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Effect of Urea Catalytic Converter on Performance And Emission of C.I. Engine Using WPO Diesel Blend

KEYWORDS: Blended fuel, Diesel fuel, Engine Performance, EngineEmission, Catalytic converter with urea.

Ankit C Jani
Master Scholar, Mechanical Engineering, Kadi Sarva Vishwavidyalaya, Gandhinagar, Gujarat, India

Tushar M Patel
Associate Professor, Mechanical Engineering, Kadi Sarva Vishwavidyalaya, Gandhinagar, Gujarat, India.

Gaurav P Rathod
Assistant Professor, Mechanical Engineering, Kadi Sarva Vishwavidyalaya, Gandhinagar, Gujarat, India.

ABSTRACT *Diesel engines are widely used in heavy duty applications like transportation, power generation etc. but the quantity of diesel is limited in the world. So the price of diesel increased as the use of diesel increased day by day. With increase in use of these fossil fuels environmental problem is one of the issues which are increased day by day. These environmental concern and limited quantity of fuels have caused interests in the search for alternative fuels for IC engine. This paper represents the effect of varying load and effect of catalytic converter with urea on performance and emission of diesel engine using WPO diesel blend in different proportion. Experiment was carried out by taking 0%, 10%, 20% and 30% WPO diesel blend with constant injection pressure. Experimental results shows that SFC decreases with increase in load but ME and BTE increases in all blend and 20% WPO diesel blend has minimum SFC and higher BTE and ITE compare to diesel fuel but little increase in NOX and HC emission. Emission results show that emission of HC, NOX and CO2 increases with increase in load. With compare to diesel Emission of CO and CO2 is lower in 20% blend and emission of NOX and HC is little higher. So catalytic converter with urea is being used to control the emission of these harmful gases and run the engine with 20% WPO Diesel blend to get optimum performance and emission. So diesel engine can be run at 20% WPO diesel blend with proper catalytic converter.*

INTRODUCTION

With time passing by, the fossil fuel reserves are depleting at a faster rate, causing continuous increase in price of petroleum products all over the world. The high price of petroleum products is a big concern for Indian economy. India imports on an average 80% of total demand of crude oil. Therefore an alternative cheaper fuel is required to fulfil the needs of common man.

Alternative source of fuel lies in plastic. In India 56 lakh tones of plastics are generated each year and only 60% of it is recycled. Safe method of disposing the waste plastic has not yet been implemented here, and dumping of waste plastic underground is hazardous to the environment. But we can use it as an alternative source of fuel for diesel. This will save the environment from hazardous effect as well as to boosting the Indian economy. Previously, many researches were done experiment on alternative fuels. All of them showed encouragement results. However, the drive for search of a new source of alternative fuel, we have performed the engine performance test by using Waste Plastic oil + Diesel of various blends viz. B10, B20, B30. We found that the blends of Diesel & Waste Plastic Oil gives better values to Diesel fuel in the Kirloskar Diesel engine, without any further modification in the engine itself. [1]

In this study there is little problem of higher emission and to solve this problem we use catalytic converter with urea. Urea is one of the best materials to reduce the emission of NO_X.

LITERATURE REVIEW

Sachin kumar et al have been used blend of diesel and waste plastic oil as a fuel in diesel engine and check performance and analysis of engine.The experimental results showthat the SFC increases with increase inWPO blend ratio and decreases with increase in engine load. Mechanical efficiency increases withincreasing brake power for all fuel blends. The unburnt hydrocarbon emission decreases with increase in the engine loadand increases with increase in percentage of waste plastic oil in blends. The carbon dioxide emissionfor the blends is lower than diesel for almost all loads and all blends. [2]

G. Nagarajan et al.have been used blend of diesel and waste plastic oil andit is observed that the engine could operate with 100% waste plastic oil and can be used as fuel in diesel engines. NOx was higher by about 25% and carbon monoxide (CO) increased by 5% for waste plastic oil operation compared to diesel fuel (DF) operation. Hydrocarbon was higher by about 15%. Engine fueled with waste plastic oil exhibits higher thermal efficiency up to 80% of the full load compared to DF operation.[3]

M. Mani et al have been used waste plastic oil as a fuel. In the present work, the influence of injection timing on the performance, emission and combustion characteristics of a single cylinder, four stroke, direct injection diesel engine has been experimentally investigated using waste plastic oil as a fuel. Tests were performed at four injection timings (23, 20, 17 and 14 bTDC). When compared to the standard injection timing of 23 BTDC the retarded injection timing of 14 bTDC resulted in decreased oxides of nitrogen, carbon monoxide and unburned hydrocarbon while the brake thermal efficiency, carbon dioxide and smoke increased under all the test conditions.[4]

M. Mani et al have been used waste plastic oil as a fuel. Investigation was to study the effect of cooled exhaust gas recirculation (EGR) on four stroke, single cylinder, direct injection (DI) diesel engine using 100% waste plastic oil. An experimental result shows thatNOx emissions were reduced when the engine was operated with cooled EGR.[5]

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WASTE PLASTIC OIL

Waste plastic oil or pyrolysis oil is the chemical product from decomposition process of organic substance (waste plastic) by heating. The waste plastic is treated in cylindrical reactor at temperature 400-500 degree Celsiuswithout oxygen. This pyrolysis process can also be used to produce liquid fuel similar to diesel. Presently, pyrolysis oil or oil from waste plastic widely use in dual fuel-generator set for generation electricity, marine diesel engine, and agriculture engine. Oil is the main product of pyrolysis process. Plastic scrap or waste plastic is used as raw material for pyrolysis process. The properties of waste plastic oil and diesel fuel are shown in Table 1.[6]

Table -1: Property of WPO and diesel

Property	Diesel	WPO
Cetane number	55	51
Viscosity (cst)	2.0 (at 40° C)	1.69 (at 40° C)
Density(gm/cc)	0.832	0.788
CV(kj/kg)	42000	58341
Flash point	50	22
Sulfur (% by mass)	0.045	0.01

EXPERIMENTAL SETUP

The experiments were conducted on a single-cylinder,4-Stroke, water-cooled diesel engine of 5 HP rated power. The engine is coupled to a rope brake dynamometer through a load cell. A five exhaust gas analyzer was used for measuring NO_x, CO_2, HC and CO. The exhaust gas analyzer determined the emissions of NO_x, CO2, HC and CO by means of electrochemical sensors.Catalytic converter with urea is being used to control the emission of harmful gases. It is being connected at the end of exhaust line of engine set up as shown in figure 2. The experimental setup is shown in below Figure 1 and 2.-

Figure -1: Engine Setup

Table -2: Engine Specifications

Parameter	Details
Engine	Single cylinder diesel engine
Cooling	Water cooled
Parameter	Details
Bore × Stroke	80 mm × 110 mm
Compression ratio	16 : 1
Maximum Power	5 hp or 3.7 kW
Rated speed	1500 rpm
Capacity	553 CC

Figure -2: catalytic converter with urea

METHODOLOGY

In this experiment, diesel engine connected with the rope brake dynamometer. By using dynamometer, varies the load on the engine and gas analyzer is utilized to quantify the emission from exhaust gas. The readings are taken at varying the load from 1 to 11kg by keeping injection pressure constant at 190psi.

To perform this experiment, the first set of load varying (1 to 11kg) was carried out with a conventional diesel engine using 0% WPO diesel blend. Then after different blend ratio of WPO diesel blend of 10%, 20% and 30% respectively were selected and fuel consumption was recorded at every time to calculate performance of engine at every stage. The data for HC, NOx, CO and CO_2were recorded by exhaust gas analyzer.From result it was seen that 20% WPO Diesel blend gives better performance but there is little problem of increase in emission so catalytic converter with urea is being used at exhaust line of engine set up. Readings were taken again by 0% and 20% blend with varying load from 1kg to 11kg with using catalytic converter with urea and compare it with previous data (without catalytic converter by 0% and 20% blend).

RESULTS AND DISCUSSION

Graphs of performance and emission using 0%, 10%, 20% and 30% WPO Diesel blend are shown as below. Experimental results show that 20% WPO Diesel blend has lower SFC and higher BTE and ITE than diesel fuel data. Emission results show that 20% blend has lower CO and CO_2than diesel fuel but little increase in HC and NOx. Performance and emission data tables and graphs are shown below from fig. 3 to 10.

Figure – 3: Load vs SFC graph in all blend without cc

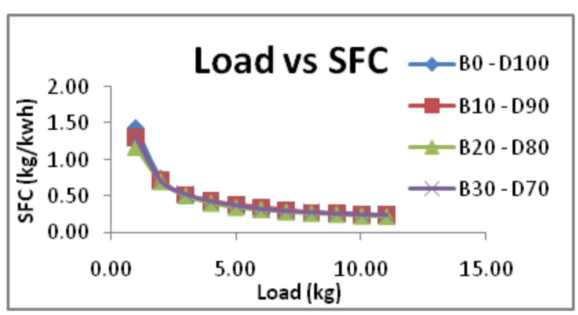

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Figure – 4: Load vs Mech. Effi. graph in all blend without cc

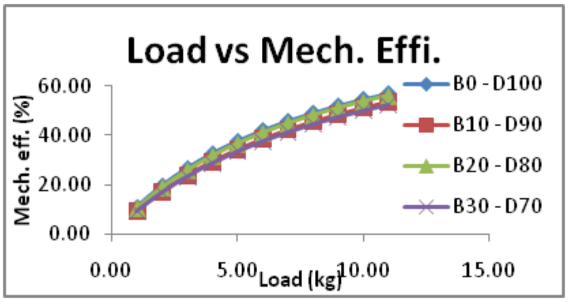


Figure – 5: Load vs BTE graph in all blend without cc

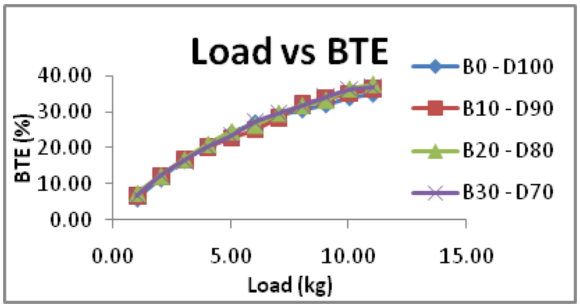


Figure – 6: Load vs ITE graph in all blend without cc

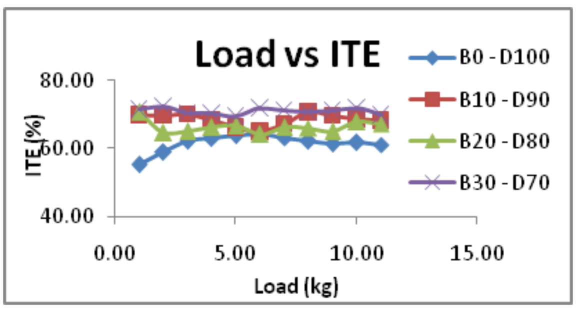


Figure – 7: Load vs CO graph in all blend without cc

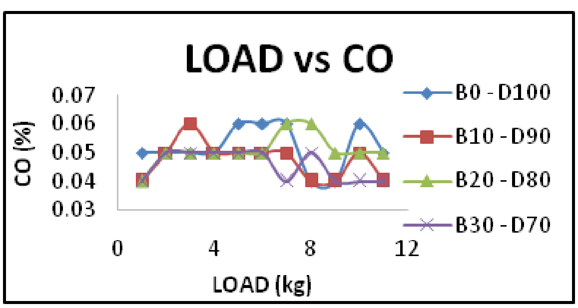


Figure – 8: Load vs HC graph in all blend without cc

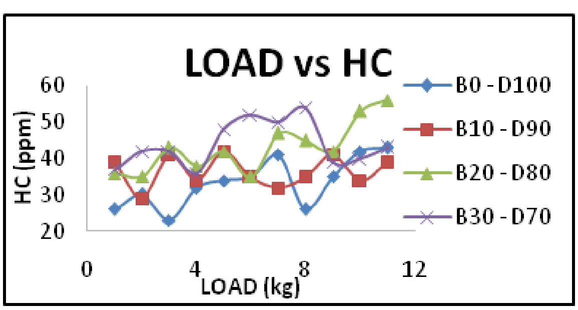


Figure – 9: Load vs CO_2 graph in all blend without cc

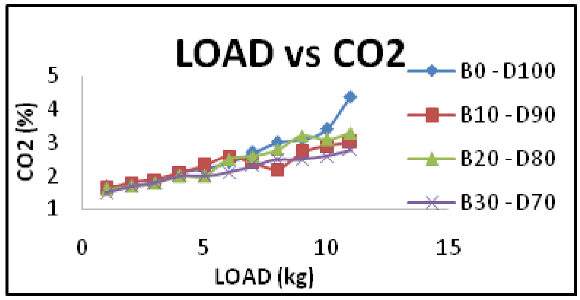
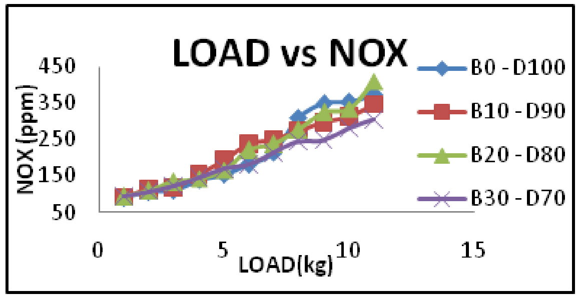


Figure – 10: Load vs NO_x graph in all blend without cc



Now catalytic converter is being used with 0% and 20% WPO Diesel blend and we compare the result with previous data. While we use catalytic converter better performance is obtained than without cc. There is also reduction in emission with catalytic converter. Here also better performance is being got in 20% blend and emission result shows that CO and CO_2 is lower but HC and NO_X increases little.

Figure – 11: Load vs SFC comparison in 0% and 20% blend with cc

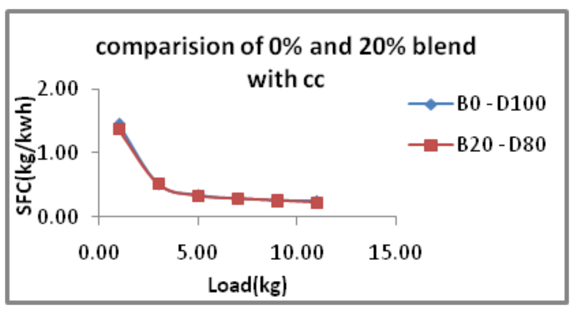


Figure – 12: Load vs ME comparison in 0% and 20% blend with cc

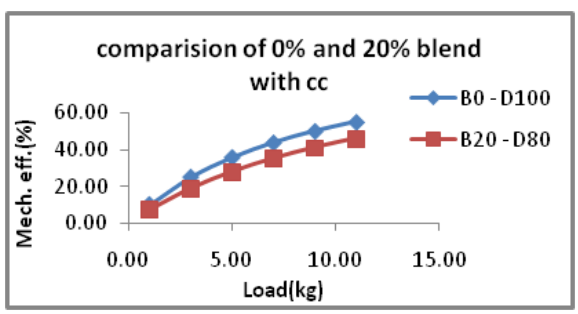


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Figure – 13: Load vs BTE comparison in 0% and 20% blend with cc

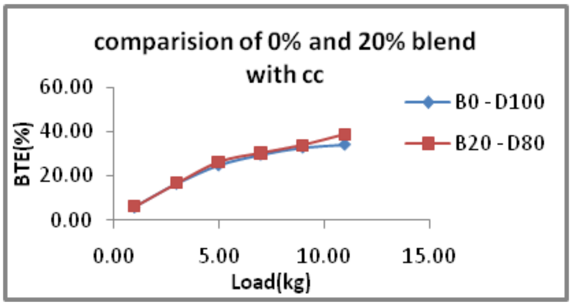

Figure – 14: Load vs ITE comparison in 0% and 20% blend with cc

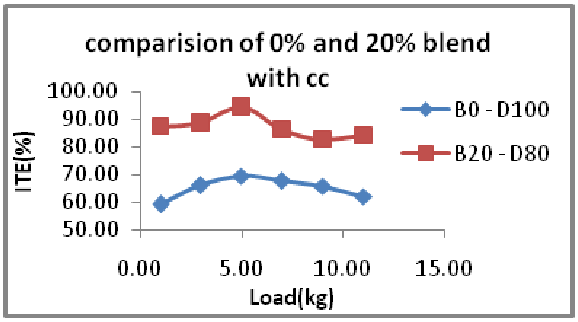

Figure – 15: Load vs CO comparison in 0% and 20% blend with cc

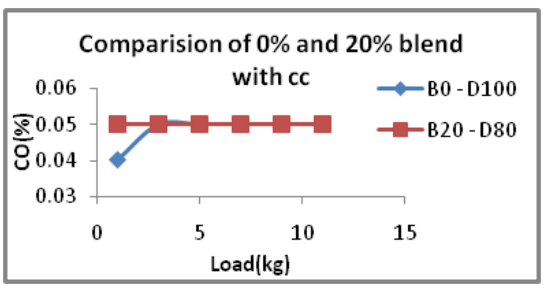

Figure – 16: Load vs HC comparison in 0% and 20% blend with cc

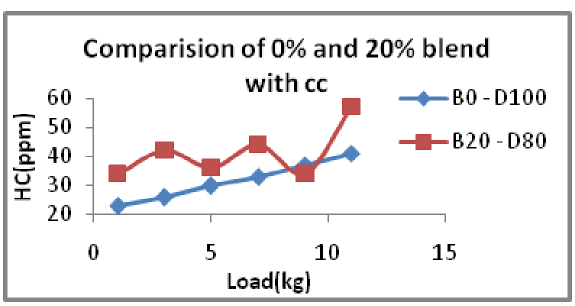

Figure – 17: Load vs CO_2 comparison in 0% and 20% blend with cc

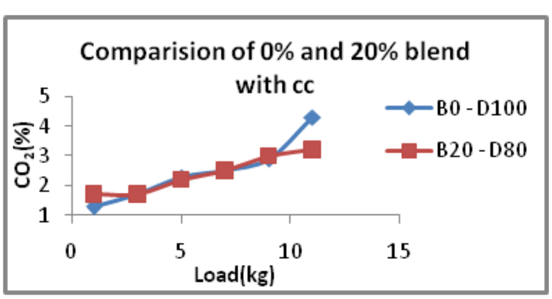

Figure – 18: Load vs ITE comparison in 0% and 20% blendwith cc

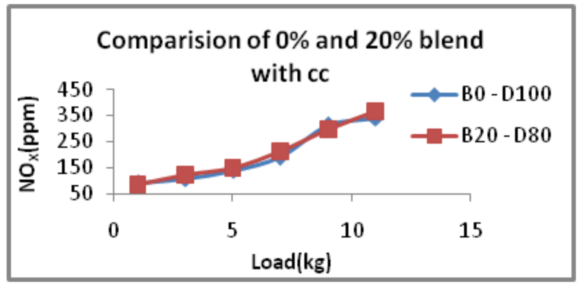

Figure 19 to 26 shows performance and emission comparison in 0% blend with and without catalytic converter. We can see that from the graph that catalytic converter gives better performance and emission is being reduced while we use catalytic converter. Figure 27 to 34 shows performance and emission comparison in 20% blend with and without catalytic converter. Here also we can see that from the graph that catalytic converter gives better performance and emission is being reduced while we use catalytic converter. So finally Results show that better performance is obtained by cc and emission is being reduced with urea cc.

Figure – 19: Effect of cc in SFC for 0% blend

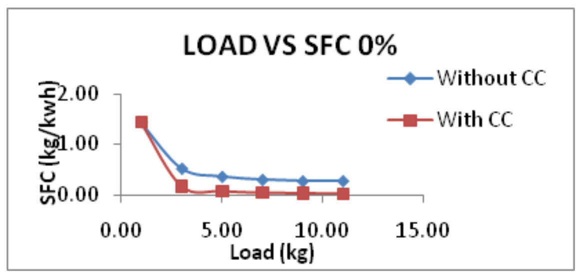

Figure – 20: Effect of cc in ME for 0% blend

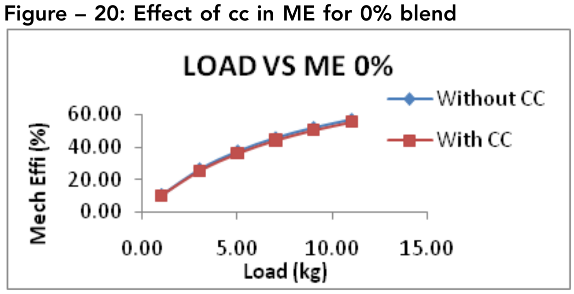

Figure – 21: Effect of cc in BTE for 0% blend

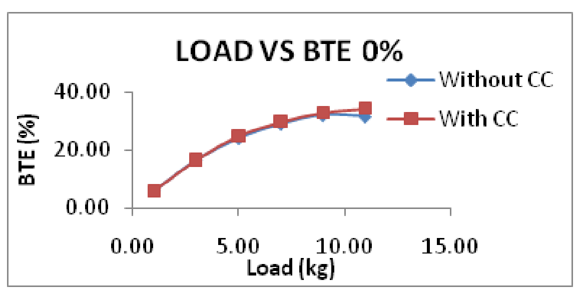

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Figure – 22: Effect of cc in ITE for 0% blend

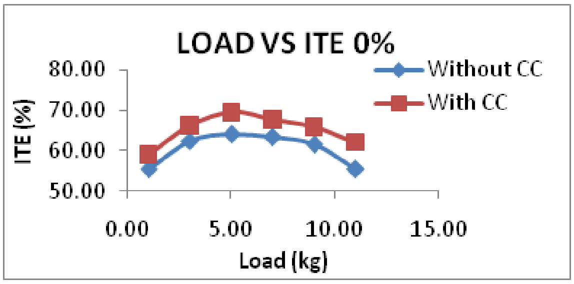

Figure – 23: Effect of cc in emission of CO for 0% blend

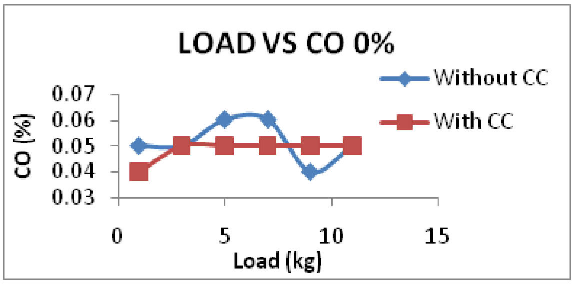

Figure – 24: Effect of cc in emission of HC for 0% blend

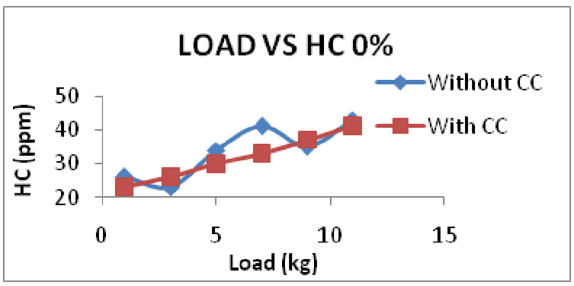

Figure – 25: Effect of cc in emission of CO_2 for 0% blend

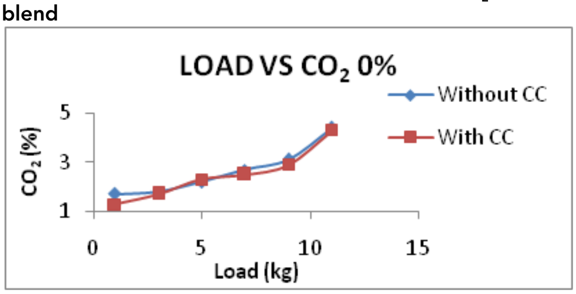

Figure – 26: Effect of cc in emission of NO_X for 0% blend

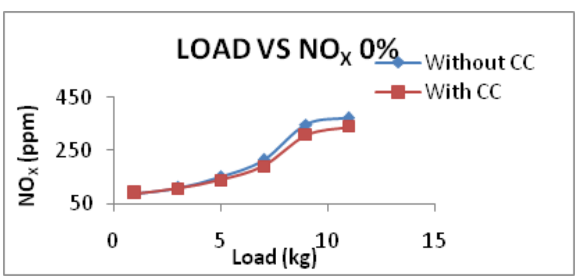

Figure – 27: Effect of cc in SFC for 20% blend

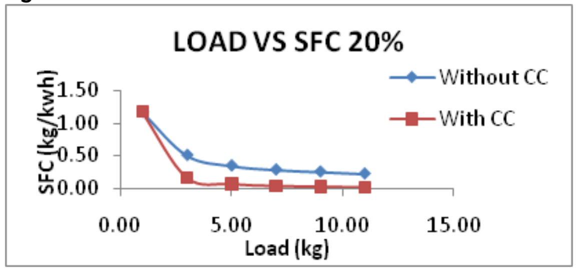

Figure – 28: Effect of cc in ME for 20% blend

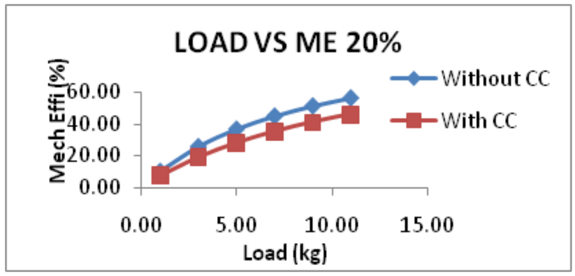

Figure – 29: Effect of cc in BTE for 20% blend

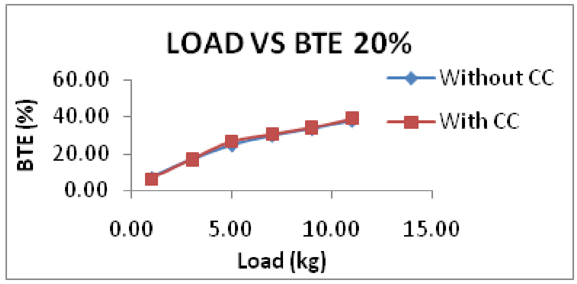

Figure – 30: Effect of cc in ITE for 20% blend

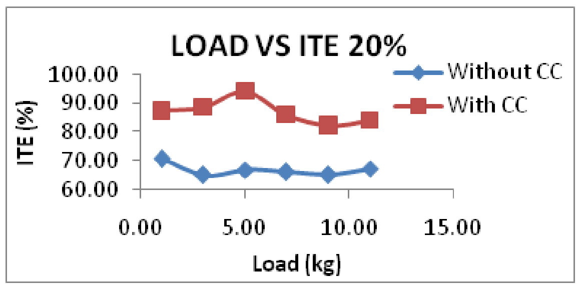

Figure – 31: Effect of cc in emission of CO for 20% blend

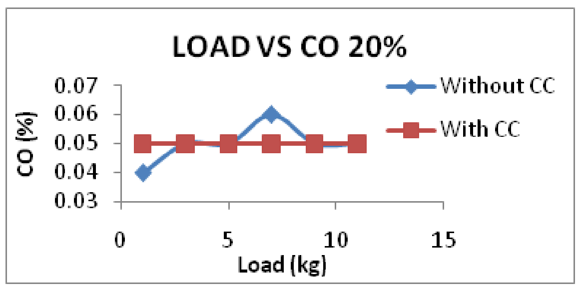

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Figure – 32: Effect of cc in emission of HC for 20% blend

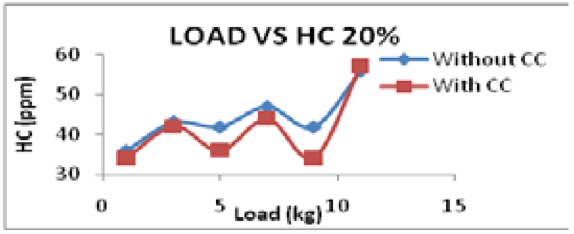


Figure – 33: Effect of cc in emission of CO_2 for 20% blend

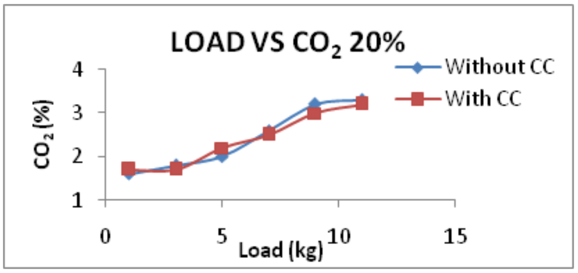
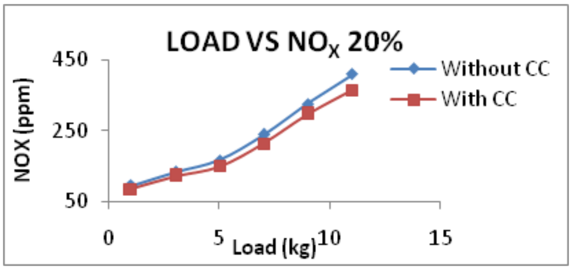


Figure – 34: Effect of cc in emission of NO_x for 20% blend



CONCLUSIONS

From experimental result it has been concluded that WPO can be used in CI engine with diesel. 20% WPO Diesel blend gives better result for performance and emission of diesel engine when catalytic converter with urea is being used.

SFC decreases in 20% WPO Diesel blend with compare to diesel.

BTE and ITE increases in 20% WPO Diesel blend with compare to diesel.

Emission of CO and CO_2decreases in 20% WPO Diesel blend with compare to diesel.

Emission of NO_X and HC is slightly increases with compare to diesel.

Better performance can be achieved by using urea catalytic converter.

Urea catalytic converter reduces Emission of NO_X at higher level and other gases in little proportion. So it can be used to control the emission of harmful gases.

20% WPO Diesel blended fuel gives better result than diesel fuel when catalytic converter with urea is being used.

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We owe a great many thanks to a great many people who helped and supported us during this Research work. Especially we take an immense pleasure in thanking Mr Samir Patel for providing us Plastic Pyrolysis Oil and related information selflessly. We wish to express a deep sense of gratitude to him for showing faith in us for this research work and we would expect the same in future if needed. Details of Plant producing Plastic Pyrolysis Oil are provided below.

Mr SAMIR PATEL, S. R. Industries, G-142, Growth Centre, Ricco Mawal, Abu Road, Rajasthan.

APPENDIX

Abbreviation	Title
WPO	Waste plastic oil
SFC	Specific fuel consumption
BTE	Break thermal efficiency
ITE	Indicated thermal efficiency
ME	Mechanical efficiency
HC	Hydro carbon
CO	Carbon monoxide
NOx	Oxides of nitrogen
CO_2	Carbon dioxide
EGR	Exhaust gas recirculation
CC	Catalytic converter

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