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REDUCTION OF CO & HC EMISSION OF GASOLINE ENGINE WITH CHARCOAL-OIL SILENCER

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ABSTRACT

The automobiles play an important role in the transport system. With an increase in population and living standard, the transport vehicles as well as car population is increasing day by day. In addition to this there is steep increase in the number of two wheelers during the last two decades. All these are increasing exhaust pollution and particularly in metros as density of these vehicles in metros are very high. Lot of efforts are made to reduce the air pollution from petrol and diesel engines and regulations for emission limits are also imposed in USA and in a few cities of India. Undesirable emissions in internal combustion engines are of major concern because of their negative impact on air quality, human health, and global warming. Undesirable emissions include unburned hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter (PM). There are many methods to reduced these emissions from SI engine, but in this work attempt has been made to study the effect on emission treating exhaust outside cylinder using the Charcoal-Oil incorporating in silencer.

KEYWORDS : Charcoal-Oil Silencer, Gasoline Engine, Outside Cylinder Treatment, CO & HC emissions.

INTRODUCTION

Today world marching to have eco-friendly systems and the automotives are of most concern about pollution problems. Air pollution is most important from the public health point of view, the main pollutants contributed by automobiles are carbon monoxide (CO), unburned hydrocarbon (UBHC), oxides of Nitrogen (NO_x) and Lead. Two major ways are –treatment inside the cylinder and after treatment or treatment outside the cylinder.

Author's previous work on treatment inside the cylinder, title “ Experimental Investigation of Performance of Diesel Engine with Copper Coated Piston” published in International Journal of Mechanical Engineering and Information Technology, (IJMEIT), Volume 3, Issue 6, June 2015 [1].

1. Major Automobile Pollutant

Automobile engine exhaust mainly consist of Carbon monoxide (CO), Hydrocarbon (HC), Nitrogen Oxides (NO_x), Smoke, Aldehydes and other Poly-nuclear Aromatics. The effect of these pollutants on human health & environment are discussed in short along with their formation mechanisms in diesel engine.

- **Carbon Monoxide (CO)**

Carbone Monoxide is a colourless and odourless but a poisonous gas. Haemoglobin in blood has about 200 times more affinity towards CO than it has for

oxygen. Thus when carbon monoxide is absorbed in blood, it forms a compound called carbonyhemoglobin, which increases the viscosity of blood causing effect on blood circulation and brain function. Its effects can be anything like headache, unconsciousness etc.

- **Hydrocarbons (HC)**

Hydrocarbon do not have any direct serious effect on human health, these hydrocarbons and oxides of nitrogen in presence of sunlight, undergo some photochemical reactions forming smog. Smog causes poor visibility, burning and watering of eyes and effect on respiratory systems.

- **Smoke**

Smoke is one of the emitting being seriously objected as far as diesel exhaust is concerned. Smoke is offensive and unpleasant in nature. It causes tremendous eye imitation and poor visibility, which becomes a road safety problems more so in metropolitan cities. Smoke is known to be containing harmful carbon particles and carcenogenous benzo (a) – pyrines.

- **Oxides of Nitrogen (NO_x)**

Oxides of Nitrogen are one of the major pollutants of diesel exhaust, not only because it has serious effects on human health and environment but also because the NO_x concentration in diesel exhaust are quite high and comparable to gasoline engines.

Oxides of Nitrogen are formed in various forms such as :

- Nitric Oxide --- NO
- Nitrous Oxide --- N₂O
- Nitrogen Dioxide --- NO₂
- Nitrogen Pent-oxide --- N₂O₅
- Nitrous Anhydride --- N₂O₃

All together are termed as Oxides of Nitrogen and are denoted by NO_x. Among all these, Nitric Oxide (NO) is in major proportion (98% of NO_x) in the exhaust emission.

The effect of these oxides of nitrogen on the human body have been widely investigated. Oxides of Nitrogen are called insidious because they ignore the lungs by destroying tissues without causing pain. These oxides produce Nitric Acid in the lungs, which burns or perforated the alveoli of lungs (the alveoli of the lungs are semi-permeable membrane which permit the oxygen to enter the blood and permit carbon dioxide to discharge from blood). This results in subsequent lung edema. These oxides act on the lungs, as does the pneumonia virus. Antibiotics can cure pneumonia, but they do not have significant effect on Nitric Oxide victims.

At low concentrations the effect can be insidious and death can occur several days after the initial exposure to the hazard. The Nitric Oxide when oxidized to NO₂, combines with atmospheric moisture to form dilute nitric acid, which has corroding effect on metal surfaces. It also damages the plant life. Nox also contribute towards formation of photochemical smog. Apart from the damage to plants and materials, the products that are formed in smoke forming photochemical reactions, irritate eyes and throat, evoke attacks in asthmatics and reduce visibility. The occurrence of smog has been recognized in almost all urban areas all over the world.

2. Objective Of The Current Work

The objective of the present work is to study through experiments the HC and CO emission by treatment outside the cylinder. Here is an attempt made to reduce this environmental pollution from two wheelers using oil and charcoal (Absorber of Hydrocarbon and carbon-monoxide & CO₂). Therefore develop a silencer which uses charcoal and oil.

MATERIALS AND METHODS

1. Other Emission Control Methods

After the combustion process ends the exhaust gas constituents in the cylinder gas mixture that have been partially burned continue to react during the expansion stroke, during exhaust blow down, and into the exhaust process. Over 90% to 95% of the HC remaining after combustion reacts during this time

either in the cylinder, near the exhaust port, or in the up-stream part of the exhaust temperature. The more these secondary reaction occur and the lower the engine emission. Higher exhaust temperature can be caused by stoichiometric air-fuel combustion, high engine speed and a low expansion ratio. Hence in order to reduce emission, some after treatments are necessary.

• Thermal Converters

Secondary reaction occur much more readily and completely if the temperature is high. So some engine are equipped with thermal converter as a means of lowering emission. Thermal converters are high temperature chamber through which the exhaust gas flows. They prompt oxidation of CO and HC which remain in the exhaust.

• Catalytic Converters

The most effective after treatment for reducing engine emission is the catalytic converter on most automobiles and other modern engine of medium or large size. CO and HC can be oxidized to CO₂ and H₂O in exhaust systems and thermal converters if the temperature is held at 600°C - 700°C. If certain catalysts are present, the temperature needed to sustain these oxidation processes is reduced to 200°C - 300°C making the much more attractive system.

A catalyst is a substance that accelerates a chemical reaction by lowering the energy needed for it to proceed. Catalytic converters are chamber mounted in the flow system through which exhaust gases pass through. These chamber contents catalytic material which promotes the oxidation of the emission contained in the exhaust flow.

• Charge Dilution

The chemical kinetic equilibrium calculation of Nitric Oxide formation have established that any reduction in peak combustion temperature will lead to the reduction in Nitric Oxide concentration. One of the method of achieving the reduction in peak combustion temperature is by dilution of the combustion charge in the engine by addition of an inert or non-combustible substance.

There are three ways by diluting the combustion charge as,

1. Increasing Valve Overlap – The dilution of the combustion charge can be achieved by increasing the valve overlap period of the intake and exhaust valve. Because of this the quantity of residual gas in the cylinders increased and combustion charge is diluted.
2. Introduction of an Inert Gas – Dilution of the combustion charge can also be achieved by introduction of an inert non-combustible gas in the engine cylinder. The inert gas introduction reduces the peak combustion temperature and

consequently decreases the NOx concentration.

- Exhaust Gas Recirculation (EGR) – Tested conducted by a number of investigators indicated that charge dilution by recirculation of portion of exhaust gas is an effective technique for control of NOx emissions. EGR is preferred to other methods of charge dilution because no additional provision for supply of this required.

2. Material Used : Charcoal and Oil

The charcoal powder and granular Charcoal used to absorb CO and HC, after breaking down into small mass, oil used to absorb some amount of CO & HC.

EXPERIMENTATION

1. Experimental Engine Specifications

For the above experiment, TVS Wego is used, which have following specifications.

Description	Specification
Engine Type	4-Stroke, Single Cylinder
Cooling	Air Cooled
Fuel	Gasoline (Petrol)
Displacement	109.7 cc
Max. Power	8 BHP @ 7500rpm
Max. Torque	8 Nm @ 5500 rpm
Transmission	V-matic
Ignition	Self and Kick

Table 1 Engine Specification



Figure 1 Indus 5-way Gas Analyser

2. Experimental Methodology

Engine run first with regular silencer for half hour and then take down the reading using Indus 5 way gas analyser for the no load condition and idling to 60 kmph speed, then after Charcoal-Oil Silencer is fitted to the engine and same process is repeated. As exhaust gas passes through exhaust manifold first it reaches in to charcoal casing from the perforated tube where the CO is absorbs by the charcoal powder and granular Charcoal after breaking down into small mass. Then after the gas passes through the convergent portion to tube which is immersed in the oil as shown in figure. Then gas reaches in to oil

chamber where the bubbles are form and high mass bubble are converted in to low mass as the gas passes through liquid by forming bubble. In this process as burnt oil is used to absorb some amount of CO & HC as well as the sound is damped.

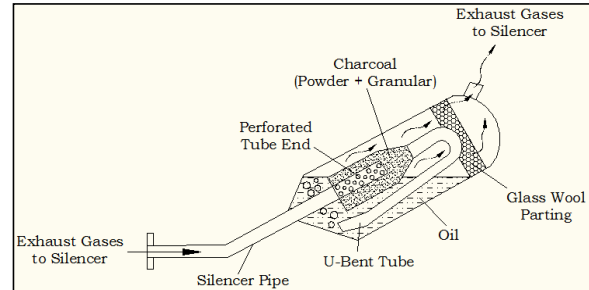


Figure 2 Charcoal-Oil Silencer

RESULTS AND DISCUSSION

The emission value of Oxides of Nitrogen (NOx), Carbon Dioxide (CO₂) and Residual Oxygen (O₂) in exhaust gas remain unchanged, there is reduction observed only in Carbon Monoxide (CO) and Hydro-Carbon (HC) emissions.

1. Decrease in CO Emission

As shown in figure the CO emission exhausted to atmosphere is reduced from 0.6% to 0.2% at idling and 1.7% to 0.9% at the speed of 60 kmph by using the Charcoal-Oil Silencer, thus reduction in CO emission is observed for the entire range of speed.

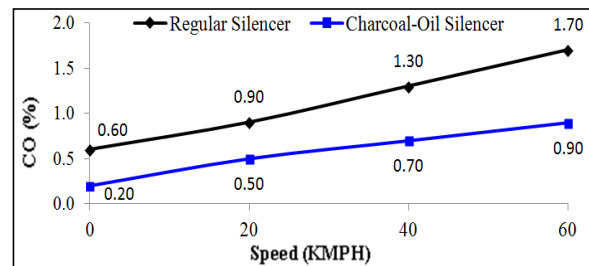


Figure 3 Variation of CO Emission

2. Decrease in HC Emission

As shown in figure the HC emission exhausted to atmosphere is reduced from 4.2% to 1.5% at idling and from 8.6% to 4.7% at the speed of 60 kmph by using the Charcoal-Oil Silencer, thus reduction in HC emission is observed for all speed range.

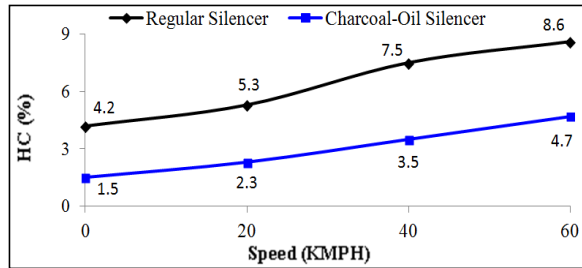


Figure 4 Variation of HC Emission

CONCLUSION

This system does not affect the emission values of NO_x, CO₂ and Residual O₂. The result obtained for CO and HC emission with the Charcoal-Oil Silencer following are the concluding point are derived,

- CO and HC emission is reduced for the entire range of speed from idling to 60 kmph.
- CO and HC emission shows the same trend of reduced which is as per expectation.
- The Noise is damped to some extend.
- All this reduction is achieved without any engine modification.

FUTURE SCOPE

- The reduction in CO and HC to be studied with trying other absorbing elements like silica-get, brick, alumina etc.
- A small attachment like system to be developed which can directly mount to any regular silencer to achieve Charcoal-Oil Silencer impact.
- A study to be focused to reduced other emissions like NO_x and Thermal Pollution.

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