Effects of Diesel−Biodiesel Blend on a Submissive Mode of Selective Catalytic Reduction with Ag-Zsm5 and Ni-Zsm5 Coated Converter to Reduce the CI engine emissions.

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ABSTRACT

Downwards reserves of petro-diesel and rosed cost of the petroleum demands researchers for a search of new alternative fuels. The stringent emission regulations given way for usage of less emission fuelled like biofuels derived from edible and non – edible oils. In the present work biodiesel produced from jatropha seed by the technique trans-esterification or alcoholysis methods. An experimental investigation carried out in twin cylinder CRDI turbo charged engine with diesel and biodiesel and it's with varying concentrations. They found high oleic acid jatropha fuel gives out low emissions compared to diesel fuel except oxides of nitrogen. The result revealed that BTE is JB10 is 27.9% and BSFC is JB30 is 299.1kg/kW- hr. Further one high oxides of nitrogen is reduced by Ion exchanging technique namely SCR.

Keywords: Jatropha, Emission, biodiesel, catalytic converter.

INTRODUCTION:

The application of diesel engine utilization grown in many sectors like agriculture, automobile industry, and combustion industry etc., the utilization of diesel fuel also develops the environmental pollution in one end. The various governments made stringent emission regulations to minimize the greenhouse gases, ozone layer depletion.

To overcome this problem many researchers were worked on the numerous alternative fuels namely, alcohols, pyrolysis oil, biofuels, edible oil, non- edible respectively. In this the most adopted diesel substitutes recommended by many researchers was biodiesel due to their physio-chemical proportion, low sulphur content no aromatics, non-toxic, biodegradable nature of the fuels.

Numerous research works conducted in numerous biodiesel fuels. Venkatesawaro Rao et al [1] studied the methyl ester of PME, JME, NHE in compression ignition engines performances and emission for the blend B20 and observed reduction in smoke CO,HC emissions respectively. In this context V.Siva reddy et al.,[2] uses jatropha cureas as a bio diesel fuel to enhance the BTC and found lowered SFC. [3] performed different bio diesel blends namely B20, B40,B70 and B100 for various load conditions. From their results it is evident that significant reduction in CO2, carbon monoxide and hydrocarbon emission with slight increase NOx emission by using diesel biodiesel blends.

The Author suggested that jatropha oil methyl ester have prepared and tested the fuel using cooled EGR or Diesel engine. Less than 100% of JOME among the extensive level of EGR (upto 75%) was used to reduce the NOx emission 62.5% and increased Hc and CO emission. [4] Diesel engine to improve its physio- chemical characteristic was tested by using (20%) diesel fuel, straight Jatropha or (70%) and 10% heptane. [5] Experimental on single cylinder CI Engine operating on straight vegetable Jatropha Ethanol Blends and its volume 5,10,15 &20% (v/v) Jatropha blends with ethanol.[6] The performance characteristics were comparable with diesel break thermal efficiency & brake specific fuel consumption is higher. Oxides of nitrogen are lower for SVJE than that of diesel.

Objective of the work:

The work is divided into two phase. In the first phase of the work CI engine experiment were conducted for normal diesel, Jatropha methyl ester oil and jatropha blends without anay catalytic converter. The results were recorded and studied the engine performance, combustion and emission characteristics. In the second phase of the work two types of catalytic converter (Ni-Zsm5 and Ag- Zsm5) were studied. There two Catalytic converter is called as after treatment technique. In which the emission of diesel jatropha bio diesel were experimentally investigated and studied.

Materials and Methods:

Due to scarcity of vegetables oils using in the production of biodiesels, non- foody seeds and crops shows better yield of biodiesel. Jatropha is one of the non- foody crop utilized for biodiesel production. For the present work biodiesel from jatropha methyl ester prepared from two steps trans-esterification technique by employing methanol and NaOH as base catalyst.

Since FFA content of jatropha oil is more than 5% an acid catalyst esterification carried out followed by base catalyst for higher yield of biodiesel.

ACID catalyst esterification:

Crude jatropha oil – 250gm

Temperature- 60℃

Methanol to oil ratio-0

Table: 1:

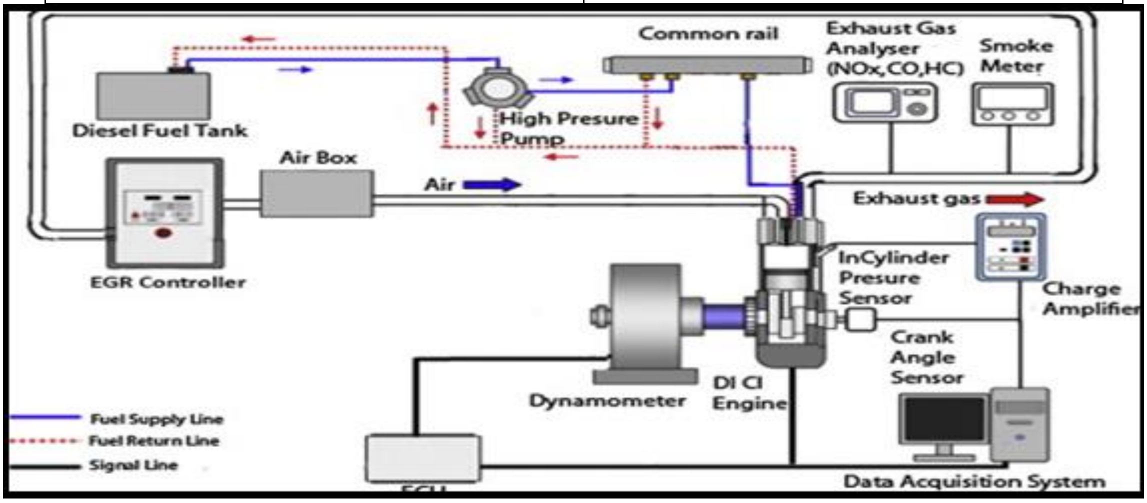
The characteristics of diesel fuel and Jatropha oil and

Properties	Diesel fuel	Jatropha	B10 D90	B20 D80	B30 D70
Calorific value	44.232	39.584	43.84	42.66	41.57
Density	0.831	0.921	848	852	860
Kinematic viscosity	3.21	38	8.68	9.25	10.65
Cetane No	47.14	43	53	54	56
Flash point	76	237	65	69	69
Cloud point	-12	-1	5.9	6.3	7

Experimental work:

Make/Model	Mahindra Maximo
Bore	83mm
Stroke	84mm
Type	CRDI
Cooling	Water
Displacement (Swept Volume)	909 cc
Fuel	Diesel

Speed	2000rpm
Torque	50 Nm
Max. Load in Dynamometer Load cell	18 kgs
Starting	Electric Start



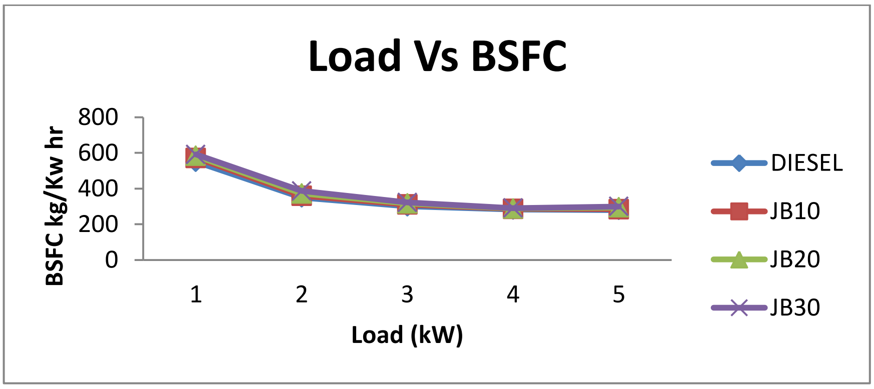
Photographic view of Experimental setup

The experimental study was carried out in four stroke solitary cylinder CRDI engine in two phase. The Phase-I holds then experimental work carried out with methyl ester jatropha blend with diesel mixture. The performance and emission characteristics of jatropha methyl ester B10, B20, B30 values were measured and recorded. The performance like BTE, BSFC and emission like CO, CO2, HC, NOx were measured.

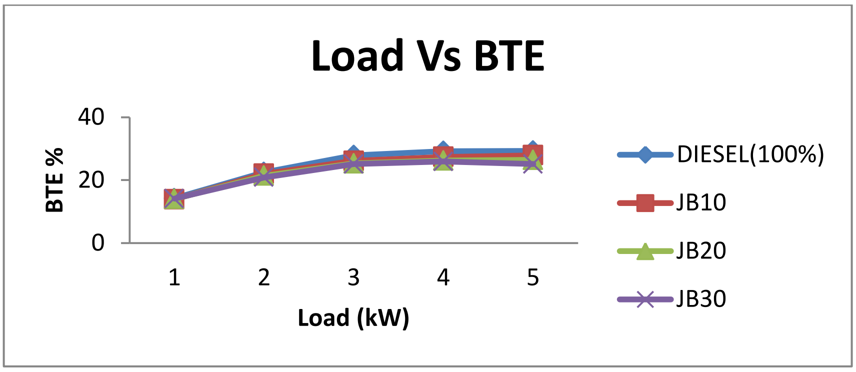
In the second phase of work the emissions coming out of the engine were directly sent to the fabricated catalytic converter (NiCl2-zsm5 and AgNo3-zsm5) in which the emissions like CO, CO2, HC, NOx values were calculated by using AVL DI gas analyser.

The comparison study was carried out in diesel engine fuelled with biodiesel without catalytic convertor and with catalytic convertor and the best of the results are noted.

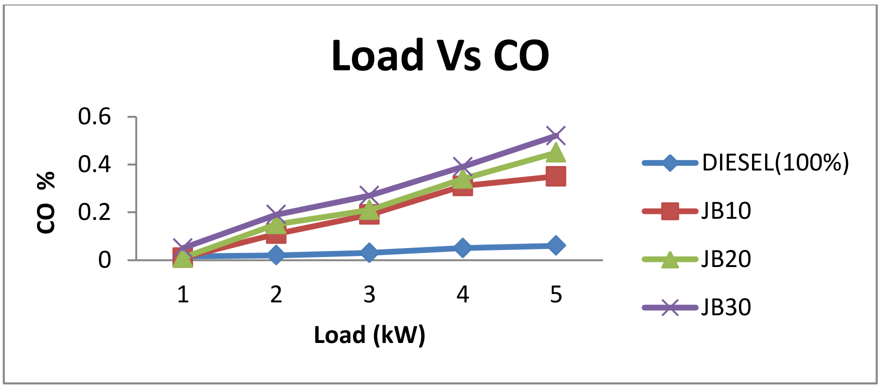
Results and discussion: (Phase- I)



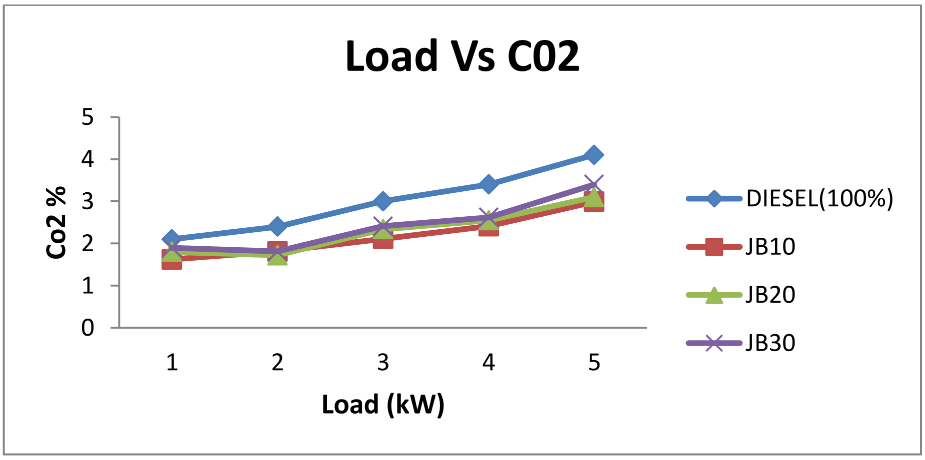
The above figure shows the history of load on BSFC. It is observed that SFC values of diesel are greater than biodiesel and its blends. The BSFC values of diesel jatropha JB10, JB20, JB30 are 310,309.2, 308.6 respectively. As load increases the BSFC value is decreases this is due to the improvement in the air- fuel mixing a higher loads which leads to complete combustion.



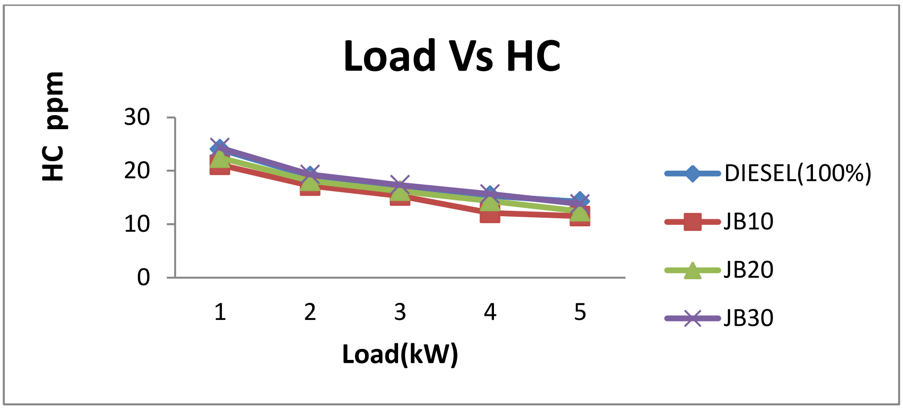
The figure shows the history of load Vs BTE. As load increases the BTE in increased for certain value and then decreased. From the findings it shows diesel records higher BTE then a jatropha bio diesel and its blends. This is due to the low C.V and higher viscosity of the blends decrease the fuel efficiency. The values of BTE for diesel, jatropha JB10, JB20, JB30 are 29.3, 27.9,26.4, 25.12 respectively at peak load conditions.



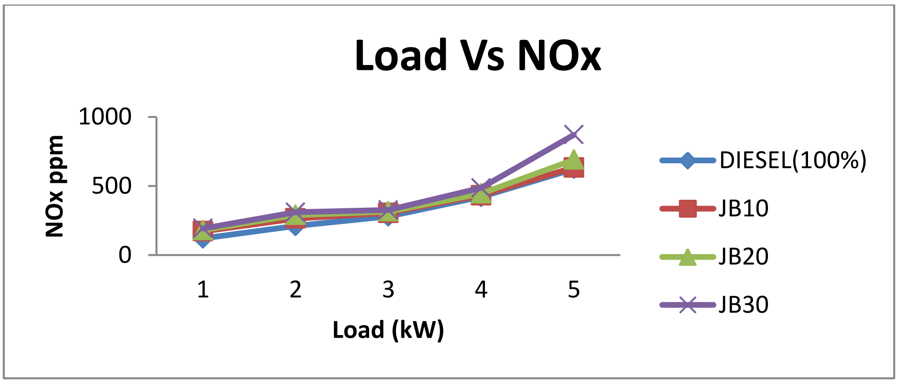
At the exhaust of tailpipe due to the in-compete combustion in the engine leads to conformation. Co depends upon the oxygen content of the fuel. From the graph it is visualized that jatropha biodiesel and its blends have higher CO formation than that of diesel fuel for all the loading conditions. This is due to the higher density and viscosity of the fuel which leads to poor atomization and emits more Co that diesel fuel.



Carbon-di-oxide gas shows the complete combustion behaviour of the engine. Hence we observed CO emission is lower biodiesel than that of diesel. This indicates CO2 emission holds lower value than diesel fuels. It is due to the lack of oxygen during combustion as load increases. The CO2 values at peak load conditions were 4.1, 2.99, 3.1, 3.4 for diesel, JB10, JB20, JB30 respectively.



Due to the higher viscosity and low heating value of biodiesel fuel the hydrocarbon emission observed some increasing and decreasing trends. At low load conditions the HC for JB30 is higher compared to diesel fuel. This is due to the improper oxidation process of fuel leads many unburnt fuels in the exhaust pipe. As load increases than increase in cylinder temperature burns the previous unburnt fuels in the combustion chamber. At peak load conditions the values observed were 11.22, 11.5, 12.4, 13.77 diesel, JB10, JB20, JB30 respectively.



The NOx value depends upon the oxygen content of fuel, In-cylinder temperature and pressure of an engine loads good amount of nitrogen oxide emission. From the graph it is observed that at low load conditions Nox finds to be marginally closer to the diesel fuel this is due to the fact that presence of longer ignition delay and longer time for proper mixing of air and fuel reduces the NOx emissions. At higher loads increase in cylinder temperature and shorter duration of air- fuel mixing loads high NOx emission. The NOx emission values for JB10, JB20, and JB30 are 850.1, 810.2, 822.3, and 832.2

Fabrication of catalytic converter: Phase- 2

ZEOLITE

Zeolites, which have an Al+Si ratio of 2, are highly porous crystalline hydrated alumina silicates formed of extra-framework charge-balancing alkali and alkaline earths and tetra-hedrally connected three-dimensional frameworks. Zeolites are a constituent of the same mineral family as feldspar and felspathoids. The pores in the zeolite frameworks can hold molecules as small as 1 nm in diameter and contain cages and channels that are coupled in one, two, or three dimensions. Zeolite, which meaning boiling stone, gets its name from two Greek words: zeo, which means to boil, and lithos, which means stone. Zeolites are frequently employed as adsorbents, catalysts, and ion exchangers.

PROPERTIES OF ZEOLITE

A thorough explanation of the many different aspects of zeolites, including their physical, chemical, ion exchange, and adsorption capabilities, as well as their mineralogical and morphological features, thermal properties, acid resistance, crystal structure, and structural framework.

Cordierite Monolith:

Bocent Advanced Cermics Co., Ltd. received commercial orders for oxidation monoliths and blank monoliths. The monolith has a diameter of 90mm and a length of 400cpi. Both monoliths have a 0.17mm cell density. The empty monoliths are seen in Fig.

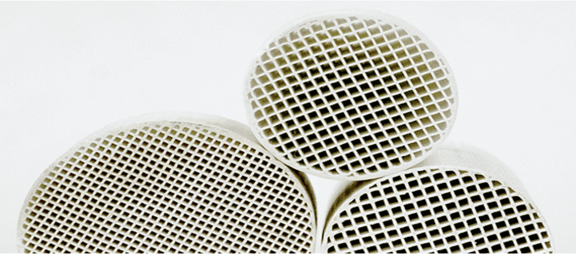


Fig: Ceramic monolith

Preparation of catalyst:

The catalyst is prepared from the high activity zeolites suggested by many researchers. From the experiment zeolite sample zsm5 is purchased from zeolites international USA. It is used as a base metal and AgNo3 and Nicl2 as a transaction metal. Two types of catalyst (AgNo3-zsm5 & Nicl2-zsm5) are prepared in the lab by the following procedure.

Na+ ion exchange method:

Na+ ion exchange method is used to prepare the catalyst because this method is effective and simple in nature. A sample of 100gm of zsm5 zeolite powder and 0.5m of AgNo3 of 100ml is mixed with 1000ml of 0.5M AgNo3 solution to form a final solution. The mixture is placed in a round bottom flask and stirred continuously for 24hrs at normal room temperature. During this period ion exchange of Ag and Ni takes place. The slurry is then placed in the oven and heating slowly at 500℃ for a time of 6 hrs. A same method is used for prepare the zeolite catalyst.

Catalytic converter:

Catalyst Characterization- SEM Image:

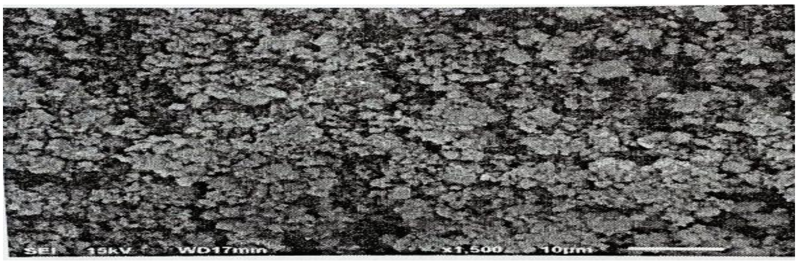


Fig -SEM image of zsm5 (Parent zeolite)

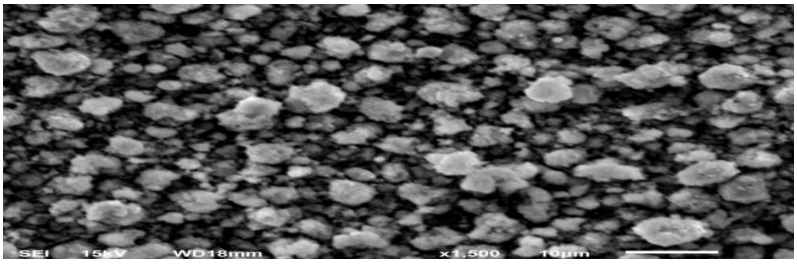


Fig.-AgNo3-zsm5 Zeolite-SEM image

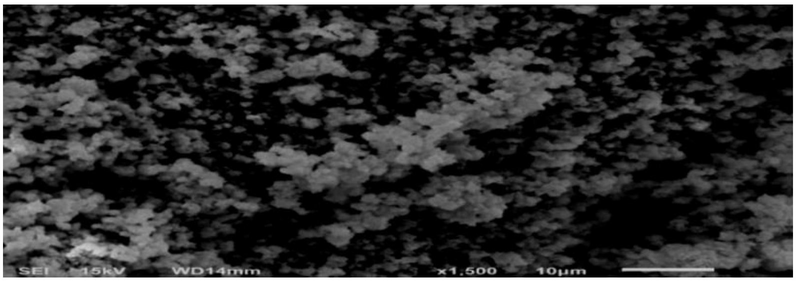


Fig.-Nicl2- Zsm5 Zeolite-SEM imag

Catalyst Characterization- XRD Image:

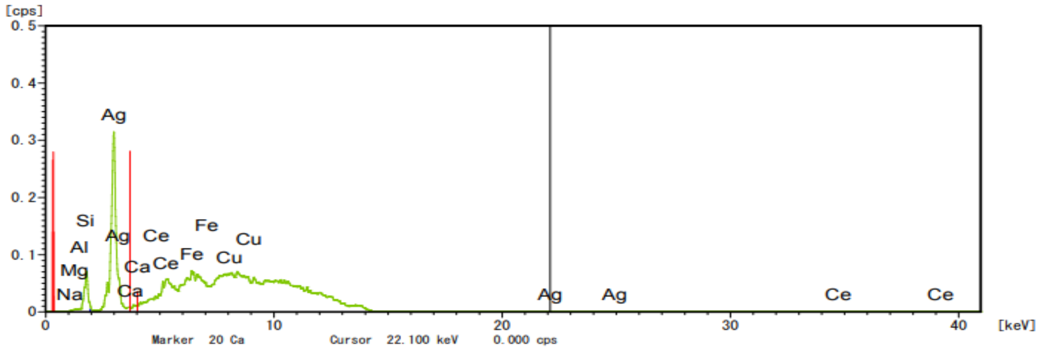


Fig- Zsm5- Zeolite- xRD

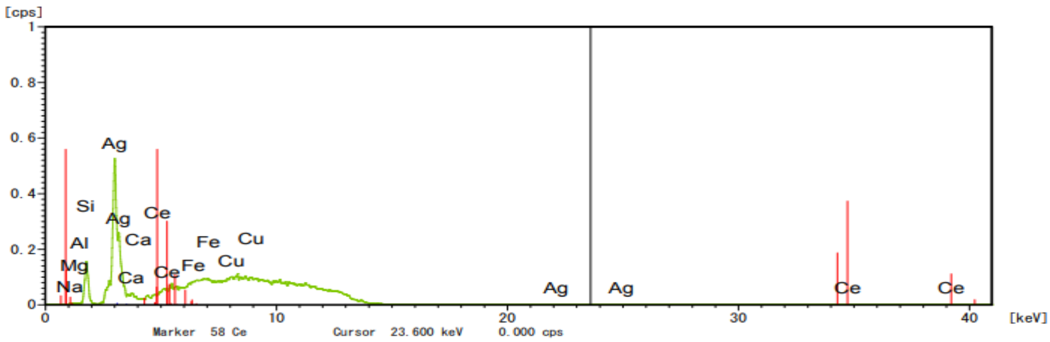


Fig- AgNo3+Zsm5 – xRD

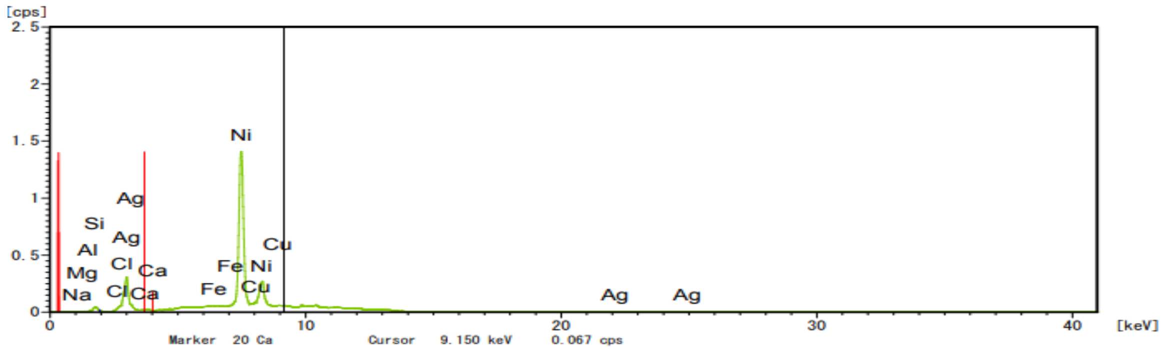
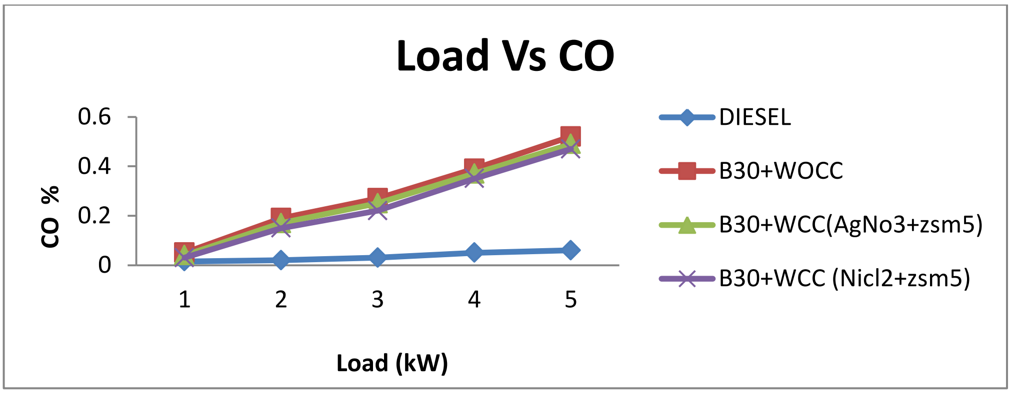


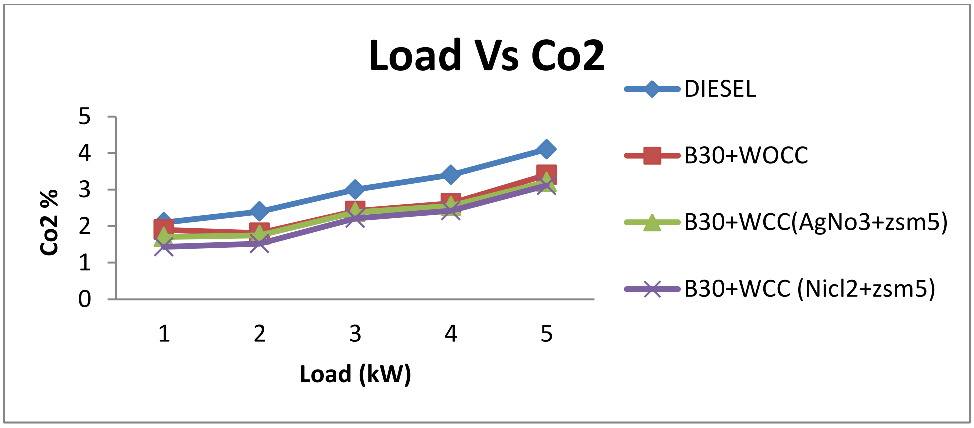
Fig-NiCl2- Zsm5- xRD

Experimental Setup:

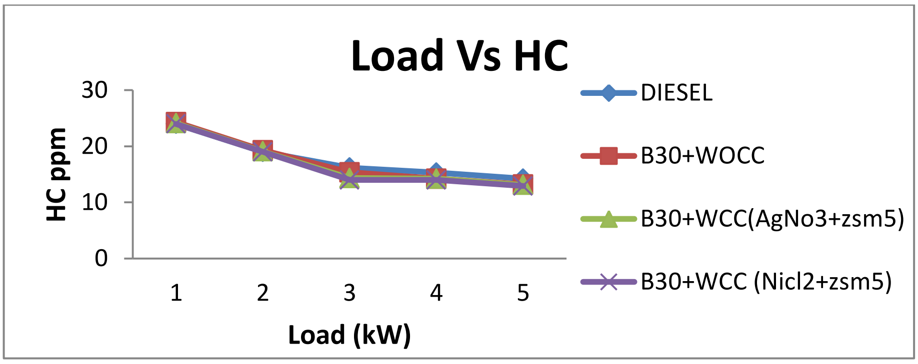
It is noted that NOx emission found that higher for all the blends ends worth B30 shows to be compared to B10 and B20. So In order to reduce the NOx emission the selective catalytic converter technique is used to reduce the Nitrogen oxides emission partially. We designed and fabricated the monolith coated convertor AgNo3+zsm5 and Nicl2+zsm5 are used for effective reduction of NOx and other emission.



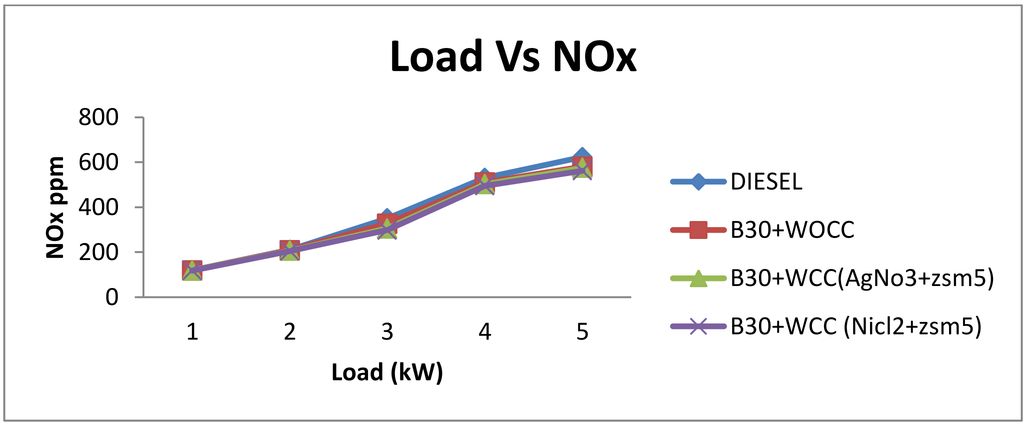
The above fig indicates the load Vs CO emission is influenced by volume of biodiesel and engine level. From the graph history it is observed that Nicl2+zsm5 catalytic converter shows decreasing trend in CO emission comparing to AgNo3+zsm5.This is due to high ion exchanging conversion efficiency of Nicl2+zsm5 which . At peak load conditions the recorded CO values are dominates the AgNo3+zsm5.



The above figure depicts the history of load Vs CO_2 emission. Complete combustion indicated by CO_2 in the exhaust tail pipe which influenced by higher oxygen- to carbon ratios. From the graph diesel shows higher CO2 emission possible with (AgNo3+zsm5) and (Nicl2+zsm5) catalyst.



The above figure depicts the load Vs HC. The unburnt hydrocarbon found in the engine tail pipe due to the lack of oxygen in the test fuel. The graph history depicts the UHS values of diesel, B30 WOCO, B30+WCC ($AgNo_3$+Zsm5) and B30 WCC($NiCl_2$+zsm5). It is evident that diesel records higher HC values than that of other biodiesel blends and other catalysts. B30+WCC (NiCl2+zsm5) show lower HC value compared to others catalysts used. This is due to the fact that unburned HC emission leaving the oxidation coated caltalyst again reacts with observed oxygen and produce CO_2.



The above figure shows the history of NOx Vs Load. The NOx formation depends upon the oxygen content of the fuel and largely on in cylinder temperature of the engine. This may lead to the formation of acid rain. The graph history depicts the zeolite based catalytic converter which reduce the NOx emission efficiently and observed Nox reduction about 30-40%. In zeolite based catalytic convertors more active sites are available for NOx conversion. The exhaust gas from the engine tail pipe leaving the oxidation monolith conducts the zeolite- based monolith, the following heterogeneous reaction occurs.

Conclusion:

In this work the CI engine performance and emission characteristics were studied using Jatropha biodiesel as a fuel and its values compared to conventional diesel fuel. The first phase conducted that comparison of engine performance and emission without catalytic converter. The second phase describes the emission studies of CI engine with selective catalytic converter and its reduction were studied and compared with first phase of work.

- Due to higher free fatty acid composition of jatropha oil first acid based esterification is carries out with jatropha oil. After that trans-esterification is done by using base catalyst for high yield of biodiesel.

- BSFC was found to be higher for jatropha biodiesel due to their higher viscosity and density characteristics of oil.
- At BTE is inversely proportional to BSFC. It observed BTE results lower for biodiesel than that of diesel fuel.
- For emission studies with and without catalytic convertor the CO2 and HC found to be lower for biodiesel blends compared to diesel.
- The NOx and carbon monoxide observed to be higher emission found to be slightly decrease value after undergone with in-house selective catalytic convertor.

In which the NiCl2-zsm5 zeolite properties successfully adopted for the reduction. Henceforth from this experiment it can be concluded that biodiesel emits some higher values of emissions like NOX in comparison with CO2 and HC were lowered. Thus SCR with zeolite as main components which efficiently reduces the NOx emission without having the environments.

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