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Reduction of Exhaust Gas Emissions by using Activated Charcoal and Copper Oxide in Two Wheeler

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Abstract: ***Forthcoming emission standards for two wheelers are mainly aiming to reduction of exhaust gas emissions like hydrocarbon, carbon monoxide and NOx etc., Modern engines have been improved engine fuel economy and significantly reduced emissions, it achieved by advanced technologies like after treatment technologies and catalytic systems.***

In the present paper is mainly focused on decreasing the level of CO2, HC, and NOx emissions in two wheeler four stroke IC engine by using absorption technology. The absorption is carried out with help of suitable absorbers such as activated charcoal and copper oxide II. After adsorption we found a significant amount of emissions are condensed in proposed device.

Keywords: Global warming, emission, exhaust gases, two wheeler motorcycle, adsorption, Absorber.

I. INTRODUCTION

Vehicular pollution year by year increasing enormously which leads more emissions that affects the environment, human beings and living things. 2-stroke engines, low fuel quality, inadequate conservation, jammed traffic, worst road condition and old automotive technologies lead the reason for more emissions which was controlled as discussed below.

J.Jayakumar and C.V.Durai arasan et al [1] use silica as a catalyst (SiO_2) due to its low cost, wear & corrosion resistance properties, It is preferred. This catalyst used to reduce only Hydro carbon (HC) and carbon monoxide (CO) of the SI engine.

Famesh D. Thakre, Bidyut K. Talukdar, Gaurav S. Gosavi, Prashant R. Tayade et al [2] focused to decreasing the level of CO_2 from exhaust gases of a two wheeler or motorcycle by absorption technology. This type of CO_2 absorption is reversible that is physical absorption is observed. The saturated bed of charcoal is again recharged or dumped as a fertilizer in the field to increase crop yield.

M.Amin, Pravin P.Rathod, Jigish J.Goswami et al [3] using the non-noble metal based material such as copper as a catalyst. By using this wire mesh copper catalytic converter to reduce the Hydro carbon in 38% and carbon monoxide in 33% of the four stroke two wheeler engine.

R.Gangadevi, B.K.Vinayagam, S.Senthilraja et al [4] using the copper –zirconium alloy coated exhaust pipe and reduces the emission before leaking to the atmosphere hence carbon monoxide emission reduced by 0.3% and carbon dioxide emission by 0.8% compared to the non-coated exhaust pipe.

P.Deepikal, M.Naren Kumar et al [5] where successfully implement the exhaust gas recirculation system in two wheeler. It mainly reduces the Nitrogen oxides (NOx) and combustion chamber temperature.

K N Balan, [6] where using the molecular sieve 5A of 1.5mm in two wheeler exhaust pipe and reduces the emissions like carbon dioxide, carbon monoxide and hydro carbon in considerable manner.

Pei- Hsing Huang, Hao-Hsiang Cheng, and Sheau-Horng Lin et al [7] where find out the adsorption of carbon dioxide by using specially prepared coconut shell based activated charcoal. It will absorb the carbon dioxide in effective manner.

II. DESCRIPTION OF COMPONENTS

A. Copper (Ii) Oxide

Copper (II) oxide is the inorganic chemical compound with the formula of CuO. This is one of the two stable oxides of copper, the remain being Cu_2O which carries black colored solid fine particle. As a mineral, it is called as tenorite.

It is produced when the chemical reaction take place between copper and air at 300 – 800°C

$$2\ Cu + O_2 \rightarrow 2\ CuO$$

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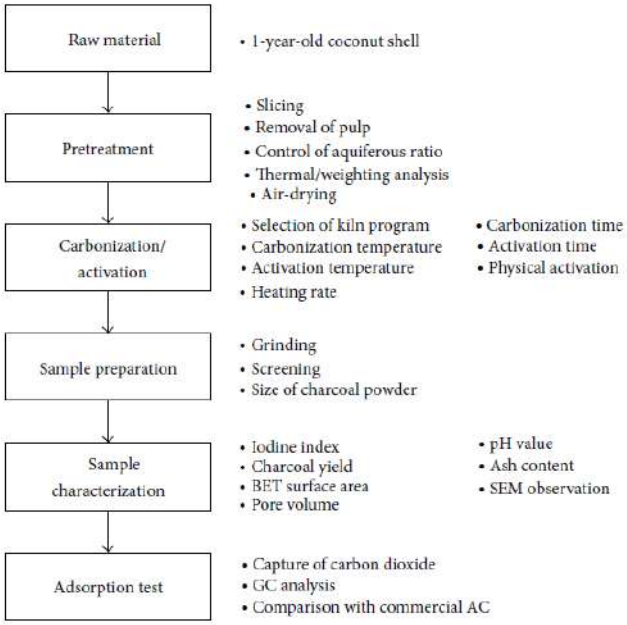
Fig.1. Copper (II) oxide

B. Activated Charcoal

It is the element used to absorb the carbon-di-oxide particulate matter. Most commonly used activated charcoal is prepared by coconut shell.

The preparation procedure of coconut shell based activated charcoal is explained in the flow chart.



C. Three way Catalytic Converter and Working

The emissions from a four stroke engine have unwanted substances like oxides of nitrogen (No_x), carbon monoxide (CO) and hydrocarbons (HC). 3-way catalytic converters convert these toxic substances to toxic fewer gases like nitrogen (N_2), carbon dioxide (CO_2) and water (H_2O). It has two catalysts which are: 1. Reduction Catalyst and 2. Oxidation Catalyst

Stage 1 – Chemical reactions in Reduction Catalyst:

$$2NO \rightarrow N_2 + O_2$$

$$NO2 \rightarrow N_2 + 2O_2$$

Stage 2 – Chemical reactions in Oxidation Catalyst:

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

$$HC + O_2 \rightarrow CO_2 + H_2O$$

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D. Automobile Emission gas analyzer (GASBOARD-5020)

GASBOARD—5020 exhaust gas analyzer can be used for measurement of the concentration of automobile emission gas CO, CO_2, HC, O_2 and NO (optional). It is based on the pulsable infrared source and single source two beams non-dispersion infrared (NDIR) method, this analyzer is designed with portable and smaller physical dimensions experimental setup and procedure

Experimental setup:

In two wheeler exhaust pipe the top most part is modified by using three components. That is copper (II) oxide, catalytic converter and activated charcoal.

First the copper (II) oxide coated honeycomb structure is placed, after that the three way catalytic converter and activated charcoal bed is implemented.

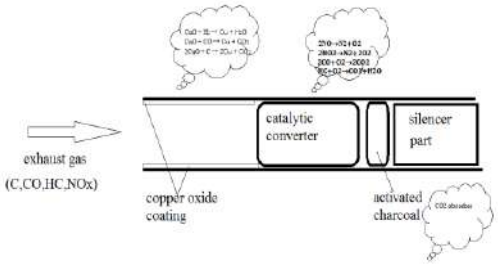

Fig.2. Experimental Setup of Proposed Exhaust system

III. WORKING

While starting the four strokes two wheeler engines the intake valve open and air fuel are introduced as the piston goes down drawing the air fuel mixture into the cylinder. Once reaching the bottom the intake valves close and the piston starts back up compressing the air fuel mixture to the optimal stoichiometric ratio of about 15:1 (air: fuel).As the piston reaches the top of the cylinder and the mixture is compressed, a spark is introduced by the spark plug igniting the mixture and the "explosion" drives the piston down again. Once reaching the bottom, the exhaust valves open and the piston again returns to the top, this time pushing all of the residual gases from the cylinder. This residual gas contains the poisonous gases like hydrocarbons, lead/benzene, carbon monoxide, sulphur dioxide, nitrogen dioxide, carbon dioxide and particulate matter. These gases are entered into the copper (II) oxide coating. Here the copper (II) oxide is reacted to the carbon monoxide, some carbon particles and then it converts into the copper particles and carbon dioxide.

$$CuO + CO \rightarrow Cu + CO_2$$

$$2CuO + C \rightarrow 2Cu + CO_2$$

After that the exhaust gases, copper particles and carbon dioxide are entered into the three way catalytic converter. In three way catalytic converter there are two catalysts are presented. One is reduction catalyst and another one is oxidation catalyst. The reduction catalyst (platinum and rhodium) converts the nitrogen oxides into N_2 and O_2 gases.

$$2NO \rightarrow N_2 + O_2$$

$$2NO_2 \rightarrow N_2 + 2O_2$$

The oxidation catalyst (platinum and palladium)

converts the carbon monoxide and hydro carbons into O_2, CO_2 gases and some H_2O traces.

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

$$HC + O_2 \rightarrow CO_2 + H_2O$$

Then finally these exhaust gases are entered into the activated charcoal bed. Here the carbon dioxide particles and some carbon particles are absorbed and non-toxic gases are emitted to the environment.

IV. RESULT AND DISCUSSIONS

A.TEST RESULTS:

Using automobile emission gas analyzer (gas board- 5020) the emission test where conducted at idling speed of four stroke engines before and after implementation of modified exhaust silencer.

Table –I: Before implementation of Proposed system

Factors	Regulation limit	Actual
CO (%by vol)	3.5	2.246
HC (PPM)	4500	2744
CO_2 (%by vol)	-	6.62
NOx (%by vol)	0.08	0.074

Fig.3. PUC Certificate before implementation

Table- II: After implementation of proposed system

Factors	Regulation limit	Actual
CO (%by vol)	3.5	1.214
HC (PPM)	4500	2264
CO_2 (%by vol)	-	4.36
NOx (%by vol)	0.08	0.068

Fig.4. PUC Certificate after implementation

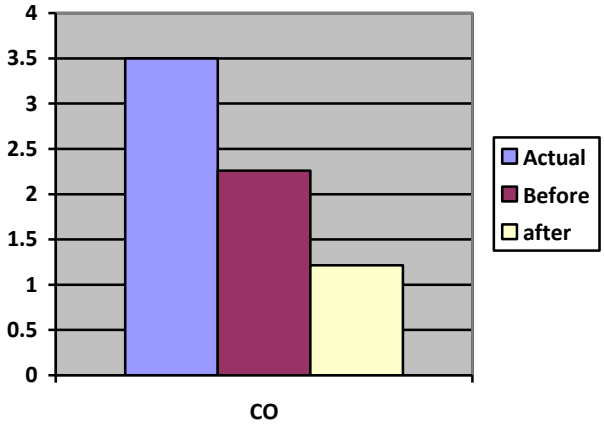

Fig.**5. Comparison Chart of carbon monoxide**

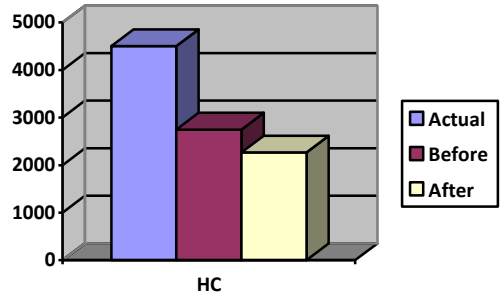

Fig.6. Comparison of carbon monoxide

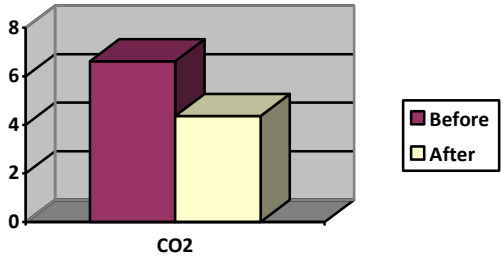

Fig.7. Comparison of carbon monoxide

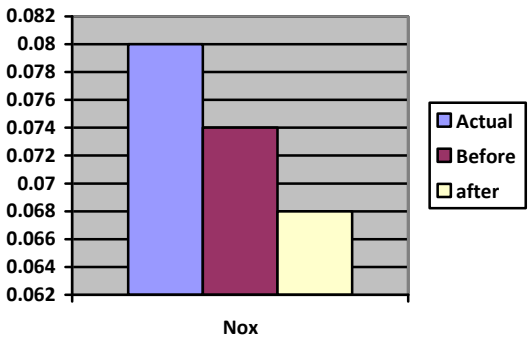

Fig.8. Comparison of carbon monoxide

V. CONCLUSION

The result will shows the reduction of carbon monoxide (CO) in 1.214% of volume, Hydro carbon (HC) in 2264 PPM, Carbon dioxide (CO2) in 4.36% of volume and Nitrogen oxide (NOx) in 0.068% of volume from the standard PUC.

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