A Review Study on Experimental Investigation on Improving Thermal Performance of IC Engine By Varying The Piston Coating And Using Biodiesel as a Blend

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Abstract- *This paper is based on the general overview about previous research papers to improve the performance and emission characteristics of an IC engine using different ceramic coating and biodiesel blend. In the modern world automobile manufacturer industry may not produce an effective performance of IC engine. Because of the major reason is, when the friction would be developed at the high speed working condition of an IC engine. Due to this mechanical components are piston, connecting rod, cylinder head, valves and crankshaft are mainly affected and reduced the life span. However it is very difficult to avoid this problems but minimize the problem based on applying the different ceramic coating on the surface of mechanical components, also improve the emission characteristic and reduce the specific fuel consumption of an IC engine by using an effective biodiesel.*

Keywords- Thermal Barrier Coating, Piston crown, Biodiesel Blend, Emission, and Diesel Engine.

I. INTRODUCTION

As we know that the function of a piston is to compress the air during the compression stroke and transmit power to the crank through connecting rod during the expansion stroke. When the piston is generally made up of cast iron, aluminum etc. The thermal expansion coefficient of the piston made from aluminum alloy material is greater than the thermal expansion coefficient of cast iron. When combustion of fuel takes place inside the cylinder into C.I. engine, high heat is generated. 30% of the heat supplied is lost through the coolant and 30% is wasted against friction and other losses, thus remaining 30% of heat can be utilized for working purpose. It will lead to increase the fuel consumption and reduce the thermal efficiency. In nowadays the demand for diesel engines increases, people use it for transportation and also in agriculture; therefore the environment becomes more polluted. The automobile industries are facing a serious challenge to increase the fuel efficiency and do hard work to reduce the emission. So many research works are continuing on the alternate fuel of diesel engine or efficient use of a diesel fuel into the diesel engine. There are so many methods are used to improve the efficiency of the diesel engine and reduced fuel consumption. For this purpose, one of the technologies is used that is ceramic ally coated IC engine. It is also known as Thermal barrier coating (TBC) or low heat rejection engine (LHR).

A. LIST OF COATING METHODOLOGY

- Physical Vapor Decomposition (PVD)
- Chemical Vapor Decomposition (CVD)
- Splash Coating
- Electron Beam Evaporation Coating
- Flame Spray (FS)
- Plasma Spray (PS)

In the above mention coating methodology, Plasma coating are widely used.

PLASMA SPRAY COATING

Plasma spraying techniques are coating processes in which melted materials are sprayed onto a surface. The "feedstock" (coating precursor) is heated by electrical (plasma or arc) or chemical means (combustion flame). Thermal spraying can provide thick coatings (approx. thickness range is 20 micrometers to several mm, depending on the process and feedstock), over a large area at high deposition rate as compared to other coating processes such as electroplating, physical and chemical vapor deposition. Coating materials available for thermal spraying include metals, alloys, ceramics, plastics and composites. They are fed in powder or wire form, heated to a molten or semi molten state and accelerated towards substrates in the form of micrometer-size particles. Combustion or electrical arc discharge is usually used as the source of energy for thermal spraying. Resulting coatings are made by the accumulation of numerous sprayed particles. The surface may not heat up significantly, allowing the coating of flammable substances. Coating quality is

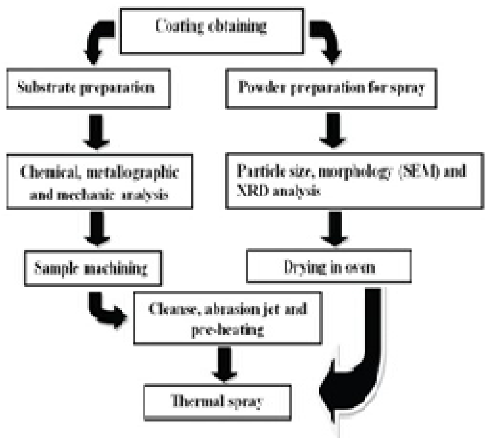

Figure 1. Plasma Spray Coating

usually assessed by measuring its porosity, oxide content, macro and micro-hardness, bond strength and surface roughness. Generally, the coating quality increases with increasing particle velocities.

B. MATERIALS USED FOR THERMAL BARRIER COATING IN ENGINE

The selection of coating materials is restricted by some basic requirements. They are the high melting point, no phase transformation between room temperature and operation temperature, low thermal conductivity, chemical inertness, thermal expansion, good adherence to the substrate and low porosity. So for only a few materials are found. Those Ceramics Materials which are used for Thermal Barrier Coating below.

ZIRCONATES

It has low sintering activity, low thermal conductivity, high thermal expansion coefficient and good thermal cycling resistance. The main disadvantages are the high thermal expansion coefficient which results in residual stress in the coating, and this can cause coating delamination.

YITTRIA STABILIZED ZIRCONIA

It has high thermal expansion coefficient, low thermal conductivity, and high thermal shock resistance. Disadvantages of yttria-stabilized zirconia are sintering above 1470 K, phase transformation at 1443 K, corrosion and oxygen transparent.

MULLITE

It has low density, high thermal stability, stability in severe chemical environments, low thermal conductivity and favorable strength and creeps behavior. It has higher thermal conductivity and lower thermal expansion and is much more oxygen resistant than yttria-stabilized zirconia. The low thermal expansion coefficient of mullite than yttria stabilized zirconia in high thermal gradients and under thermal shock conditions. However, the large mismatch in thermal expansion coefficient with metallic substrate leads to poor adhesion. The other disadvantage of mullite is crystallization at 1023-1273K.

ALUMINA

Alumina has high hardness and chemical inertness .It has high thermal conductivity and low thermal expansion coefficient compared with yttria-stabilized zirconia. AS well as alumina alone is not a good thermal barrier coating, its addition to yttrium stabilized zirconia can increase the hardness of the coating and improve the oxidation resistance of the substrate. The main problem of alumina is phase transformation at 1273K, high thermal conductivity and very low thermal expansion coefficient.

SPINEL

Spinel has very good high temperature and chemical properties, its thermal expansion coefficient prevents its II-176 usage as a reliable choice for thermal barrier coatings.

C. BENEFITS OF CERAMIC COATED PISTON

- Resistant to high temperatures
- High chemical stability
- High hardness values
- Low densities
- Resistant to wear
- Low heat conduction coefficient
- High compression strength
- Reduction in friction
- Improvements occur at emissions.
- Increased effective efficiency,
- Increased thermal efficiency
- Reduced specific fuel consumption,
- Improved reliability,
- Smaller size,
- Lighter weight,

- Reduce the heat removed by the cooling system
- Reduction knocking and noise caused by combustion
- Increase the life of component.

D. APPLICATION OF CERAMIC COATED PISTON

- IC Engine
- Reciprocating compressor
- Turbocharger
- Missile Rockets
- Nozzle
- Turbine blade
- Surgical Equipment's.

E. MOST COMMONLY USED BIODIESEL BLEND

JATROPHA

Jatropha is a genus of flowering plants in the spurge family, Euphorbiaceous, Jatropha species have traditionally been used in basket making, tanning and dye production. In the 2000s, one species, Jatrophacurcas, generated interest as an oil crop for biodiesel production.

Uses:

It is also used as a house plant. The oil from Jatrophacurcas is mainly converted into biodiesel for use in diesel engines. The cake resulting from oil extraction, a protein-rich product, can be used for fish or animal feed.

KEROSENE

Kerosene, also known as paraffin, lamp oil, and coal oil (an obsolete term), is a combustible hydrocarbon liquid which is derived from petroleum, widely used as a fuel in industry as well as households. Paraffin wax is a waxy solid extracted from petroleum.

Uses:

Paraffin wax is a waxy solid extracted from petroleum. Kerosene is widely used to power jet engines of aircraft (jet fuel) and some rocket engines and is also commonly used as a cooking and lighting fuel and for fire toys.

NEEM

Neem oil is a vegetable oil pressed from the fruits and seeds of the neem (Azadirachta indica), an evergreen tree which is endemic to the Indian subcontinent and has been introduced to many other areas in the tropics.

Uses:

Neem oil has been used in traditional folk medicine and as a home remedy for acne because of the aspirin-like compound that helps rid the skin of bacteria. It also helps reduce redness and inflammation. The high fatty-acid content in neem oil is said to prevent and treat scars from acne and is non-comedogeni.

COTTON SEED

Definition of cottonseed oil. :a fatty oil that is obtained from cottonseed, is pale yellow after refining, contains principally glycerides of linoleic, oleic, and palmitic acids, and is used chiefly in salad and cooking oils and after hydrogenation in shortenings and margarine.

Uses:

This vegetable oil is frequently used for frying, deep-frying, and baking. Because of its neutral taste, cottonseed oil is said to enhance the natural taste of food, unlike other oils.

F. BENEFITS OF BIODIESEL BLENDS

- Ease to use.
- Power performance and economy.
- Emission and green house reduction.
- Energy balance security.
- Economic development.
- Renewable fuel, obtained from vegetable oils or animal fats.
- Low toxicity, in comparison with diesel fuel.
- Degrades more rapidly than diesel fuel, minimizing the environmental consequences of biofuel spills.
- Lower emissions of contaminants: carbon monoxide, particulate matter, polycyclic aromatic hydrocarbons, aldehydes.
- Lower health risk, due to reduced emissions of carcinogenic substances.
- No sulfur dioxide (SO2) emissions.
- Higher flash point (100C minimum).

G. DRAW BACKS OF BIODIESEL BLENDS

- Slightly higher fuel consumption due to the lower calorific value of biodiesel.
- Slightly higher nitrous oxide (NOx) emissions than diesel fuel.

- Higher freezing point than diesel fuel. This may be inconvenient in cold climates.
- It is less stable than diesel fuel, and therefore long-term storage (more than six months) of biodiesel is not recommended.
- May degrade plastic and natural rubber gaskets and hoses when used in pure form, in which case replacement with Teflon components is recommended.

H. ESTERIFICATION PROCESS

The chemical reaction of producing biodiesel is a biodiesel esterification. Animal and plant fats and oils are typically made of triglycerides which are esters of free fatty acids with the trihybrid alcohol, glycerol. In the transesterification process, the alcohol is deprotonated with a base to make it a stronger nucleophile. Commonly, ethanol or methanols are used. Normally, this reaction will proceed either exceedingly slowly or not at all. Heat, as well as an acid or base are used to help the reaction proceed more quickly. It is important to note that the acid or base are not consumed by the transesterification reaction, thus they are not reactants but catalysts. Almost all biodiesel is produced from virgin vegetable oils using the base-catalyzed technique as it is the most economical process for treating virgin vegetable oils, requiring only low temperatures and pressures and producing over 98% conversion yield (provided the starting oil is low in moisture and free fatty acids). However, biodiesel produced from other sources or by other methods may require acid catalysis which is much slower.

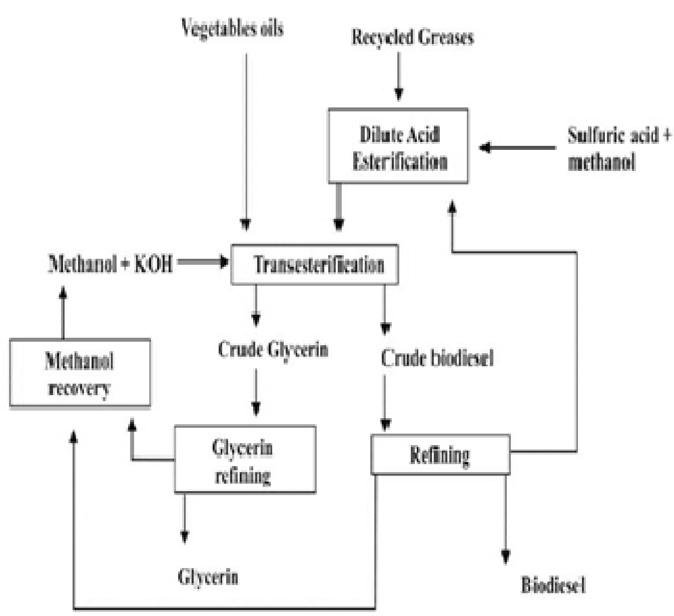

Figure 1. Esterification Process

II. LITERATURE REVIEW

(2010) In [1], Tadeusz Hejwowski introduced a Comparative Study of Thermal Barrier Coatings for Internal Combustion Engine (2010). The goal of this paper has used the investigation of thermal fatigue resistance of thermal barrier coatings (TBC). Two groups of double-layered thermal barrier coatings (TBC) were investigated: plasma sprayed with ZrO_2-8%Y_2O_2, Al_2O_3-40%TiO_2 or Al_2O_3-40%ZrO_2 top coats and powder flame sprayed with ZrO2-30%CaO, Al_2O_3-40%TiO2 and Al2O3-30%MgO. Flame sprayed coatings were found more to damage than plasma sprayed ones. The highest thermal fatigue resistance revealed TBC plasma sprayed with PSZ.Phase stability of plasma sprayed Al_2O_{3}-40%TiO_2 was evaluated by means of X-ray diffraction method. Thermal growth of oxides at the top coat/bond coat is best for the composition of Al_2O_3-40%TiO_2 were found. It improves the diesel engine performance.

(2013) In [2], Helmisyah Ahmad Jalaludina, Shahrir Abdullahb, Mariyam Jameelah Ghazalib, Bulan Abdullahc, Nik Rosli Abdullah introduced an Experimental Study of Ceramic Coated Piston Crown for Compressed Natural Gas Direct Injection Engine. The main objective of this paper, when the heat flux how differ from coated and uncoated piston, why the heat flux varies .what's the purpose of reducing heat flux. In CNGDI engine produces high temperature leads to thermal stress. Without appropriate heat transfer mechanism, the piston crown would operate ineffectively. In this paper work, bonding layer NiCrAl and yttria partially stabilized zirconia (YPSZ) was plasma sprayed onto AC8A aluminum alloy CNGDI piston crowns and normal CamPro piston crowns in order to minimize thermal stresses. Many samples were deposited with NiCrAl bonding layers prior to coating of YPSZ for comparison purpose with the uncoated piston. High temperature against the performance was tested using a burner rig. The temperatures on the top of the piston crown and piston underside were measured. Finally, they calculated the heat flux in all condition. In short, the YPSZ/ NiCrAl coated CNGDI piston crown experienced the least heat fluxes than the uncoated piston crowns and the coated Campo piston crown, giving extra protection during combustion operation.

(2017) In [3], Hiregoudar Yerrennagoudarua, Manjunath introduced a Combustion Analysis of Modified Inverted M Type Piston for Diesel Engine with Platinum Coating and without Coating by Using CFD. In this paper, we understand the nature of the flows and combustion in internal combustion engines are important for improving engine performance. When the flows in IC engines can be characterized by swirl, tumble, and compression in the cylinder. In this flow, motion has a strong influence on the engine combustion process and hence on the engine emission of pollutants. By using Computational Fluid Dynamics codes are used in the development and optimization of new engines by car manufacturers (automotive industry). The in-cylinder fluid motion in internal combustion engines is one of the most important factors controlling the combustion process. Tumble and swirl are well- known approaches for in-cylinder flow enhancement. Tumble and swirl are generated in the intake stroke as a result of the inlet port shape and orientations. In this paper, the Conventional and Modified Piston is designed in the Unigraphics software and analyzed in the analysis software. Compare temperature in the conventional piston and Modified Piston, during analysis Conventional piston means without ceramic and platinum coating, Modified piston means with without ceramic and platinum coating and for these pistons Swirl ratio, Tumble ratio Y, Cross Tumble Ratio graphs have drawn. Finally compare the results obtained for Conventional and Modified Piston in terms of temperature, Swirl ratio, Tumble ratio Y, Cross Tumble Ratio.

(2016) In [4], Ravindra Gehlot N, Brajesh Tripathi introduced a Thermal Analysis of Holes Created on Ceramic Coating for Diesel Engine Piston.They deals with respect to time for thermal analysis of piston coated engine with a ceramic coating having holes on its surface. When temperature distribution on the piston's top surface and the substrate surface is investigated by using finite element based software called Ansys. Yttria-stabilized Zirconia is used as the ceramic coating on Al–Si piston crown. The two layer of thickness ceramic top coating is about 0.4 mm and for the NiCrAl bond coat, it is taken to be 0.1 mm.The temperature profile is investigated by choosing various radiuses of holes created on the ceramic coating surface about 2.5 mm, 2 mm and 1.5 mm. From the results we observed that the top surface (coated surface) temperature is increasing with increase the radius of the holes. The maximum temperature of the coated surface occurs for highest whole radius of about 2.5 mm.Although, the substrate temperature is decreasing with increase the radius of the holes.

(2016) In [5], Erdinç Dural, Bülent Özdalyan, Serkan Öze introduced an Experimental Investigation on Effect of the Zirconium + Magnesium Coating of the Piston and Valve of the Single-Cylinder Diesel Engine to the Engine Performance and Emission .The four-stroke single cylinder diesel engine has been used in this study, the pistons and valves of the engine have been stabilized, the aluminum oxide (Al_2O_3) in different ratios have been added in the power of zirconium (ZrO_2) magnesium oxide (MgO), and it has been coated with the plasma spray method. The pistons and valves of the combustion chamber of the engine are coated with 5 different (ZrO_2 + MgO), (ZrO2 + MgO + 25% Al_2O_3), (ZrO_2 + MgO + 50% Al2O_3), (ZrO_2 + MgO + 75% Al2O_3), (Al_2O_3) sample. The material tests have been made for each of the coated engine parts with the scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDX) and X-ray diffraction (XRD) using Cu Kα radiation surface analysis methods. The tests had been repeated for each sample in any electric dynamometer in full power 1600 rpm, 2000 rpm, 2400 rpm and 2800 rpm engine speeds. The material analysis and engine tests have shown that the best performance has been performed with (ZrO_2 + MgO + 50% Al_2O_3).There is no significant change in HC, but increased in emission of NOx, as the engine improves power, torque, specific fuel consumption and CO emissions in the tests made with sample A3.

(2014) In [6], G. Sivakumar, S. Senthil Kumar introduced an Investigation on the effect of Yttrium Stabilized Zirconia coated piston crown on performance and emission characteristics of a diesel engine. An experimental investigation is carried out under different loading conditions in a three-cylinder diesel engine with its piston crown coated with Yttria Stabilized Zirconia (YSZ) to understand the effect of TBC on performance and emission characteristics in comparison with baseline engine characteristics. YSZ has chosen as the candidate material for coating the piston crown because of its desirable physical properties such as high coefficient of thermal expansion, low thermal conductivity, and stable phase structure at higher temperature conditions. Experimental results revealed that the heat loss to the cooling water is reduced up to 5–10% and the thermal efficiency is increased by 3–5% with reduction of brake specific fuel consumption by up to 28.29%. Experimental results also revealed that Hydro carbon (HC) emission is reduced up to 35.17%, carbon monoxide (CO) by up to 2.72% and Carbon di-oxide (CO_2) emission is increased by up to 5.6%.

(2016) In [7], Ahmed I. EL-Seesya, Ali K. Abdel-Rahmana, Mahmoud Badya, and S. Ookawarab introduced a Influence of Multi-Walled Carbon Nano tubes Additives into Non-Edible Biodiesel-Diesel Fuel Blend on Diesel Engine Performance and Emissions .This paper reports on an experimental investigation that was conducted to recommend the most suitable dose level of multiwall carbon nano tubes (MWCNT) into biodiesel-diesel fuel blend at which the optimum diesel engine performance is attained. The study of paper, Nano-particles of size from 10 to 15 nm with tube length 1-10 microns, the dose level is varied from 10 to 50 mg/l by step of 20 mg/l was mixed into the biodiesel-diesel fuel blend with the help of ultrasonicator. A diesel engine test facility was used to study the effect of nano particles dose level on engine combustion and environmental performance parameters with a constant speed of 2000 RPM and different engine torque. When the use of MWCNTs is found to improve all engine performance parameters no matter the studied dose level. Hence the best emission characteristics are obtained at a dose level of 40 mg/l (emission reduction is observed; NOx by 45 %, CO by 50 %, and UHC by 60 %). While the engine combustion characteristics are achieved at a dose level of 50 mg/l (the increase in the in-cylinder peak pressure - Pmax, is about 7 %). Finally, it valuable to recommend the dose level of 40 mg/l where reasonable improvement in engine performance is achieved.

(2014) In [8], S. Imtenan, H.H. Masjuki, M. Varman, M.A. Kalam, M.I. Arbab, H. Sajjad, S.M. Ashrafur Rahman introduced an Impact of additives to palm and jatropha biodiesel blends in the context of performance and emissions characteristics of a light-duty diesel engine. In upcoming years, palm and jatropha biodiesels have been considered as potential renewable energy sources in Malaysia. Therefore, this experimental investigation was conducted to improve the blend of these two biodiesels (20% biodiesel blend, named P_20 and J_20, respectively) with the help of oxygenated additives. The comparative improvement of P_20 and J_20 blends with ethanol, n-butanol, or diethyl ether as additives were evaluated in terms of performance and emissions characteristics of a four-stroke single cylinder diesel engine. The blend consisted of 85% diesel, 10% biodiesel, and 5% additive. Tests were conducted at different speeds (1200–2400 rpm) at constant full load conditions. Use of additives significantly improved brake power and brake thermal efficiency (BTE). Q The use of diethyl ether as additive increased brake power and BTE by about 4.10% and 4.4%, respectively, at 2200 rpm. A similar improvement was observed for J20. The other two additives also improved performance. Although HC emission increased slightly, all blends with additives reduced more NOx and CO emissions than P20 and J20 almost throughout the entire engine test. When the use of ethanol an additive reduced CO emission by up to 40%, while the use of diethyl ether as additive reduced NOx emissions by up to 13%. An analysis of the combustion chamber pressure, temperature and heat release rate of the modified blends improvement of palm and jatropha biodiesel blends with the addition of three promising additives.

(2014) In [9], MurariMohon Roy, Wilson Wang, Majed Alawi introduced a Performance and emissions of a diesel engine fueled by biodiesel–diesel, biodiesel–diesel-additive and kerosene–biodiesel blends. The performance and emissions parameters of a direct injection (DI) diesel engine are investigated with three blend types such as biodiesel–diesel, biodiesel–diesel-additive and kerosene–biodiesel. The Biodiesel is produced from canola oil and the new biodiesel additive, Wintron XC 30 (2 vol %), is examined for engine performance and emissions. The experiment is undertaken with different blends, such as 0%, 5% (B5),10% (B10),20% (B20), 50% (B50) and 100% (B100) percent of biodiesel in biodiesel–diesel and biodiesel–diesel-additive blends, and 0%, 5% (B5),10% (B10),20% (B20), 50% (B50) and 100% (B100)volume percent of kerosene in kerosene–biodiesel blends. Engine performance and emissions at constant engine speed of 1800 rpm but with various load conditions such as low, medium and high are investigated. The performance parameters such as Brake specific fuel consumption (bsfc) and fuel conversion efficiency (%f) are used to compare engine performance, and emission analysis is based on emission of parameters such as carbon monoxide (CO), Hydrocarbon (HC), nitrous oxides (NOx) and Carbon dioxide (CO2).

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2014) In [10], Naveen, T.Parameshwaranpillai, Azhagar pon introduced an Experimental Investigation of Variable Compression Ratio Diesel Engine using ZiziphusJujuba oil. Due to the lack of petroleum source, it makes researchers find an alternative for the source. The researchers after the extensive research conclude that biodiesel can be used as fuel in compression ignition engine. The Biodiesel produced from Ziziphusjujuba which is the edible in nature is tested as fuel in single cylinder, four stroke, and variable compression ratio diesel engine. Experimental investigation of an engine was made with different composition 20% (B20), 40% (B40) and 60% (B60) blending of Ziziphusjujuba oil with diesel for compression ratio from 15:1 to 18:1 and the results were compared with diesel. Performance factors such as Specific fuel consumption, Brake thermal efficiency and Exhaust gas temperature for varying compression ratio and blending has been presented.

III. COMPARISON OF METHODOLOGIES

This section provides an overview about the pros and cons that are occurred in the research methodologies whose functional scenarios are discussed in depth in the previous section. From the following table, it can be predicted a better approach that provides considerable improvement in the proposed scenarios.

Table 1.

SI N O.	TITLE	AUTHORS	MERITS	DEMERITS	CITED
1.	Comparative Study of Thermal Barrier Coatings for Internal Combustion Engine.	Tadeusz Hejwowskiv	Thermal growth of oxides and the decomposition of Al2TiO5 were found in the engine-tested TBCs. Al2O3-40%TiO2-based TBC improves diesel engine performance.	The substrate interface is subjected to the highest stress variations. The developed flame test cycles whereas the furnace test can be used to control the production process of coatings	40
2.	Experimental Study of Ceramic Coated Piston Crown For Compressed Natural Gas Direct Injection Engines.	Helmisyah Ahmad Jamaluddin, Shahrir Abdullahb, Mariyam Jameelah Ghazalib, Bulan Abdullahc, Nik Rosli Abdullah	From the experiment, the average heat flux of YPSZ/NiCrAl coated piston crown exhibited 98% lower than the uncoated piston crowns. This might be due to the existence of lower conductivity of the ceramic coating.	The result may lead to contribution for the betterment of heat protection to the piston in CNGDI engine.	11
3.	Combustion Analysis Of Modified Inverted "M" Type Piston For Diesel Engine With Platinum Coating And Without Coating By Using CFD.	Hiregoudar Yerrennagoudar ua, Manjunatha	Thermal stress of the modified piston is lower than the conventional piston	It's having low Cetane value.	8
4.	Thermal Analysis of Holes Created on Ceramic Coating for Diesel Engine Piston.	Ravindra Gehlot N, Brajesh Tripathi	The higher temperature of top surface improves the engine performance by increasing the amount of burned fuel and reduces the hydro carbon emissions.	The substrate surface temperature decreasing as the radius of holes increases.	3
5.	Experimental Investigation on Effect of the Zirconium + Magnesium Coating of the Piston and Valve of the Single-Cylinder Diesel Engine to the Engine Performance and Emission.	Erdinç Vural, Bülent Özdalyan, Serkan Öze	There is improvement in the engine power, engine torque and specific fuel consumption. There are considerable improvements in the CO, HC, fume emissions.	The increase of the NOx emissions appears as negative factor.	3
6.	Investigation on effect of Yttria Stabilized Zirconia coated piston crown on performance and emission characteristics of a diesel engine.	G. Sivakumar, S. Senthil Kumar	Brake thermal efficiency is improved at all loads and speed conditions in the TBC coated engine.TBC coated engine reduces the specific fuel consumption. Hydrocarbon emissions were reduced drastically Carbon monoxide emission is reduced.	Exhaust gas temperature increased monotonically at all loading conditions which in turn increased the NOx emissions of the TBC coated engine.	13
7.	The Influence of Multi-Walled Carbon Nano tubes Additives into Non-Edible Biodiesel-Diesel Fuel Blend on Diesel Engine Performance and Emissions.	Ahmed I. EL-Seesya, Ali K. Abdel-Rahmana, Mahmoud Badya, and S. Ookawarab	The NOx, UHC, and CO emissions have a marginal reduction when using the MWCNT addition into JB20D blended fuels compared to that of JB20D blended fuel.	The peak pressure is higher for the MWCNT addition into JB20D blended fuels due to shorter ignition delay compared to that of JB20D blended fuel.	1
8.	Impact of oxygenated additives to palm and jatropha biodiesel blends in the context of performance and emissions characteristics of a light-duty diesel engine.	S. Imtenan, H.H. Masjuki, M. Varman, M.A. Kalam, M.I. Arbab, H. Sajjad, S.M. Ashrafur Rahman	N-butanol and diethyl ether showed overall improvement regarding performance and emission,	Ethanol showed improvement regarding only emission.	64
9.	Performance and emissions of a diesel engine fueled by biodiesel–diesel, biodiesel–diesel-additive and kerosene–biodiesel blends.	MurariMohon Roy, Wilson Wang, Majed Alawi	HC emissions can be decreased significantly with the increase of biodiesel in both biodiesel–diesel and biodiesel–diesel-additive blends under all load conditions	NOx increases with the increase of biodiesel in the blends of biodiesel–diesel and biodiesel–diesel additive up to medium loads	55
10.	Experimental Investigation of Variable Compression Ratio Diesel Engine using ZiziphusJujuba oil.	K.Naveen, T.Parameshwar anpillai, Azhagar pon	SFC decreases with increasing load for the compression ratio from 15:1 to 18:1 and increases with increasing percentage blending of biofuel. B20 having lower specific fuel consumption when comparing with B40 & B60.	EGT decreases with increasing the compression ratio and blending percentage. B60 register lower EGT at all compression ratio comparing with B20 & B40 as well as Diesel.	6

IV. CONCLUSION

By the literature review, we conclude that by the use of different ceramic thermal barrier coating and biodiesel blend, to improve the performance characteristics of the IC engine. Research or innovation regarding any of the subjects can be made possible only through the knowledge of past work related to the same field. Required preparation before carrying research work can be made well by discussing the previous work carried out by the researchers in the various fields which are related to the topic. In this literature discussed about the detailed coating materials and effect of piston crown coating in the performance of an engine. Following conclusion should be made, such as low thermal conductivity coating materials are yittria, MgO, AL Sic, ZnO, Al_2O_3, ZrO_2 this material coating gives maximum thermal efficiency. Biodiesel blends are ethanol, jatropha, and neem. It leads to improve the specific fuel consumption and improve the emission characteristics.

V. FUTURE SCOPE

The performance of an engine can be increased by using of TBC method but it is difficult to perform it experimentally. When ceramic coating is used in IC engine, the different types of practical problems are occur such as thermal mismatch due to improper adhesion and difference in thermal expansion coefficient between bond coat and piston materials and it has to withstand with wear and tear. In future try to develop new material or select proper material to avoid the above problem and reduce NOx emission also.

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