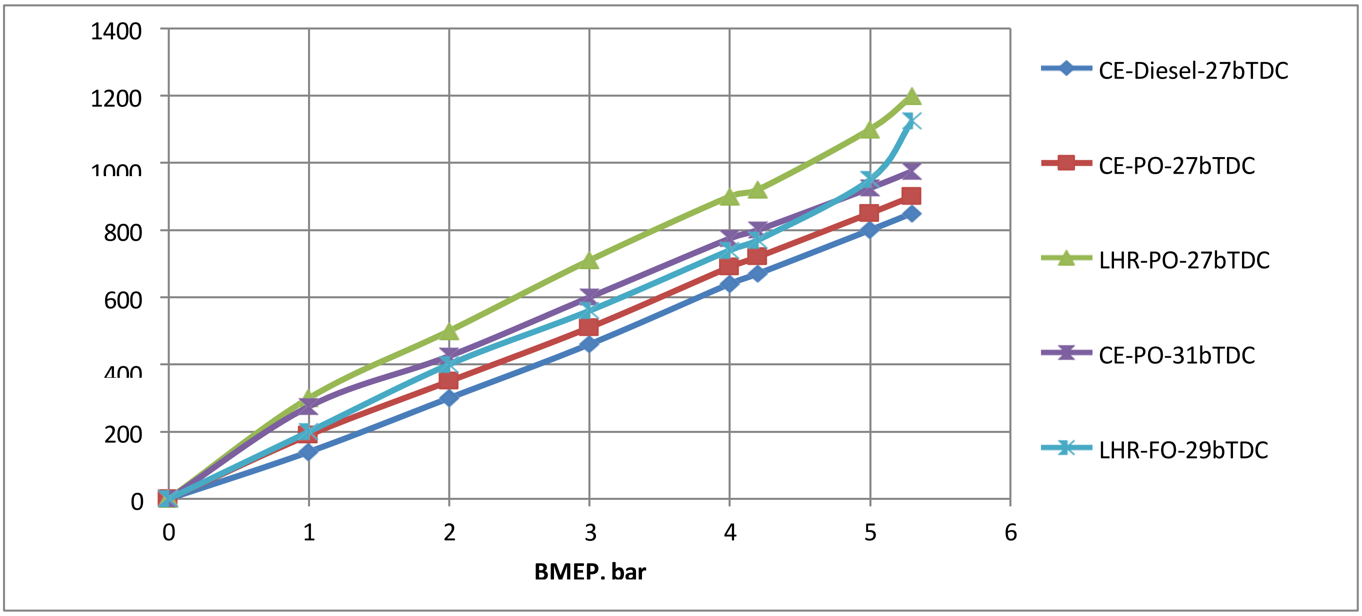
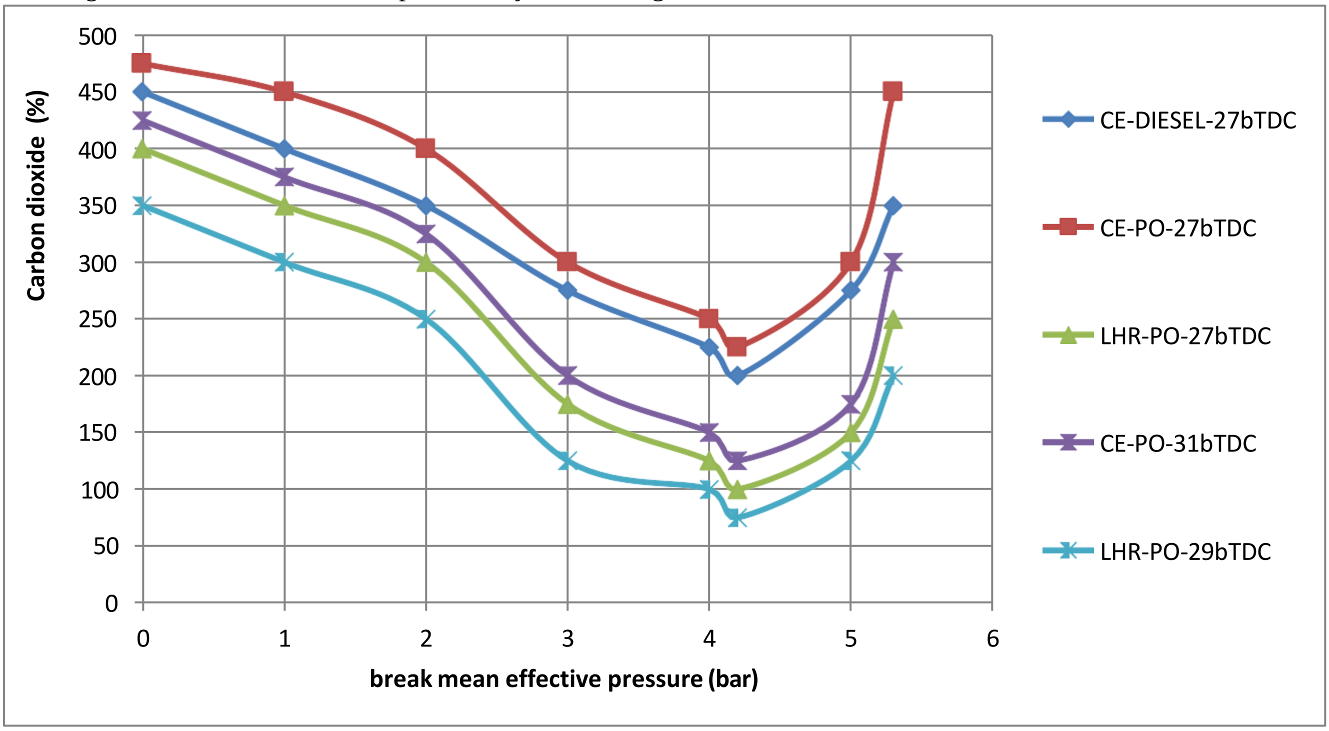


Figure 4.6 : variation. Of NOx with break mean effective pressure for the different versions of the engine and recommended and optimum Injection timing.

Figures 4.6 shows variation. Of NOx with break mean effective pressure for the different versions of the engine and recommended and optimum Injection timing. Co is due to incomplete combustion of fuel .

NOx emission increase with increase of BMEP for two different version of engine . At different injection timing NOx depend up on availability of oxygen and temperature as BMEP increase gas temperature as to increase NOx Advanced injection timing increase for conventional engine while they decrease with LHR. This is due to increase of residential timing of conventional Engine and improve combustion with LHR however LHR engine increase NOx drastically than conventional engine due to faster rate of combustion, high turbulence, high heat rate. Release Reduction of ignition delay.

4.7 The variation. Of Carbon dioxide with break mean effective pressure for the different versions of the engine and recommended and optimum Injection timing.



Figures 4.7 variation. Of Carbon dioxide with break mean effective pressure for the different versions of the engine and recommended and optimum Injection timing.

Carbon dioxide emission decrease up to 80% of the load and beyond the load their increase with Conventional engine and Low Heat Rejection engine. both version of engine at different injection timing. Carbon dioxide emission is observed higher at no load for two different version of the engine at different injection timing this is due to reduce the dilution of exhaust gases and the chat leading to avoid this condition more amount of fuel is burn at the inlet manifold causing increase of rich mixture and reduction of Oxygen quantify at 80%. Of the load co emission observe to be very. much lower due to increase of thermal efficiency at full load the vehicle gain power therefore more amount of fuel is burn give rise to more amount of co. Low Heat Rejection engine. reduce co emission. Than Conventional engine due to improve in combustion because of the turbulence created by torlite piston and good amount heat release rate advance injection timing reduce co emission due to improve in automization characteristics.

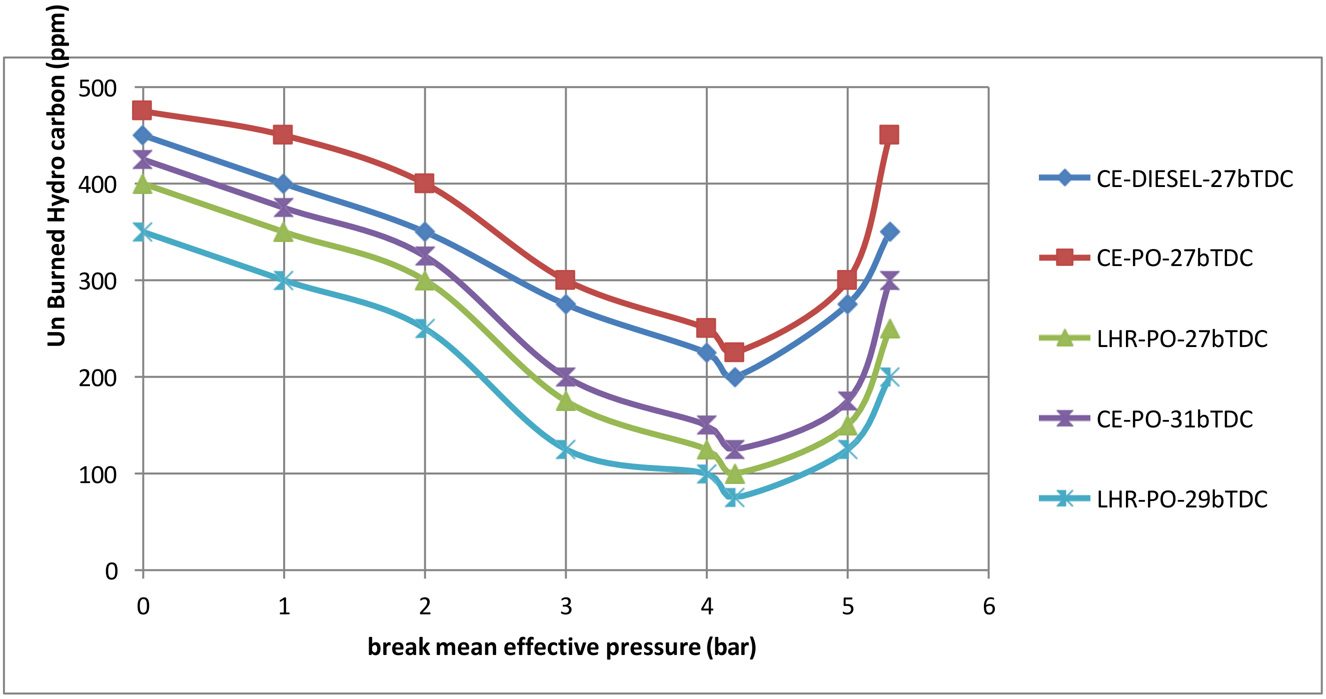


Figure 4.8 : variation. Of Un Burned Hydro carbon with break mean effective pressure for the different versions of the engine and recommended and optimum Injection timing.

Figures shows variation. Of Un Burned Hydro carbon with break mean effective pressure for the different versions of the engine and recommended and optimum Injection timing.

Un Burned Hydro carbon is due to formation of the fuel particle crevice volume. Un Burned Hydro carbon is also due to incomplete combustion of fuel. Un Burned Hydro carbon follow similar trends as that of co at no load Un Burned Hydro carbon emission observe to be higher 80% of the varied load and at full load there are very much high advance injection timing improve combustion with both version of engine due to improve in automization characterises LHR engine reduce Un Burned Hydro carbon emission effectively then convectional engine due to fuel settle on crevice volume will be burn effectively with high heat release rate improve combustion with high turbulence create by Torlite piston.

4.8 the variation of peak pressure with different version of the engine with different injection timing

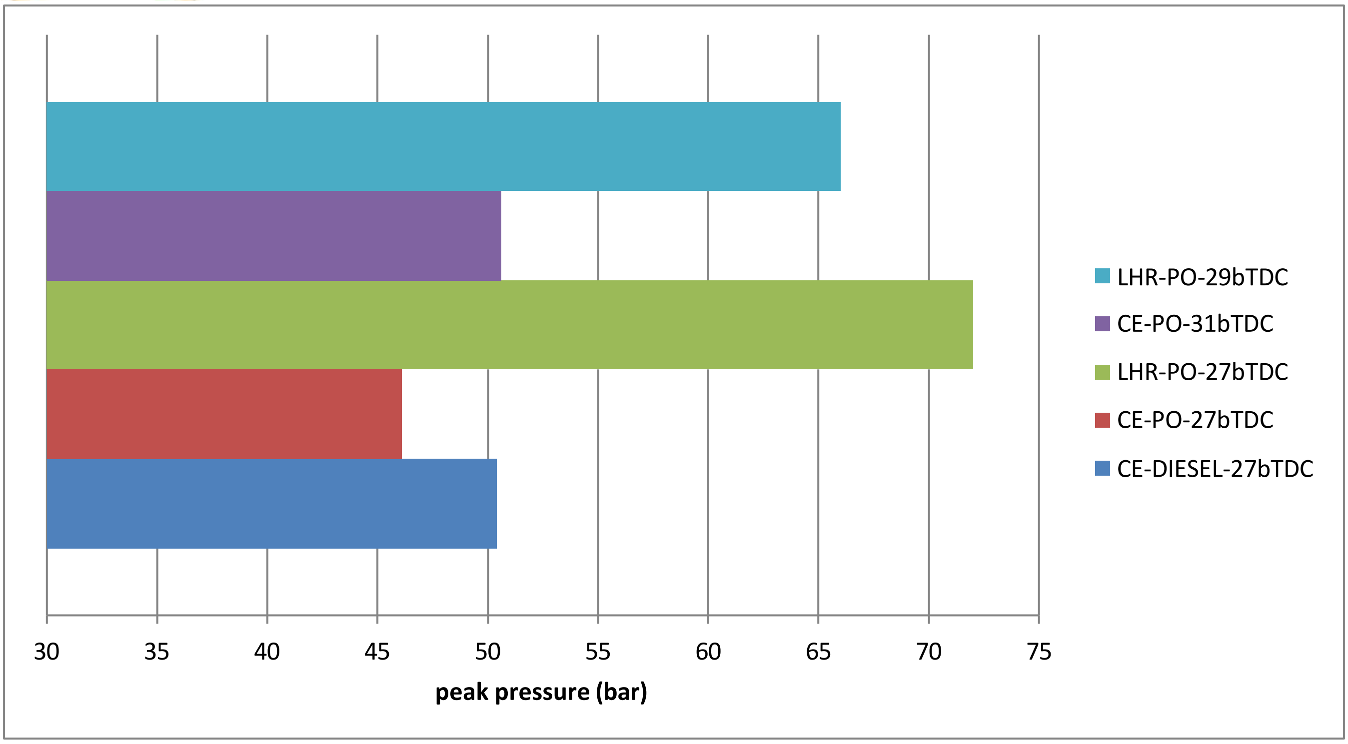


Figure 4.9 the variation of peak pressure with different version of the engine with different injection timing

Bar Chart present bar chart showing the variation of peak pressure with different version of the engine with different injection timing .

Peak pressure are marginally comparable with plastic fluid with diesel. The heat input his given in term of density of the fluid and calorific value since density and calorific value of the fuel are comparable with diesel fuel there for the peak pressure is comparable with advance injection timing the peak pressure increase marginally with Conventional engine and reduce with LHR engine this is due to increase of resident time with convectional engine and improve combustion with LHR engine leading to reduce combustion temperature and combustion pressure LHR engine increase peak pressure at full load drastically with high heat reduce rate faster rate of combustion, reduction of ignition delay and faster rate of turbulence created by Torlite piston.

4.9 Maximum rate of pressure rise Bar Chart present bar chart showing the variation of peak pressure with different version of the engine with different injection timing

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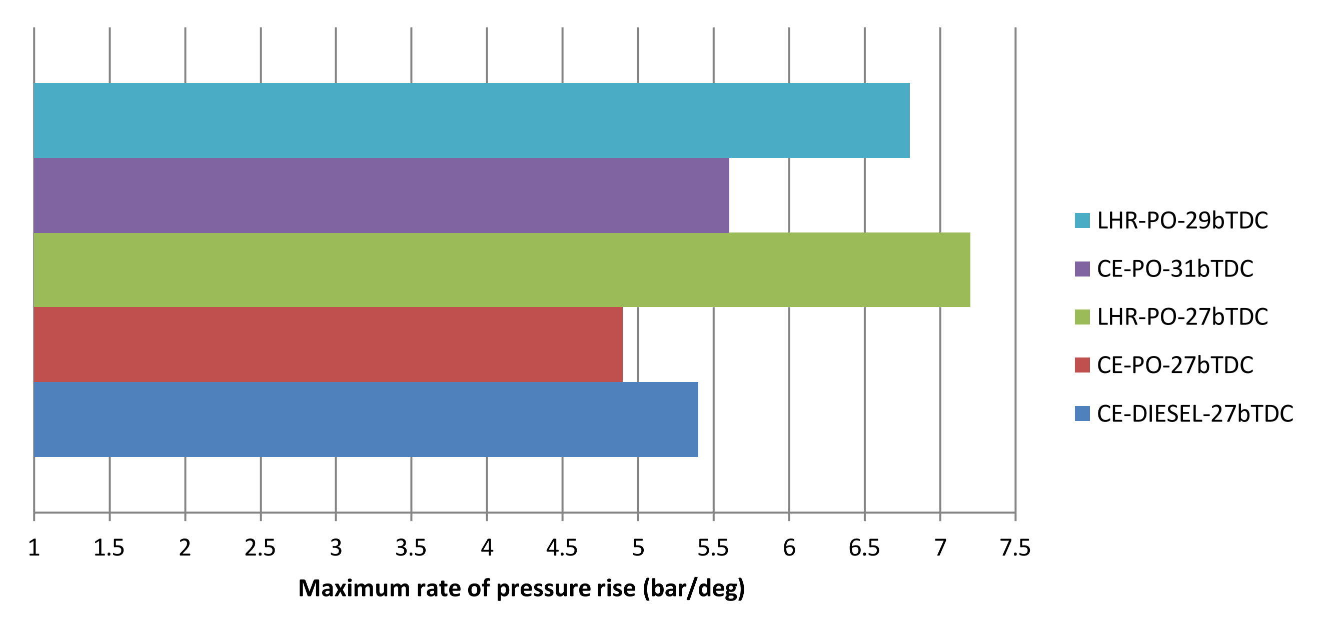

Figure 4.10 : Maximum rate of pressure rise Bar Chart present bar chart showing the variation of peak pressure with different version of the engine with different injection timing

Maximum rate of pressure rise Bar Chart present bar chart showing the variation of peak pressure with different version of the engine with different injection timing .

Maximum rate of pressure rise follow similar trends with peak pressure at full load Maximum rate of pressure rise increase with convectional engine and marginally reduce with LHR engine. LHR engine drascially increase with Maximum rate of pressure rise engine than conventional engine TOPP at recommended injection timing with conventional engine with plastic fuel marginally greater than diesel fuel this is due to increase of viscosity and duration of the combustion and LHR engine at recommended injection timing.

Show sustained reduction in Time of occurrence Of Peak Pressure than diesel fuel due to improve in combustion with high heat release rate advance injection timing with both version of the engine with plastic fuel reduce Time of occurrence Of Peak Pressure due to improve in automization characteristics. LHR engine can be conventionally used with plastic fuel as alternative fuel.

6-CONCLUSIONS

Conclusions were drawn after conducting experiments, while discussions were made based on results. These conclusions were based on type of the configuration, test fuels, injection timing, super charging and injection pressure.

1. LHR engine improved performance over conventional engine in terms of peak BREAK THERMAL EFFICIENCY BSEC at full load, marginally increased EXHAUST GAS TEMPERATURE at all loads, decreased volumetric efficiency and coolant load at all loads. It decreased particulate emissions, CO levels, UBHC emissions at full load and increased NOx levels. LHR engine increased PP at full load, MRPR at full load and

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reduced TOPP at full load in comparison with CE

2. Combustion Improved with Turbulent Created By torlite pistons

3. Plastic fuel improved performance in terms of performance parameters, pollution levels and combustion characteristics marginally in comparison with diesel fuel with different operating conditions. This is due to blending of DEE, as DEE improved cetane number and reduced viscosity of the oil.

4. Advanced injection timing improved performance in terms of performance parameters, pollution levels and combustion characteristics in comparison with diesel fuel with different operating conditions. This is due to blending of DEE, as DEE improved cetane number and reduced viscosity of the oil. This is due to improved atomization characteristics of the fuel.

5. Supercharging improved performance in terms of performance parameters, pollution levels and combustion characteristics in comparison with out supercharging with different operating conditions. This is due to containing oxygen which promotes combustion and increase of volumetric efficiency.

6. Increased injection pressure improved the performance, pollution levels and combustion characteristics of the engine due to improved spray characteristics of the fuel.

7. The ceramic coating on the cylinder head helps in reducing heat transfer to the coolant and enhances thermal efficiency. This can lead to better combustion and reduced energy loss, resulting in improved overall engine performance.

8. Plastic fuel improved the workability parameters, reduced workability exhausts and improved the parameters when compared to diesel operation.

9. The addition of a supercharger increases the amount of air/fuel mixture entering the cylinders, thereby enhancing power output. The combination of a ceramic- coated cylinder head and a supercharger can deliver significant gains in engine performance, especially in terms of horsepower and torque.

10. The SCRT technology incorporated in the exhaust system can effectively reduce harmful emissions such as nitrogen oxides (NOx), particulate matter (PM), and other pollutants. This helps in meeting stringent emissions regulations while maintaining engine performance.

11. Ceramic coatings offer superior resistance to wear, corrosion, and high- temperature environments. The coating on the cylinder head can improve its durability and prolong the engine's lifespan.

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