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Emission Control of Diesel Engine Exhaust by Modifying Silencer

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ABSTRACT:Diesel engines are playing a vital role in road and sea transport, Agriculture, mining and many other industries. We cannot ignore the harmful effect so the large mass so the smoldered gasses, which dissolves the virtue of our surroundings. Toxic gas like [CO, CO2, SOx, NOx, HC] from diesel Smoke, before it is radiated to the climate. This framework can be securely utilized for diesel engine for accomplishing these Toxic gasses are to be decreased as far as possible before they are radiated out in air. Our project regarding to control emission from diesel engine exhaust by use of modifying silencer. Present silencer helps to reduce exhaust noise, back pressure and toxic gas. Hence, we are made an attempt to reduce more exhaust toxic gas before it drops in to environment. So, by using new design and different material of silencer for control more emission for diesel engine exhaust over present silencer.

KEYWORDS: Diesel engine, Toxic gasses,control emission, back pressure, environment.

I. INTRODUCTION

Now a present day more use of diesel engine is increase because diesel has high efficiency and less cost over then petrol. But diesel engine produces more air and noise pollution. So, it necessary to control air and noise pollution. The purpose of this project is to reduce air and noise pollutions in an efficient way by using silencer. Silencer is used in automobile vehicles to reduce the noise produced by the exhaust gases of the engine. Silencer is also used in many other engines and generators. The size, shape and construction varies according to the type and size of the engine. Silencer is device use in engine exhaust system for control air and noise pollutions. In Presents many types of silencer are available in market and number of company produce it. Silencer help engine to reduce exhaust with low toxic value, low back pressure, and reduce noise before emit in environment. In this project design new silencer for control more air and noise pollutions over present silencer.

1.1 What is silencer?

A device fixed to the exhaust of motor vehicle to reduce engine noise, exhaust temperature and control exhaust emissions.

1.2 why silencer required?

The internal combustion engine is a major source of noise pollution. Engine noise is classified as aerodynamic noise- due to the flow of gases and surface radiated noise- due to vibration of engine components. Sources of engine noise include intake system, combustion and exhaust system out of which exhaust noise is attenuated by the use of mufflers. Excess engine noise also deteriorates the ride quality and indicates lower finesse. Furthermore, automobiles are a source of air pollution too. Emissions as a result combustion process led directly into atmosphere are of major concern because of their negative impact on air quality, human health, and global warming. Government bodies implement, control and regulate emission standards for primary pollutants such as unburned hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (PM). Over all silencer require for reduce engine exhaust noise, back pressure, and toxic gases effects.

1.3 Types of silencer

- Reactive silencer.

Responsive silencers for the most part comprise of a few channel portions that interconnect with various bigger chambers. The commotion diminishment system of reactive silencer is that the region irregularity gives an impedance befuddle for the sound wave traveling along the funnel. This

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impedance befuddles results in an impression of piece of the soundwave back around the source or forward and backward among the loads. The intelligent impact of the silencer chambers and funnelling (normally alluded to as resonators) basically keeps some solid wave components from being transmitted past the silencer. The responsive silencers are more compelling at lower frequencies than at high frequencies, and are most generally used to weaken the Smoke commotion of interior burning motors. A nonspecific responsive motor silencer included two relatively estimated chambers with a couple of interconnecting tubes is demonstrated as follows. Fig.1.

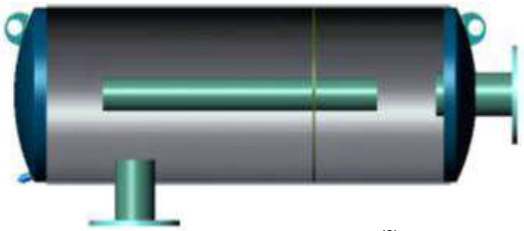

Fig.1: Reactive Silencer[9]

Absorptive silencer:

Absorptive silencers as a rule have moderately wideband commotion diminishment attributes at center and higher bsorptive silencers are regularly used to weaken the motor admission commotion or supplement the execution of responsive silencers for the motor clamor control. The sound retaining materials are for the most part held in position by the utilization of a punctured metal liner. Learning of the basic substance of a Smoke framework is imperative while considering the incorporation of a reactant component or Selective Catalytic Reduction (SCR) framework in conjunction with the silencer. Particulate relocation of the protection into the Smoke stream over a timeframe can bring about the synergist component to wind up fouled and considerably affect or block its execution. Fig 1.2 Absorptive silencer Combinationsilencer. Some silencers responsive and absorptive segments to extend the uproar tightening execution over a broader fuss range. Blend silencers are also extensively used to decrease engine exhaust commotion. The sound holding materials are overall held in position by the use of a punctured metal liner. Learning of the assistant substance of an exhaust structure is indispensable while considering the fuse of a synergist part or Selective Catalytic Reduction (SCR) system in conjunction with the silencer. Particulate movement of the insurance into the exhaust stream over a time period can achieve the synergist segment to wind up fouled and liberally influence or impede its execution.

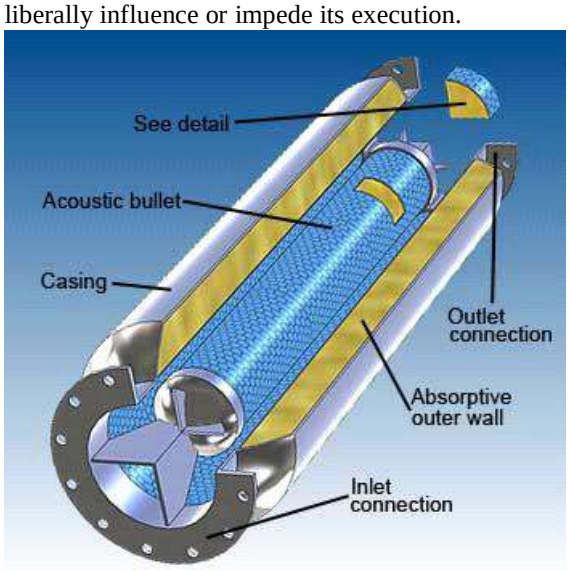

Fig.2: Absorptive Silencer[9]

Combination silencer:

Some silencers combine both reactive and absorptive elements to extend the noise attenuation performance over a broader noise spectrum. Combination silencers are also widely used to reduce engine exhaust noise. Figure 19-1 shows typical noise attenuation curves of reactive, absorptive, and combination silencers.

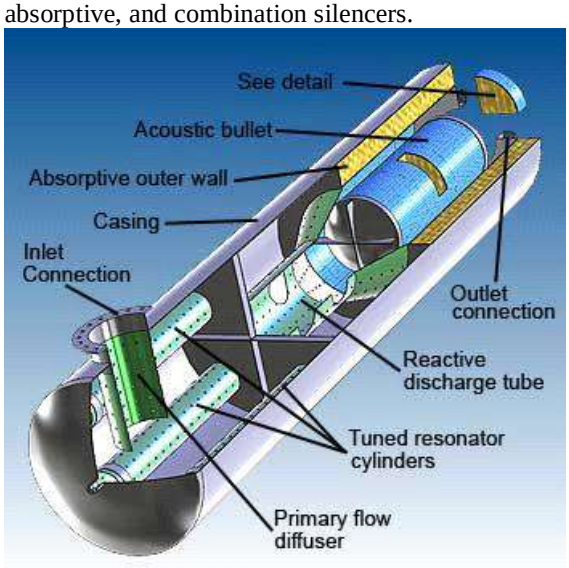

Fig.3: Combination Silencer[9]

1.4 Components of silencer

- Shell
- Tube
- Baffles

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- Packing material

Shell:

There are many types of shell like cylindrical, rectangular…etc. most of shell made from steel. Shell is main housing of silencer. it provides support other parts of silencer. It is provided safety against engine hot exhaust.

Fig.4: Shell [11]

Tube:

Tube is use in silencer for give direction of exhaust flow in silencer. Tube made from different material like aluminium, steel alloy, chromium, etc.

Fig.5:Tube [9]

Baffles:

Baffles' provide in silencer for resist exhaust flow and increase area of gases in silencer for reduce back pressure and temperature.

Fig.6: Baffle[14]

Packing material:

Packing material are use in silencer for leakage of exhaust flow and reduce noise level inside silencer. Packing material like glass, fibres.

Fig.7: Packing material [9]

1.5 MATERIAL OF SILENCER

- Stainless Steel
- Aluminum
- Copper

1.6PROPERTIES OF MATERIALS

Name, symbol, number	copper, Cu, 29
Density (near r.t.)	8.96 g·cm^{-3}
Melting point	1357.77 K, 1084.62 °C, 1984.32 °F
Boiling point	2835 K, 2562 °C, 4643 °F
Heat of vaporization	300.4 kJ·mol^{-1}
Thermal conductivity	401 W·m^{-1}·K^{-1}
Thermal expansion	25 °C) 16.5 µm·m^{-1}·K^{-1}
Brinell hardness	369 mpa

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1.7 Factor affecting silencer

- Back pressure: It is delivered by the motor to defeat the water driven resistance of the Smoke framework to release the gasses into the air.
- Temperature: Silencer material are stand with it's temperature limit. When temperature increase in silencer by exhaust gases silencer material property take changes. In temperature reduce strength silencer. It also effect silencer life.
- Vibration: Vibration produce in silencer cause of un proper fitting with vehicle engine. Vibration decrease the strength of silencer parts and increase the noise pollution. It also decrease silencer life.
- Engine exhaust: Engine exhaust also effect on silencer material. Exhaust with high temperature and pressure absorb by silencer material so it can take changes in it property. Ash contact also present in exhaust. It is required filter in silencer. After some time it is necessary to changes filter in silencer. Water particle in silencer it may responsible for corrosion in silencer parts.

II. EMISSION

2.1 What is emission?

Pollution (including noise, heat, and radiation) discharge into the atmosphere by residential, commercial, and industrial facilities.

- Health Effects from Emissions:

CI Smoke is an unpredictable blend of gasses and fine particles. The essential toxins discharged from diesel motors include,

→Particulate matter (PM)
→Carbon monoxide (CO)
→Nitrogen oxides (NOx
→Hydrocarbons (HC)
→Volatile organic compounds (VOCs)

The outflows from a great many vehicles include up. These discharges are side effects from the motor burning procedure and from the vanishing of fuel. In spite of the steadily developing number of vehicles out and about, studies demonstrate that ten to thirty percent of vehicles cause the greater part of vehicle-related air contamination. This sheet records an air's portion toxins connected with vehicle discharges. Since introduction to these poisons can bring about genuine wellbeing issues, the U.S. Natural Protection Agency has built up air quality principles to ensure our wellbeing.

- Carbon Monoxide:

Carbon monoxide is a dull, unscented, toxic gas discharged from the vehicle's Smoke as a consequence of fragmented burning. It meddles with the blood's capacity to convey oxygen to the mind, heart, and different tissues. Unborn or infant kids and individuals with coronary illness are in most serious threat from this toxin, yet even sound individuals can encounter cerebral pains, weariness and lessened reflexes because of CO introduction.

- Sulfur Dioxide:

Sulfur dioxide is radiated when fuel containing sulfur is blazed in diesel motors. Sulfur dioxide presentation contracts air entries, making issues for individuals with asthma and for youthful kids, whose little lungs need to work harder than grown-ups' lungs.

- Nitrogen Dioxide:

Nitrogen dioxide and related nitrogen oxides (NOx) are delivered when fuel is smoldered. These mixes add to ozone development and are a wellbeing issue themselves. The impact of NOx presentation on the respiratory framework is like that of ozone and sulfur dioxide.

- Lead:

Lead substance has been diminished in fuel. Accordingly, there is a huge drop in broad daylight introduction to outside lead contamination. Lead harming can decrease mental capacity, harm blood, nerves, and organs, and raise pulse. Indeed, even little ingestions or inward breaths of lead can be destructive in light of the fact that lead aggregates in the body.

- Particulate Matter:

Particulate matter incorporates minuscule particles and small beads of fluid. In view of their little size, these particles are not halted in the nose and upper lungs by the body's characteristic safeguards yet dive deep into the lungs, where they may get to be caught and cause aggravation. Introduction to particulate matter can bring about wheezing and comparative indications in individuals with asthma or touchy aviation routes. Particulate matter can serve as a vector for lethal air contaminations.

- Toxic Air Pollutants:

Lethal air contaminations, for example, benzene and formaldehyde are substances from vehicles discharges that are known not or are associated with creating malignancy, hereditary transformation, conception deformities, or different genuine diseases in individuals even at moderately low levels. The chemicals can be breathed in specifically or conveyed by little particles (dust or build up) into the lungs.

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III. DESIGN OF SILENCER

3.1 Design of silencer

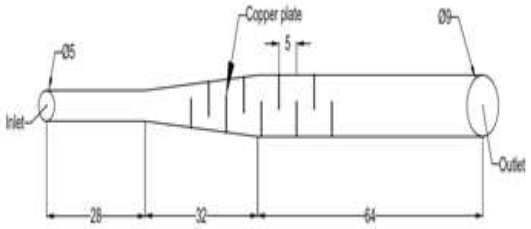

Fig.8: Modify Silencer Design

3.2 Construction of Silencer

Silencer made by using different machining process. There are following machining process use for made silencer.

1. Cutting:

- In cutting operation silencer shell cut by cutter in full length up to inlet to outlet of exhaust as shown in fig.9.
- Cutting process also use for cut copper plate in to a small plat.

2. Welding:

- Welding process is use for fit copper plate inside in silencer.
- Then after it is use for packing of silencer after copper plate fit in it as shown in Fig.10.

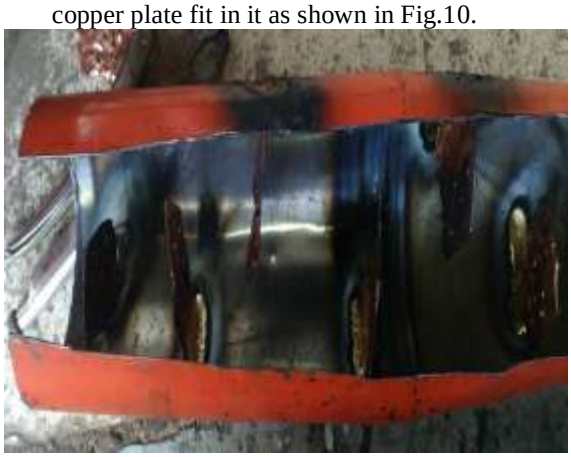

Fig.9: Cutting of Silencer

Fig.10: Fitting of Silencer

IV. EXPERIMENTAL SETUP

4.1 Introduction:

In our experiment we used four-cylinder four stroke High speed, water cooled, naturally aspirated, high pressure direct injection diesel engine with dry liners.

The present study was conducted on a TATA-407, Diesel engine. The engine is four strokesfour-cylinder direct injection engine with a swept volume of 2956 cc. A Kirloskar brand electrical dynamometer was used for engine loading. The setup has stand-alone type independent penal box considering of air tank, fuel tank, manometer, and burette. Engine jacket cooling water inlet, outlet and calorimeter is displayed on temperature indicator. Flow meters are provided for cooling water and calorimeter flow measurement. In addition, exhaust emission measurement equipment worked separately. The equipment was used for O2, CO, CO2 and NOx measurement.

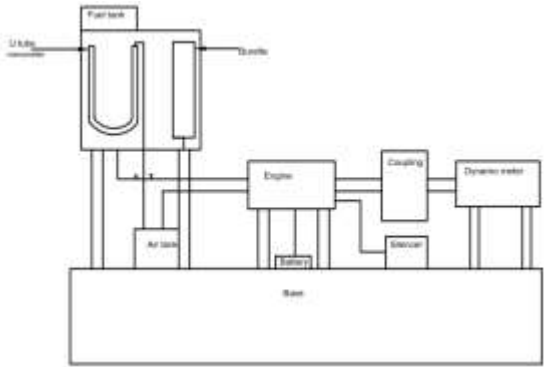

Fig.11: AutoCAD drawing of diesel engine test rig.

4.2 Measuring instrument:

- **Tachometer:**

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Fig.12: Tachometer

- **Multi gas analyzer:**

A multi gas analyzer is used to measure the emission rate, which is produce after combustion process of fuel. In this type of analyzer we measures different emission gases like, HC, CO, CO_2, O_2, NOx.

Fig.13: Multi gas analyzer

Gases	HC	CO	CO_2	O_2	NOx
Range	0-20,000 ppm	0-0.99 %	0-20.00 %	0-25%	0-5000 ppm
Accuracy	±10 ppm	±0.03 %	±0.04 %	±0.1 %	±25 ppm

Table2: Rang of Gas analyzer.

4.3 Engine specification:

- **Model**

Model	Tata 407
Type	High speed, water cooled, naturally aspirated, high pressure direct injection diesel engine with dry liners.
No. of cylinders	4 in line
Bore (mm)	97
Stroke (mm)	100
Capacity (cc)	2956
Compression ratio	17.1
Power (HP)	50 (37.50 kw)
Idling speed (RPM)	600
Maximum operating speed (RPM)	3000
Engine Torque (Nm)	135 at 2500 rpm
Air filter	Oil bath type
Fuel injection pump	Inline type
Fuel injection begins	15 degree BTDC

Table3: Specifications of diesel engine testrig

4.4 Procedures of experiment:

1. Fill up sufficient diesel in diesel tank. Check oil level in engine. It should be set up to the top edge of flat portion provided over the oil dipstick. If oil level is reduced, add up clean 20W/40 oil to the crankcase by opening the valve cover after filling the oil.
2. Fill up water in manometer up to half of the manometer height.
3. Start water supply & see that water is flowing engine jacket & calorimeter.
4. If diesel tank was empty before filling the diesel, remove air trapped in fuel pipe, to remove air, unscrew the knob of priming pump on fuel injection pump and press it several times until it feels hard to press, now screw down the knob of priming pump in place.
5. Now turn the ignition key clockwise to start the engine and when engine starts, release the key.
6. As engine starts, increase the accelerator and set the engine speed is required.
7. Open the valve at the bottom of the burette. Take sufficient diesel in burette; close the valve of the tank line so that diesel in the burette passes through the engine. Note down the time required to consume 50 ml of diesel.
8. Note down the speed, manometer difference, various temperature & water flow through the engine jacket & calorimeter.
9. Repeat procedures for different loads.

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10. After completion of test, remove the entire speed by the accelerator rotate in anticlockwise direction. Put "OFF" the main switch & put "OFF" engine by passing governor lever near the flywheel.

4.5 Precaution:

1. Use high-speed diesel fuel oil.
2. Before starting engine, oil level in the sump must be checked. Also, ensure water supply through engine, cooling jacket and calorimeter.
3. Never stop the engine on load and never decompression lever for stopping.
4. Do not put hand in water rheostat while in operation.
5. Do not temper with any of engine setting like governor, fuel injector etc.
6. After completion of experiment, do not close the orifice while engine in operation.
7. Add salt in the water rheostat in correct percentage.

4.6 Maintenance:

1. Every 10 hrs of operation,
- Check crank case oil level in the engine crankcase and top if necessary.
- Clean air filter of engine.
- Clean fuel filter of engine.
- Check the leakages, if any, in fuel line or water supply.

2. Every 200 hrs of operation,

Remove all oil from engine crankcase. Clean the engine crankcase and add pure flushing oil up to level. Run the engine for 1 to 2 minutes. Removing flushing oil. Clean lubricating oil filter and fill up fresh lubricating oil up to the level.

4.7 Chemical Reaction

1. $CO + Cu + O_2 \rightarrow CuCO_3$ (Copper carbonate)
2. $CO_2 + Cu + 1/2O_2 \rightarrow CuCO_3$ (Copper carbonate)
3. $SO_2 + Cu + O_2 \rightarrow (CuSO_4$ (Copper Sulfate)
4. $NOx + Cu \rightarrow CuNO_3$ (Copper Nitrate)

SR.NO.	RPM(N)	MANOMETER DIFFERENT (hf)	TIME TF FOR 50 ml	COOLING WATER TEMP. ENGINE JACKET		EXHAUST GAS TEMP. OF SILENCER		TIME IN SEC. 1 Ltr. OF WATER THROUGH ENGINE JACKET
				T_1 (INLET)	T_2 (OUTLET)	T_3 (INLET)	T_4 (OUTLET)	
1	860	16.9	46	30	39	190	170	8
2	940	14.1	43	30	41.5	220	212	8
3	1025	13.7	39	30	42	240	224	8
4	1150	12.6	35	30	42.8	269	242	8
5	1375	12.4	30	30	43	290	259	8

Table4: Observation table of experiment by using Diesel

SAMPLE CALCULATION:

Break power:

B.P = 2ΠNT / 60 × 1000
= 2Π×860×46.44 / 60 ×1000
= 4.18 KW
Where, N = Revolution per minute (RPM)
T = Torque

Fuel Consumption:

Fc = (20 / tf) × (3600/1000)
= (20 / 50) × (3600/1000)
= 1.44 kg / hr
Where t_f= Time required for 50ml fuel (sec)

Specific fuel Consumption:

SFC = Fc/ B.Pkg/kw.hr
= 1.44 / 4.18
= 0.3445 kg/kw.hr

Indicator power :

IP = BP + FP
= 4.18 + 8
= 12.18KW
Hf = Fc× C.V
= 1.44 × 43400
= 62496
C.V = 43400 calorific value in KJ/Kg of fuel
HBP = B.P × 3600
= 4.18 × 3600
= 15048 KW
HIP = IP × 3600
= 12.18 × 3600
= 43848 KW

Efficiency:

- Mechanical Efficiency:

Ƞ mech = (B.P /I.P) × 100
= (4.18 / 12.18) × 100

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= 34.3

- Brake thermal efficiency:

Ƞbt = HBP / Hf × 100
= 15048 / 62496 × 100
= 24.07 %

- Indicated thermal efficiency:

Ƞit = HIP / Hf× 100
= 43848 / 62496 × 100
= 70.16%

- volumetric efficiency:

Ƞvol = va/vth × 100
Where, Va = 840 × A_0 × C_d × (hw/ ζa)1/2
A_0 = Area volume of air in cylinder
= 2.83 × 10^{-3} m^2
C_d = co-efficient of discharge
= 0.62
hw = head of water in cm of water
ζa = density of water = 1.165 kg/ m^3
Va = 840 × 2.83 × 10-3×0.62× (0.01/ 1.165)1/2
= 0.1365 m^3/ min
V th = 3.14/4 × d^2× L × N
= 0.785 × (0.097)^2 × 0.1×1.1×880
= 1.2710 m3/ min

Ƞvol = va/vth×100
= 0.1365 / 1.2710
= 10.73 %

Heat balance sheet:
Total heat supplied by fuel:
Hf = f.cin kg/hr × C.Vkj/kg
= 1.44 × 43400
= 62496kj/kg

Heat equivalent to B.P. = B.P. × 3600
= 4.18 × 3600
= 15048 KJ/hr
Heat carried away by jacket cooling water:
Hj = 3600/ Tj× Cpw× (T_2- T_1)
= 3600/8 × 4.18 × (39–30)
= 16929 KJ/ hr

Heat lost by radiation and unaccounted losses:
H = H_f - [HBP+ Hjw]
= 62496 - [15048 +7524]
= 39924KJ/ hr

4.9 RESULT TABLE

Sr. No.	Speed (RPM)	CO In %	CO_2 In %	O_2 In%	HC In PPM	NOx In PPM
1	860	0.098	3.30	15.79	92	367
2	940	0.082	3.60	15.36	105	853
3	1025	0.070	4.10	14.69	104	1162
4	1150	0.062	4.69	13.87	111	2195
5	1375	0.059	5.36	13.08	131	2767

Table 5: Emission test result of experiment of engine with regular silence

Sr. No.	Speed (RPM)	CO In %	CO_2 In %	O_2 In%	HC In PPM	NOx In PPM
1	860	0.054	3.30	18.44	29	109
2	940	0.055	3.60	18.45	31	117
3	1025	0.056	4.10	18.57	31	93
4	1150	0.075	4.69	18.25	46	77
5	1375	0.065	5.36	18.36	37	70

Table 6: Emission test result of experiment of engine with modify silencer

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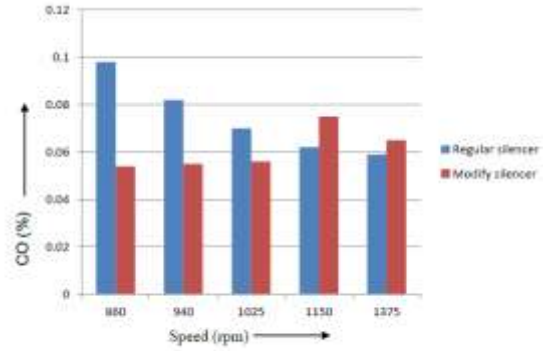
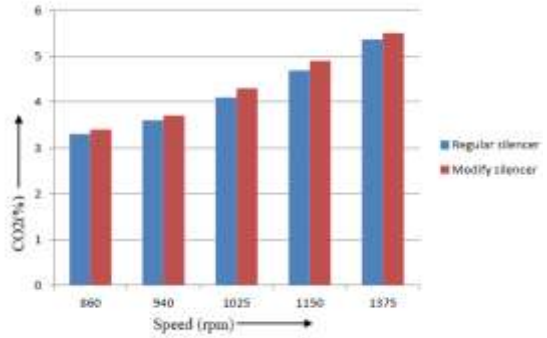
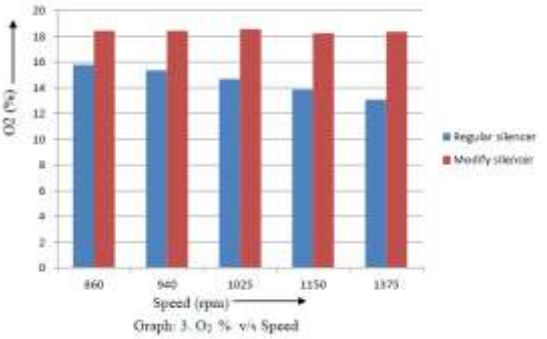
2. Result Graph



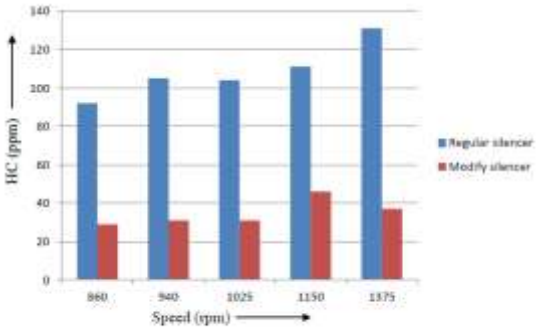
Graph: 1. CO % v/s Speed



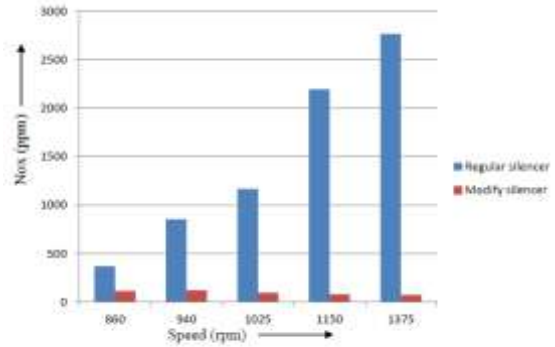
Graph: 1. CO_2 % v/s Speed



Graph: 3. O_2 % v/s Speed



Graph: 4. HC(ppm) v/s Speed



Graph: 4. NO_x(ppm) v/s Speed

V. CONCLUSION

It is the determination of actual cost of an article after adding different expenses incurring in various department. It may also define as system, which systematically records all the expenditure incurred in various departments to determine the cost of manufacture.

Aim of costing:

The important aims of costing are as follows.

1. To determine the cost of each article.
2. To determine the cost of each article operation
3. To help in deciding sale price.
4. To supply information for the detection of waste.
5. It helps in reducing the total cost of manufacture.

Procedure ofcosting:

Costing is the technique and process of ascertaining cost. It is the classifying, recording and location expenditure for determination of the cost of the production or service.

The main elements of cost of any product areas under,

1. Material cost.
2. Labour cost.
3. Other Expenses.

Material cost:

Direct material cost

Material which is directly used for manufacturing of a particular product and which becomes the part of final product is called direct material.

The cost of this material is called direct material cost.

In-direct material cost

Material which is not directly used for manufacturing of a particular product and which does not becomes the part of final product is called direct material.

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The cost of this material is called indirect material cost.

Labour cost:

Material Cutting cost, Fitting cost, Welding cost

Final cost

1. Material cost: -

Steel plate (130cm x 15cm) = 400/-

Copper plate cost (5cm x 4cm) = 8 x 40

= 320/-

2. LabourCost: -

Steel plate cutting & welding cost = 800/-

Copper plate welding cost = 200/-

3. Other cost: -

Multi gas analyser cost = 2200/-

Transportation cost = 200/-

4. Total cost of project = Material cost + Labour cost + Other cost

= 720 + 1000 + 2400

= 4120/-

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