A Investigation to Reduce Emissions from Engine

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***Abstract*:- At present every nation is suffering to the effects caused by emission from the automobiles either from 2 stroke engines or from engines operating at 4 stroke, either diesel or gasoline engine. Every type of engine has its own parameters of emission in terms of Unburned Hydrocarbon (UBHC), Carbon Monoxide (CO), Nitrogen oxide (NOx) and many other parameters like particulate matter etc.**

In our attempt to reduce the emission from the 2 stroke petrol engine we are using an exhaust silencer pipe which is coated with a mixture containing sodium silicate, aluminum silicate and activated charcoal in the required proportionate, the coating is done manually to the exhaust pipe and care is taken so that the coating is uniform to maximum extent. The exhaust pipe is fitted with a baffle so that the exhaust gases from the engine are exposed to the refractory coating which is coated on the baffle as well as the inner surface of the exhaust pipe which will help to reduce the emissions of the exhaust. The results obtained are significant in reduction of the emissions of UBHC and CO.

I. INTRODUCTION

The emissions which are undesirable for the atmosphere from the automobiles are studied extensively in the recent decades to ensure that the pollution of the atmosphere does not exceed the limit for human breathing. Also various methods are also in practice to reduce the emissions for all types of engine so as to reduce the emissions i.e. UBHC, CO and NOx and stringent rules are being followed for the norms of emissions for the engine day by day. Being in a situation where we need to spread the awareness about emissions and also find a solution to ensure that the emissions from our automobiles are not exceeding the limit of the emissions set by the country's pollution board for the vehicles. Hence it is essential for us to study the emissions and also find methods to reduce the same.

During the project planning we thought of reducing the emission, by coating materials like aluminum silicate, sodium silicate and activated carbon. The materials used are significant to reduce the emissions of UBHC and CO. Modification was planned carefully for replacing the conventional silencer with newly fabricated silencer coated with aluminum silicate, sodium silicate and activated carbon. It was found that the emissions reduced with the use of fabricated silencer.

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1.1 Experiment Details

The experiment was carried out on a two stroke engine whose specifications are given below:

Number of cylinder	Single cylinder
Number of stroke	2-stroke
Type of cooling	Air cooled
Bore x Stroke	42.6mm x 42mm
Displacement	59.9cc
Maximum power	3.5 hp at 5500rpm
Maximum Torque	4.5 Nm at 5000rpm

II. METHODOLOGY

The silencer body is designed and constructed as per dimensions by using processes like cutting, welding. The aluminum silicate, sodium silicate and activated carbon are mixed in required composition to prepare slurry which is coated on the inner surfaces of the silencer and also to the baffle, which is situated inside the silencer. The figures represent the design, constructed model and silencer coated with the mixture. The silencer is heated to remove excess moisture from the coating. The emission test of the conventional silencer and the coated silencer are carried out and results are discussed.

Figures

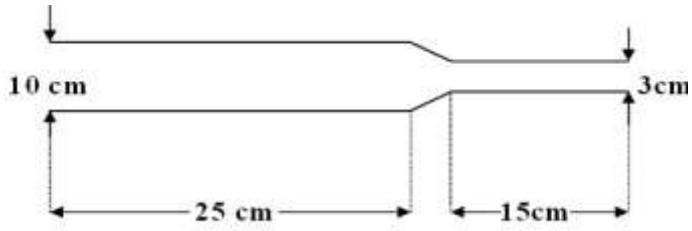

Figure 1. Dimensions of the silencer model

Figure 2. Constructed model as per dimensions.

Figure 3. Coated silencer with baffle inserted

The emission tests were carried out on the vehicle with the conventional silencer and the fabricated silencer without baffles (20% refractory) and with baffles for the coated silencer.

2.1 Chemical Reactions Involved

The reactions involved are oxidation of carbon monoxide and hydrocarbons, which give products which are permissible

Oxidation of carbon monoxide to carbon dioxide.

$$2CO + O_2 \rightarrow 2CO_2$$

Oxidation of hydrocarbons (unburned and partially burned fuel) to carbon dioxide and water

$$CXH_2X+2 + [(3X+1)/2]\ O_2 \rightarrow XCO_2 + (X+1)H_2O$$

2.2 Tests and Results

The tests for emissions were carried out at an emission testing centre, which showed that coated silencer had reduced emission than the conventional silencer for UBHC and CO. The UBHC emissions reduced to 66% in comparison to conventional silencer whereas the CO emissions reduced to 55% in comparison to the conventional silencer. The comparisons of the emissions are made between conventional silencer, fabricated silencer without baffle and fabricated silencer with baffle for UBHC and CO. The following graphs represent the emission characteristics of hydrocarbons and carbon monoxide.

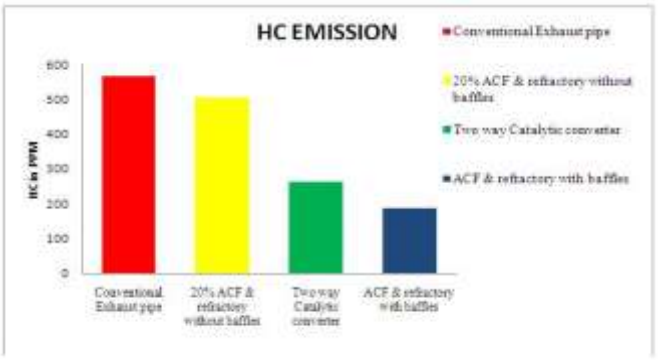

Fig 5. UBHC emission characteristics

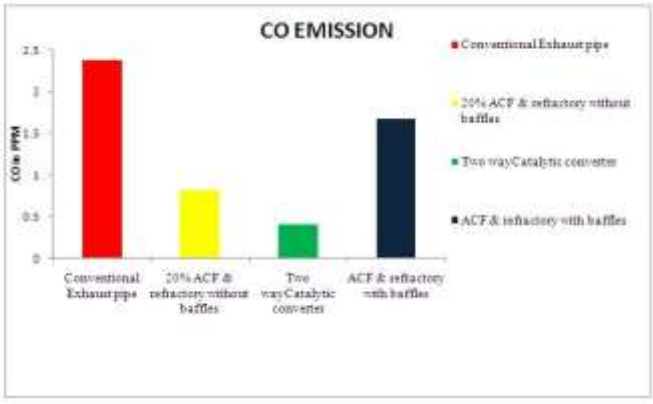

Fig 6. CO emission characteristics

Model preparation by using software like solid edge or auto cadd:

The physical model is measured and accordingly constructed in solid edge or auto cadd software. The model is sketched on a paper for a reference basis to build the model in the software. The dimensions are to be ensured when the model is completed and it is checked for mistakes in dimensions, and if no mistakes exist the model is assembled if it contains more than one part. The model when imported to Ansys software, should be checked so that it does not show a disturbed model.

There are different file extension formats which can be used for importing the file in ANSYS software. For our simulation we are using the STEP file extension (.stp/step). The model constructed is pertaining to the part where the boundary conditions are applied and the results are expected. The preferences are set based on the type of analysis is to be carried out.

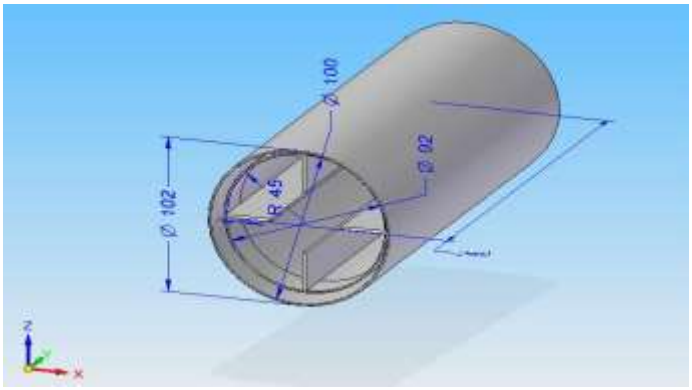

Fig 7: Model created in pre processing software (Solid edge) as per dimensions

The analysis of the model requires meshing of the model. Discretisation or Meshing is a process of dividing the model into elements consisting of nodes. The processing for all these nodes will yield the results. Meshing is an important part of analysis and determines the efficiency and effectiveness of analysis. So more time should be taken for meshing of the model if the model is complex in structure. 1D, 2D and 3D meshing can be carried out depending upon the model.

We are using 3D meshing for our model. The meshing work is checked for errors in the model if the mesh is not generated properly and the model needs some tweaking for the mesh to be generated effectively. If the mesh is not as per the model requisite the meshing procedure is re iterated to obtain the mesh to a good quality. The model is imported to NX software and meshing is carried out. Quadrohedral mesh type is used which gives good meshing quality and the property of real constraints, elements nodes are set.

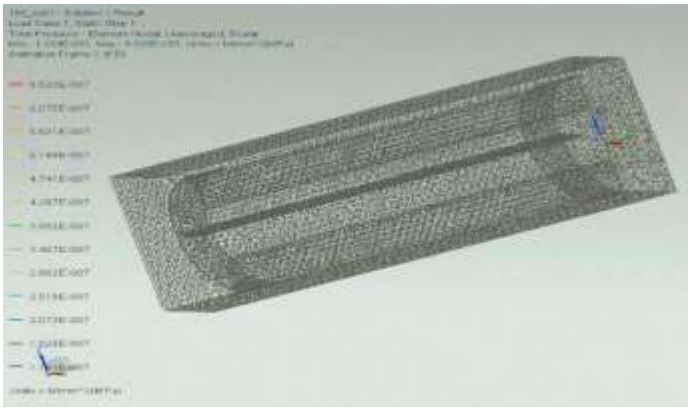

Fig 8. Completely Meshed model.

Boundary conditions are very necessary to define how the model should interact with the system flow. Boundary conditions occur at the edges of the active model area and other areas where the conditions are to be applied. Boundary conditions are the setoff conditions applied to the model with the temperature, pressure and material properties involved in the model. In our model, the conditions were given in temperature, flow rate of the gases and the respective parameters required for the analysis to be carried out.

Material properties of the model	
Model Metal	Steel
Thermal conductivity (W/MK)	53.6
Density (Kg/m3)	7833
Refractory Thermal conductivity (W/MK)	1.312
Fluid properties involved in the model (Exhaust flue gases)	
Temperature of the flue gases(Degree Celsius)	700
Mass flow rate of the exhaust gases	2.3405 g/sec.

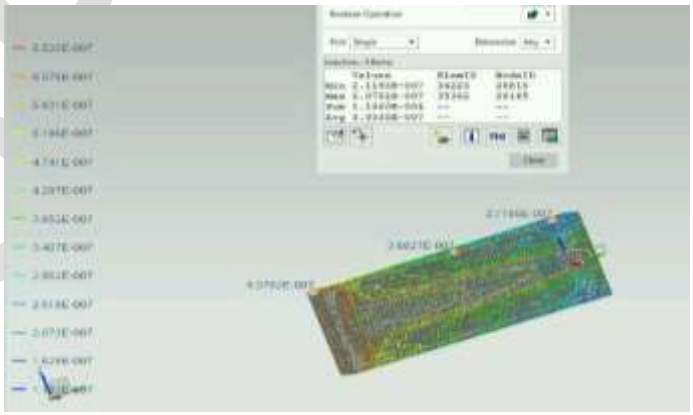

Fig 8. Image showing the turbulent flow nature at three points of the model.

Position in the model length	Temperature (degrees)
Initial point	650
Middle point	380
Ending point	220

Temperature readings for conventional silencer

Position in the model length	Temperature (degrees)
Initial point	607
Middle point	366
Ending point	212

Temperature readings for modified coated silencer

III. CONCLUSION AND FUTURE WORK

In this paper a new experiment is carried out with refractory coating to the silencer. The UBHC and CO emissions reduced considerably compared to the emissions of traditional silencer. The exhaust gases flowing through the silencer should ensure there is no back pressure designing the silencer.

There is a reduction of 66% in HC emissions comparing conventional exhaust pipe with fabricated exhaust pipe with 20% activated carbon with baffles. There is a reduction in CO emissions up to 55% comparing conventional exhaust pipe with fabricated exhaust pipe with 20% activated carbon with baffles. Due to the baffles inside the silencer and the hot gases passing through baffles, there are hot spots created at certain points in the silencer which could have high temperatures which is not desired. There is good scope for future work in this regard to try different refractory materials and apply different design of the silencer so that the emissions are reduced. Automotive industries are trying to reduce emissions from the vehicles and this experiment is a step to reduce emissions, similar various methods using materials which oxidize the CO into CO2 and UBHC into H2O can be studied and brought into practice.

NOMENCLATURE

UBHC=Unburnt Hydro-carbon

CO= Carbon Monoxide

NOx= Oxides of Nitrogen

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