COMPARISON OF EMISSIONS BY PURE DIESEL WITH CATALYTIC CONVERTOR AND PURE DIESEL WITHOUT CATAYLTIC CONVERTOR ON SINGLE CYLINDER DI-DIESEL ENGINE USING FIVE GAS ANALYSER

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***Abstract*— Air pollution generated from mobile sources is a problem of general interest. Vehicle population is projected to grow close to 1300 million by the year 2030. Due to incomplete combustion in the engine, there are a number of incomplete combustion products CO, HC, NOx, particulate matters etc. These pollutants have negative impact on air quality, environment and human health that leads in stringent norms of pollutant emission. Numbers of alternative technologies like improvement in engine design, fuel pretreatment, use of alternative fuels, fuel additives, exhaust treatment or better tuning of the combustion process etc. are being considered to reduce the emission levels of the engine. Among all the types of technologies developed so far, use of catalytic converters based on aluminium (noble) group metal is the best way to control automotive exhaust emissions. This review paper discusses Comparison Of Emissions By Pure Diesel And Biodiesel(B10) By Five Gas Analyser Using Catayltic Convertor**

***Index Terms*- Automotive emission, Catalytic Converter, Catalyst, aluminium group metal**

I. INTRODUCTION

Issue always been debated among the environmentalists over the decades and recent years is air pollution. As the technology keep on evolving and emerging, it carries along undesirable effects apart from its broad application and use. One of the main contributors is said to be the emission of harmful gases produced by vehicle exhaust lines. The number of vehicles miles travels per year continues to increase as a result of higher demand and needs. Consequently, an increasein the number led to the increase of the content of pollutants in air.

The need to control engine emissions was recognized as early as 1909. Due to the more stringent rules and emission standards, automotive manufacturers begun to develop a treatment device for exhaust gases known as catalytic converter for their vehicle models. pollution generated from mobile sources such as automobiles contributes major air quality problems in rural as well as urban and industrialized areas in both developed and developing countries. About 50million cars are produced every year and over 700 million cars are used worldwide. Vehicle population is projected to grow close to 1300 million by the year 2030.Most vehiculartransportation relies on combustion of gasoline, diesel and jet fuels with large amount of emission of carbon monoxide (CO), unburned hydrocarbons (HC), nitrogen oxides (NOx) and particulates matter (PM) are especially concern.HC and CO occur because the combustion efficiency is less than 100%. The NO*x* is formed during the very high temperatures(>1500 0C) of the combustion process resulting in thermal fixation of the nitrogen in the air which forms NO*x*. Typical exhaust gas composition at the normal engine operatingconditions are: carbon monoxide (CO, 0.5

vol.%), unburned hydrocarbons (HC, 350 vppm), nitrogen oxides (NO_x, 900 ppm) hydrogen (H2, 0.17 vol.%), water (H2O, 10 vol.%),carbon dioxide (CO2, 10 vol.%), oxygen (O2, 0.5 vol.%).Carbon monoxide is a noted poison that has an affinity for haemoglobin in the blood 210 times greater

Reduction of toxic substances emission from combustion engines can be achieved by primary (inside engine) measure and secondary (outside engine) measures. As primary measures many different possibilities and technical methods of reducing exhaust gas emission are used e.g. combustion of lean air fuel mixture, multistage injection fuel, exhaust gasrecirculation, fuel gas after burning, loading of additional water into cylinder volume . Nowadays secondary measures, in automotive exhaust after treatment processes a range of advanced technology is applied based on oxidation and threeway catalyst adsorption storage and filtration process. This enables reduction of the carbon monoxide (CO), hydrocarbons (HC), nitrogen oxide (NOx) and particulate emissions from a gasoline or diesel engine to meet the demands of current and future exhaust emission regulations. This paper discusses automotive exhaust emissions and its impact, automotive exhaust emission control by platinum (noble) group metal based catalyst in catalytic converter, history of catalytic convertor, types of catalytic convertor, limitation of catalytic convertor and also achievements of catalytic convertor.

II. LITERATURE REVIEW

P.K.V.S.Subramanyeswararao, *et al,* 2014investigated on back pressure for different models catalytic converters by changing the lengths and diameters of the substrate. In his study, it is also seen that the increase in catalyst diameter would result in decrease of exhaust emissions. Comparison between catalytic converters with external air supply and without external air supply was done and concluded that NO emissions are lower in case of external air supply.

Andreassi, *et al*, 2004:It has been observed and investigated that the role of channel cross section shape on mass and heat transfer processes. The development of catalytic converter systems for automotive applications is, to a great extent, related to monolith catalyst support materials and design. In this paper improvements of converter channels fluid-dynamics aiming to enhance pollutant conversion in all the engine operating conditions are studied

Rajadurai, *et al,* 2006 investigated the effect of Knitted wire mesh substrates with different geometry and channels on the back pressure of catalytic converter. The primary requirements of exhaust after treatment systems are low back pressure, low system weight, better emission performance and lower cost. Combinations of these properties provide better engine performance and higher system value. Combinations of these properties provide better engine performance and higher system value

Ekstrom and Andersson, *et al,* 2002 Investigated the pressure drop behavior of catalytic converter for a number of different substrates, suitable for high performance IC-engines, regarding cell density, wall thickness and coating. The measurements have been performed on an experimental rig with room-air flow and hot-air flow. The data has been used to develop an empirical model for pressure drop in catalytic converters.

Narasimha Kumar, *et al,* 2011: Investigations have been carried out for reducing pollutants from a variable compression ratio, copper-coated spark ignition engine fitted with catalytic converter containing sponge iron catalyst run with gasohol (blend of 20% ethanol and 80% gasoline by volume).The major pollutants emitted from spark ignition engine are carbon monoxide (CO) and unburnt hydrocarbons (UHC).

Mohiuddin and Nurhafez, *et al*, 2007 conducted an experiment to study the performance and conversion efficiencies of ceramic monolith three-way catalytic converters (TWCC) employed in automotive exhaust lines for the reduction of gasoline emissions. Two ceramic converters of different cell density, substrate length, and hydraulic channel diameter and wall thickness were studied to investigate the effect of varying key parameters on conversion efficiencies and pressure drop.

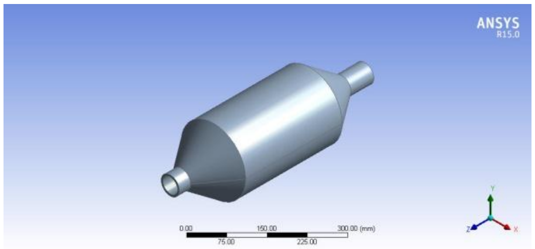
Muthaiah, *et al,* 2010 conducted an experimental test on a 10 hp, twin-cylinder, and four-stroke, direct-injection, vertical diesel engine. At present, the wall flow ceramic substrate is used as filters which are expensive and also offer more back pressure resulting in more fuel consumption. In the present study, catalytic-coated steel wire mesh materials with coarse, fine, and very fine grid sizes are used for PM filtration. The soluble organic fractions of diesel PM is oxidized by DOC system. So this provides strong motivation for development of improved catalytic converter.

Heywood, *et al*, 1988 conducted experimental test in which rhodium is used as the main catalyst to reduce NOx emissions.

Schmidt, Franz and Merdes, *et al*, 2002 used a ceramic substrate inserted into a metal container called a can, inorder to mount the catalytic converter to the exhaust system.

III. EXPERIMENTAL PROCEDURE

3.1. Geometry



The geometry has been modeled by using computational fluid dynamics (cfd) analysis. The geometry which is modeled is taken and fabricated an used for experimental purpose. The cylinder has undergone several tests and through five gas analyser emissions are checked. The main advantage of using a catalytic convertor is that when this is fitted to the exhaust pipe of an diesel engine heavier particles of dust comes out through the engine which when inhaled gives lot of pollution problem. The main work of this catalytic convertor is that these heavier particles settles down at the mesh and lighter particles only comes out into the atmosphere which when inhaled is not so harmful.

3.2. Fabrication data

3.2.1. Outer shell

- The outer diameter of the shell is 160mm
- The inner diameter of the shell is 154mm
- Thickness of the shell is 3mm
- Length of the shell is 254mm
- Operations performed are lathe machining

3.2.2.Mesh

Fig.7: Mesh

- The outer diameter of the mesh is 154mm
- The inner diameter of the mesh is 148mm
- Thickness of the mesh is 3mm
- Grid 8*8
- Operations performed are slotting and arc welding

3.2.3. Welded geometry

Fig.8: Welded geometry

- Outer diameter of shell=160mm
- Inner diameter of shell=154mm
- Length=254mm
- Thickness of plate=3mm
- Operations performed are Lathe machining and Arc welding

The mesh is now connected as channels and is welded together and this is galvanized by using Al_2O_3 (aluminium oxide) and then is placed inside the outer shell and welded together

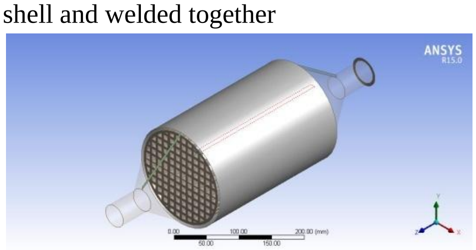


Fig.9: grid with channels

3.2.4. Final Geometry

Fig.10: final geometry

- Funnel length=144mm
- Angle=6 degrees
- Overall length =542mm
- Funnel outer diameter=48.1mm
- Funnel inner diameter=42.1mm
- Outer diameter of shell=160mm
- Inner diameter of shell=154mm
- The inner diameter of the mesh is 148mm
- Grid 8*8
- Length=254mm
- Operations performed are Galvanizing of inner mesh with aluminium oxide (Al2O3),Grinding, Fitting, Arc welding and Lathe machining

3.2.5. Engine setup

Engine specifications

- Single cylinder DI-diesel engine
- Stroke length=185mm
- Diameter=87.5mm
- Length of the cylinder=1100mm
- Speed =1500 r.p.m

Fig.11: Engine setup

3.2.6. Catalytic convertor fitted to engine exhaust

Fig.12: Catalytic convertor fitted to engine

3.2.7. Five GAS Analyser

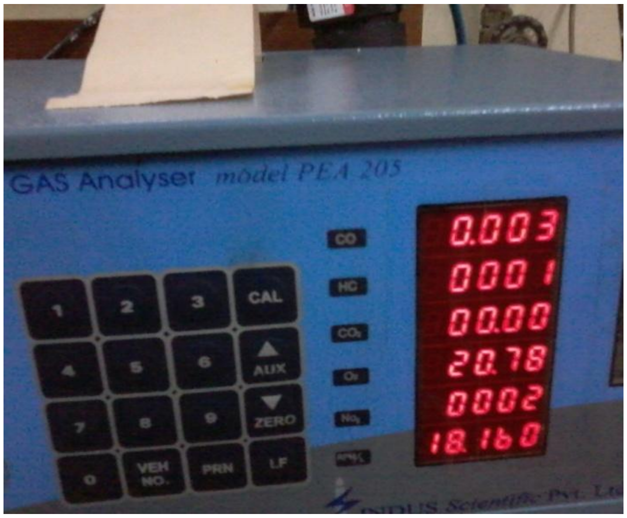


Fig.13: 5 Gas analyser

This is mainly used to check the emissions generated by the engine. The five gas analyser is placed inside the exhaust of the catalytic convertor and the exhaust is completely blocked so that no air enters enters into the exhaust which thereby helps the five gas analyser to get accurate values for emissions.

Load/compounds	CO	HC	CO2	O2	NOx
0	0.267	0.019	2.39	17.52	62
3	0.116	0.007	3.06	16.40	278
6	0.072	0.019	2.70	17.36	432
9	0.064	0.015	2.93	17.13	591
11	0.032	0.010	0.40	18.18	496

The five gases which this analyser works on is CO(carbon monoxide), HC(hydrogen carbide), CO2(carbon dioxide), O2(oxygen), NO2(nitrogen dioxide).

3.3.Experimental procedure

Using this experimental setup we have conducted the test Diesel with catalytic convertor

When catalytic convertor is fitted to the exhaust of the engine where diesel is used as a fuel for running the engine. First the engine is started and made to run at no load condition and the time taken for consumption for 10c.c fuel is taken and the same procedure is carried out at one fourth load, half load, three fourth load and full load.Five gas analyser is fitted to the exhaust and the emissions are calculated and tabulated and then the readings of diesel with catalytic convertor and without catalytic convertor are compared.

IV. RESULTS

4.1. Emissions using pure diesel with catalytic convertor

Table 1: diesel with catalytic convertor

4.1.2. Graphical representation of load versus CO

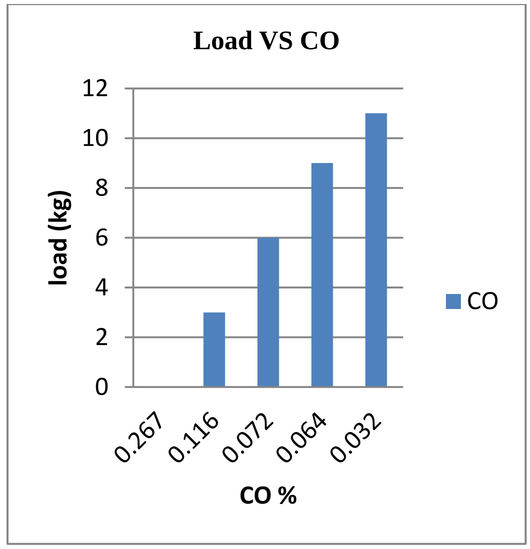


Fig.14: Load Vs CO

4.1.3. Graphical representation of load versus HC

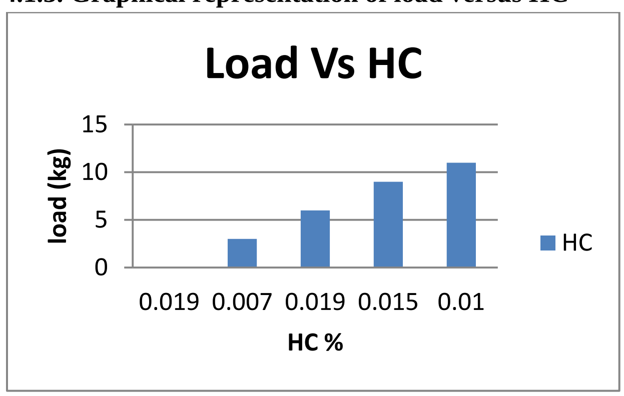


Fig.15: Load Vs HC

4.1.4. Graphical representation of load versus CO_2

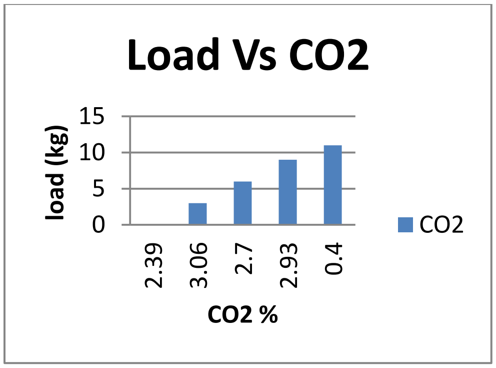


Fig.16: Load Vs CO2

4.1.5. Graphical representation of load versus O_2

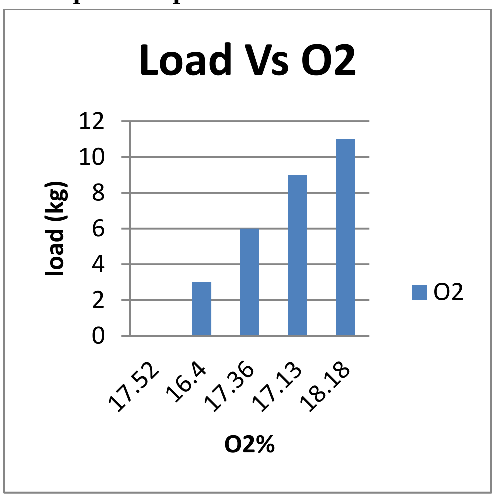


Fig.17: Load Vs O2

4.1.6. Graphical representation of load versus NO_2

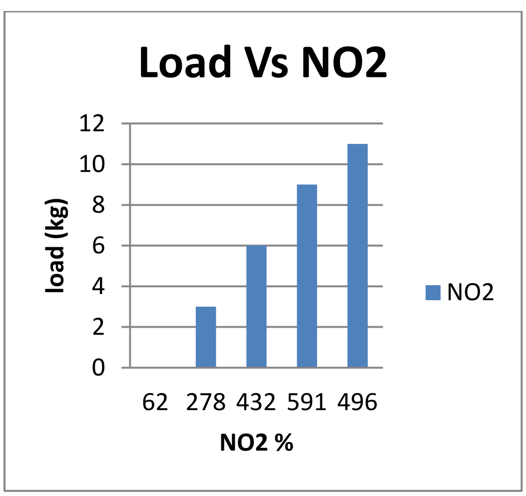


Fig.18: Load Vs NO2

4.2. Emissions using pure diesel without catalytic convertor

load	CO	HC	CO2	O2	NO2
NL	0.06	0.001	0.40	20	90
¼ L	0.06	0.005	0.40	18	100
½ L	0.028	0.005	0.40	19	200
¾ L	0.03	0.005	0.40	18	350
FL	0.03	0.007	0.40	18	370

Table 2: diesel without catalytic convertor

4.2.1. Graphical representation of load versus CO

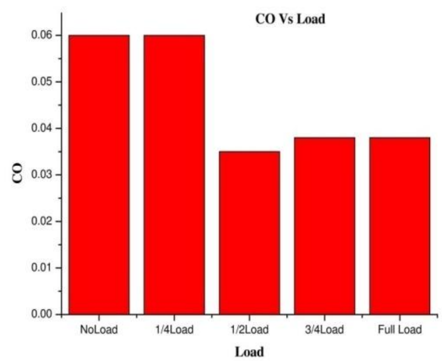


Fig.19: CO Vs Load

4.4.2. Graphical representation of load versus HC

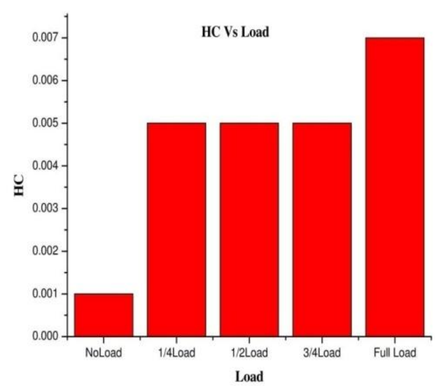


Fig.20: HC Vs Load

4.4.3. Graphical representation of load versus CO2

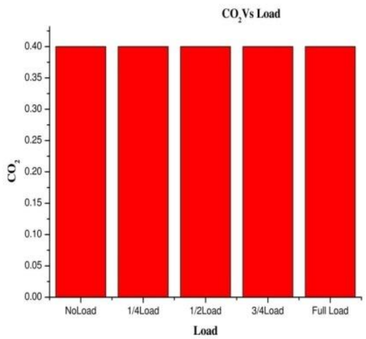


Fig.21: CO2 Vs Load

4.4.4. Graphical representation of load versus O2

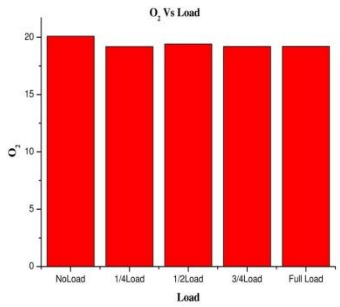


Fig.22: O2 Vs Load

4.4.5. Graphical representation of load versus NO2

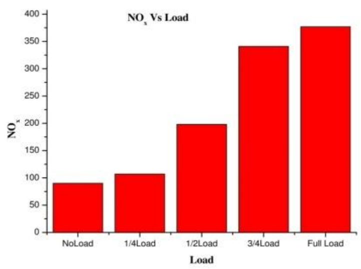


Fig.23: NO2 Vs Load

V. CONCLUSIONS

The NOx values have been reduced on comparing emissions using diesel with catalytic convertor with emissions using diesel without catalytic convertor and indicated thermal efficiency is also decreased while comparing diesel with catalytic convertor and diesel without catalytic convertor which reduces release of toxic substances into the atmosphere.

Today's automobiles are meeting emission standards thatrequire reductions of up to 99 percent for HC, CO and NOxcompared to the uncontrolled levels of automobiles sold in the1960s.

Environmental, ecological and health concern result in increasingly stringent emissions regulations of pollutant emissions from vehicle engines. Among all the types of technologies developed so far, use of Metal Monolith type catalytic converters is the best way to control auto exhaust emission. Three-way catalyst with stoichiometric engine control systems remain the state of art method forsimultaneously controlling hydrocarbon, CO and NOx emissions from vehicle. The economical reasons, limited resources of platinum group (noble) metal and some operating limitations of platinum group metal based catalytic converters have motivated the investigation of alternative catalyst materials.

This type of Catalytic converters have also been developed for use on trucks, buses and motorcycles as well as on construction equipment lawn and garden equipment marine engines and other non-road engines. Catalytic converters are also used to reduce emissions from alternative fuel vehicles powered by natural gas, methanol, ethanol and propane. To date more than 500 million vehicles equipped with catalytic converters have been sold worldwide. In 2005, 100 percent of new cars sold in the U.S. were equipped with a catalytic converter, and worldwide over 90 percent of new cars sold had a of metal monolith type catalyst.

VI. FUTURE SCOPE

Further by using catalysts like platinum, rhodium, palladium there can be more reduction in NOx values which thereby reduces release of toxic substances into the atmosphere.

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