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DESIGN AND FABRICATION OF EXHAUST GAS ANALYZER

Mandar.K.Pitale[1], Yash.N.Rane[2], Ritwik.S.Tiwari[3], Khushal.C.Prajapati[4]
[1](Department of Mechanical Engineering, Viva institute of technology, India)
[2](Department of Mechanical Engineering, Viva institute of technology, India)
[3](Department of Mechanical Engineering, Viva institute of technology, India)
[4](Department of Mechanical Engineering, Viva institute of technology, India)

Abstract: *This paper deals with the design of Exhaust Gas Analyzer for measuring the concentration of contents in exhaust gas emissions from vehicles using MQ135 sensor along with Carbon Monoxide CO using MQ7 sensor. Measuring Exhaust gas emissions from vehicles is an essential element for bringing awareness in the people to take care of increase in pollution caused by vehicle emissions and to safeguard the environment. Based on this, Government of India had already implemented certain NORMS to vehicle emissions to reduce the pollution. We are trying to implement the Exhaust gas analyzer using the Bluetooth device to notify the user about their vehicle emissions, we can bring awareness to every individual about the harm from vehicle emissions causing to our environment by the implementation of our system. We have developed the system as user friendly system for convenient use by every individual .The Exhaust gas analyzer will measure the vehicle emissions or exhaust gases ,the output from sensors will be compare with the current or ongoing issued norms, the concentration of gases will be notified to user to aware the user for vehicle maintenance and flaw detection. Also, the cost of system is economically affordable for everyone.*

Keywords– *Analyzer, Exhaust Gases, Sensors , Pollution ,Emissions.*

I. INTRODUCTION

An exhaust gas analyzer is an instrument for the measurement of carbon monoxide and carbon dioxide among other gases in the exhaust of equipments and motor vehicles , caused by an inaccurate combustion. Due to increase in use of private vehicles the exhaust emission of gases like Co, Co2, HC, PM have increased which gets trapped in atmosphere and rising the global temperature i.e. GLOBAL WARMING which triggers the harmful calamities and has adverse effect on living organisms. Exhaust gas analyzer not only identifies the species but it also gives the content value of the quantity which it displays either in numerical form or shows it graphically.

1.1 Project History

In 1972 at Pierburg in Neuss with the development of the first exhaust gas analyzer. The analyzer employs a monochromatic source of infrared radiation and a multibeam optical comparator system, which is common and shared by all of the measuring channels. The measurement of gases is carried by absorption principle of gases and comparing the light intensity source.

Fig.1.1: First Exhaust Gas Analyzer

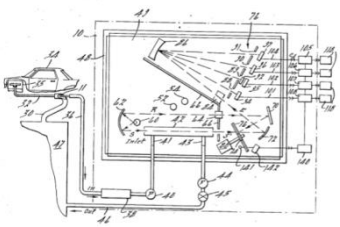


Fig.1.2: Layout

1.1.1 Norms

If all the fuel burns completely in combustion chamber of an engine, the only component coming out of the Exhaust pipe would be water and carbon dioxide. However perfect combustion cannot be achieved so some carbon monoxide and hydrocarbon traces are present in the exhaust along with, Nitrogen Oxide. Bharat stage emission standards are emission standards developed by the Government of India to regulate and limit the output of pollutants from devices having internal combustion as prime mover, including motor vehicles. The standards for implementation are set by the Central Pollution Control Board under the Ministry of Environment & Forests and climate change.

PETROL EMISSION NORMS

NORM	CO	HC	NO_x	$HC+NO_x$	PM
BS-III	2.30	0.20	0.15	-	-
BS-IV	1.00	0.10	0.08	-	-
EURO-VI	1.00	0.10	0.06	-	0.005

DIESEL EMISSION NORMS

NORM	CO	HC	NO_x	$HC+NO_x$	PM
BS-III	0.64	-	0.50	0.56	0.05
BS-IV	0.50	-	0.25	0.30	0.025
EURO-VI	0.50	-	0.06	0.17	0.005

(All figures in g/km) Source: Indian Emissions Regulations/ARAI

Fig 1.3: Bharat Stage Norms

II. PROBLEM DEFINITION

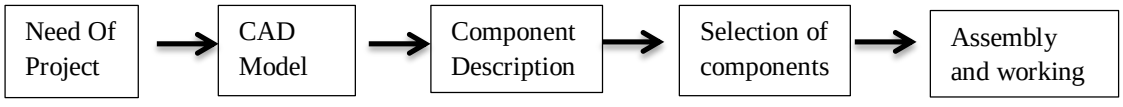
2.1 Problem Statement

- Increase in pollution by the emissions of vehicles had led to global warming and its adverse effects.
- Unawareness in society about vehicles emission and problem associated with it.
- No routine maintenance of vehicles by user.
- Existing machine are costly and skilled person required to operate.

2.2 Objectives:

- To create an exhaust analyzer prototype equipped with BT module and LCD display.
- To construct machine which has an ability to detect the amount of Co and Co_2 from exhaust of vehicles.
- Using power source as DC.
- Easy to use.
- Proper suggestion for flaw detection in vehicle contributing for high Co and Co_2 level.
- Can provide Suggestion for PUC and maintenance of vehicle.

III. METHODOLOGY



3.1 Need Of Project : Due to increase in pollution by the emissions of vehicles had led to global warming and its adverse effects on environment and living organism, hence to aware user about vehicle emissions and suggest the remedy to reduce the concentration of exhaust gases within limit.

3.2 CAD Model Of Project :

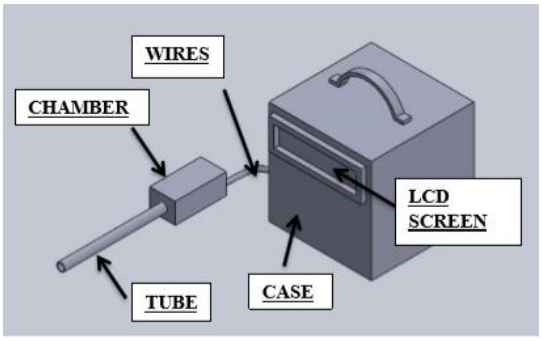


Fig 3.1: CAD Model

3.3 Component Description :

The tube of analyzer will be placed at exhaust gas pipe of vehicle to be tested in idling condition.
The idling exhaust temperature is about 100 – 120°c.
Considering idling exhaust temperature or operating temperature T_{op} =200°c
Material Selection for tube : Stainless Steel
Justification : Tube material must be chemically inactive to get effective result by sensor and economic in cost.
Properties of Material for tube:
Thermal conductivity = 50.2 W/mk
Coefficient of linear expansion = 13.2* 10^{-6} /°c
Yield strength =σy= 210 N/mm^2
D = 12mm
d = 10mm
t = 1mm
Calculation:
(1) σt = $\frac{\sigma y}{FOS}$ = $\frac{210}{4}$ =52.5 N/mm^2
Assuming Factor of safety (FOS)=4
Allowable pressure due to exhaust gases, calculated by hoop stress theory
Considering tube as thin cylindrical shell,

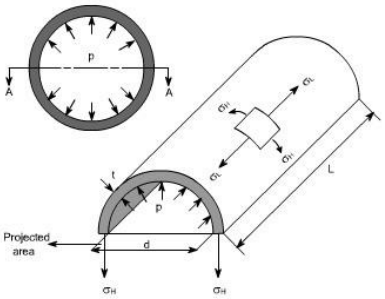


Fig : 3.2 Pressure Distribution

(2) Circumferential stress or hoop stress (σc) = $\frac{Pd}{2t}$
(3) Longitudinal stress (σL) = $\frac{pd}{4t}$
Pressure exerted by exhaust gases is about 1atm , p=1 atm = 0.10132 N/mm2
(4) Therefore, σc = $\frac{0.10132*d}{2*t}$
(5) σL = $\frac{0.10132*d}{4*t}$

Table 4.1 Stress Calculation

Selection	σt (N/mm2)	σc (N/mm2)	σL (N/mm2)	σc+σL (N/mm2)
A53(Steel) d=10mm t=1mm	52.5	0.506	0.25	0.756

Since ,(σc+σL) < σt
Therefore, Design of tube is safe
Allowable or withstand temperature of stainless steel tube is 1510 °c , Hence design is safe in temperature .

3.4 Selection of Secondary Components:

TABLE 4.2 Specifications

Component	Specification	Justification
1. Arduino UNO	1. ATmega328P – 8 bit AVR family microcontroller 2. Operating Voltage: 5V 3. Analog Input Pins 6 (A0 – A5) 4. Digital I/O Pins 14 (Out of which 6 provide PWM output)	1. To control the sensors and LCD display. 2. Process the received data from sensor to evaluate results 3. Low cost
2. MQ135 Sensor	1. Wide detecting scope. 2. Fast response and High sensitivity. 3. Stable and long life. 4. Operating Voltage is +5V. 5. Detect and measure CO2.	1. Specially used to measure co2 2. Low cost 3. Wide detecting scope 4. Easy to use
3. MQ7 Sensor	1. Fast response and High sensitivity. 2. Stable and long life. 3. Operating Voltage is +5V. 4. Detect and measure CO	1. Specially used to measure co 2. Low cost 3. Wide detecting scope 4. Easy to use
4. LCD display	1. Operating Voltage is 4.7V to 5.3V. 2. Current consumption is 1mA without backlight. 3. Alphanumeric LCD display module, meaning can display alphabets and numbers. 4. 16x2 display area, 16 column and 2 rows 5. Each character is build by a 5×8 pixel box.	1. To display the values of concentration of gases and comment. 2. Low operating voltage 3. Easy to use 4. Low cost
BT Module HC05	1. It uses the 2.45GHz frequency band. 2. The transfer rate of the data can vary up to 1Mbps and is in range of 10 meters. 3. The HC-05 module can be operated within 4-6V of power supply.	1. Wireless data transmission 2. Easy to use 3. Good range 4. Low Cost

3.5 Assembly and Working:

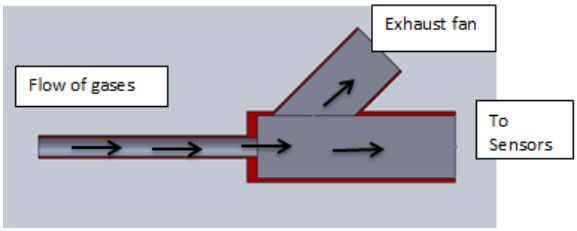


Fig 3.3: Flow of gases

1. Assembly consist of chamber, case and tube. The tube of stainless steel will be placed in exhaust pipe of vehicle to be tested. Before placing the pipe in exhaust of vehicle, vehicle should be accelerated little and to be maintained in idling state.
2. Before inserting the pipe of machine, the machine sensors are to be preheated for certain time interval. After placing the pipe choose the vehicle type i.e. two wheels of four wheels from micro switches.
3. The sensor will read the data and send it to arduino for processing, the the data will be displayed on LCD screen for user reading as well as the data will send to user android phone through Bluetooth.
NOTE: User must have the arduino serial monitor app. To get reading from machine.
4. If the gasses concentration Is within limit then arduino will display the "SAFE" message on LCD otherwise "NO SAFE" message will be displayed.
5. Once the readings are obtained user can reset the arduino and turn on exhaust fan to remove gases from chamber so that no residues are present for future use.

IV. CONCLUSION

To spread awareness in society from emissions of vehicles and increase in pollution is expected from project. The design of product with the necessary selection of components with its specification which are required for analyzing is also stated in paper. The product is expected to analyze the exhaust gases and notify the user about their concentration and contents also warn the user if the concentration of gases exceeds the permissible limit or set limits as per NORMS.

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