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Silencer Emission Test and Analysis by FEM

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Abstract - *In the present scenario, the emission from automobiles is becoming a serious problem to the environment. Automobiles are one of the wide area which constitute to the air pollution with emission of CO2, CO and HC. This occurs due to unburned products of the fuel and air in engine during combustion. Also advances in engine and vehicle technology continuously to reduce the emission from engine exhaust are not sufficient to reduce the HC, CO and specially CO2 emission. This work concentrates on design, fabrication and analysis of silencer to reduce CO2, CO and HC emission from exhaust of automobiles by introduction of zeolite a nanoparticle mixture like a paste in a silencer. Significant progress were also achieved in understanding and prediction of zeolite catalyst operation.*

Key Words: Air pollution, silencer, analysis, Zeolite, Emission reduction

1. INTRODUCTION

Petrol and Diesel fuel is evidently indispensable. In general, the consumption of fuel is an index for sorting out the economic strength of any country. In spite the use, we cannot ignore the harmful effects of the large mass of the burnt gases, which erodes the purity of our environment every day. In recent years, these concerns have risen than ever before because the large amounts of carbon dioxide (CO2) being emitted into the atmosphere could cause severe global climate changes.

Recent atmospheric observations confirm that the concentration of CO2 in the atmosphere has increased by nearly 30% for the last 150 years, with an accelerating trend in last year's. No action is taken to address the current situation. Global CO2 concentration is predicted to rise to above 750 by 2100. To develop an application oriented catalyst model, we should focus on the phenomena that are really important in real world operating conditions. After studying a series of measurements on SGB and on a diesel catalyst equipped car driven on a driving cycle, we concluded that the following points should be given special attention Since the operation temperatures of the catalyst are low and very near the light-off region of CO, HC it is critical to have highly accurate oxidation reactions kinetics.

The control Effective CO2 emission abatement strategies such as Carbon Capture and Storage (CCS) are required to combat this trend.Recent researchers are doing some carbon capture technique in the exhaust of the automobiles to overcome this effect zeolite pellets used has a capability of carbon sequestration which is used in the designed silencer to reduce the effects of pollutant released to the environment. The main advantage of this exhaust system is that the whole other systems are unaltered, so this concept can be implemented on existing automobiles too. It is currently envisioned that the zeolite can be used in automobile exhaust systems to capture all three major acid gases (SO2, NOX, and CO2) and also HC, which may be present in the flue gases.

2. MATERIALS AND METHODS

The main components used for testing zeolite silencer are as follows

2.1 Zeolite

The high thermal and chemical stability of these inorganic crystals make them ideal materials for use in high temperature applications such as catalytic membrane reactors. Zeolites also have the potential to achieve precise and specific separation of gases including the removal of H_2O, $CO_2$and $SO_2$from separate light gas mixtures it is a microporous material which is used to adsorb the CO_2, CO and HC from the exhaust gases of the engine

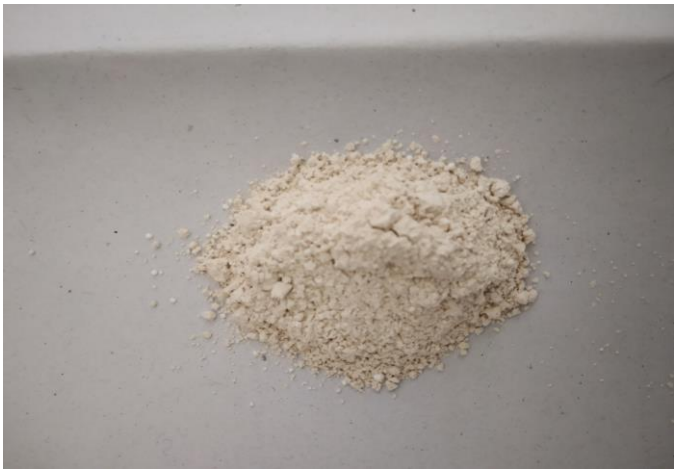


Fig-1: zeolite

In this project the engine used for the testing purpose is TVS excel 100 then the results of the test are given in the following discussion

The exhaust gas is allowed to pass into the inlet of the tailpipe. Pressure gets reduced and velocity of the gas increases because of the conical section. The flowing exhaust gas is free to move in all directions inside the tailpipe. As the movement of exhaust gas is not abruptly obstructed anywhere in its path, the back pressure is limited to minimum level. The flowing gas passes over the trap which is fixed at the inner of the tailpipe. Gas entering the perforated sheet mesh holes gets exposure to the zeolite pellets. The exposure of the exhaust gas is maximum by increased in size of the pellets. Zeolite pellets are highly porous and consistent matrix of zeolite that provides the adsorption of impurities. The exhaust gas containing CO2 and other particles are adsorbed by the zeolite pellets. Adsorptions takes place by locking of gaseous CO2 molecules over the porous layer of the zeolite.

Adsorption quantity of CO2 depends on the type of zeolite used. Maximum adsorption limit of zeolite depends on the amount of exhaust produced from the engine. The material for sheet mesh is considered as steel which has high thermal properties. Sheet mesh also has filtration efficiency which will also filters the black carbon particles up to certain extent. As this is the first device to be designed to reduce CO2 emission. Its limitations will be considered. The Carbon emission levels will be reduced to maximum by implementing this device on the exhaust manifold.

3. DESIGN CALCULATION

Type of engine used for the testing: TVS excel 100

Engine specification

Bore (D) = 51mm

Stroke (L) = 48.8 mm

No. Cylinders (n) = 1

Engine power (P) = 4.35 PS @ 6000rpm

Torque (T) = 6.5 Nm @3500rpm

Max. RPM (N) = 7500rpm

Engine displacement = 99.77 cc

Compression pressure = 10.5 – 11.6 kg/cm^2

Allowable back pressure for muffler = not available in zeolite

Transmission Loss Noise target (muffler) = 30 dB

To find fundamental frequency

Cylinder Firing Rate (CFR)

CFR = Engine Speed in RPM/60 …. For a two stroke engine

CFR= Engine Speed in RPM/120 ….For a four-stroke engine

Here it is a four stroke engine

CFR =7500/120

=62.5 Hz

Engine firing rate (EFR)

EFR = No. of cylinder x Cylinder firing rate

= 1x 62.5

EFR =62.5 Hz

Muffler volume calculations

(V_s) = (Px d^2 x l)/4

= (3.14 x 51 x 48.8)/4

= 99639.108 cm^3

= 0.099639 Lit.

Volume to be consider for calculation

Volume = No. of cylinder x V_s

= 0.099639 Lit.

Volume of silencer must be at least 12 to 25 times the volume considered. Volume can be adjusted depending on the space constraint.

Factor consider = 25

Silencer Volume = Factor x Consider Volume

= 25 x 0.099639

= 2.490975 Litres.

Internal configuration of muffler and concept design

Diameter of muffler calculated as

V_m = (P/4) x D^2 x L

0.00249097556= (3.14/4) x D^2 x 0.410

D = 80.34mm OR D= 80 mm

Here, we take L = 410mm after studying various muffler of similar length of similar engine mufflers and overall space

available on a motorcycle for mounting of a muffler and hence select the same length

Tail pipe design

Generally tail pipe diameter and shape is taken as the same by OEM or manufacturer for lesser flow resistance and optimum flow characteristics. Hence, tail pipe diameter = 20 mm

4. DESIGN AND ANALYSIS

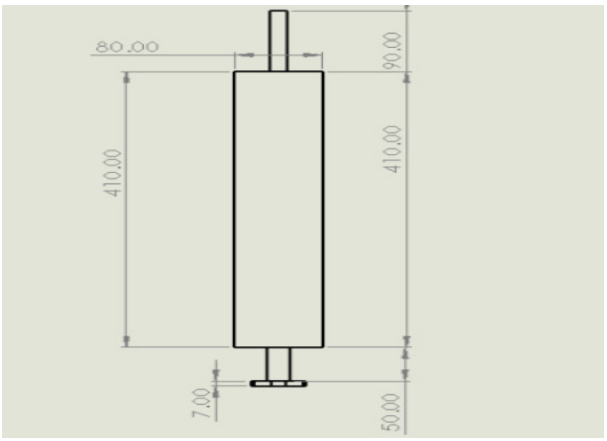


Fig-2: Drafted view of silencer

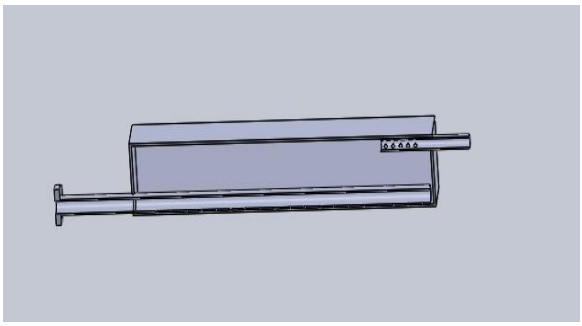


Fig-3: sectional view of silencer

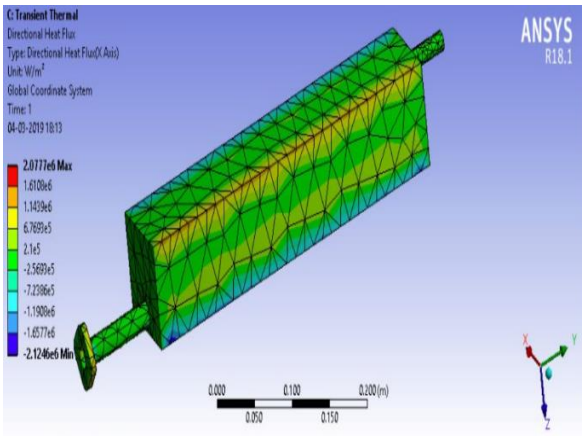


Fig-4: Directional heat flux (x axis)

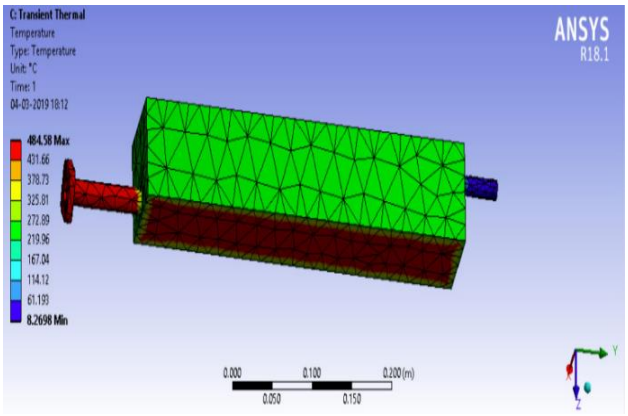


Fig-5: Temperature analysis

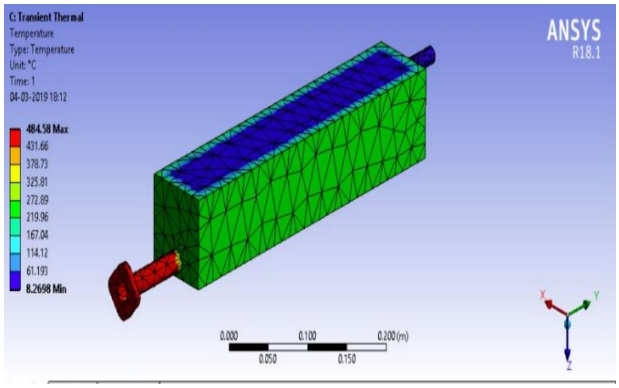


Fig-6: Temperature analysis on upper side

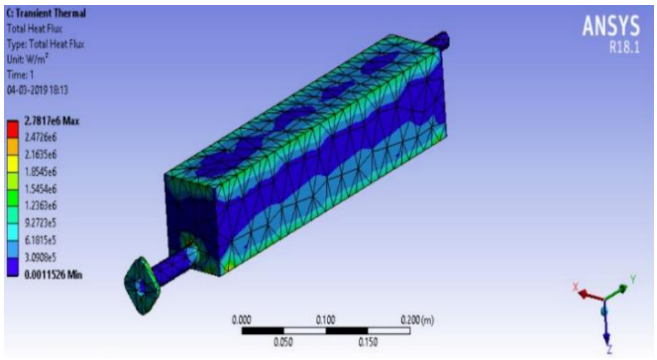


Fig-7: Total heat flux analysis

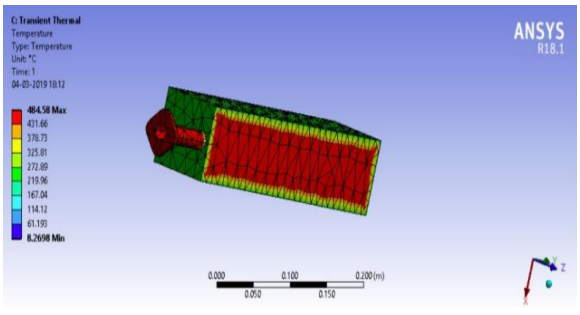


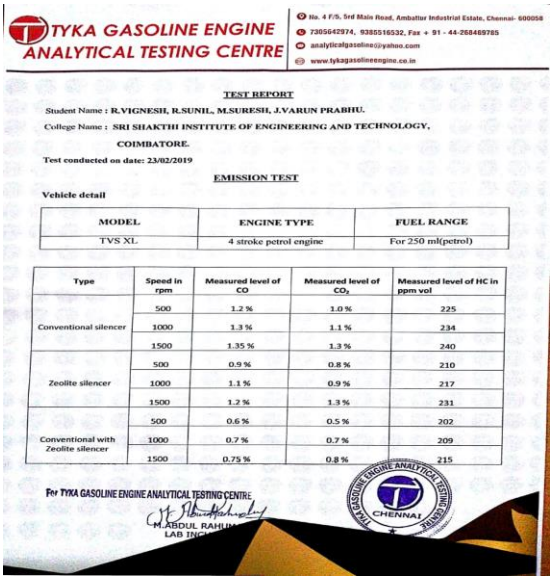
Fig-8: Temperature analysis on lower side

5. Experimental set up and testing

The fabricated model for testing the zeolite silencer is as follows

Fig-9: Experimental setup of zeolite silencer

By using the NETEL auto gas analyzer, two experiments were carried out for the two wheeler, four stroke petrol engine with conventional silencer, zeolite silencer and by using conventional with zeolite silencer then their results are recorded at relative volume at a speed range of 500 rpm to 1500rpm shown in figure



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TEST REPORT

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College Name : SRI SHAKTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY, COIMBATORE.
Test conducted on date: 23/02/2019

EMISSION TEST

Vehicle detail

MODEL	ENGINE TYPE	FUEL RANGE
TVS XL	4 stroke petrol engine	For 250 ml(petrol)

Type	Speed in rpm	Measured level of CO	Measured level of CO_2	Measured level of HC in ppm vol
Conventional silencer	500	1.2 %	1.0 %	225
	1000	1.3 %	1.1 %	234
	1500	1.35 %	1.3 %	240
Zeolite silencer	500	0.9 %	0.8 %	210
	1000	1.1 %	0.9 %	217
	1500	1.2 %	1.3 %	231
Conventional with Zeolite silencer	500	0.6 %	0.5 %	202
	1000	0.7 %	0.7 %	209
	1500	0.75 %	0.8 %	215

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Fig-10: Gas analyzer test report

Table -1: comparison of results

Type	Speed in rpm	CO in % vol	CO_2 in % vol	HC in ppm vol
Conventional silencer	500	1.2	1.0	225
	1000	1.3	1.1	234
	1500	1.35	1.3	240
Zeolite silencer	500	0.9	0.8	210
	1000	1.1	0.9	217
	1500	1.2	1.2	231
Conventional with zeolite silencer	500	0.6	0.5	202
	1000	0.7	0.7	209
	1500	0.75	0.8	215

6. CONCLUSION

We conclude from our experimental results that zeolite silencer is more effective in the use than the conventional silencer by reducing the exhaust gas emission from the engine by using zeolite mixture. By using water as a medium the sound can be lowered and also by using lime stone in water we can control the exhaust emission to a greater level. The water contamination is found to be negligible in zeolite silencer. It is smokeless and pollution free emission and also it is very cheap. It can be also used both for two wheelers and four wheelers.

7. REFERENCES

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