EXPERIMENTAL ANALYSIS ON EMISSIONS& BACK PRESSURE OF A DIESEL ENGINE USING CATALYTIC CONVERTER WITH AIR-BOX

Jamuna Rani.G[1], Dr. Y.V.Hanumantha Rao[2], Dr. B. Balakrishna[3]

[1]*Assistant Professor, Department of Mechanical Engineering, V.R Siddhartha engineering college, AP, India.*

[2]*Professor, Department of Mechanical Engineering, KL University, Guntur, Andhra Pradesh, India.*

[3]*Professor , Department of Mechanical Engineering , University College of Engineering Kakinada, Jntuk, AP.*

---***---

Abstract-*Now a days the pollution of air becomes a serious problem which causes simultaneously global warming. The main reason for the air pollution is caused by the vehicular pollution. The cars or any transportation vehicles are releasing emissions in abnormally. So, there is a need to identify how to reduce the emissions. In the present work, we studied experimentally how the emissions are varying for a diesel engine by using with and without catalytic converter and back pressure is analyzed for the diesel engine at exhaust pipe with and without using air-box. Catalytic converter plays an important role in reducing harmful exhaust emissions, but the presence of catalytic converter resulting in increase the exhaust back pressure which results decreasing the volumetric efficiency and simultaneously increases the fuel consumption. The experiment has been done on the diesel engine of tractor (4-stroke, 4–cylinder) Mahindra Bhoomiputra 475 DI, at different speeds by introducing the catalytic converter and air box to the engine exhaust manifold. The aim is to reduce the emissions using the catalytic converter as well as the back pressure which is being produced by the honey-comb structure of a catalytic converter can be reduced by using the air box arrangement. The results are obtained for different speeds and compared, and how the back pressure is being reducing.*

***Key Words*: catalytic convertor, emissions, back pressure, air box, Diesel engine**

1.INTRODUCTION

As the number of Vehicles increases, subsequently the Pollution of air is also increases. This has become a major issue. Every Vehicular Industry is concentrating on this problem to eradicate the emissions as well as to increase the performance of the engine whether it is Diesel engine or Petrol engine. The pressures, velocity profiles are varying throughout the process of reducing emissions by the usage of Catalytic converter to reduce the emissions of 4-stroke single cylinder petrol engine[1]. The operating conditions affect the emissions of a tractor engine. This study deals with the effects of types of tractors and operation conditions on engine emission[2]. Analysis of catalytic converter is very important. Apart from all the particulate filter materials, knitted steel wire mesh is selected as filter materials in this paper. Through Computational Fluid Dynamics (Fluent) analysis[3]. Analysis of Catalytic Converter is used to Reduce Particulate Matter and to Achieve Limited Backpressure in Diesel Engine. In CFD analysis, various models with different wire mesh grid size combinations were simulated using the appropriate boundary conditions and fluid properties specified to the system with suitable assumptions[4]. The catalytic converter is a device which converts harmful exhaust gases from internal combustion engine into harmless gases. Harmful gases like NOX, CO , unburned HC etc. are converted into N2, CO2, H2O respectively. Which include, NOX CO, unburned HC, smoke etc . Apart from these unwanted gases, it produces Particulate Matter (PM) such as lead, soot[5]**.** The transient catalytic converter performance is governed by complex interactions between exhaust gas flow and the monolithic structure. This research illustrates the effect of flow distribution in the thermal response of a catalytic converter, during the critical phase of catalytic converter warm-up[6]**.**Concept of reversal reactor (CFRR) was introduced in some applications. This concept was first discussed by Frank-Kamenetski(1955).The transfer of energy is observed to be a significant factor in the reactor operation, which is shown by comparison of the heterogeneous model to a pseudo-homogeneous reactor model[7].Discussed ordinary computational liquid motion(cfd)strategies for reproducing the move through car fumes impetuses expect a stone

monument resistance in light of one- dimensional laminar stream[8].Experimental analysis and Comparison of Performance Characteristics of Catalytic Converters[9].The pressure, velocity, mass flow and temperature fields in the converter with respect to inlet conditions are studied. In CFD analysis, fluid properties are specified with suitable assumptions. Parameters are taken from an experiment on a four stroke single cylinder spark ignition engine running at a speed of 3000rpm.Catalytic converter plays an important role in reducing harmful gases without changing the design of an engine, but the presence of catalytic converter increases the exhaust back pressure which results in the volumetric efficiency decrease and higher fuel consumption. NO_X emissions are become high as the engine running at high speeds

2. EXPERIMENTAL SETUP

2.1 Catalytic Converter Specifications:

The catalytic converter is a device which can reduce the emissions, Here we are using the 3-way Catalytic converter which can reduce the emissions of CO, NO,HC by oxidizing, reducing the emissions which are coming from engine exhaust manifold.
Specifications: **TATA eV2 [2011-2012]LX**
Fuel: **Diesel**
Displacement: **1396cc**

2.2.Engine(Diesel)Specifications

Model : MDI2385
Category Type : Water cooled four strokes, Direct injection diesel engine.
Number of Cylinders: Four
Bore and Stroke (mm):88.9 / 101.6
Displacement: 2523cc
Rated Engine Speed:2300
Max Torque:140 Nm @ 1200 to 1400rpm
Cooling System: Water cooled

2.3. AIR BOX

The Air box is a device, which can be used before the catalytic converter. As our aim is to reduce the back pressure, for that this air-box will have a passage that atmospheric air can enter into the catalytic converter to reduce the back pressure.

- Air box of measurements of length nearly meets the length of catalytic converter.
- Dimensions29*17*17cm
- Pipe length=10cm,diameter=1.5inch

3. EXPERIMENTATION

Experimentation is carried out in three ways
i) Emissions without using Catalytic converter.
ii) Emissions& Back pressure after using Catalytic converter.
iii) Emissions& Back pressure after using Catalytic converter along with Air-box.

3.1. Experimental Test on Emissions without using Catalytic converter

The 5 Feet GI pipe is attached to the engine exhaust manifold by the help of corner joint. The emissions are being tested by the Pollution control van check-up. The emission test has been done by varying the speed in regular intervals. As the min speed of the tractor is 750RPM.The below table shows the experimental results of emissions without using catalytic converter.
The below chart is drawn for the emissions of the CO, HC+NO with respect to the speed or RPM. The chart shows along x-axis speed in RPM and y-axis shows the emissions in percentage. The emissions of CO should be in the limits of CO -12%, HC+NO- 15% is from without using catalytic converter at different speeds.

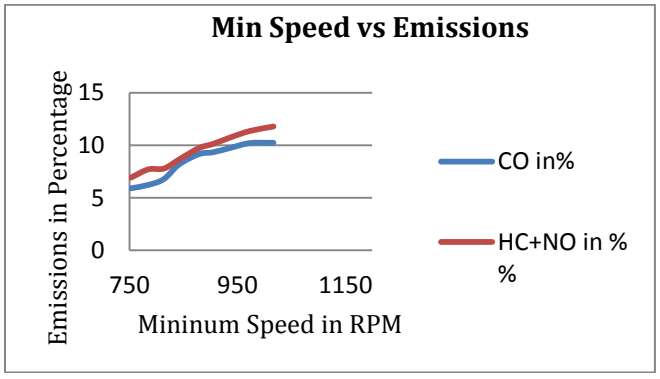

Chart No-1: Graphical representation of emissions Speed Vs Emissions

3.2. Experimental Test on Emissions & Back pressure with Catalytic converter

The Engine setup is then connected to the catalytic converter, to check the emissions levels and to check the Back pressure produced. For that the Gauges are also be fitted to the catalytic converter. For the Pressure gauge fitting, there should be passages are provided for the iron hollow rods in the flow direction. The Teflon Tape is applied on the Threading provided on the Pressure gauge. For avoid the leakages, then the gauge is fitted. The leakages should be avoided. The Pressure Gauges are fitted before and after the Catalytic converter. The converter is connected to the GI pipe. Whether to check the emissions are reduced by the use of catalytic converter or not.

The emissions of pollutants HC+NO and CO are measured. After using Catalytic converter of3-way.The chart shows along x-axis speed in RPM and y-axis shows the emissions in percentage. The same emissions are again measured at varying the speed at regular intervals. The percentage of emissions is reduced ineffectively.

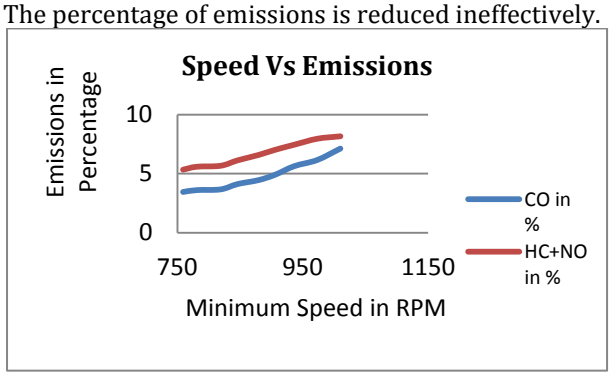

Chart No-2: Graphical representation of Speed Vs Emissions with Catalytic converter without Air-box.

3.2.1. BACK PRESSURES OBTAINED BY THE USE OF CATALYTIC CONVERTER:

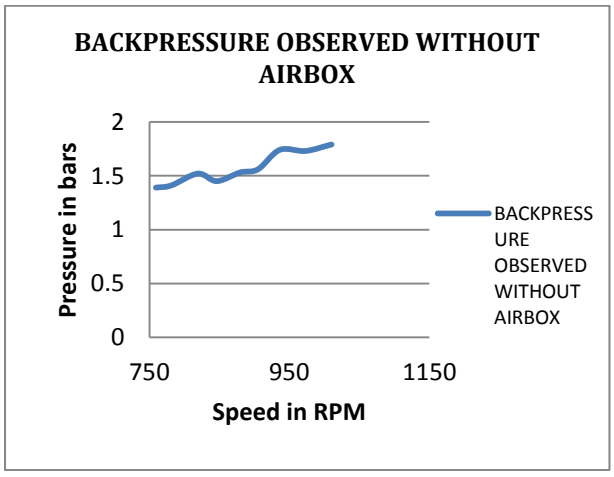

Chart No-3: Backpressure observed without Airbox.

3.3. Experimental Test on Emissions& Back pressure with Catalytic converter along with Airbox.

In the third test the Air box is attached before the Catalytic converter of the Experimental setup.

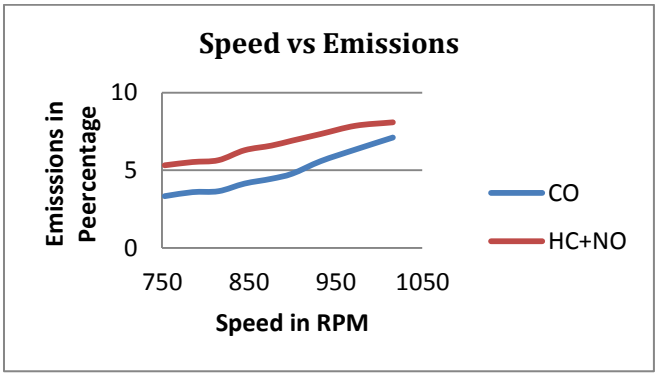

Chart No-4: Graphical representation of Speed Vs Emissions with Catalytic converter &Air box.

3.3.1BACK PRESSURES OBTAINED:

Back pressures obtained at different speeds after attaching air-box along with Catalytic converter.

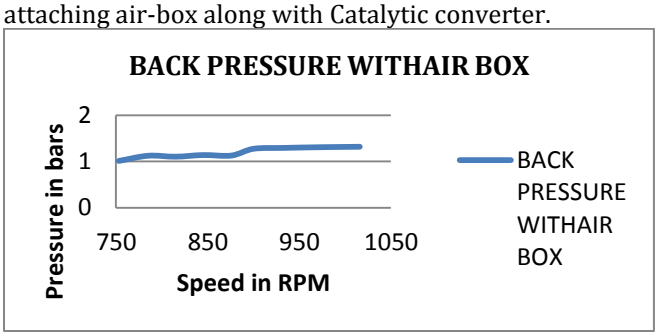

Chart No-5 :Backpressure observed with Airbox.

4.RESULTS ANDDISCUSSIONS:

4.1.EMISSIONS COMPARISION:

- The emissions of CO, NO+HC are being reduced by the Catalytic converter.
- We can observe how the emissions are reduced in percentages.
- The percentage of CO emissions are reduced by 3%, the percentage of HC+NO emissions are reduced approximately by3%.

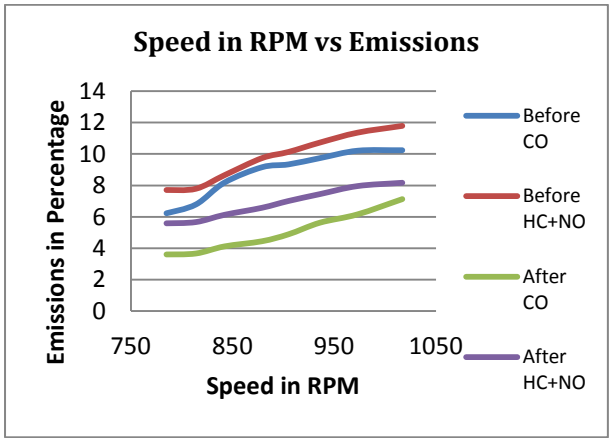

Chart No-6: Comparison of Emissions before and after using catalytic converter

4.2. BACK PRESSURES COMPARISION

The Back pressures exerted by the Catalytic converter, are reduced in fractions by using the air box along with converter. The Back pressure is reduced nearly of0.5%.

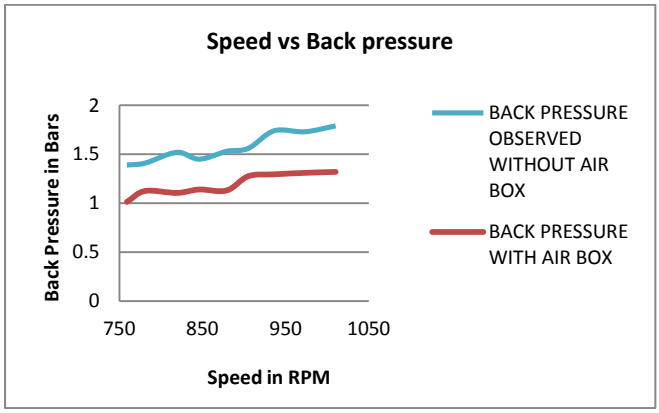

Chart No-7: Graphical representation of Back pressures with and without using catalytic converter**.**

5.CONCLUSION:

1. According to the type of engine, the discharge of emissions into the atmosphere through an exhaust pipe is different. We can reduce the emissions by the use of catalytic converter. Even the catalytic converter is used, itself causing the problem of increasing the Backpressure.
2. The emissions and the back pressures are identified at different speeds. The Back pressure exerted by the catalytic converter during the working condition causes the decrease in the volumetric efficiency and it leads to increase in fuel consumption
3. So here the back pressure is reduced by using the air box, by which atmospheric air enters into the Exhaust emissions will increase the performance of the engine, as well as the performance and durability of the catalytic converter.

6. FUTUREWORK:

1. In the present work, we have been discussed the practical or experimental results how the emissions and back pressures are varying with respect to speed. It is proposed to reduce the emissions by the Catalytic converter, and back pressure by the Air-box.
2. There is a scope to analyze the back pressure by modeling the process and using the fluent analysis. And also we can go through the performance test by attaching the Air box as well as the catalytic converter.

REFERENCES

[1] Ch. Indira Priyadarsini, Flow in Catalytic Converter of Spark Ignition Engine with Air Box, International Journal of Scientific Engineering and Technology (ISSN :2277-1581)
[2] Gholami Rashid, RabbaniHekmat, Lorestani Ali Nejat, JavadikiaPayam, JalilianterFarzad (2013)
[3] B.bala Krishna and Srinivasarao,(2014) The air pollution is due to emissions from an internal combustion engine. The harmful gases like , NOX, CO, unburned HC and particulate matter increases the global warming,
[4] PL.S. Muthaiah, Dr.M. Senthilkumar, Dr. S. Sendilvelan, CFD Analysis of Catalytic Converter to Reduce Particulate Matter and Achieve Limited Backpressure in Diesel Engine , Page 2 Vol.10 Issue 5 October 2010 ,Global Journal of Researches in Engineering.
[5] Nagalliraghu, G.V.Devra, jai sagar (2015)the catalytic converter is a device which converts harmful exhaust gases from internal combustion engine into harmless gases. Harmful gases like nox, co, unburned hcetc
[6] D. N. Tassioglou, G.C. Koltsakis a, D.K. Missirlis b, K.J. Yakinthos, Transient modeling of flow distribution in automotive catalytic converters, ELSEVIER.
[7] S. Salomons , R. E. Hayes , M. Poirier , H. Sapoundjiev , Modeling a reverse flow reactor for the catalytic combustion of fugitive methane emissions, ELSEVIER Computers and Chemical Engineering 28 (2004) 1599–1610.
[8] S F Benjamin, N Haimad, C A Roberts and J Wollin, Modeling the flow distribution through automotive catalyticconverters.
[9] A.M.K. Mohiuddin and Muhammad Nurhafez, Experimental analysis and Comparison of Performance Characteristics of Catalytic Converters including Simulation, IJMME, vol.2 (2007),No.1,1-7.