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A Review of Performance and Emission Characteristics of a Catalytic Coated CI Engine with Biodiesel

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***Abstract:** This paper is a review outline of references of CI engine (Combustion Ignition Engine) journals. CI Engine is the most preferred sort of engine as a result of its high thermal efficiency than any other internal or external combustion engine. Due to the demand for petroleum fuel, increasing cost, and hazardous emission by CI Engine, it is required to enhance the performance, combustion, and emission characteristics of CI Engine. Bio-fuels are well-tried to be superb substitutes for the present diesel. Nowadays, numerous researches are going on in biodiesel blends at varying ratios to increase the performance of the engine. Also many researches are going on coating the piston head in order to reduce the black smoke at the exhaust.*
***Keywords:** Bio-fuels, Emission, Performance, Diesel, Engine.*

I. INTRODUCTION

Diesel engines are the type of internal combustion engines which perform the combustion process because of the extremely high temperature in a combustion chamber raised under the high pressure of piston in the cylinder. Although they are said to be the most efficient and widely used types nowadays, they also have shortcomings. A diesel engine has been a preferable type of engine because of its low fuel consumption, reliability, durability, higher brake thermal efficiency, high compression ratio, and leaner fuel-air mixture. But the wastes of its combustion products are emitted into the environment, which leads to pollution. The demand for petroleum is high due to the rapid increase in the use of automobiles which increases the cost of petroleum products.

To resolve the shortcomings, various researches are conducted for the improvement of performance, combustion, and emission characteristics of a diesel engine using different methods such as introducing identifying alternative fuels, design modification, etc. So that we are able to obtain better performance.

II. LITERATURE REVIEW

In this section a review of literatures has been presented on the improvement of performance, combustion and emission characteristics of diesel engine.

Raghvendra Gautam and Saket Kumar (2020) the exhibition and burning examination of diesel and fat biodiesel in CI motor". In this investigation, biodiesel is delivered from fat oil and mixed in various proportions (10%, 20% and 30% contracted as B10, B20, and B30 individually). Biodiesel mixes about 5% lower when contrasted with ordinary diesel fuel. Along these lines from this examination we came to realize that fat biodiesel could be utilized with no motor adjustment and harmless to the ecosystem fuel.

Veronica Ezekoye, et al., (2019) "The blends and portrayal of biodiesel from Citrus Sinensis Seed Oil (CSSO)". The removed CSSO was changed over into biodiesel utilizing antacid synergist transesterification strategy at a consistent of temperature, which gives great yield of 76.93%. In this manner the created biodiesel make citrus sinensis seed a decent feedstock for biodiesel.

Sundar and Udayakumar (2019) "Examined the near evaluation of the exhibition of rice grain and cotton seed biodiesel mixes in VCR (Variable Compression Ratio) diesel motor ". The emanation boundaries of Carbon monoxide (CO) and Hydro Carbon (HC) for B20 mixes are lower by 18.4%, 17.5% and 3.86% 3.13% individually contrasted with diesel. In this manner the cycle is utilized for lessening the fumes discharge in climate.

Hazart, et al., (2019) -"The Emission qualities of polymer added substance blended diesel-sunflower biodiesel fuel". In this investigation, two fuel mixes were considered for comparison of outflow attributes. Consequently the Nitrogen Oxide (NOx) and CO emanation supposedly was decreased with the SF5PS5 mix. Hence the polymer added substance may not be considered as a danger to natural outflows.

Muhammad Bhuiya, et al., (2019) –"Analyzed the performance and emission characteristics of a compression ignition CI engine operated with beauty leaf biodiesel". Here the excellence leaf (Calophyllum inophyllum.L.) biodiesel mixes were utilized to assess the presentation and discharge qualities of a pressure start CI motor. The BP (Brake Power), BTE (Brake Thermal Efficiency), and BMEP (Brake Mean Effective Pressure) are decreased, though, the BSFC (Brake Specific Fuel Consumption) is expanded. The NOx discharge increments, though CO, HC and Particulate Matter (PM) emanation diminishes with speed up 1200rpm to 2400rpm. Though, NOx discharge is expanded when the motor is worked with biodiesel-diesel mix rather than diesel.

Kalam Azad and Mohammad Rasul (2019) "Analyzed performance and combustion analysis of diesel engine fueled with grape seed and waste cooking biodiesel". Its exhibition and burning qualities are like that of super low sulfur diesel. The examination suggested performing outflow and tribological conduct investigation of GS-B5 mixes to evaluate its maintainability as an elective fuel.

Ahmed, et al., (2019) "The performance of a diesel engine operated with jojoba Biodiesel-diesel-n-butanol ternary blends". Engine performance was analyzed at variable loads, going from no heap (0 Nm) to 13.5 Nm at a consistent speed of 2000. Motor outflows of NOx, CO, and Unburnt Hydro Carbon (UHC) were essentially decreased by 80%, 80%, and 65%, individually. It tends to be presumed that the suggested mixing proportion of jojoba biodiesel-diesel-n-butanol is J40D10Bu which gave the main improvement in the engine execution and fumes emanations.

Praveen, et al., (2018) "The performance and emission characteristic of a diesel engine using calophyllum inophyllum biodiesel blends with Titanium Oxide (TiO_2) nanoadditives and Exhaust Gas Recirculation (EGR)". The biodiesel-diesel mix was set up by blending 20% of Calophyllum Inophyllum in with 80% diesel (B20) in volumetric methodology. The smoke outflows were diminishes with the expansion of TiO_2 nano particles into the B20 fuel test and increments for the B20 + 20%EGR, B2040TiO_2 + 20% EGR powers contrasted with the B20 fuel.

Rozhdestvensky, et al., (2016) have investigated the "Effect of the Heat Insulating Coating of the Piston Crown on Characteristics of the 'Piston-Cylinder Liner' Pair". Utilizing a bunch of limit conditions for heat move, a limited component model is applied to the cylinder – chamber liner tribosystem to assess warm and disfigured conditions. The explored heat protecting covering on the cylinder crown diminishes the warmth stream from the working gas in the ignition office of the diesel motor in the outside of the cylinder. Thus a decrease of the most extreme temperature of cylinder crown of 12–14°C, and of the cylinder skirt of 5–6°C is assessed.

Sivakumar and Senthil Kumar (2014) "Investigation on effect of Yttria Stabilized Zirconia coated piston crown on performance and emission characteristics of a diesel engine". Test examination is completed under various stacking conditions in a three chamber diesel engine with its cylinder crown covered with Yttria Stabilized Zirconia (YSZ) to comprehend the impact of the warm boundary covering (TBC) on execution and outflow attributes in correlation with gauge motor qualities. The TBC covered engine shows better Brake warm proficiency and better BSFC contrasted with the gauge motor. TBC covered motor lessens the particular fuel utilization by 3.38% and 28.59% at full load and 25% of the full load conditions, individually when contrasted with the standard engine.

Helmisyah Ahmad Jalaludina, et al., (2013) -"Experimental Study of Ceramic Coated Piston Crown for Compressed Natural Gas Direct Injection Engines (CNGDI)". In this work, holding layer NiCrAl and ceramic based yttria part of the way balanced out zirconia (YPSZ) were plasma showered onto AC8A aluminium combination CNGDI cylinder crowns and ordinary CamPro cylinder crowns to limit thermal stress. From the test, the normal heat flux of YPSZ/NiCrAl covered cylinder crown displayed 98% lower than the uncoated cylinder crowns.

Jai Kumar Sharma, et al., (2021) "Finite Element Modelling of Lanthanum Cerate (La2Ce2O7) Coated Piston used in a Diesel Engine". These days, the presentation of IC engine and its segments are improved by having a warm boundary covering which diminishes the warmth misfortunes. The Al-Si cylinder is utilized in this investigation and the ceramic material which is utilized for covering. In correlation with the un-covered cylinder, the burning chamber temperature inside the engine gets higher and it prompts an expanded in thermal effectiveness. The temperature at the cylinder's substrate surface is decreased which will decidedly affect the performance and efficiency of the engine.

Aravindha et al., (2020) "Study of combustion characteristics on single cylinder direct injection diesel engine with plasma and High Velocity Oxy Fuel (HVOF) coated ceramic powders on piston crown". In this paper the fuel utilized for burning is a bio fuel which is the consequence of mixing the jatropha seed oil with that off methyl ester. Since the bio fuel influence the exhibition of the motor the cylinder are recommended to be covered with Cr3C2-PS, ZrO2 powders which goes about as a warm also wear obstruction boundary on the cylinder. Here the jatropha bio diesel mixes are utilized in the diesel motor whose outcomes expresses that the exhibition of the cylinder covered motor is exceptionally strengthened for about 10% ,demonstrating that the wear obstruction of covered cylinder will in general move by 47% to by and large decrease wear pace of 35%.

Sachita and NandishaMallikarjunb (2018) "Thermal analysis of Cr2O3 coated diesel engine piston using Finite Element Analysis (FEA)". Powder metallurgy is one of the successful composite preparing strategies underway of half breed nano composites powder metallurgy that gives the appropriate comprehension of part of support, impact of grain size and compaction ability of the metal framework nano composites. Metal network nano composite are extremely appealing for auto, aviation, military and tribological applications. This article is an endeavour to comprehend the cycle of powder metallurgy and its impact on various properties of composites.

Hiregoudar Yerrennagoudaru and Manjunatha (2017). "Comparison of Aldehyde Emissions in Alcohols blended with Vegetable oils fuelled CI engine using with and without Ceramic and Platinum Coated Pistons". The current examination assesses the CI engine adjusted alongside and without Ceramic and Platinum Coated Pistons to consider the Brake warm effectiveness, Brake explicit energy utilization, and Aldehydes Emissions. In this examination, the diesel engine was tried utilizing Alcohols mixed with Vegetable oils. From this examination the discharges like Aldehydes has been diminished and discovered Alcohols mixed with Vegetable oils are appropriate substitute energizes to diesel.

Arka Roychoudhury, et al., (2020) "An FEA material strength modelling of a coated engine piston". To improve material life, at times covering is done to diminish the impact of warm pressure conduct. This examination means to research a mix impact of covering and mathematical change on the material strength of a motor cylinder. A cylinder head, with a bowl shape was investigated by limited component method, covered with TiSiCN slight layer. The examination was created to foresee the material strength of two kinds of cylinders: uncoated level crown and a TiSiCN covered bowl on the crown. The outcome showed a 33.96% decrease on feeling of anxiety and 11.9% decrease in misshapening accomplished because of such covering measure.

Yessian, et al., (2020) "Optimization of Performance and Emission Characteristics of Catalytic Coated IC Engine with Biodiesel Using Grey-Taguchi Method". The performance and emission affected by piston catalytic coating are analyzed during this study. The main contributing factors for improving performance like load, fuel and speed are preferred to scale back the emission and improve the performance of an IC engine. These specific standard parameters have been modified with copper alloy coated diesel engine with the aid of design of experiment by Taguchi with grey relational analysis optimization (GRA) method, for improving the IC engine performance and reducing the emissions. The result shows modified copper chromium zirconium (CuCr1Zr) catalytic coated piston produces less emission and improves performance in comparison to plain un-coated piston type engine. In this investigation cotton seed oil is used as a bio- diesel and the piston and combustion chamber were coated with copper chromium zirconium material with a thickness of 250 microns.

Finally the results of the experiments were compared with un-coated engine and optimized parameters are identified for catalytic coated modified IC engine using Taguchi with GRA approach.

Sureshbabu, et al., (2014) "Study the emission characteristics of catalytic coated piston and combustion chamber of a four stroke spark ignition (SI) engine". In recent years, development of internal combustion(IC) engines with high fuel economy and fewer emission has become more important due to customer satisfaction, government emission regulations and heating problems. Most of the researchers have used an external exhaust gas after-treatment system to scale back the emission. In this paper, an alternate method for reducing emission formation and fuel consumption inside the interior combustion engine, without the exhaust gas after-treatment system, is surveyed in detail. Catalytic coated piston and combustion chamber is one among the important technologies prescribed by many researchers to realize the above said goals. In this paper, the literature of experimental investigation of catalytic coated combustion chamber, piston crown component is reviewed. From the literature review it's clear that the catalyst coating on the piston, combustion chamber gives the maximum brake thermal efficiency. In the presence of the catalyst, the combustion process will happen at lower temperature and hence this may cause complete combustion of un-burnt carbon monoxide gas (CO) and hydrocarbon (HC). The possible coating materials on the engine, piston and their performances are studies intimately during this paper.

Sureshbabu, et al., (2019) "Experimental investigation on four strokes catalytic coated spark ignition (SI) engine". The future of automobile combustion (IC) engine facing twin challenges because of emission norms and improving engine performance. Hence it's vital to spot some technique to scale back the emission level and also to enhance the engine performance. Catalytic coating is one among the foremost suitable techniques for reduction of pollution level and increase the engine efficiency. In this paper, the investigations administered within the single cylinder catalytic coated four stroke spark ignition (SI) engine is discussed intimately . The engine combustion chamber and piston crown were coated by copper (catalyst). The performance of catalytic coated engine various parameters like torque, brake power at different engine speed conditions measured by using two wheeler chassis dynamometer.

In this investigation the comparative study also were carried out for copper coated engine with conventional (Un-coated) SI engine and the results showed that copper coated engine has significant reduction of the carbon monoxide gas (CO), Hydrocarbon (HC), and CO2 (CO2) level compare to standard engine (uncoated) emission levels.

Balaji, et al., (2020) "Experimental Investigation of Chemical and Tensile Properties of Sansevieria Cylindrica Fiber Composites". The natural fibre reinforced composites are least expensive material and alternative material of wood, plastic material for the development and industrial applications. The polymer based composites are wont to fabricate the car components. The present investigation the composite materials reinforced with sansevieria cylindrica fibers were fabricated. These fibers were used due to their impressive mechanical properties. The composite panels are fabricated by hand lay-up technique. Sansevieria cylindrica fibers and polyester resin to supply the material . Sansevieria cylindrica plant has each leaf 20 to 30mm thickness and height 1000 to 2000mm approximately. The chemical tests of fiber and tensile strength for different fiber length composites such as 10mm, 20mm, 30mm, 40mm, & 50mm are determined.

III. LEARNING AND OUTCOMES

From these literature surveys, we can able to perceive that biodiesel will increase engine performance and scale down emissions. The power initially increases with increasing engine speed till it reaches the peak value. At the same time, engine power has the same trend in line with the addition of biodiesel content in the blend. Brake Thermal Efficiency (BTE) is the brake power of an engine as a function of the thermal input from the fuel. From these literature surveys, we can able to perceive BTE is maximum at initial load and then decreases when the load increases. Specific Fuel Consumption (SFC) is the quantity of fuel consumed by an engine for every unit of power output. From these literature surveys, we can able to perceive Specific Fuel Consumption is minimum at lower load and then increases till it reaches the peak value. Biodiesel has a higher SFC than diesel for all loads. Biodiesel has oxygen which improves the combustion of fuel.

The diesel fuel is pumped to the engine cylinder based on volume and also the density of the biodiesel higher than that of diesel. Therefore, a larger mass flow rate for a similar fuel volume is pumped to the engine, which results in a rise in torque and power. At a similar time, it is noted that a lower blending fuel mixture can improve the combustion characteristics of diesel. Thus Tamanu oil is taken into account for analysis work because of its high density and low viscosity compared to diesel.

Piston coating increases the wear resistance, engine performance and reduce the emissions characteristics. Coating of piston will increase the temperature of combustion chamber. When the temperature in combustion chamber is high, the fuel will get completely burnt which in turn increases the thermal efficiency. The thermal stresses produced inside the combustion chamber can be controlled by coating materials.

The brake power produced by coated piston is higher than the uncoated piston because the coating acts as a thermal insulator, due to this the heat loss can be minimised. Because of lower heat loss we can maintain high temperature in the combustion chamber which in turn increases the brake power.

The CO, HC, NO_x emission can be reduced by piston coating, because coating material such as Cr2O3 has high oxygen content. This high oxygen content results in low emission. Thus copper alloy coating is taken in to account for analysis work. Although there are some practical difficulties in piston coating and biodiesel. Piston coating increases the cost and it has to be done precisely for good results and also production of bio diesel at large scale is difficult.

IV. CONCLUSION

From the review of literatures above it has been concluded that diesel engines are widely used types nowadays because of its low fuel consumption, reliability, durability, higher brake thermal efficiency, high compression ratio and leaner fuel-air mixture, in opposition they also have shortcomings as well that needed to be improved such as their performance, combustion and emission characteristics. Hence in this review study it is clearly noticed that many researchers have addressed many solutions as interpreted in the review of literature above for the improvement of the performance, combustion and emission characteristics of diesel engine such as using alternative fuels and piston head coating.

From the literature survey, we can understand that the emission of HC, CO, NO_x in coated piston is less when compared to uncoated piston while the engine performance of biodiesel such as BP, BTE are higher when compared to diesel. So, we can obtain better performance and less emission characteristics by using coated piston with biodiesel.

Low cost coating material and time consuming coating technique will increase the production of coated piston. We have to identify a bio diesel which can be produced in the large scale, So that we can reduce cost and pollution.

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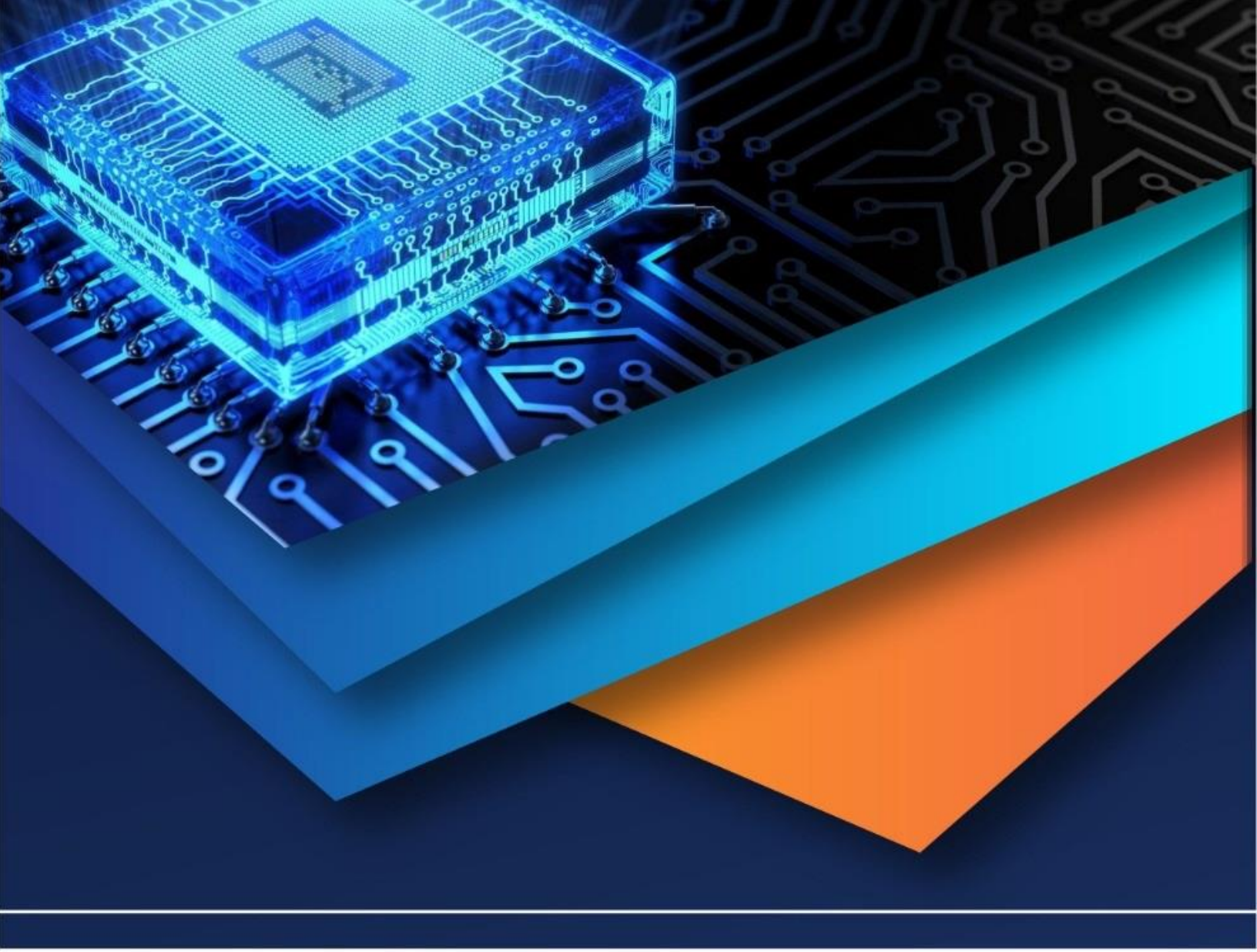

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