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CARBONDIOXIDE ABSORBER

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Abstract - *Transportation is the largest source of air pollution in many countries around the world due to the high number of vehicles that are functional on the roads today. Motor vehicles collectively cause 75 percentage of carbon dioxide emission. The increase in carbon dioxide emissions causes global warming, ocean acidification, and carbon fertilization. And they have a significant adverse impact on human and natural systems. The existing method to reduce vehicular emission includes the catalytic convertor. The function of the catalytic convertor is to convert CO, HC and NOx emissions into Carbon dioxide, water, Nitrogen and Oxygen. Our aim is to control the carbon dioxide (CO2) emission from the vehicles. This is achieved by fabricating a membrane which is made of Polyvinyledene difluoride (PVDF) and Mono Ethanol Amine (MEA) which absorbs CO2. Monitoring the vehicular pollution also plays an important role in this process. The monitoring proves to be effective only when it is done on the individual vehicles. The vehicle owner and the authorities are alerted when the emission exceeds that is when the membrane saturates which is found using gas sensors and Arduino.*

***Key Words*: PVDF, MEA, Gas sensors, Arduino, GSM and GPS**.

1. INTRODUCTION

Vehicular pollution has become very high in India due to urbanization in the country. The air pollution from vehicles in urban areas, particularly in big cities, has become a grave problem. The pollution has caused health impacts like cough, headache, nausea, various bronchial, eye irritation and visibility problems [1].

The increase in CO2 level is predominantly irreversible, which causes a huge environmental impacts. One of the major impact is reduction in the rainfall. This also results in high heat waves due to which dust bowls are created. The drastic rise in the carbondioxide level in the atmosphere also impacted the global temperature [2].

Presently, automobiles are designed with catalytic converter as the emissions control system which converts toxic gases into harmless gases. Catalytic converters are usually used with IC engines which is run by either gasoline or diesel. Catalytic converter is made of a structured substrate with high geometric surface areas (GSA) [3]. Catalytic converters are used on vehicles and they help in reducing the emissions from the vehicles for more years. The construction of the catalytic convertor consists of a catalyst support, washcoat, ceria which is an oxide and the catalyst which is a mix of precious materials. The work of the catalytic convertor is to convert CO, HC and NOx emissions into CO2, water, N2 and O2. Only the toxic gases are removed but not CO2 [4].

2. RELATED WORKS

The Removal of CO2 is also done in many industries. The CO2 is removed from the flue gas of the industries. The source of flue gas in industries are oven, furnace, boiler and steam generator. Frequently, it refers to the combustion exhaust gas produced at power plants. Its number depends on what is being burned, but it usually consists of mostly nitrogen (N2), derived from the combustion air, carbon dioxide (CO2) and water vapour as well as excess oxygen. Conventionally, the gas absorption process for capturing CO2 can be carried out in many reactors. Although the conventionally packed bed absorbers have been used in the chemical industry for decades, but the conventional method had much disadvantages. Then the membrane gas absorption technique was employed. The membrane gas absorption technique used PVDF and MEA for the absorption process [5]. Amine scrubbing is another method of carbondioxide removal.It is also the emerging method in the carbondioxide removal. Amines are mostly the ammonia derivatives. Monoethanolamine (MEA), diethanolamine (DEA) and methyldiethanolamine (MDEA) are the most commonly used amines in scrubbing applications. The CO2 absorbing capacity of MEA is 720 g CO2 per kilogram of MEA [6].

The government of India has enacted many acts to prevent the pollution in the natural resources of the country.One of such acts is the Air Act 1981 which helps in the prevention and control of Air pollution and some amendments were done in the act to reduce the pollution level. Presently the government has regulated new emission rules for monitoring the air-pollution. Taxi, public transports, and trucks are responsible for large amount of CO and NOx release in the urban areas. Due to these alarming conditions Central Pollution Control Board made Fitness Certificate renewal mandatory every year for Heavy Transport Vehicles (HTVs) and five years for Light Motor Vehicles (LMVs). As per the regulations every vehicle has to undergo examination to obtain Pollution under Control (PUC) certificate for every 3 months [7].

As reported in [8], [9], [10] and [11] the transportation sector is the main reason for the air pollution in various

countries. For this problem, most of the countries deployed the Wireless Sensor Networks to know the pollution levels in their country. And by identifying the areas they implement certain measures to curb the air pollution in their country.

3. DESIGN OF THE PROPOSED SYSTEM

The proposed methodology focuses in controlling and monitoring the individual vehicle emission level as well as alerting the vehicle owner and RTO if the vehicle exceeds the standard limit. The system can be implemented for every automobiles. When the engine is ON, the exhaust gases gets emitted . Behind the exhaust system i.e the tail pipe of the vehicle, a polymer membrane made up of carbon fibre fabric coated with Polyvinylidenefluoride (PVDF) and Monoethanolamine (MEA)is fitted.The purpose of the polymer membrane is to absorb the carbon content from the harmful gases like CO2,NO2 and hydrocarbon .With the help of gas sensors, the exhaust gases can be found and can be monitored by the Arduino. Whenever the value is greater than the standard limit, we can say that the membrane has reached its saturation point . Any abnormality in the comparison is communicated to the driver through buzzer and to the nearest RTO with their location via GSM and GPS module.The Engine Control Unit (ECU) is connected to the arduino and it is turned off when the emission level gets exceeded.This will be done by cutting down the electrical connection going to the spark plug, for the same the warning to the driver is provided with maximum of 200 seconds for parking the vehicle in a safer lane.

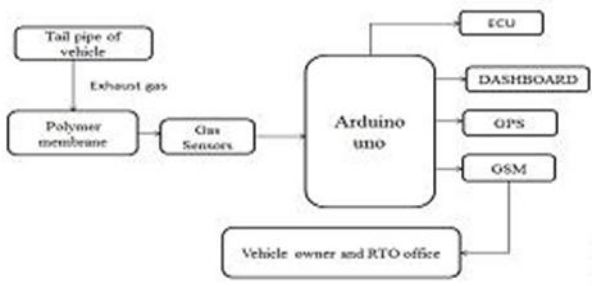

Fig. 1. Block Diagram.

3.1. POLYMER MEMBRANE

- The membrane is made of polyvinylidene fluoride(PVDF) granules.
- Monoethanolamine solution is employed as liquid absorbent
- Carbon fibre mesh is used as a support to hold the polymer

3.2 FEATURES

- POLYVINYLIDINE FLUORIDE(PVDF):
  - stability of PVDF is upto 707F (375 °C)
  - Outer layer
  - MONOETHANOLAMINE(MEA):
    - Nominal CO2 absorbing capacity of MEA:720g CO2/kg MEA
    - Liquid absorbent

3.3. FABRICATION OF THE MEMBRANE

The Polymer membrane is fabricated by coating PVDF and MEA over carbon fibre fabric. First of all, 0.5g pellets of PVDF is added with 10ml of dimethyl formamide (DMF). To dissolve, it is kept over a hot pan for a period of 15-20 minutes. The solution is then mixed with 6 ml of MEA and colour change is observed. Then it is coated over the carbon fibre fabric of 12x3 cm and kept inside hot air oven for 8 hours. Porous cylindrical metal tube is then covered by the polymer membrane to get fitted behind the tail pipe.

3.4. ARDUINO

The processing is done with the help of Arduino UNO which acts as the central unit. The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller. The Arduino is interfaced with gas sensors, GPS and GSM. It receives the data from gas sensor and GPS and responds accordingly.

3.5. GAS SENSORS

1) MQ2: This sensor detects the presence of hydrocarbon gases (HC) (methane, propane and n-butane) at concentrations from 3000 to 10,000 ppm. measuring hydrocarbon gases is important for pollution monitoring. It has 4 pins (power, ground, digital and analog output). The sensitivity of the sensor can be varied by the onboard timer. The sensor can operate at temperatures from -20 to 50-degree Celsius.

2) MQ7: This sensor is used to detect Carbon Monoxide(CO) from 20 to 2000ppm. The sensitivity of the sensor can be adjusted by using a potentiometer. It has 4 pins (power, ground, digital and analog output). The output is directly proportional to the density of Carbon monoxide gas. The data from the sensor is in terms of analog output.

3) MQ135: SnO2 is a sensitive material used in MQ135 gas sensor. Which has lower conductivity in clear air, when the concentration of gas gets increase it's conductivity also get's increase. It has high sensitivity to Sulphide, Ammonia, Benzene steam and also sensitive to smoke. It is used to detect gases from a concentration of 10 to 10,000 ppm.

3.6. GSM

SIM900A Modem is constructed with Dual Band GSM/GPRS based SIM900A modem from SIMCOM. When the emission level is exceeded the Arduino uses the GSM to give a message alert the vehicle owner and officials about the same.

3.7. GPS

The GPS module used is NEO-6module.The GPS tracks the location of the vehicle where the emission of the vehicle has exceeded. The data given by the GPS is sent as a google map URL to the user.

3.8. PROCESS

Polymer membrane made of microporous polyvinylidene fluoride(PVDF) Monoethanolamine solution as liquid absorbent is coated on the Carbon fibre fabric . The gas sensors output is compared by the arduino and an indication is sent to the dashboard of the vehicle. When the emission limit is exceeded it sends message alert to the RTO office nearby. When the vehicle exceeds the emission limit, a timer of 200 seconds turns on after which the vehicles is turned off automatically. Turning off the vehicle is done by turning off the DC motors in the prototype model which are connected to the wheels of the chasis. In Real time it is done by turning off the kill switch using a relay.

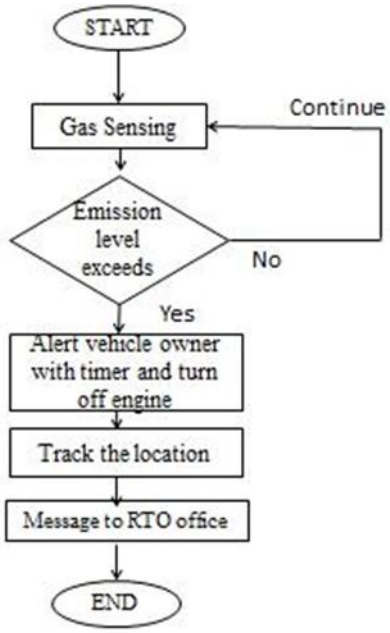

Fig. 2. Flow Chart

4. RESULTS AND DISCUSSION

4.1. SEM IMAGE RESULTS

Scanning Electron Microscopes uses electrons for imaging. The signals used by a SEM to produce an image result from interactions of the electron beam with atoms at various depths within the sample. The wavelength of electrons is much smaller and the resolution of SEMs is high. The figure describes coatings on the carbon fibre, When it is not coated with PVDF and MEA there is no particles embedded to it.

When the carbon fibre is coated with 0.15gram of PVDF and 3 ml MEA, there are some particles embedded on the fibre.

When the carbon fibre is coated with 0.5gram of PVDF and 6 ml MEA, there are relatively large number of particles embedded on the fibre than the previous.

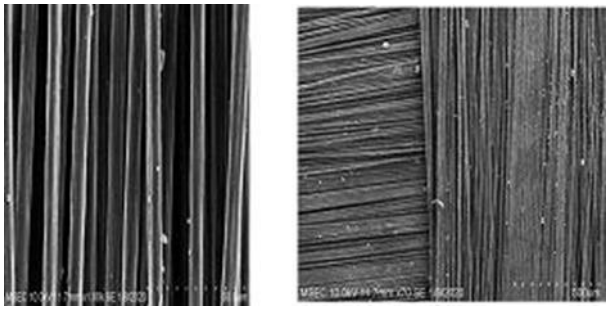

Fig. 3. Uncoated fibre

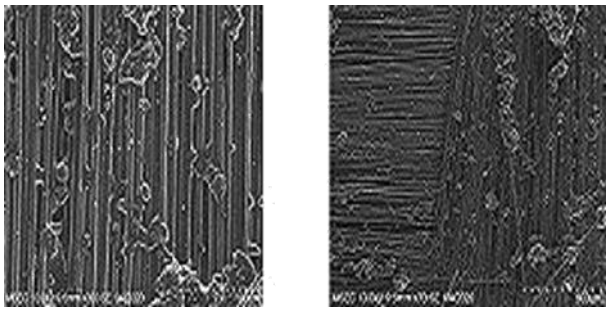

Fig. 4. coated fibre 1(0.15g)

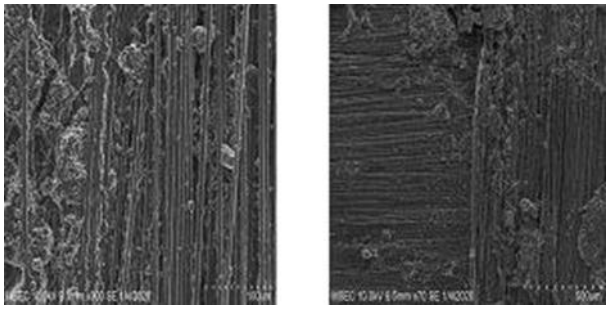

Fig. 5. coated fibre 2(0.5g)

4.2. FIXATION OF THE MEMBRANE

The fibre is coated over a porous cylindical tube and it is fixed in the tail pipe of the vehicle

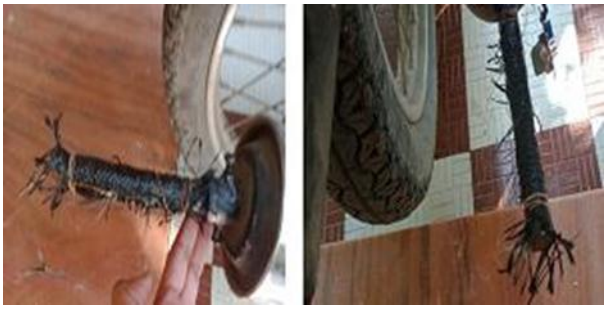

Fig. 6. Fibre fixed

4.3. TESTING RESULTS

The membrane is tested using a gas analyser named Technovation Model-FEM

Table-1 Atmospheric condition

Gases	Concentration
O2	21.1%
NO	NIL
NO_2	NIL
SO_2	NIL
CO	NIL

From the Table 1 it can be inferred that there is no harmful gases in the environment

Table-2 Without membrane

Gases	Concentration
O2	17.9%
NO	NIL
NO_2	NIL
SO_2	236ppm
CO	0.767%

From the Table 2 it can be inferred that Oxygen level is reduced as the air gets polluted,SO_2 and CO level is increased

Table-3 With membrane

Gases	Concentration
O2	19.8%
NO	NIL
NO_2	NIL
SO_2	144
CO	0.365%

From the Table 3 it can be inferred that Oxygen level gets increased, SO_2 and CO level is decreased to 50%.

4.4. SENSOR RESULTS

1) WITHOUT MEMBRANE: When the membrane was not fixed the air quality obtained by the sensor was 882 PPM. The air quality is measured with MQ135 gas sensor.

Fig.7 Without membrane

2) WITH MEMBRANE: When the membrane was fixed the air quality obtained by the MQ135 sensor was 141 PPM.With this we can infer that the emission has reduced to a consider-able amount.

Fig.8 With membrane

4.5. MESSAGE ALERT

The GPS tracks the location by measuring the latitude and longitude values and those values are converted into google map's URL.The GSM then sends the message alert to the respective authority.

Fig. 9. Message Alert

4.6 DURABILITY

The membrane can absorb the CO2 upto 80 Kilometers.

5. CONCLUSION

Our methodology helps in controlling as well as monitoring of the emission from the individual vehicles. The fabricated membrane absorbs 50% of the carbon content from the exhaust gas. Thus controlling 50% of the emissions from the vehicle. This method proves to be a cost effective one and successfully implemented in the society.

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