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MINIMIZATION OF POLLUTANTS OF EXHAUST GAS FROM HIGH TRAFFIC AREA & INDUSTRIAL SECTOR BY USING EXOTHERMIC REACTION.

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ABSTRACT

It is today undoubted that humans have to reduce their impact on the environment. IC engines, being the major power source in the transportation sector, play an important role in the man-made emissions. While the mobility in the world is growing, it is important to reduce the emissions that result from transportation, which are believed to be the main cause of global warming. Exhaust by fuel combustion contains toxic gases, various harmful pollutants mainly nitrogen oxides (NOX) and soot particles. These emissions are therefore limited by the authorities in most countries.

In heavy traffic area and in industrial sector we find very high Pollution. This research work is carried out to minimize the pollution in our focused area. An unsteady state behaviour of gas absorption column for CO_2-NaOH system was carried out using the arm field gas absorption column. A model equation was developed by considering material balance around the system. The concentrations of the inlet and outlet liquid streams and the gas outlet stream varied as functions of time. By Experimental analysis, the percentage of pollutants from exhaust gas is minimized. The test conducted for the duration of 90 minutes showed that 0.2 gram mole/litre of NaOH solution reacts with CO_2 to give 0.1 gram mole/litre of Na_2CO_3.This clearly shows that the results of experiments conducted are in agreement with the model results.

INDEX TERMS: Pollutants, Carbon dioxide emission, Global warming, Exothermic Reaction,

I. INTRODUCTION

An important task in the development of internal combustion engines is the reduction of emissions. As the individual mobility in the world is increasing and the transportation sector I growing, it is important to limit the impact of traffic on both the environment and the health of the population. The main combustion products that are contained in engine exhaust gases are water vapor (H2O), carbon dioxide (CO2), nitrogen oxides (NOX), particulate matter (PM), hydrocarbons (HC) and carbon monoxide (CO). All of these, except for the water vapor, are considered environmentally harmful. This is also reflected in the fact that governments all over the world enact limits for the emission of these gases. Therefore, engine developers work on diminishing these emissions.

During Diesel combustion, several toxic and non-toxic gases are formed. The non-toxic parts are water and carbon dioxide. While water is completely unproblematic, the emission of CO2 has negative impacts on the environment. CO2 is believed to be the main cause of global warming and therefore, emission has to be reduced. The formation of CO2 is directly proportional to the fuel consumption of an engine, if fossil fuel is burned. This means, that for a reduction of CO2, the fuel consumption has to be reduced. The two most problematic emissions in diesel engines are nitrogen oxides and soot particles. HC and CO emissions are quite low and can be removed fairly easy from the exhaust with the help of an oxidation catalyst.

The negative effect of automotive emissions does not affect only the person driving but also the others around them. Various greenhouse gases such as carbon dioxide, methane, nitrous oxide and other gases like chlorofluorocarbon (CFCs) are emitted. The gases act like a blanket and increase the global temperature which is otherwise called as global warming.

The planet's thermostat had been set at a pleasant average temperature of 59°F for the last 10 years and recently it is increasing rapidly2. A typical engine combustion process is represented below3.

Fuel + Air ® Hydrocarbons + NO2 + CO2 + CO + H2O

Hydrocarbon emissions are the fragments of fuel molecules, which are only partially burnt.

II. VARIOUS EXHAUST GASES AND THEIR EFFECTS

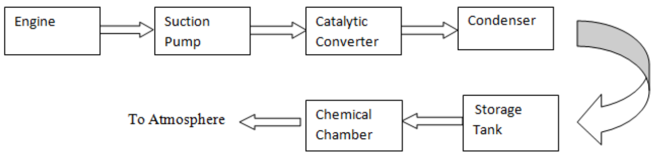
Nitrogen Oxides: Converters basically are used to break down gases. A higher percentage of nitrogen-dioxide (NO2) is formed as product compared to carbon-dioxide. NO2 makes up about 7.2% of the gases that cause global warming3. But these converters, though break down molecules, they emit a higher quantity of their oxides into the atmosphere.

Carbon Monoxide: Most CO gas is produced when the fuel is not combusted properly in the engine. This happens when there is an insufficient flow of air into the engine4. This occurs when the vehicle is under prolonged use, in mountains where the oxygen content is comparatively low or by general ageing of the engine itself. Two-third of carbon monoxide emissions come from transportation sources, mainly from the urban areas where the population is high.

Carbon Dioxide: Originally carbon dioxide viewed as a product of perfect combustion, but now, it has become a pollution concern. Carbon dioxide is a greenhouse gas that traps the earth's heat and contributes to global warming.

III. WORKING PRINCIPLE

Important Design aspects



- An I.C. engine is the first element of the model. Pollutants are released in the chamber by using suction pump.
- A catalytic converter inline converts harmful gases in harmless gases partially and supplies it to the condenser.
- In a condenser the temperature of polluted air is brought to the normal temperature and required pressure is maintained and outlet of condenser is further connected to chemical chamber where chemicals are stored.

The exhaust gas is allowed to pass into the inlet of the Catalytic Converter. Pressure gets reduced and velocity of the gas increases because of the conical section. The flowing exhaust gas is free to move in all directions inside the Catalytic Converter. As the movement of exhaust gas is not abruptly obstructed anywhere in its path, the back pressure is limited to minimum level. The flowing gas passes over the trap which is fixed at the inner of the Catalytic Converter. Gas entering the perforated sheet mesh holes gets exposure to the zeolite pellets. The exposure of the exhaust gas is maximum by increased in size of the pellets. Zeolite pellets are highly porous and consistent matrix of zeolite that provides the adsorption of impurities.

The exhaust gas containing CO_2 and other particles are absorbed by the zeolite pellets. Adsorptions take place by locking of gaseous CO_2 molecules over the porous layer of the zeolite. Adsorption quality of CO_2 is depends on the type of zeolite used. Maximum adsorption limit of zeolite is depends on the amount of exhaust produced from the engine. The material for sheet mesh is considered as steel which has high thermal properties. Sheet mesh also has filtration efficiency .which will also filters the black carbon particles up to certain extent. As this is the first device to be designed to reduce CO2 emission. Its limitations will be considered. The Carbon emission levels will be reduced to maximum by implementing this device on the exhaust manifold.

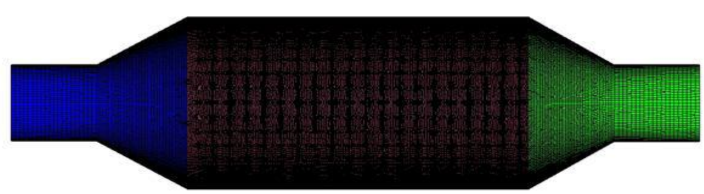


Fig. No. 01- Catalytic Converter

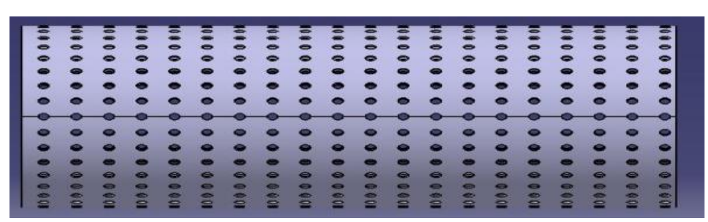


Fig. No. 02- Honey comb structure of Catalytic Converter

Using catalytic converter & chemicals, pollutants are made to react with the chemical to reduce the air pollution. Whenever the harmful exhaust is generated, the suction pump sucks the pollutants into the chamber and is passed to the catalytic converter where pollutants are partially cleaned. Further pollutants are passed through water and then NaOH solution. Here, water first removes the dust particles and reaction with NaOH is as follows:-

$$2NaOH + CO_2 \rightarrow Na_2CO_3$$

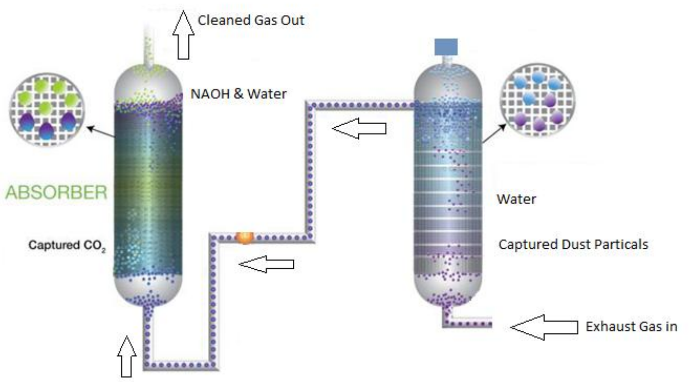


Fig. No. 03 Chemical Analysis (Exothermic Reaction)

IV. METHODOLOGY

- First we start the Exhaust Gas Analyzer and wait for 10 minutes. Then we start the engine. Put the EGA on test mode for 40 seconds. Put the gun of the EGA in the exhaust pipe. Then wait for 1 minute and take the readings on the screen of the EGA.
- After that connect the inlet of the Exhausted Pollutant Minimiser to the exhaust of the engine. After this the exhaust passes through the catalytic convertor
- And the exhaust is partially cleaned. Then the partially cleaned exhaust passes through the water for filtering purpose. And then that exhaust is passed through the (NaOH + H_2O) Sodium Hydroxide. Then it is passed through the baffle chamber and finally in the EGA for taking the readings.
- 7.5 litters of IM solution of caustic soda was prepared and poured in 30 litres of water to make 37.5 litters of 0.2M-solution of caustic soda that was poured into the reservoir tank at the base of the column. The gas flow control valves were closed. The liquid pump and the compressor were switched on and the flow of caustic soda through the column and the airflow were regulated to 3litres / min and 30 litters / min respectively.
- The pressure-regulating valve on the carbon dioxide cylinder was carefully opened and the flow of CO_2 to the column was 3 litters/min. Product samples were withdrawn after 30mins for analysis using titre metric method.

V. RESULTS AND DISCUSSION

Traffic Conditions	Reading Before Test	Reading After test
Normal	Vehicle Exhaust GasAnalyzer CO : 0.04% HC:0000ppm CO_2:11.82% NO:——ppm O_2: 4.72% λ:1.27 OilT: 24.0 ℃ RPM : 0 rpm Car NO. : Inspector: Pass :(Y / N) 3\ 8\2017 12: 4:31 S	Vehicle Exhaust GasAnalyzer CO : 0.00% HC:0000ppm CO_2: 4.34% NO:——ppm O_2:20.80% λ:2.50 OilT: 24.0 ℃ RPM : 0 rpm Car NO. : Inspector: Pass :(Y / N) 3\ 8\2017 12: 8:47 S
Moderate	Vehicle Exhaust GasAnalyzer CO : 0.13% HC:0000ppm CO_2: 7.37% NO:——ppm O_2:18.41% λ:2.50 OilT: 24.0 ℃ RPM : 0 rpm Car NO. : Inspector: Pass :(Y / N) 3\ 8\2017 12: 6:53 S	Vehicle Exhaust GasAnalyzer CO : 0.00% HC:0000ppm CO_2: 0.12% NO:——ppm O_2:20.80% λ:2.50 OilT: 24.0 ℃ RPM : 0 rpm Car NO. : Inspector: Pass :(Y / N) 3\ 8\2017 12:18:49 S
High	Vehicle Exhaust GasAnalyzer CO : 0.93% HC:0000ppm CO_2:10.58% NO:——ppm O_2:12.44% λ:1.70 OilT: 24.0 ℃ RPM : 0 rpm Car NO. : Inspector: Pass :(Y / N) 3\ 8\2017 12:48:32 S	Vehicle Exhaust GasAnalyzer CO : 0.26% HC:0000ppm CO_2: 0.84% NO:——ppm O_2:20.80% λ:2.50 OilT: 24.0 ℃ RPM : 0 rpm Car NO. : Inspector: Pass :(Y / N) 3\ 8\2017 12:52: 4 S

Result reveals that there is considerable difference in CO. CO2, PM at various conditions of traffics (Normal, Moderate and high). Pollutants from exhaust gas are measured by Exhaust gas analyzer before and after passing through catalytic converter and chemicals. The testing is at nearby place of Traffic Signal and near Chimney of Industrial sector.

VI. EXPERIMENTAL SETUP

Fig No. 4 Pollution testing Setup

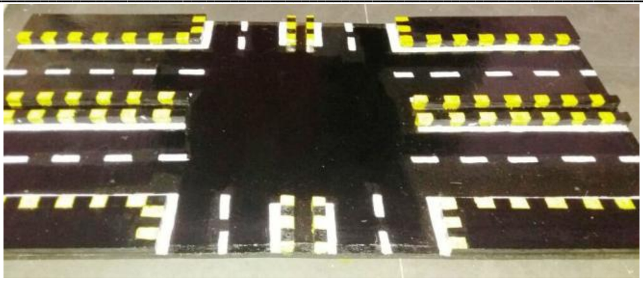


Fig No. 4Location Plan of setup (Heavy Traffic Area)

VII. CONCLUSION

In this work it has been presented a dynamic work effort to reduce CO2 emissions through Carbon capture mechanisms .Adsorption technique is followed to control the Carbon emissions from the exhaust gas. The solid adsorbent used in this work is Catalytic Converter, were it locks and holds the carbon molecules from the exhaust. The carbon capture by exothermic reaction is successively designed for automotive emission control. It is the first action taken from automobile sector for controlling CO_2 emission from the automobile exhaust and Industrial sector. The design model is analyzed for its fluid flow inside the system. The model derived has been seen to agree with experiment, which was conducted under unsteady state regime. Thus, the values of the carbon dioxide concentrations in caustic soda can be predicted if given initial NaOH concentration, volume of NaOH and flow rate. This naturally translates into the Na_2CO_3 formed.

VIII. REFERENCES

1) S.Jenoris Muthiya, V.Amarnath, P.Senthil Kumar, S.Mohan Kumar., Carbon capture and storage from automobile exhaust to reduce co2 emission, Volume 3, Special Issue 2, April 2014.
2) Muralikrishnan R., Swarnalakshmi M. and Nakkeeran E., Nanoparticle-Membrane Filtration of Vehicular Exhaust to Reduce Air Pollution., Vol. 3(4), 82-86, April (2014)
3) Maryam Mahmoudkhani , David W. Keith. Low-energy sodium hydroxide recoveryfor CO2 capture from atmospheric air.,
4) Mahmoudkhani M.a,, Heidel K.R.a, Ferreira J.C.a, Keith D.W.a, Cherry R.S., Low energy packed tower and caustic recovery for direct capture of CO2 from air.,
5) Coulson J.M., Richardson J.F., Chemical Engineering, Vol.2, 4th Ed., Butterworth Heinman Pub., London, 1996, pp. 530-550.
6) Himmelblau D. M, Basic Principles and Calculations in Chemical Engineering, Prentice-Hall international, New York, 1996.
7) Babatunde A. O., Principles of Mathematical Modelling and Analysis in Chemical Engineering, Done Publishers, University of Lagos, Nigeria, 1985, pp. 5-12.
8) Meyers R., Encyclopedia of Physical Science and Technology, Vol. 9, Harcourt Brace Jovanovich Publishers, London, 1988, pp. 519-528.

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