Study of Performance Improvement by using Thermal Reactor Setup in Automotives

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***Abstract*— IC Engines are responsible for too much atmospheric pollution, which is detrimental to human health & environment. Thus concerted efforts are being made to reduce the responsible pollutants emitted from the exhaust system without sacrificing power & fuel consumption. Air pollution can be defined as an addition to our atmosphere of any material which will have a deleterious effect on life upon our planet. Besides IC engines other sources such as electric power stations, industrial and domestic fuel consumers also add pollution. Pollutants are produced by the incomplete burning of the air-fuel mixture in the combustion chamber. CARBON MONOXIDE (CO) is a poisonous gas which, when inhaled, replaces the oxygen in the blood stream so that the body's metabolism cannot function correctly. Small amounts of CO concentrations, when breathed in, slow down physical and mental activity and produces headaches and while large concentration will kill. Generally petrol engine is a type of internal combustion engine. The cycle of an internal combustion engine has only (linear movements of the piston). It is usually found in low power applications like lawn mowers, mopeds, small outboard motors, etc. There is no dedicated lubrication system in engines; the lubricant is mixed with fuel. Engines do not use fuel efficiently. Each time a new charge of air-fuel is loaded into the combusting chamber, a part of it leaks out through the exhaust port. The burning of lubricating oil and the exhaust of un-burnt fuel makes them more polluting causing emission of carbon monoxide. This paper explains the reduction of CARBON MONOXIDE (CO) emitting form petrol engines using THERMAL REACTORS.**

I. INTRODUCTION

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, NO_X unburned hydro-carbons (HC) and other particulate emissions. Other sources such as Electric power stations industrial and domestic fuel consumers also add pollution like NO_X, SO and particulate matters. In addition to this, all fuel burning systems emit CO_2 in large quantities and this is more concerned with the Green House Effect which is going to decide the health of earth.

Undesirable emissions in internal combustion engines are of major concern because of their negative impact on air quality, human health, and global warming. Therefore, there is a concerted effort by most governments to control them. Undesirable emissions include unburned hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter (PM), we present the U.S. and European emissions standards, both for gasoline and diesel operated engines, and strategies to control the undesirable emissions. The role of engine design, vehicle operating variables, fuel quality, and emission control devices in minimizing the above-listed pollutants are also detailed. "Emissions" is a collective term that is used to describe the undesired gases and particles which are released into the air or emitted by various sources, Its and analyzed by Hocheng and Tsao. They developed a mathematical model to predict the critical thrust force using various drill bits. Khashaba et al. studied the effect of machining parameters in the drilling of GFR/epoxy composites and they developed a model to predict the critical thrust force during drilling. Mohan et al. optimized cutting process parameters in drilling of glass fiber reinforced composite (GFRC) material and found that speed and drill size are more significant influence factors in cutting thrust than the specimen thickness and the feed rate.

Amount and the type change with a change in the industrial activity, technology, and a number of other factors, such as air pollution regulations and emissions controls. The U.S. Environmental Protection Agency (EPA) is primarily concerned with emissions that are or can be harmful to the public at large. EPA considers carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), and sulphur dioxide (SO_2) as the pollutants of primary concern, called the Criteria Pollutants. These pollutants originate from the following four types of sources.

- Point sources, which include facilities such as factories and electric power plants.
- Mobile sources, which include cars and trucks but also lawn mowers, airplanes, and anything else that moves and releases pollutants into the air.
- Biogenic sources, which include trees and vegetation, gas seeps, and microbial activity.

- Area sources, which consist of smaller stationary sources such as dry cleaners and degreasing operations.

Gasoline and diesel fuels are mixtures of hydrocarbons, compounds which contain hydrogen and carbon atoms. In a "perfect" engine, oxygen in the air would convert all the hydrogen in the fuel to water and all the carbon in the fuel to carbon dioxide. Nitrogen in the air would remain unaffected. In reality, the combustion process cannot be "perfect," and automotive engines emit several types of pollutants.

A. WORKING OF 4STROKE PETROL ENGINE

In four stroke cycle engines the four events namely suction, compression, power and exhaust take place inside the engine cylinder. The four events are completed in four strokes of the piston (two revolutions of the crankshaft. This engine has got valves for controlling the inlet of charge and outlet of exhaust gases. The opening and closing of the valve are controlled by cams, fitted on the camshaft. The camshaft is driven by crankshaft with the help of suitable gears or chains. The camshaft runs at half the speed of the crankshaft. The events taking place in engine are as follows:

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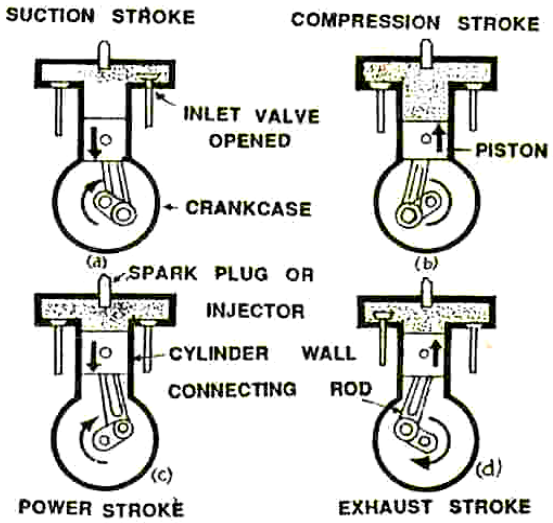


B. PROBLEM FOUND

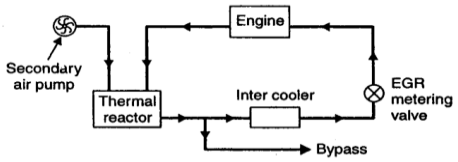
The burning of lubricating oil and the exhaust of un-burnt fuel makes them more polluting causing emission of carbon monoxide (CO). Pollutants are produced by the incomplete burning of the air-fuel mixture in the combustion chamber. The major pollutants emitted from the exhaust due to incomplete combustion are:

- Carbon monoxide (CO)
- Hydrocarbons (HC)
- Oxides of nitrogen (NO)

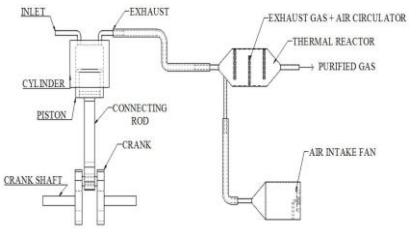
Other products produced are acetylene, aldehydes etc. If, however, combustion is complete the only products being expelled from the exhaust would be water vapor which is harmless, and carbon dioxide, which is an inert gas and, as such it is not directly harmful to humans.

C. Thermal Reactors setup

If high exhaust gas temperatures are maintained and sufficient free oxygen is present in the exhaust gases, CO and HC can be oxidized in the engine exhaust system



D. Arrangement of Thermal reactor setup



The basic components of a thermal reactor are,
Petrol engine setup
Thermal reactor converter housing(Nickel)
Air intake turbine
Exhaust gas + air circulator plate(Nickel)

E. The chosen thermal reactor must be a good thermal resister and as well as best in insulating properties. Here we are choosing a Nickel is the thermal reactor material.

Chemical formula- Ni
Melting point-1453° C
Boiling point-2732° C
Density-8.9 g/cm³

Appearance- Nickel is silver in color**.**Other physical properties- Nickel is magnetic, hard, malleable, and ductile. It conducts electricity**.**

F. 2 DIMENSION OF THERMAL REACTOR

Length = 25 cm
Height = 15 cm
Thickness = 3mm
Inlet and exhaust pipe dimension are 5 cm with a thickness of 2 mm.
Number of circulating plate = 3
The thickness of the plate is 3 mm
Air intake in the thermal reactor is 50% of heat exhaust from the thermal reactor
Exhaust heat temperature in petrol engine 300-500 of

II. BHARAT STAGE EMISSION STANDARDS

Bharat Stage emissions standards are emissions standards instituted by the Government of the Republic of India that regulate the output of certain major air pollutants (such as nitrogen oxides (NO), carbon monoxide (CO), hydrocarbons (HC), particulate matter (PM), sulfur oxides (Sox)) by vehicles and other equipment using internal combustion engines. They are comparable to the European emissions standards. India started adopting European emission and fuel regulations for four-wheeled light-duty and for heavy-dc from the year 2000. For two and three wheeled

vehicles, the Indian emission regulations are applied. As per the current requirement, all transport vehicles must carry a fitness certificate which is to be renewed each year after the first two years of new vehicle registration. The National Fuel Policy announced on October 6, 2003, a phased program for implementing the EU emission standards in India by 2010.

The phasing out of 2 stroke engine for two wheelers, the stoppage of production of Maruti 800 & introduction of electronic controls has been due to the regulations related to vehicular emissions.

While the norms help in bringing down pollution levels, it invariably results in increased vehicle cost due to the improved technology & higher fuel prices. However, this increase in private cost is offset by savings in health costs for the public, as there is a lesser amount of disease-causing particulate matter and pollution in the air. Exposure to air pollution can lead to respiratory and cardiovascular diseases, which is estimated to be the cause for 620,000 early deaths in 2010, and the health cost of air pollution in India has been assessed at 3 per cent of its GDP.

Table Indian Emission Standards (2-Wheel Vehicles)

Standard	Reference	YEAR	Region
India 2000	Euro 1	2000	Nationwide
Bharat Stage II	Euro 2	2001	NCR*, Mumbai, Kolkata, Chennai
		2003.04	NCR*, 13 Cities†
		2005.04	Nationwide
Bharat Stage III	Euro 3	2005.04	NCR*, 13 Cities†
		2010.04	Nationwide
Bharat Stage IV	Euro 4	2010.04	NCR*, 13 Cities†
Bharat Stage V	Euro 5	2017.04 (proposed)	Entire country
* National Capital Region (Delhi) † Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad, Pune, Surat, Kanpur, Lucknow, Sholapur, Jamshedpur and Agra			

The above standards apply to all new 4-wheel vehicles sold and registered in the respective regions. In addition, the National Auto Fuel Policy introduces certain emission requirements for interstate buses with routes originating or terminating in Delhi or the other 10 cities.

The progress of emission standards for 2-and 3-wheelers.

Table 4.2 Indian Emission Standards (2 and 3 wheelers)

Standard	Reference	Date
Bharat Stage II	Euro 2	1 April 2005
Bharat Stage III	Euro 3	1 April 2010
Bharat Stage IV	Euro 4	1 April 2012
Bharat Stage V	Euro 5	1 April 2017 (proposed)

In order to comply with the BSIV norms, 2 and 3 wheeler manufacturers will have to fit an evaporative emission control unit, which should lower the amount of fuel that is evaporated when the motorcycle is parked.

Emission standards for light-duty diesel vehicles (GVW ≤ 3,500 kg) are summarised in Table 4.3. Ranges of emission limits refer to different classes (by reference mass) of light commercial vehicles; compare the EU light-duty vehicle emission standards for details on the Euro 1 and later standards. The lowest limit in each range applies to passenger cars (GVW ≤ 2,500 kg; up to 6 seats).

Table 4.3 Emission Standards for Light-Duty Diesel Vehicles, g/km

Year	Reference	CO	HC	HC+NOx	NOx	PM
1992	–	17.3–32.6	2.7–3.7	–	–	–
1996	–	5.0–9.0	–	2.0–4.0	–	–
2000	Euro 1	2.72–6.90	–	0.97–1.70	0.14–0.25	–
2005†	Euro 2	1.0–1.5	–	0.7–1.2	0.08–0.17	–
2010†	Euro III	0.64 0.80 0.95	–	0.56 0.72 0.86	0.50 0.65 0.78	0.05 0.07 0.10
2010‡	Euro 4	0.50 0.63 0.74	–	0.30 0.39 0.46	0.25 0.33 0.39	0.025 0.04 0.06

III. PETROL ENGINE EMISSIONS

emissions are a major contributor to air pollution due to a large number of vehicles on the road. Initial refinements to engines and fuel systems were followed up by the introduction of catalytic converters due to stricter global emissions regulations. A catalytic converter treats the exhaust gas before it leaves the car and removes about 90% of the pollutants. This is the main method of pollution control in petrol engines.

The table shows the main emissions from a petrol engine.

Non-toxic Emissions	
Nitrogen gas (N_2)	Air is 79% nitrogen gas, most of which passes straight through the engine
Water vapour (H_2O)	Produced during combustion when the hydrogen in the fuel combines with oxygen in the air
Carbon Dioxide (CO_2)	Produced during combustion when carbon in the fuel combines with oxygen in the air (a greenhouse gas which is the major contributor to global warming)
Harmful Emissions	
Carbon Monoxide (CO)	Produced during combustion, this is a poisonous gas that is colourless and odourless
Volatile Organic Compounds (VOC's)	Consisting of unburned hydrocarbons and products of combustion reactions, these can further react to form ground-level Ozone (O_3), a major component of smog.
Nitrogen Oxides (NOX)	NO and NO_2 contribute to smog and acid rain and also cause irritation to human mucus membranes.

The harmful emissions are the three main regulated emissions, and also the ones that catalytic converters are designed to reduce. Thus often is referred to as a three-way catalytic converter.The converter uses two different types of

catalysts. The reduction catalyst is the first stage and uses platinum and rhodium to help reduce the NOx emissions by converting harmful NO or NO2 molecules to harmless Nitrogen and Oxygen molecules.The oxidation catalyst is the second stage and it completes the removal of unburned hydrocarbons and carbon monoxide by burning (oxidising) them over a platinum and palladium catalyst. This catalyst aids the reaction of the harmful carbon monoxide and hydrocarbons with the remaining oxygen in the exhaust gas converting them into non-toxic Carbon Dioxide and water vapour.

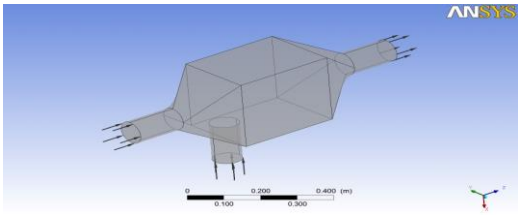
For the emission control system to work properly, the fuel/air ratio must be carefully controlled so that all of the fuel is burnt using all of the oxygen in the air. An essential part of the catalytic conversion process is a control system that monitors the exhaust stream and uses this information to control the fuel injection system. An oxygen sensor tells the engine computer how much oxygen is in the exhaust. The engine computer can then increases or decrease the amount of oxygen in the exhaust by adjusting the air-to-fuel ratio. This control scheme allows the engine computer to ensure that there is enough oxygen in the exhaust to allow the oxidation catalyst to burn the unburned hydrocarbons and CO.

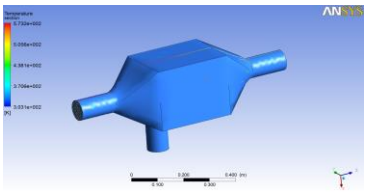
Since the late 1980's, three-way catalyst systems have been universally employed on petrol-engine vehicles in the USA, Japan and Europe, enabling increasingly stringent emission standards to be met. Their use in South Africa continues to increase, and will by 2008 be compulsory for all new petrol vehicles.

The largest part of most combustion gas is nitrogen (N2), water vapor (H2O) (except with pure-carbon fuels), and carbon dioxide (CO2) (except for fuels without carbon); these are not toxic or noxious (although carbon dioxide is a greenhouse gas that contributes to global warming). A relatively small part of combustion gas is undesirable noxious or toxic substances, such as carbon monoxide (CO) from incomplete combustion, hydrocarbons (properly indicated as CxHy, but typically shown simply as "HC" on emissions-test slips) from unburnt fuel, nitrogen oxides (NOx) from excessive combustion temperatures, and particulate matter (mostly soot).

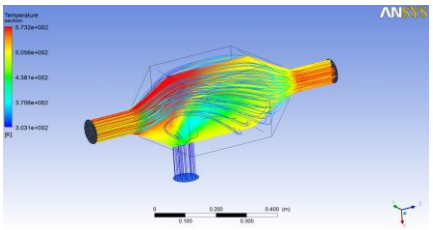
IV.

V. DESIGN OF REACTOR

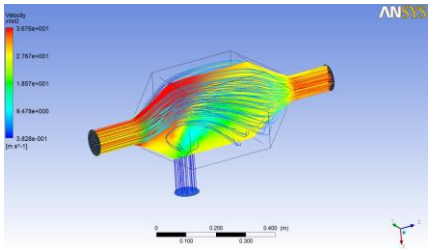




VELOCITY DIAGRAM



TEMPERATURE-2



TEST REPORT

LABOURATORY DETAIL

Laboratory Name: MICROLAB
Report No: ML/30A/1/17-18
Nature of test Vickers Hardness Test, Salt spray test

TEST 1

Sample: Aluminium specimen without coated

- Vickers Hardness Test:
  - Observation in HV5Kg – 50.3, 51.7, 50.8
- Salt Spray Test:
  - Chamber Temperature – 34.5 – 35.5oC
  - pH value – 6.65 – 6.85
  - Volume of Salt Solution Collected – 1.0 – 1.5 ml/hr
  - Concentration of solution – 5% NaCl
  - Air pressure – 14 – 18 psi
  - Components loading in Chamber position – 30 Dgree angle
- Observation
  - White Rust Formation Noticed at 12 Hrs.

TEST 2

Sample:2

Aluminum specimen with 60% alumina and 40% titania coated

- Hardness Test:
  - Observation in HV5Kg – 55.6, 57.1 ,57.8
- Salt Spray Test:
  - Chamber Temperature – 34.5 – 35.5oC
  - pH value – 6.65 – 6.85
  - Volume of Salt Solution Collected – 1.0 – 1.5 ml/hr

- Concentration of solution
  – 5% NaCl
- Air pressure
  – 14 – 18 psi
- Components loading in Chamber position
  – 30 Degree angle

➢ Observation
- No White Rust Formation Noticed at 12 Hrs.

VI. CONCLUSION

This paper gives the clear idea about how the thermal reactors are used in the 2stroke engines for reducing the emission of carbon monoxide emitting from engines. Thus the design of thermal reactor is done using Pro-E design software and its material properties and working functions were analyzing by ANSYS software for the better understanding of the heat exchanger concept. Then future work of this project is fabricating the thermal reactor with specified dimensions.

VII. FUTURE WORK

As the objective of this research has been mainly on optimization of the process parameters, deeper analysis on the significance of influence has not been carried out for a wide range of process parameters including volume fraction and fiber type. This opens up ample scope for future work in this area. The inferences drawn through this study can be of great significance to the practitioners, in minimization of tool wear and cutting energy, as Solid carbide tool is being widely used in machining GFRP.

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