"ANALYSIS OF COMBINE EFFECT OF THERMAL BARRIER AND BLENDING OF DIESEL WITH EGR SYSTEMS"

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ABSTRACT

Now a day we all know that fuel crisis is increase day by day. Due to this limited source of the fuel in next generation we have to find other option for it. Vegetable oil can be used as diesel fuel just as it is, without converted to biodiesel. But vegetable oil have drawback is that it much more viscous (thicker) than conventional diesel fuel or biodiesel, and it doesn't burn the same in the engine studies have found that it can damage engines which I found in one of the research work which I shown in literature paper. So their find a solution we can mix it with diesel fuel or kerosene then just put it in and go. Also there is a major problem finding in IC engine which is thermal losses from the engine part. Which is note useful and decries overall efficiency. About 25-30% heat is convert into the work in which fuel quantity is burned in a one cycle of engine

So that the Purpose of this research is to improve the performance and thermal efficiency of diesel engine by applying the thermal barrier coating on piston crown, blending of diesel with EGR system. This study is made about thermally insulated diesel engine using vegetable oils blending in it. First, I tested the standard diesel fuel in the engine, to comparison of experiment then the engine was thermally coated by insulating some parts of it, such as piston, exhaust and intake valves surfaces. The purpose of engine coating is to reduce heat rejection from the walls of combustion chamber and to increase brake thermal efficiency, specific fuel consumption thus to increase performance of the engine that using vegetable oil blends and study of exhaust gas with EGR system to reduce emission.

Keyword: - *EGR, Coating, Vegetable oil, Diesel engine*

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1. Introduction:

Thermal barrier coatings (TBC) modern processes usually apply to metallic surfaces, such as automobile engine parts and gas turbines and aviation-engine parts, which is generally working at high temperatures in the form of heat energy of temperature. These 100 microns to 2mm coatings work to adopt components from large and long heat weights using ceramic insulating material. To increase the operating temperature, it may utilization to increase the life by decreasing oxidation and thermal fatigue.

Structure: Thermal barrier are two material coatings systems, which include a ceramic topcoat and metal intermediate bond coat. The topcoat has ceramic material whose work is to reduce the temperature of the fundamental, minor heat resistant metal part. Bond coat is contemplated to protect the metal substrate from oxidation and rusting and promotes ceramic topcoat adherence.

Types of thermal barrier material

Yitriya stabilized zirconia: The rate of 7-8% YSZ high thermal spreading factor, less thermal conductivity and high thermal shock resistance. Main diseconomy of this material are hard to steering above 1473 K, 1443 K after phase changing is done, corrosion and oxygen transparent.

Mullite Mullite: have low density property and stability at high thermal temperature, stability in many chemical environments, low thermal conductivity and favourable strength and creep behaviour ceramic material there for it is important material. If we Compared to Yitriya stabilized zirconia, multitite has very very low thermal spreading factor and high thermal conduction, and is high oxygen- obstructive than YSZ material. The low thermal spreading factor of mullite is a benefit paralel to high stabilized ziconia in high thermal declivity and in the case of thermal shock condition. However, the large discrepancy in the thermal spreading factor with metallic substrate leads to poor adhesion. The second loss of Mullait is crystallization of 1023-1273k temprature.

Alumina: There is too much rigidity and chemical inertia. Alumina is relatively high thermal conductivity and low thermal spreading factor, which is comparable to YSZ. Although alumina alloy is not a better thermal barrier coating material, apart from YSZ(yittria stabilized zirconia), it's coating can increase the hardness and the oxidation resistance of the substrate may improve. Alumina's losses are phase changes in phase at1273k temprature, high thermal transferability and very low thermal spreading factor

Zirconates: Zircorenets are their low sintering activity it is the main benefits of that, they have low thermal conductivity and high thermal spreading factor and also batter thermal rotation resistance. The main disadvantage is high thermal spreading factor, which results in remaining stress in the coating, and it can lead to coating demerits.

Rare earth oxides: Rare earth oxides mixture is cheapest, easily available, and effective TBCs. It's have higher thermal expansion coefficients and lower thermal conductivity when we compared to yittria stabilized zirconia (YSZ). The main dislike of this material to carry is the polymorphic behavior of the raree earth oxide at high temperatures, because the phase instability causes negative impact on the thermal shock resistance.

Forsterite: The Forrestite has a high thermal spreading factor material, which allow to gives a good fit with the substrata. At around hundred micron thickness, it shows a very good protection against thermal shock.

Material comparisons

Material / Property	YSZ	Mullite	Aluminium oxide	Magnesium Zirconium dioxide
Melting point	2973K	2123K	2323K	2973K
Thermal conductivity	1273K	1400K	1400K	1273K
Thermal expansion coefficient	293-1273K	293-1273K	1273K	1273K
Molar mass	347.69 g/mol	384.16 g/mol	101.96 g/mol	123.218 g/mol
Pries per 100g	2000-3000 Rs.	300-400 Rs.	120-200 Rs.	1000-1500 Rs.

2. Literature review:

Surapol Raadnui & Anant Meenak. On the wear of diesel engine components, refined palm oil (RPO) used as an alternative fuel is assessed. Testing is carried diesel fuel replacement by 100% RPO fuel or 50% RPO and 50% conventional diesel fuel mixture. The base line is a pure conventional petroleum diesel fuel engineAnalysis of the engine lubricating oil used when switching oil on vehicles was done, compared to analysis of 100% samples of diesel fuel engine extracted from the engine. [1]

M.P. Doradoa &At all The exhaust emissions of a Diesel direct injection Perkins engine fueled with waste olive oil methyl ester were studied at several steadystate operating conditions. Emissions were characterized with neat biodiesel from used olive oil and conventional Diesel fuel Combustion efficiency remained constant using either biodiesel or Diesel fuel. The proposed option for diesel fuel can significantly reduce the huge amount of waste frying oil, besides fossil oil is becoming less dependent on imports and the environmental pollution is declining. [2]

Gvidonas Labeckas & Stasys Slavinskas In this paper the comparative bench testing results of a naturally aspirated four stroke, four cylinder, water cooled, direct injection, Diesel engine operating on Diesel fuel and cold pressed rapeseed oil. The motto of this research work is that to see the rapeseed oil can flow in fuel line or not, to check effect of renewable fuel can run in high speed diesel engine and check performance and condition of injection spray at various condition. [3]

Imdat Taymaz in this paper to study about performance of the ceramic coated diesel engine. The search engine was a quarter, direct injection, six cylinders, turbo-charged and inter-cooled diesel engines. This engine was tested in case of load without different speed and coating. Then, cerimic material coting on cylinder head, piston crown, top of the valve surface. The layers were coated on the basis of $CaZrO3$ and $MgZrO3$ and Plasma NICRAL Bond Coat. The coated engine was tested in the same condition as without coated engine. [4]

P.K. Devan & N.V. Mahalakshmi tests carried out to evaluate the performance, emission and combustion characteristics of a diesel engine using Neat poon oil and its blends of 20%, 40%, and 60%, and standard diesel fuel separately. When blended with diesel, poon oil presented lower viscosity, improved volatility, better combustion and less carbon deposit. Also found that NOx emission is reduce. [5]

Hüseyin Aydin the possibility of using pure vegetable oils in a thermally insulated diesel engine has been experimentally investigated. Initially, pure diesel was tested in the engine. Then some parts of it, such as piston, exhaust and intake valves surfaces are thermally insulated by coating of zirconium oxide ($ZrO2$). Main purpose of engine coating was increase thermal efficiency by reducing heat rejection from the walls of combustion chamber and increase performance of the engine that using vegetable oil blends. [6]

Himansh Kumar & At all There is an option for the requirements of bio-diesel diesel. Fresh vegetable oil can cause a shortage of oil seeds for daily food, for which the identification of new type of vegetable oil is required. With this objective, this paper focused on the performance of waste vegetable oil and its mix with diesel, the wastewater washed clean and oils and their blends were selected. Physical and chemical properties of soya bean oil were determined. Generally, the viscosity of clean vegetable oil is high, which can be reduced by mixing it with diesel and heating them. It has been concluded that waste soya bean oil can be used as an alternative to diesel, which is low cost. This use of clean bio-diesel has a great effect in reducing the dependence of India on oil imports. [7]

Helmisyah Ahmad Jalaludin & At all direct compression system (CNGDI) engine with compressed natural gas high temperature is produce and it could have contributed to thermal stress. Without proper heat transfer mechanism piston crown will not operate effectively in this work, the binding layer NiCrAl and ceramic based yttrium was partly sprayed on AC8A aluminum alloy CNGDI piston crown and normal camphor pistons crown to reduce partially stable zirconia (YPSZ) plasma thermal stress. [8]

T. Karthikeya Sharma Intake of SI engine was introduced to the dust of the air, in which one of the exhaust control techniques without exhaust gas restructuring, combustion chamber and cyclic variability in water injection, emission control technology and / or thermal efficiency (TE) is. It examines the effects of using argon (R) gas to reduce the exposure of the spark ignition engine intake to increase paper performance and primarily reduce nitrogen oxide emissions. [9]

Selman Aydin & At all In this study, for use in laboratories, 95% of bio-diesel and 100% petroleum-based diesel and 100% biofuel were prepared from residual frying oil of biofuel Cottonseed. “These fuels were tested in a cylinder, four strokes. Top surfaces of piston and valve were coated with plasma". Spray coating technology use 100 mm NiCrAl as film layer and the same surface on this layer was coated with a 400 mm mixture, which includes% 88 ZrO2,% 4 MgO and% 8 Al2O3. Coatings are done according to the fuel mentioned after the test. [10]

B. Rajesh kumar & S. Saravanan In this work, the emission characteristics of the diesel engine are examined under the N-Pentnol mixture, the effects of second generation biofuels with diesel on the impact and exhaust gas rearrangement (EGR) conditions. The test was done using four N-Pentnol / Diesel Blends on a single-cylinder, constant speed, un-modified, direct injection diesel engine: 10%, 20%, 30% and 45% (by volume). The possibility of using high Pentnol / Diesel mixture (45%) was also detected for the purpose of maximizing the renewable component in the fuel. Three EGR rates (10%, 20% and 30%) were used to reduce high nitrogen oxides (NOx) which were prevalent on high engine load using these blends. The results of the test show that the increase in EGR rates reduced the NOx emissions by up to 41% on medium load and 33.7% on high load. [11]

Vikrant Garud & At all Thermal barrier coatings (TBC) are used not only for the thermal fatigue protection of the in-cylinder heat rejection and the underlying metal surfaces, but also to imitate adiabatic engines with the intention of potential reduction in engine emissions. In this paper, with the support of a detailed sample of in-cylinder pressure, the main emphasis is on checking the effect of TBC on engine fuel consumption. In this study, the emission measurement of unbalanced hydrocarbons and carbon monoxide was also organized. The piston crown is coated with YSZ ceramic materials using plasma spraying technology. By increasing the brake thermal efficiency and decree on all emissions, there is a good gas expansion in the stroke of electricity, causing the top cylinder pressure to increase and the brake has an effect on thermal efficiency which increases by 1.4%. [12]

Above Number of paper are finding which is work based on efficiency, heat rejection , combustion parameters, emission of biodiesel blends, fuel consumed, Brake thermal efficiency, etc But hear none of the research work done on blending of waste fried oil with thermal barrier coated engine. And also none research work done on thermal barrier coated engine with edible oil. There is none of the work found which is work on tri combine effect of NO_X emission control in thermal barrier coated engine with blended edible oil.

3 Experimentation:

The performance and emission from the engine running on diesel blended with fuel derived from cottonseed oil (CSO) were evaluated and compared with diesel fuel. The fuel blends were prepared just before starting the experiment to ensure that the fuel mixture was homogenous and to avoid the reaction. A series of experiments were carried out using diesel, and the various diesel blends. All the blends were constantly tested under the speed of the engine. Engine diesel fuel was started and it was operated until it reached the position of a stable position. After the engine reached the stabilized working condition, emission parameters such as CO, HC, NOx and the exhaust gas temperature from an online and accurately calibrated exhaust gas analyzer were recorded. All experiments have been carried out at full throttle setting. Before receiving data from an engine powered with a new composite fuel, the engine was operated using the new fuel for a sufficient time to clean the remaining fuel from the previous mix. Fuel properties were determined at the J.K. Analytical Laboratory & Research Center. In this report, the quantity AX represents a blend consisting of X% biodiesel by volume, e.g., B15 indicates a blend consisting of 15% biodiesel in 100% diesel. Two test fuels were used in this study: 15% blend (85%diesel + 15% CSO) B15; 35% blend B35. After testing of blended fuel, exhaust gas recirculate to the engine by EGR setup. Quantity of the recirculate exhaust gas is measure by flow meter. Amount of flow is given at absolute flow rate, its denoted by EGR10 (10 liter/minute) or EGR20 (20 liter/minute)

Table 1: Fuel Properties

	Blends		
Properties	D	B15	B35
Density	0.830	0.0846	0.854
Viscosity	3.4	3.75	5.6
Calorific Value kJ/kg	42700	41754	40638

Table 2: Specification of Test engine to be used

Manufacturer	***Fieldmarshal***
Engine Type	*4 stroke Direct Injection CI engine*
kW Rating	*4.4 kW*
Rated RPM	*1500 RPM*
Compression Ratio	*17.9:1*
Bore (mm)	*85mm*
Stroke(mm)	*110mm*
No. of cylinders	*1*
Cubic Capacity(cc)	*625 CC*
Fuel Consumption (g/Kw/h)	*245 g/Kw/h*
Cooling Type	*Water cooled*

Figure1: The arrangement of experiment.

4 Results:

4.1 Unburned Hydro Carbon

The results of hydrocarbon emissions occur when the fuel molecules are burned or only partially burnt in the engine, hydrocarbons react in the presence of nitrogen oxides and sunlight so that ozone levels can become a major component of smoking. Ozone disturbs the eyes, damages the lungs, and promotes respiratory problems. This is our most comprehensive and unorganized urban air pollution problem. Many exhaust hydrocarbons are toxic even with the possibility of causing cancer.

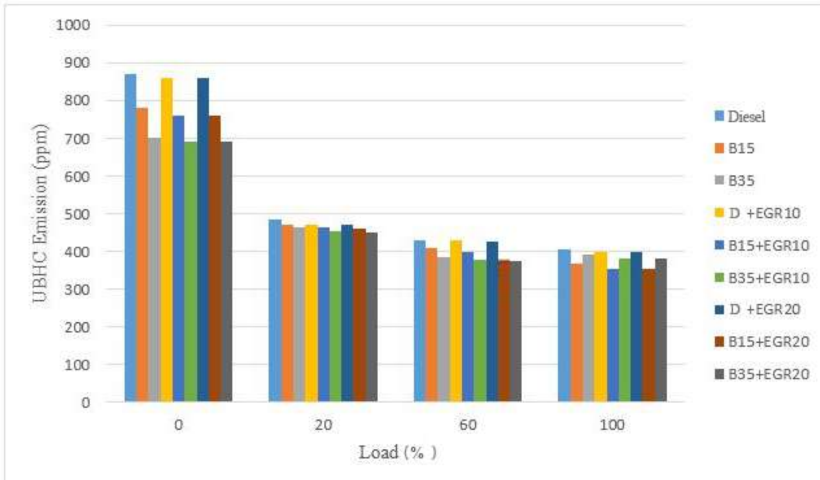

Figure 2. UBHC Emission graph

Unburned Hydro Carbon after thermally coted piston head

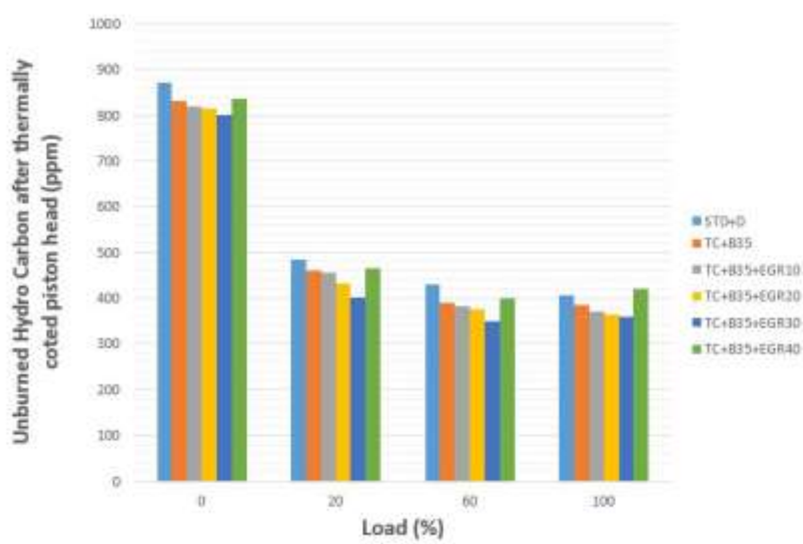

Figure 3. UBHC Emission graph after coating

4.2 Carbon Monoxide Emission

In last few years, the “American Environmental Protection Agency” (EPA) has started seeing carbon dioxide products of "right" combustion as a pollution concern. Carbon dioxide does not directly damage human health, but it is a "greenhouse gas" that makes the earth heat and contributes to global warming.

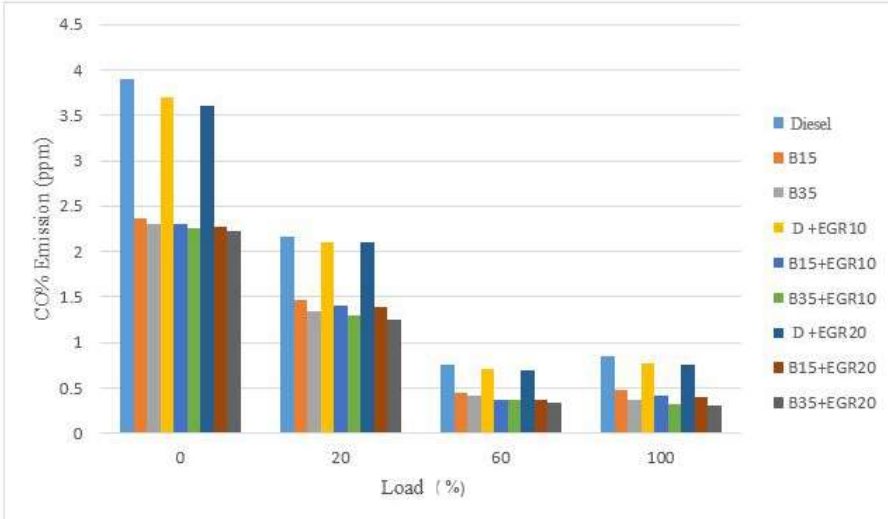

Figure 4. CO Emission graph

Carbon Monoxide Emission after thermally coted piston head

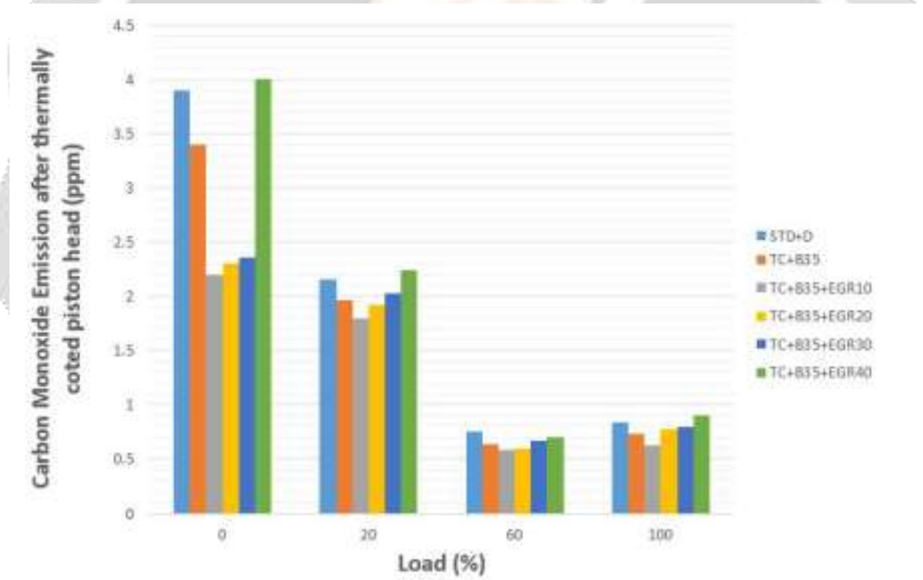

Figure .5 CO Emission graph after coating

4.3 Nitric oxide emission

Under high pressure and temperature conditions in an engine, nitrogen and oxygen atoms in the air react to the formation of various nitrogen oxides, which collectively known as NOx. Nitrogen oxides, such as hydrocarbons, are precursors for the formation of ozone. NO_X is referred to here as a mixture of nitric oxide (NO) and nitrogen dioxide (NO_2). NOx emissions are controlled because NO and NO_2 low levels contribute to chemical formation of ozone or smoke, which is an environment and human health threat. NO_2 is also a matter of concern in the form of wrinkles of human lungs. They also contribute to the production of acid rain, decrease in lung function and the burning of eyes, nose and throat. The important time period of formation of the NOx occurs when the amount of burned gas is maximized, i.e. immediately after the occurrence of combustion and the peak cylinder pressure. After peak pressure, the gas temperature decreases as the expansion of cylinder gases. The temperature decreases in temperature and the combination of high temperature gas with air or cooler burn gas prevents the formation of NO_X

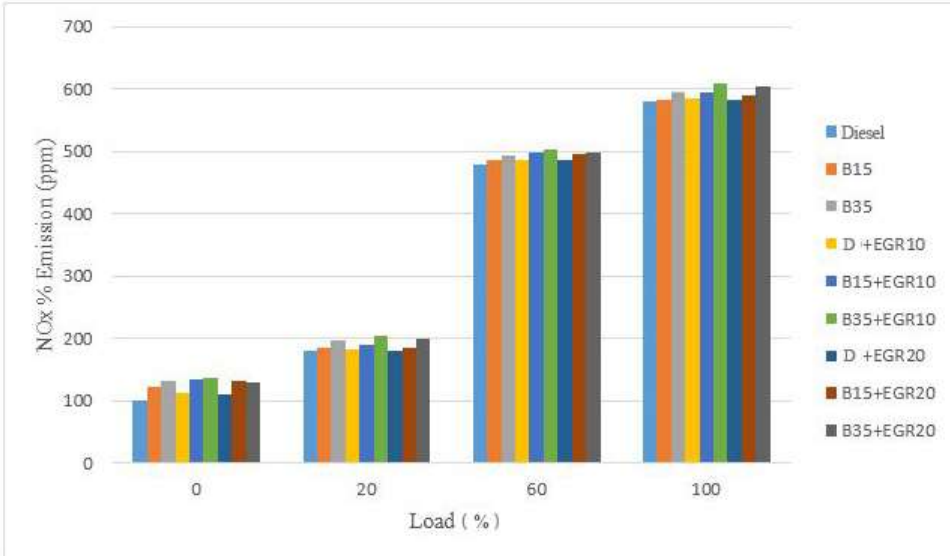

Figure 6 NOx Emission graph

NOx Emission after thermally coted piston head

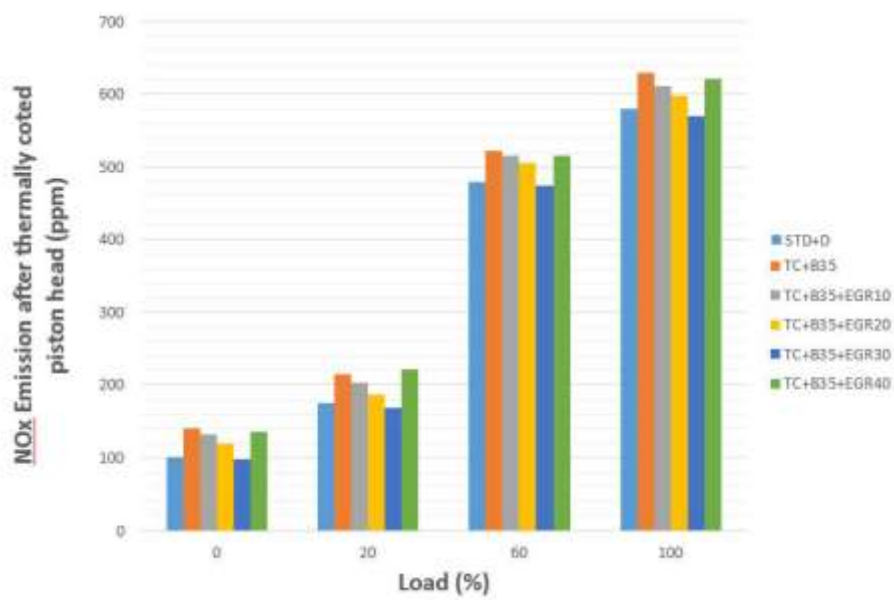

Figure 7 NOx Emission graph after coating

4.4 Fuel consumption (kg/hr)

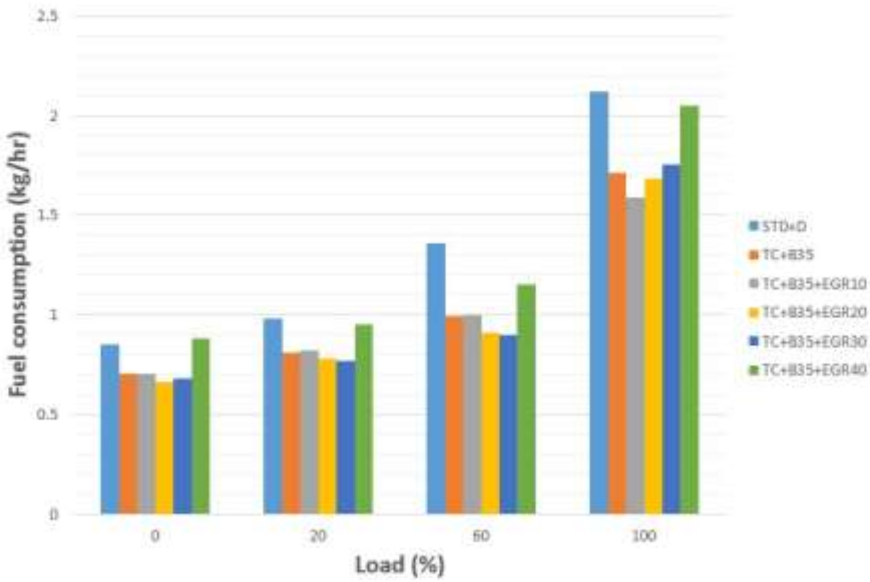

Figure 8 Fuel consumption graph

5. Conclusion

Based on the experimental data obtained on a single cylinder, vertical, air cooled self-governed two stroke spark ignition engine with diesel fuel. The engine is run with various bland of fuel and with coated piston head and EGR system. After performing and taking result of experimental, I conclude some following things.

- Four stroke engines have a good potential if Coating technology is employed with EGR system and blended fuel.
- There is overall performance is significantly increase.
- It is observed that, with increases of load Fuel consumption (FC) is lower for the thermally coted Engine with blended fuel in comparison of the STD Engine with blended fuel, which confirms the maximum efficiency, is attained at maximum load condition. By using EGR system with thermally coted Engine again FC was decries by increasing exhaust gas quantity increase till EGR30.
- It is observed that, a Carbon Dioxide (CO) emission is reduced with the increases of load for the thermally coted Engine with blended fuel in comparison of STD Engine with blended fuel. By using EGR system with thermally coted Engine again CO emission was decries by increasing exhaust gas quantity increase till EGR30.
- It is observed that, Unburned Hydro Cabin (UBHC) emission is reduced with the increases of load for the thermally coted Engine with blended fuel in comparison of STD Engine with blended fuel. Same as other by using EGR system with thermally coted Engine UBHC emission was decries by increasing exhaust gas quantity increase till EGR30.
- It is observed that, NOx emissions are increases with the increases of load for the thermally coted Engine with blended fuel in comparison of STD Engine with blended fuel and their also we found that By using EGR system with thermally coted Engine NOx emission level was decries by increasing exhaust gas quantity increase till EGR30.
- But there I was found that increasing exhaust gas flow at EGR40 I was get bed result from it all the parameter was disturb and reach at same as stander diesel engine.
- So I can conclude from my experimental result that I get better result from all other research work and stander diesel engine using blended fuel of COS35 with thermally coted piston and recirculated exhaust gas at EGR30

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