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Pollution Control in Automobiles

S. Lingamaiah (pH.d), N. Bharath Sai Reddy, N. Naveen Kumar, N. Chandrasekhar Naik, N.Raju, C. Thimothi, H. Sai charan

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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.
The main pollutants contributed by I.C. engines are CO, NOX unburned hydro-carbons (HC) and other particulate emissions. Other sources such as Electric power stations industrial and domestic fuel consumers also add pollution like NOX, SO2 and particulate matters. In addition to this, all fuel burning systems emit CO2 in large quantities and this is more concerned with the Green House Effect which is going to decide the health of earth.
In this project vinegar is mixed with lime stone. Reaction between vinegar and lime stone is very fast. This mixture is contacted with the exhaust gas which is emitted from the engine exhaust valve and get well mixed and due to some chemical reactions carbon dioxide are separated.

I. INTROUDUCTION: -

Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms or damages the natural environment .These substances called pollutants can occur naturally or they can be produced by human activities.Natural pollutants include dust, pollen, salt particles, smoke from forest fires, and gases from organic waste. Most pollution caused by human activities is directly or indirectly the result of burning of fuels in furnaces or engines.The atmosphere is a complex, dynamic natural gaseous system that is essential to support life on planet Earth. Stratospheric ozone depletion due to air pollution has long been recognized as a threat to human health as well as to the Earth's ecosystems.Air pollution in the world has emerged as the focus of environmental remediation efforts because of their toxicity and threat to human beings. Hence the removal of toxic air pollutant contaminants from atmosphere is one of the most important environmental and economic issues today pollutants .Many expensive methods of removal for air pollutants are available in developed countries but in developing countries like India these methods are hard to apply because of its cost

PERFORATED TUBE:

Perforated pipe, made of high quality carbon steel, stainless steel or aluminum steel, is also called perforated tube, perforated steel tube, perforated steel pipe or filter pipe. It has hot dip galvanized, electro galvanized or powder coated surface, including straight perforated pipe, spiral perforated pipe and perforated casing pipe. It is widely used for industrial filtration.

Perforated tube diameter is 1.5 inch because engine exhaust manifold dia. is same and 12 inch long as per design data and made from the stainless steel because it has a high melting point 1510o C

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Charcoal

As air pollution due to vehicles is becoming a major threat for the society thus. we aim towards eradicating this threat with the help of a modified exhaust system. The various pollutant gases coming out from the vehicles are very harmful to human health and environment. The motivation of this project comes from the Swachh Bharat Abhiyan, a scheme of central govt. of India for pollution free environment. We can minimize this problem by applying innovative techniques. Therefore, to suppress this problem we initiate a project which uses different chemical products. charcoal and silica gel which is reliable and inexpensive. Exhaust system is part of an automobile which is used to control emissions and to reduce noise vibrations and harshness. It consists of numbers of parts namely manifold, catalytic convertor, flexible bellow, muffler, connecting pipe and tail pipe. Automobile exhausts combine sunlight results in photochemical smog which effects human eyes and causes significant damage to plants. It is estimated that there are 500 million cars for 5.5 billion populations and demand is increasing rapidly.

The exhausts of these automobiles release over 200 types of hydrocarbons after burning of gasoline. Automobiles are responsible for 80% of total co emissions, 36% of HCs, 44% of NOx, 4% of SOx and 18% of particulate matter. These gases are responsible for worsening the condition of asthma patients and also other health hazards like encephalopathy which often result in death or permanent brain damage. We have replaced traditional exhaust system with our charcoal bed system. A charcoal based exhaust system is an effective filtration device that minimizes the concentration of pollutant gases. As charcoal and silica gel have properties like adsorption power and light in weight, we are able reduced the content of exhaust emissions. The gases from exhaust manifold flowing through the chamber passes over the charcoal bed, the pollutants present in exhaust like oxides of carbon (COx), hydrocarbons and oxides of nitrogen (NOx) adsorb on the surfaces and converted into less harmful gases like carbon dioxide and nitrogen. Vol-4 Issue-3 2018 IJARIIE-ISSN(O)-2395-4396

Working

As the exhaust gas passes from the exhaust port of the IC Petrol engine, it enters into the aqua silencer. The perforated tube converts the high mass bubbles into low mass bubbles. This gas in the perforated tube via the drilled holes enters into the mixture of vinegar and coal powder. Since charcoal has high adsorbing capacity, it adsorbs the harmful gases and purifies the exhaust gas.After passing over the vinegar and charcoal mixture some of the gases dissolve in to the vinegar and finally the exhaust gases escape through the opening in to the atmosphere. The sound produced under waste medium is less hearable than to that produced in air medium hence aqua silencer reduces noise and pollution.

Lime stone

Limestone (calcium carbonate CaCO3) is a type of carbonate sedimentary rock which is the main source of the material lime. It is composed mostly of the minerals calcite and aragonite, which are different crystal forms of CaCO3. Limestone forms when these minerals precipitate out of water containing dissolved calcium. This can take place through both biological and nonbiological processes, though biological processes, such as the accumulation of corals and shells in the sea, have likely been more important for the last 540 million years. Limestone often contains fossils which provide scientists with information on ancient environments and on the evolution of life. Limestone Sedimentary rock ElTorcal0408.jpg Limestone outcrop in the Torcal de Antequera nature reserve of Málaga, Spain Composition Calcium carbonate: inorganic crystalline calcite or organic calcareous material About 20% to 25% of sedimentary rock is carbonate rock, and most of this is limestone. The remaining carbonate rock is mostly dolomite, a closely related rock, which contains a high percentage of the mineral dolomite, CaMg(CO3)2. Magnesian limestone is an obsolete and poorly-defined term used variously for dolomite, for limestone containing significant dolomite (dolomitic limestone), or for any other limestone containing a significant percentage of magnesium.Most limestone was formed in shallow marine environments, such as continental shelves or platforms, though smaller amounts were formed in many other environments. Much dolomite is secondary dolomite, formed by chemical alteration of limestone. Limestone is exposed over large regions of the Earth's surface, and because limestone is slightly soluble in rainwater, these exposures often are eroded to become karst landscapes. Most cave systems are found in limestone bedrock. Limestone has numerous uses: as a chemical feedstock for the production of lime used for cement (an essential component of concrete), as aggregate for the base of roads, as white pigment or filler in products such as toothpaste or paints, as a soil conditioner, and as a popular decorative addition to rock gardens.

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Limestone formations contain about 30% of the world's petroleum reservoirs.

VINEGAR:-

Vinegar is a liquid produced from the fermentation of ethanol in a process that yields its key ingredient, acetic acid. The acetic acid concentration ranges typically from 4 to 8 percent by volume for table vinegar [1] (typically 5%) and higher concentrations for pickling (up to 18%). Natural vinegars also contain smaller amounts of tartaric acid, citric acid, and other acids. Vinegar is an important preservative and condiment and it is being produced since centuries. It is produced through the action of acetic acid bacteria on dilute solutions of ethyl alcohol derived from yeast fermentation. It is also produced from fermented cider, fruit juices or other fermented alcoholic solutions derived from barley malt, hydrolyzed cereals and starches. There are many manufacturers producing synthetic vinegar but not much who produce from fruits. This note considers production of vinegar from fruits. Slow methods are generally used with traditional vinegars and fermentation proceeds slowly over the course of weeks or months. The longer fermentation period allows for the accumulation of a nontoxic slime composed of acetic acid bacteria and soluble cellulose, known as the mother of vinegar. Fast methods add mother of vinegar (i.e. bacterial culture) to the source liquid and then add air using a venturi pump system or a turbine to promote oxygenation to give the fastest fermentation. In fast production processes, vinegar may be produced in a period ranging between 20 hours and three days.

WORKING:-

As the exhaust gases enter in to the aqua silencer, the perforated tube converts high mass bubbles in lo low mass bubbles after that they passes through charcoal layer which again purify the gases. It is highly porous and posses extra free valences so it has high absorption capacity.After passing over the charcoal layer some of the gases may dissolved into the water and finally the Exhaust gases escape through the opening in to the atmosphere. Hence aqua silencer reduces noise and pollution.

EXPERIMENTATION:-

NOMENCLATURE:-This refers to the position of the crank shaft when the piston is in it slowest position.

BORE(d):-Diameter of the engine cylinder is refers to as the bore.

STROKE(s):-Distance traveled by the piston in moving from TDC to the piston in moving from TDC to the BDC.

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CLEARANCE VOLUME (V):-The volume of cylinder above the piston when it is in the TDC position.
SWEPT VOLUME (V):-The swept volume of the entire cylinderVd = Vs N
Where,Vs ------- Swept Volume
N --------- Number of cylinder
COMPRESSION RATIO (R):-It is the ratio of the total cylinder volume when the piston is at BDC to the clearance volume.

ENGINE SPECIFICATION:-
Type of fuel used : Petrol
Cooling system : Air cooled
Number of cylinder:Single
Number of stroke:two Stroke
Arrangement:Vertical
Cubic capacity:110 cc

Advantages :-A century of development and refinement - For the last century the SI engine has been developed and used widely in automobiles. Continual development of this technology has produced an engine that easily meets emissions and fuel economy standards. With current computer controls and reformulated gasoline, today's engines are much more efficient and less polluting than those built 20 years ago. Low cost - The SI engine is the lowest cost engine because of the huge volume currently produced.

Disadvantages;-
Friction loss due to many moving parts
Limited compression ratio lowers efficiency

Emission Control Systems

Automotive emissions contribute significantly to urban air quality problems. HEVs can reduce this contribution significantly through increased fuel economy, use of alternative fuels, and improved power unit and after treatment technology. A well-tuned spark ignition engine produces relatively low emissions. Significant emissions occur when the vehicle is started and warming up. During this time the engine must be choked to run properly. This creates excess unburned fuel in the exhaust, which leads to hydrocarbon and carbon monoxide emissions. During normal driving, emissions are relatively low because the air-to-fuel mixture is precisely controlled, allowing the catalytic converter to effectively reduce emissions. The diesel engine emissions are primarily nitrogen oxides (NO_x) and particulate matter (PM). NO_x is produced because the engine is operated with a lean air-to-fuel mixture. The high compression ratio of a diesel engine (required because of compression ignition) creates much higher pressure and temperature in the combustion cylinder. This lean mixture and high temperature cause the higher level of NO_x production. At high engine loads, where more fuel is injected, some of the fuel burns incompletely leading to the black smoke (PM) charcoal as a diesel engine.

CALCULATION:-
Pressure exerted on the walls of the cylinder by air is P_1
$P_1 = (M_1RT)$/ Compression ratio = (Swept Volume + Clearance Volume)/ Clearance Volume
Here,
Compression ratio = 6.6:1
a. $\therefore 6.6 = (98.2 + Vc)/Vc$
b. $Vc = 19.64$

The component gases and the mixture behave like ideal gases.
Mixture obeys the Gibbs-Dalton law

Here,
c. M_1 = m/M = (Mass of the gas or air)/(Molecular Weight)
d. R = Universal gas constant = 8.314 KJ/Kg mole K.
e. $T_1 = 303\ ^oK$
f. $V_1 = V = 253.28 \times 10^{-6}\ m^3$

Molecular weight of air = Density of air x V mole 8.5
Here,
g. Density of air at $303^oK = 1.165\ kg/m^3$
h. V mole = $22.4\ m^3$/Kg-mole for all gases.
i. ∴Molecular weight of air = 1.165 x 22.4
j. $\therefore P_1 = \{[(m_1/(1.165 \times 22.4)] \times 8.314 \times 303\}/253.28 \times 10^{-6}$
$P_1 = 381134.1\ m_1$

Let Pressure exerted by the fuel is P_2
$P_2 = (N_2\ R\ T)/V$
Density of petrol = $800\ Kg/m^3$
$\therefore P_2 = \{[(M_2)/(800 \times 22.4)] \times 8.314 \times 303\}/(253.28 \times 10^{-6}$
$P_2 = 555.02\ m_2$
12.5Therefore Total pressure inside the cylinder
C. $P_T = P_1 + P_2$
1. = $1.01325 \times 100\ KN/m^2$
$\therefore 381134.1\ m_1 + 555.02\ m_2 = 1.01325 \times 100$ ---------- (1)

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Calculation of air fuel ratio:

Carbon = 86%

Hydrogen = 14%

We know that,

k. 1Kg of carbon requires 8/3 Kg of oxygen for the complete combustion.

l. 1Kg of carbon Sulphur requires 1 Kg of Oxygen for its complete combustion.

i. (From Heat Power Engineering-Belandre)

ii. Therefore,

m. The total oxygen requires for complete combustion of 1 Kg of fuel

a. = [(8/3c) + ($3H_2$) + S] Kg

n. Little of oxygen may already present in the fuel, then the total oxygen required for complete combustion of Kg of fuel= { [(8/3c) + ($8H_2$) + S] - O_2} Kg

o. As air contains 23% by weight of Oxygen for obtain of oxygen amount of air required = 100/23 Kg

p. ∴Minimum air required for complete combustion of 1 Kg of fuel

= (100/23) { [(8/3c) + H_2 + S] - O_2} Kg

q. So for petrol 1Kg of fuel requires = (100/23) { [(8/3c) x 0.86 + (8 x 0.14)] }

r. = 14.84 Kg of air

s. ∴Air fuel ratio = m_1/m_2 = 14.84/1

1. = 14.84

t. ∴ m_1 = 14.84 m_2---------- (2)

Substitute (2) in (1)

u. 1.01325 x 100 = 3.81134 (14.84 m_2) + 555.02 m_2

v. ∴m_2 = 1.791 x 10^{-5} Kg/Cycle

2.5 Mass of fuel flow per cycle = 1.791 x 10^{-5} Kg cycle

3.5 Therefore,

a. Mass flow rate of the fuel for 2500 RPM

i. [(1.791 x 10^{-5})/3600] x (2500/2) x 60

ii. = 3.731 x 10^{-4} Kg/sec

Calculation of calorific value:

b. By Delong's formula,

i. Higher Calorific Value = 33800 C + 144000 H_2 + 9270 S

1. = (33800 x 0.86) + (144000 x 0.14) + 0

ii. HCV = 49228 KJ/Kg

iii. Lower Calorific Value = HCV – ($9H_2$ x 2442)

1. = 49228 – [(9 x 0.14) x 2442]

2. = 46151.08 KJ/Kg

iv. LCV = 46.151 MJ/Kg

Finding Cp and Cv for the mixture:

c. We know that,

i. Air contains 77% N_2 and 23% O_2 by weight

d. But total mass inside the cylinder = m_1 + m_2= 2.65 x 10^{-4} + 1.791 x 10^{-5} Kg

a. = 2.8291 x 10^{-4} Kg

(1) Weight of nitrogen present = 77% = 0.77 Kg in 1 Kg of air

e. ∴In 2.65 x 10^{-4} Kg of air contains,

i. = 0.77 x 2.65 x 10^{-4} Kg of N_2

ii. = 2.0405 x 10^{-4} Kg

f. Percent of N_2 present in the total mass

i. = (2.0405 x 10^{-4}/2.8291 x 10^{-4})

ii. = 72.125 %

Percentage of oxygen present in 1 Kg of air is 23%

ii. Percentage of oxygen present in total mass

i. = (0.23 x 2.65 x 10^{-4})/(2.8291 x 10^{-4})

ii. = 21.54 %

Percentage of carbon present in 1 Kg of fuel 86%

iii. Percentage of carbon present in total mass

i.= (0.866 x 1.791 x 10^{-5})/(2.8291 x 10^{-4})

i. = 5.444%

Percentage of Hydrogen present in 1 Kg of fuel 14%

iv. Percentage of Hydrogen present in total mass

i. = (0.14 x 1.791 x 10^{-5})/(2.8291 x 10^{-4})

ii. = 0.886 %

Total Cp of the mixture is = ∑msi Cpi

v. Cp = (0.72125 x 1.043) + (0.2154 x 0.913)

1. + (0.54444 x 0.7) + (8.86 x 10^{-3} x 14.257)

vi. Cp = 1.1138 KJ/Kg.K

vii. Cv = ∑msi Cvi

i. = (0.72125 x 0.745) + (0.2154 x 0.653)

1. + (0.05444 x 0.5486) + (8.86 x 10^{-3} x 10.1333)

ii. = 0.8 KJ/Kg.K

(All Cvi, Cpi values of corresponding components are taken from clerks table) viii. n For the mixture = (Cp/Cv)

1. = 1.11/0.8

b. n = 1.38

Pressure and temperature at various PH:

viii. P_1 = 1.01325 x 100 bar

1. = 1.01325 bar

ix. T_1 = 30°C = 303 K

$P_2/P_1 = (r)^{n-1}$

Where,

x. P_1 = 1.01325 bar

xi. r = 6.6

xii. n = 1.38

g. ∴P_2 = 13.698 bar

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i. $T_2 = (r)^{n-1} \times T_1$

p1 Where,

ii. $T_1 = 303$ K

iii. $\therefore T_2 = 620.68$ K

4.5 P

Heat Supplied by the fuel per cycle

i. Q = MCv

a. $= 1.79 \times 10^{-5} \times 46151.08$

ii. Q = 0.8265 KJ/Cycle

iii. $0.8265 = MCv (T_3 - T_2)$

iv. $T_3 = 4272.45$ K

b. $(P_2 V_2) / T_2 = (P_3 V_3) / T_3$

where,

i. $V_2 = V_3$

ii. $\therefore P_3 = (T_3 \times P_2)/T_2$

Where,

iii. $P_3 = 94.27$ bar

1. $P_4 = P_3 / (r)^n$
2. $\therefore P_4 = 6.973$ bar

ii. $T_4 = T_3 / (r)^{n-1}$

iv. = 2086.15 K

DESIGN OF ENGINE PISTON : We know diameter of the piston which is equal to 50 mm

Thickness of piston:

The thickness of the piston head is calculated from flat-plate theory

Where,

1. $t = D (3/16 \times P/f)^{1/2}$

Here,

2. P - Maximum combustion pressure = 100 bar
3. f - Permissible stress in tension = 34.66 N/mm²

c. Piston material is aluminum alloy.

1. $\therefore t = 0.050 (3/16 \times 100/34.66 \times 10^6/10^5)^{1/2} \times 1000$

i. = 12 mm

Number of Piston Rings:

d. No. of piston rings = $2 \times D^{1/2}$

Here,

e. D - Should be in Inches = 1.968 inches

∴ No. of rings = 2.805

We adopt 3 compression rings and 1 oil rings

Thickness of the ring:

f. Thickness of the ring = D/32

i. = 50/32

ii. = 1.5625 mm

Width of the ring:

g. Width of the ring = D/20

i. = 2.5 mm

h. The distance of the first ring from top of the piston equals

i. = 0.1 x D

ii. = 5 mm

i. Width of the piston lands between rings

i. = 0.75 x width of ring = 1.875 mm

ii. **Length of the piston:**

j. Length of the piston = 1.625 x D

k. Length of the piston = 81.25 mm

l. Length of the piston skirt = Total length – Distance of first ring from top of

1. The first ring (No. of landing between rings x
2. Width of land) – (No. of compression ring x
3. Width of ring)

ii. = 81.25 – 5 – 2 x 1.875 – 3 x 2.5

iii. = 65 mm

Other parameter:

m. Centre of piston pin above the center of the skirt =0.02 x D

i. = 65 mm

n. The distance from the bottom of the piston to the

o. Centre of the piston pin = ½ x 65 + 1

i. = 33.5 mm

p. Thickness of the piston walls at open ends = ½ x 12

i. = 6 mm

q. The bearing area provided by piston skirt = 65 x 50

i. = 3250 mm²

EXPERIMENTAL ANALYSIS AND RESULT OF HYBRID SILENCER

- Basically a perforated tube which is installed at the end of the exhaust pipe. The perforated tube consists of number of holes of different diameters 8mm, 4mm, 2mm. It is used to convert high mass bubbles to low mass bubbles. It is made from the stainless steel.
- The charcoal layer is pasted over the perforated tube. Bead Activated carbon is used as a charcoal layer. It is a process by which the carbonised product develops porous structure of molecular dimensions and extended surface area on heat treatment in the temperature range of 800 –1000 oC in presence of suitable oxidizing gases such as steam, CO2. Bead activated carbon is made from petroleum pitch and supplied in diameters from approximately 0.35 to 0.80 mm. It is also noted for its low pressure drop, high mechanical strength and low dust content, but with a smaller grain size.

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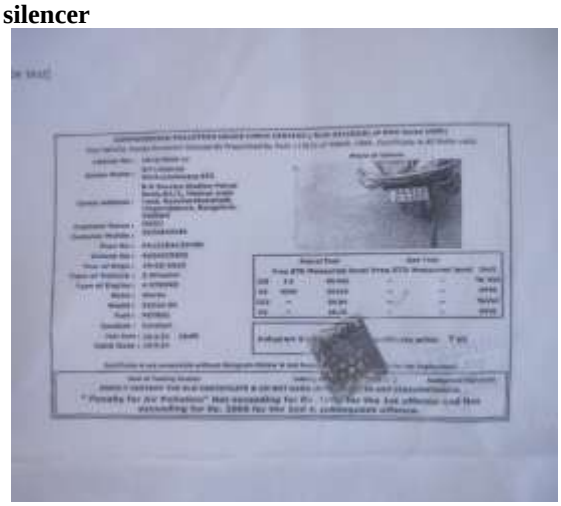
Its spherical shape makes it preferred for fluidized applications.

- Around the circumference of the perforated tube a layer of activated charcoal is provided and further a metallic mesh covers it. The whole unit is then placed in a water container. A small opening is provided at the Top of the container to remove the exhaust gases and a drain plug is provided at the bottom of the container for periodically cleaning of the container. It is made up of iron or steel. The water inlet, outlet and exhaust tube was provided in the shell.

Pollution check of the engine without hybrid silencer



Pollution check with using hybrid silencer

II. CONCLUSION

The aqua silencer is more effective in the reduction of emission gases from the engine exhaust using perforated tube and charcoal. By using water as a medium the sound can be lowered and also by using activated charcoal in water we can control the exhaust emission to a greater level. The water contamination is found to be negligible in aqua 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 and also can be used in industries.

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