==========
Engineering & Technology in India www.engineeringandtechnologyinindia.com
Vol. 1:2 March 2016
==========

EXPERIMENTAL INVESTIGATION OF EMISSION CONTROL IN IC ENGINES BY INTRODUCING VARIOUS TECHNIQUES

Rajeshkumar G., Rajapandian R., Surendrakumar G., Ananthakumar P., Vasanthaseelan S., and Senthil Ganesh A.

==========

ABSTRACT

Now-a-days the automobiles are very essential needs of human beings. The world without automobiles is unimaginable at present. But the major problem corresponding to the automobiles are unwanted emissions from the engine exhaust. The unwanted emission contains CO, CO_2, HC, SO_X, NO_X, etc. Control of these gases is very essential now, because it leads to harmful injuries to living beings and environment. So, we are going to introduce four methods to reduce these exhaust emissions. These are adding additives methods. In this, we add the 2- ethoxy ethanol and 2- methoxy ethanol with fossil fuels which can reduce the of CO_2 gas emission from the vehicles. Then HHO technology may be used to improve the fuel consumption & reduce CO_2, NO_X level during the combustion process. Then the exhaust gas is treated with the main technology, called charcoal absorber to reduce the CO, HC levels and NaOH silencer reduces more than two-thirds of carbon dioxide.

Keywords: 2-Ethoxy Ethanol, 2-Methoxy Ethanol, Baking Soda, Perforated Tube, Activated Charcoal and HHO.

1. INTRODUCTION

The advent of “first generation” catalytic converters in 1975 significantly reduced hydrocarbon and carbon monoxide emissions. The use of converters provided a huge indirect benefit as well. Because lead inactivates the catalyst, 1975 saw the widespread introduction of unleaded fuels. This resulted in dramatic reductions in ambient lead levels and alleviated many serious environmental and human health concerns associated with lead pollution The next major milestone in vehicle emission control technology came in 1980- 81. In response to tighter standards,

manufacturers equipped new cars with even more sophisticated emission control systems. These systems generally include a "three-way" catalyst (which converts carbon monoxide and hydrocarbons to carbon dioxide and water, and also helps reduce nitrogen oxides to elemental nitrogen and oxygen), plus an on-board computer and oxygen sensor.

Here, in this paper we are using various technologies to reduce unwanted emissions. The technologies like adding additives are initially by the addition of 2- ethoxy ethanol and 2- methoxy ethanol with fossil fuels which can reduce the of CO_2 gas emission from the vehicles. Then HHO technology to improve the fuel consumption & reduce CO_2, NO_X level during the combustion process. Then the exhaust gas was treated with the main technology charcoal absorber to reduce the CO, HC level and NaOH silencer reduces more than two in third of carbon dioxide. We are using these technologies like additives, activated charcoal does not affect the human beings. We are must be avoided all the toxic gases by using various technologies. Composition of the normal petrol engine exhaust is as follows:

- Nitrogen (71% of vol.)
- Carbon dioxide (14% of vol.)
- Water vapour (12% of vol.)
- Oxides of nitrogen (<0.25% of vol.)
- Carbon monoxide (1-2% of vol.)
- Hydrocarbons (<0.25% of vol.)
- Oxides of sulphur (<0.03% of vol.)

2. EXPERIMENTAL SETUP

1. HHO Gas Instead of Inlet Air

Hydrogen is a combustible gas and water on electrolysis splits into two molecules of hydrogen and one molecule of oxygen, hydrogen and oxygen though evolve separately in the electrolysis setup but combines immediately to form Oxy-hydrogen gas(HHO) or commonly called as Brown's gas in the collection tube. On introduction of the brown's gas and air fuel mixture through the air-inlet manifold of the carburettor into the IC engine, the highly flammable Browns gas ignites a fraction of a second earlier than the fuel. No flash points, explosive points or temperatures soaring, takes place during the combustion within the cylinder. The flame speed of hydrogen is very

high compared to that of gasoline. Hence there is no delay in combustion between two points in the cylinder ensuring a smoother performance, this helps in uniform and complete combustion of the additive and fuel mixture inside the cylinder of the engine. In addition to this the life and performance of the engine improves. And because of the complete combustion of the fuel and Browns gas mixture, it ensures that there are no unburned hydrocarbons and also oxidizes the partially oxidized carbon i.e. carbon monoxide (CO) into completely oxidized carbon dioxide (CO_2) which is less harmful compared to carbon monoxide. This results in significant decrease in hydro carbon level in the exhaust of the engine. The brown's gas doesn't cause any pollution as the product after combustion is steam. The brown's gas is liberated using the electrolysis process, where the current is passed through the solution of distilled water and potassium hydroxide(electrolyte), this liberated volume of brown's gas directly depends on

i. Concentration of Electrolyte.

ii. Current sent into the solution.

iii. Area of contact between the electrode and the solution

a) Production of HHO gas

HHO gas is produced by electrolysis of water. The process involves mixing of NAOH/KOH with water in 20% to 30% in order to increase the boost up the electrolysis these two catalysts were mainly chosen because of their easy availability and doesn't affect chemically. Initially container must be chosen, according to engine we selected here we chosen container of volume minimum 10L and now the volume of water taken for electrolysis depends on the engine volume, for example if we choose the sumo engine of 3.0L(engine capacity will be 3000CC) water taken must be above 6000CC (1CC = 1ml) but not to exceed 7000CC. Here we taken 800 CC engine and volume of water taken for electrolysis is 2000CC (2L) and about NAOH taken for dilution in water is about 25% of volume of water i.e.250gms. Now the electrolyte solution (Mixture of NAOH and water) needed for electrolysis is made ready.

Figure 1. Brown Gas Setup Figure 2. Brown Gas Production

2. Adding Additives to the Fuel

There were wide range of additives available to mix with the fuel but here we selected 2-ethoxy ethanol and 2-methoxy ethanol. It's because additives chosen must be oxygenated group of chemicals. Oxygenated fuel is nothing more than fuel that has a chemical compound containing oxygen. It is used to help fuel burn more efficiently and cut down on some types of atmospheric pollution. In many cases, it is credited with reducing the smog problem in major urban canters. It can also reduce deadly carbon monoxide emissions. Oxygenated fuel works by allowing the gasoline in vehicles to burn more completely. Because more of the fuel is burning, there are fewer harmful chemicals released into the atmosphere. In addition to being cleaner burning, oxygenated fuel also helps cut down on the amount of non-renewable fossil fuels consumed.

Figure 3. Additives

a) Properties of Additives Selected

Here we selected 2 – ethoxy ethanol and 2 – methoxy methanol as additive to be mixed or blended with fossil fuel in 9:1 proportion where 9 represents ratio of fuel and 1 represent ratio of additive mixed. In the ratio of additive since we are mixing two different additives, the ratio of mixture varies as .5:.5, .25:.75, .75:.25 by mixing the additives at various proportion we can found the series of variable results.

i. Properties of 2 – ethoxy ethanol

2-Ethoxyethanol is a common solvent. It, like other glycol ethers, is used in the semiconductor industry. It is also used in surface coatings such as lacquers and paints. It is used in varnish removers, printing inks, duplicating fluids, wood stains, and epoxies.

ii. Properties of 2 – methoxy ethanol

2-Methoxyethanol is used as a jet fuel de-icer. It is also used as a solvent for cellulose acetate, resins, dyes, and quick drying varnishes, enamels, nail polishes and wood stains. 2-Methoxyethanol dissolves readily in water and most organic solvents. It is flammable. It is a colourless, flammable, liquid, organic solvent.

3. Charcoal Absorber

Basically a charcoal absorber consists of a perforated tube which is installed at the end of the exhaust pipe. The perforated tube may have holes of different diameters. The very purpose of providing different diameter hole is to break up gas mass to form smaller gas bubbles. Generally 4 sets of holes are drilled on the perforated tube. Around the circumference of the perforated tube a layer of activated charcoal is provided and further a PVC pipe covers it. Also a filler plug is mounted at the both end of the container. At the inlet of the exhaust pipe a non-return valve is provided which prevents the back flow of gases.

Figure 4. Perforated Tube

a) Absorption Process

As the exhaust gases enter in to the charcoal absorber, the perforated tube converts high mass bubbles in lo low mass bubbles after that they pass through charcoal layer which again purify the gases. It is highly porous and posses extra free valences so it has high absorption capacity. Activated charcoal is available in granular or powdered form. As it is highly porous and Possess free valences. So, it possesses high absorption capacity.

Activated carbon is more widely used for the removal of taste and odorous from the public water supplies because it has excellent properties of attracting gases, finely divided solid particles and phenol type impurities, The activated carbon, usually in the powdered form is added to the water

either before or after the coagulation with sedimentation. But it is always added before filtration. Feeding devices are similar to those used in feeding the coagulants.

4. NaOH Silencer

This is the main technology for reduction of CO_2 emission in automobiles. It is a simple design and inexpensive. The emission particles will be absorbed in this technology; nearly about two in third of CO_2 gases will be absorbed in NaOH silencer.

a) Principle

The basic principle of NaOH silencer is the conversion of sodium hydroxide into sodium bicarbonate. The purified exhaust gas from charcoal absorber enters into the special arrangement called NaOH silencer. It's like a hollow cylinder through which layers of binder are rolled inside the cylinder. The cylinder surfaces have small holes throughout the binders. The binders are made by sodium hydroxide (NaOH). These NaOH directly react with CO_2 and forms $NaCO_3$.

$$\mathbf{2NaOH + CO_2 \rightarrow Na_2CO_3 + H_20}$$

These colloidal forms of sodium carbonate ($NaCO_3$) react with CO_2 and forms sodium bicarbonate or sodium hydrogen carbonate ($NaHCO_3$).The sodium bicarbonate is fully in solid form. It is also called as baking soda and it is utilized for day to day life. In this method, the toxic gases like CO_2 are converted into useful works.

$$\mathbf{Na_2CO_3 + H_2O + CO_2 \rightarrow 2NaHCO_3(s)}$$

b) Construction and Working

The NaOH silencer consists of cylindrical container & the NaOH powder is mixed with water. This NaOH silencer is fitted with exhaust pipe line in order to absorb CO_2 from exhaust gasses. In this, cylindrical container carrying NaOH mixture to absorb the CO_2 in the exhaust from the charcoal absorber and also cylindrical container have exhaust port, because after absorbing CO_2 the exhaust gas leaving the system to the atmosphere.

In previous technology we can reduce some amount of emission. But enormous amount of emission causing harmful effect gas like CO_2 can be reduced using NaOH silencer. The low velocity of exhaust gas enters into the NaOH silencer. The velocity of exhaust gas increases with the help of small holes in the arrangement of inlet pipe. The high velocity exhaust gases react with NaOH

mixture. This exhaust gas contains CO_2 gas which may react with NaOH mixture and forms $NaCO_3$ in colloidal form further the CO_2 gas reacted with mixture repeatedly and forms $NaHCO_3$.

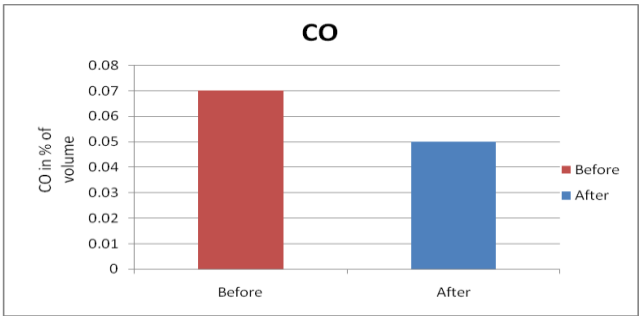
The exhaust gases before entering NaOH silencer involves some technology like adding additives and HHO technology. When it is treated, exhaust gases comes out with low temperature compared to the normal technology. This is an important advantage of our NaOH silencer, because if a high temperature gas enters into the purifier it affects the sodium carbonate reaction. But this problem will not occur in the NaOH silencer. Another advantage of this NaOH silencer is, the NaOH are reacted repeatedly with CO_2.

3. EXPERIMENTAL RESULTS

The following table & graph shows the experimental result analysed using flue gas analyser & smoke meter. The results and graphical representations are as follows:

Table 1. Result of Smoke Meter Test and Flue Gas Analyser

EMISSION TEST RESULTS			
Test/ Implementation		**Before Implementation**	**After Implementation**
Smoke Meter Test	Density	10.1 N %	3.8 N %
		0.84 m^{-1}/ ^oC	0.34 m^{-1}/^oC
Flue Gas Analyser	HC	33 PPM	15PPM
	CO	0.07%	0.05%
	CO_2	14%	12%
	NO_X	57 PPM	50 PPM



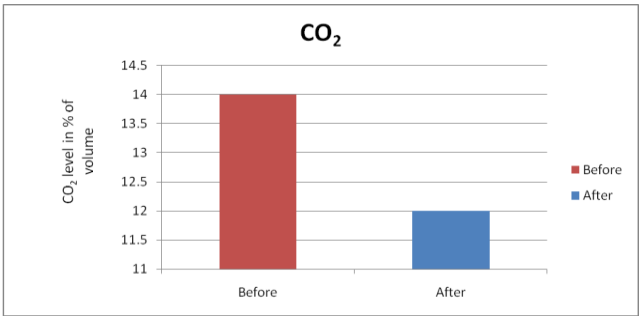
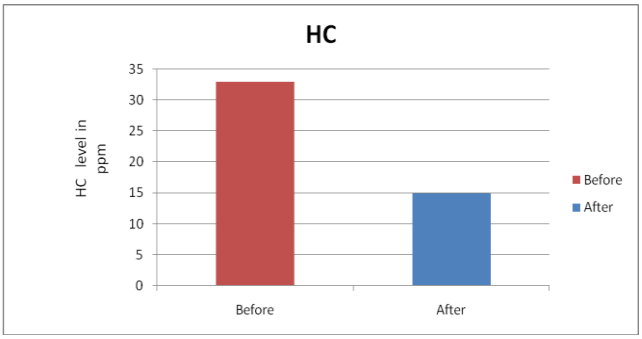


Figure 5. Graphical Representation of CO Emission

Figure 6. Graphical Representation of CO_2 Emission



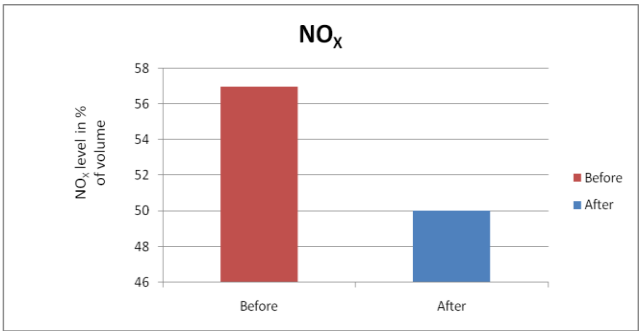


Figure 7. Graphical Representation of HC Emission

Figure 8. Graphical Representation of NO_X Emission

4. CONCLUSION & DISCUSSION

Burning of liquid fuels like petrol, diesel, gasoline etc. result in the emission of toxic gases like CO_2, CO, NO_X, HC etc., From the result of this work we reduced the unwanted emissions from the petrol engine considerably. In this work we are mainly focused on the reduction of CO_2 gas from the exhaust emission. Because CO_2 gas leads to some harmful effects on human beings as well as the environment. The main focuses of the project achieved are as follows,

- Emission control in I.C. Engine and making this setup for commercial use is achieved.
- Compact design and alternative process for current phenomenon is achieved.
- Engine life, Engine efficiency and minimise the fuel consumption also achieved at high rate.

==========

References

1. Ahmad Zaki bin zaimani "*Development hydrogen gas generator for dual fuel engine using yull brown method" 2010*
2. Swastik R. Gajjar, Keval I. Patel "*Design And Development Of Aqua Silencer For Two Stroke Petrol Engine* " International Journal for Innovative Research in Science & Technology (IJIRST) / Vol. 1, Issue 1, June 2014
3. Maryam Mahmoudkhani, David W. Keith "*Low Energy Sodium Hydroxide Recovery for CO_2 Capture from Atmospheric Air- Thermodynamic Analysis* " International Journal of Greenhouse Gas Control-2009
4. M. Al-Hassana, H. Mujafeta and M. Al-Shannag *"An Experimental Study on the Solubility of a Diesel-Ethanol Blend and on the Performance of a Diesel Engine Fueled with Diesel-Biodiesel - Ethanol Blends"* Jordan Journal of Mechanical and Industrial Engineering Volume 6, Number 2, April 2012
5. K.Balasubramaniyan, P.Balashanmugam, A.Raghupathy , G.Balasubramanian *"Studies on Emission Characteristics of Diesel Engine Run Using Diesel Di Methoxy Ethane Blend Fuel"* International Journal of Science, Engineering and Technology Research (IJSETR) Volume 2, Issue 11, November 2013
6. Saed A. Musmar, Ammar A. Al-Rousan "*Effect of HHO gas on combustion emission in gasoline engines*" International Journal of Greenhouse Gas Control, 2011

7. V.Gnanamoorthia, G. Devaradjane *"Effect of Diesel-Ethanol Blends on Performance, Combustion and Exhaust Emission of a Diesel Engine"* International Journal of Current Engineering and Technology, Vol.3, No.1 (March 2013)

8. Natalia Chraplewska, Kamil Duda, Miosz Meus *"Evaluation of usage brown gas generator for aided admission of diesel engine with fermentative biogas and producer gas"* Journal of KONES Power train and Transport, Vol. 18, No. 3 2011.

Rajeshkumar G
Assistant Professor, Mechanical Engineering
Theni Kammavar Sangam College of Technology
Theni 625 534
Tamil Nadu
India
rajesh.mech022@gmail.com

Rajapandian
Assistant Professor, Mechanical Engineering,
Theni Kammavar Sangam College of Technology, Theni.
Theni Kammavar Sangam College of Technology
Theni 625 534
Tamil Nadu
India

R, Surendrakumar G.,
Assistant Professor, Mechanical Engineering,
Theni Kammavar Sangam College of Technology
Theni 625 534
Tamil Nadu
India

Ananthakumar P,
Assistant Professor, Mechanical Engineering,
Theni Kammavar Sangam College of Technology
Theni 625 534
Tamil Nadu
India

Vasanthaseelan S
PG Scholar, Hindustan Institute of Technology
Hindustan University
Chennai
Taminadu
India
vasanthaseelan.s@gmail.com

Senthil Ganesh A
Former UG Scholar
Mechanical Engineering
Theni Kammavar Sangam College of Technology
Theni 625 534
Tamil Nadu
India
mechsenthil19@gmail.com