International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 10 (2018) pp. 8644-8647


# Absorbers for Automobile Pollutants and their on-Line Monitoring

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**Abstract**

The aim of the paper is to device a set-up which absorbs pollutants released from automobiles. Absorbers are fabricated to embed the selected pollutants namely carbon-di-oxide and carbon monoxide. A prototype has been tested for its performance to absorb pollutants present in a 4-stroke petrol engine. The intensity of selected pollutants after passing through the absorber is studied, incorporating the appropriate sensors. It is observed that there is a significant reduction of the selected pollutants after passing through the absorbers. The sensors output is interfaced to a computer for regular monitoring on-line.

**Keywords:** Exhaust-gas pollutants, Absorbers, Gas sensors, On-line monitoring

## INTRODUCTION

Global warming resulting from the emission of greenhouse gases, especially $CO_2$, has become a widespread concern in the recent years. Ambient (outdoor) air pollution is now recognized as an important problem, both nationally and worldwide. Our scientific understanding of the spectrum of health effects of air pollution has increased, and numerous studies are finding important health effects from air pollution at levels once considered safe. The concentration of atmospheric carbon dioxide has risen substantially since the beginning of the Industrial Revolution by the burning of fossil fuels. Because of the negative effects that global climate changes threatens to cause, finding ways to reduce $CO_2$ levels has become very important in both the scientific and policy worlds. Air pollution is the introduction of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans and other living organisms, or cause damage to the natural environment. The substance that is solid, liquid or gas in the air that cause harm to humans and the environment is known as pollutants. Yu Cheng-Hsiu [1] observed that chemical absorption and adsorption are currently believed to be the most effective techniques to absorb the exhaust gas pollutants. Kuropka Jozef [2] has presented the state of technology and possibilities of removal of nitrogen oxides from exhaust gases. M. Monoj Kumar [3] has emphasised progress and trends in $CO_2$ capture technologies. Raghuraj Gholap V and V. Raghunath Chowdary [4] have investigated on absorption of CO with reversible reaction in cuprous chloride. Lancia Amedeo [5] have conducted experiments on $SO_2$ absorption using a bubbling reactor with a mixture of $SO_2$ and nitrogen in gas phase and an aqueous lime stone suspension in the liquid phase.

## POLLUTANT ABSORBERS

### (a) Selection of material for each pollutant

- Carbon dioxide
  The material used to absorb carbon dioxide is sodium hydroxide (NaOH).
- Carbon monoxide
  The material used to absorb carbon monoxide is cuprous chloride ($CuCl_2$ ).

### (b) Chemical Reactions

Between Carbon dioxide and Sodium hydroxide:

$$NaOH_{(s)} + CO_{2\ (g)} \rightarrow Na_2CO_{3(s)} + H_2O_{(l)}$$

Between Carbon monoxide and Cuprous chloride (also called copper chloride):

$$CuCl_{(s)} + CO_{\ (g)} \rightarrow Cu(CO)Cl_{(s)}$$

From the above, it can be observed that due to chemical reactions there are no by products which are hazardous.

## SENSORS

### (a) MQ135 gas sensor for $CO_2$

Sensitive material of MQ135 gas sensor is SnO2. When the target gas touches the sensor there will be a change in resistance of sensor which in turn results in change in voltage which generates analog output values of gas concentration. The sensor is having variable load resistance which is used to vary the sensitivity range and for calibration. The main features of MQ135 gas sensor as shown in Fig.1 are its wide detecting range, faster response and higher sensitivity. It is a simple circuit having stable and long life.

### (b) MQ7 gas sensor for CO

Sensitive material of MQ7 gas sensor as shown in Fig.2 is SnO2. When the target gas touches the sensor there will be a change in resistance of sensor which in turn results in change in voltage which generates analog output values of gas concentration. The sensor is having variable load resistance which is used to vary the sensitivity range and for calibration. It is mainly used for detection of carbon monoxide because of

its high sensitivity. Its life can last upto 5 years under normal working conditions.


**Figure 1.** Sensing device for $CO_2$.

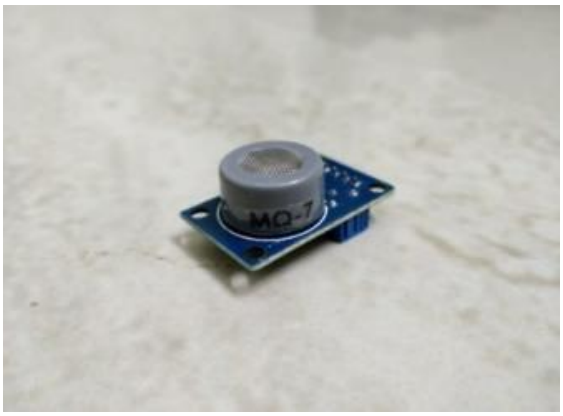


**Figure 2.** Sensing device for CO.

## EXPERIMENTAL INVESTIGATION

### (a) Specimen Preparation

The absorber for pollutants is prepared from the powdered chemicals. The powder is made into specimens of circular shape by pelletizing. The pellets are formed via amorphous powders in the presence of moisture. A solid or liquid binder if needed can be added to this powder before or while pelletizing. By this method the powdered form of chemical or absorbing material is transformed into solid porous specimens which are circular in shape. These specimens are mounted into a frame which is made of wood. A square wooden plank is blanked with circular holes (12 per plank) of equal diameter as that of specimen. The specimens (8 of each chemical type) are fixed in it with no air gaps as presented in Fig.3.

### (b) Specimen Setup

The specimens are fitted in the planks and air tightened. These planks are two in number and are inserted in a closed wooden box as shown in Fig.4, provided with a hole on one side, where exhaust of the automobile is sent into this absorber through this hole. On the other side the sensors are placed inside it as shown in Fig.4 to sense the presence of pollutants in the exhaust gas after it passes through absorbers.

**Figure 3.** A wooden plank with pellets fixed.

**Figure 4.** Programmed sensors arranged in the absorber.

### (c) Experimentation

The experiment is carried out using a 4-stroke petrol engine. The exhaust of the engine is connected to the provided hole and the exhaust gas is measured by sensors and ppm of the contaminants are determined.

The sensors are programmed using ARDUINO board and connections are made as shown in Fig.5. A screen is provided to view the ppm of the pollutants and a controller is used to regulate the resistance and to adjust screen brightness. The code is dumped and executed in Arduino IDE software. Calibration is done before starting the experiment. The sensors are preheated to get good accuracy. Once the setup is all set the sensors are placed inside the wooden box. Initially the absorbers are not placed in the box. Exhaust gases are sensed by the sensors as shown in Fig.6 directly. The ppm values obtained are direct emitants from the exhaust. Subsequently, the absorber planks are placed inside the wooden box as shown in Fig.4. And the experiment is repeated again with absorbers present. Now the pollutant ppm value is checked using the same sensors and ppm values of the pollutants are determined. The values of pollutants (in ppm) are tabled, before and after placing absorbers.

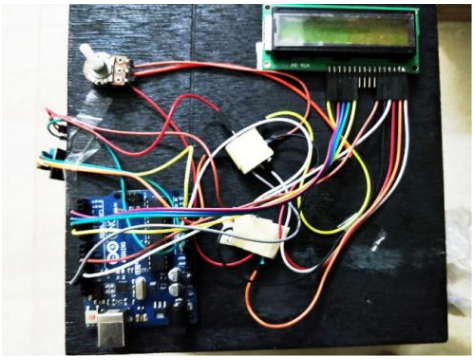

**Figure 5.** Connections of ARDUINO module MQ135, MQ7, amplifier and LCD display.

**Figure 6.** Exhaust of 4-stroke engine directed into absorber.

## RESULTS

The ppm values of the pollutants are determined by the sensors. The values of pollutants obtained before and after placing the absorbers are studied. It is found that on an average the ppm of $CO_2$ before placing absorber was 345ppm and after placing absorber was 211ppm. And in case of CO, before placing the absorber the ppm was found to be 5.86 ppm and after placing the absorber it was 5.21ppm.

In terms of percentage, it was found that the carbon dioxide was reduced by 38.84% and carbon monoxide was reduced to 11.09%.

**Table 1** $CO_2$ without absorber and with absorber.

| S. No | Without the absorber (ppm) | With absorber (ppm) |
|---|---|---|
| 1 | 333 | 202 |
| 2 | 352 | 212 |
| 3 | 382 | 229 |
| 4 | 315 | 201 |

**Table 2.** CO without absorber and with absorber.

| S. No | Without the absorber (ppm) | With absorber (ppm) |
|---|---|---|
| 1 | 5.91 | 5.26 |
| 2 | 5.89 | 5.19 |
| 3 | 5.85 | 5.29 |
| 4 | 5.82 | 5.12 |

Fig.7 and Fig.8 shows the intensity of $CO_2$ and CO before and after insertion of absorbers.

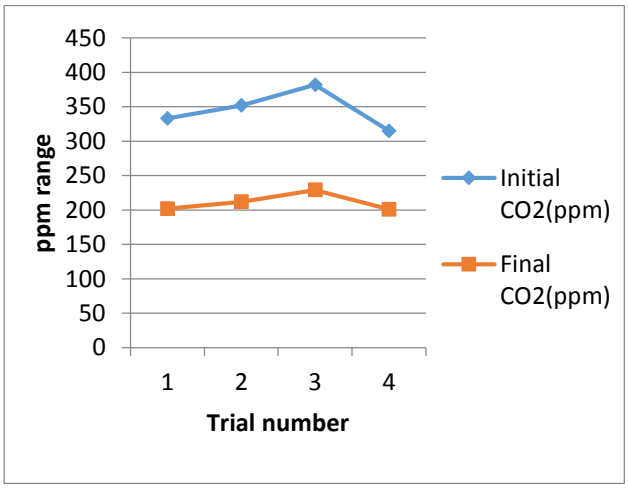


**Figure 7.** Effect of absorber on $CO_2$.

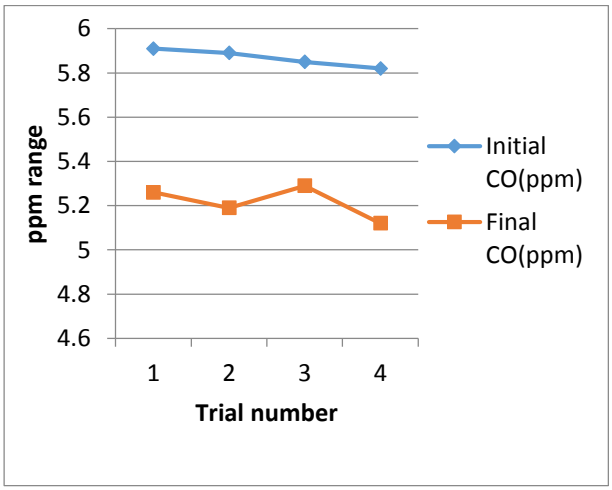


**Figure 8** Effect of absorbers on $CO_2$

## CONCLUSION

The present work highlights a simple and economical device to absorb the pollutants in automotive exhausts namely $CO_2$ and CO. Sensors for the two gases are arranged to monitor the intensity of gases after the absorption. These sensors can be coupled to a computer network for on-line monitoring of the

exhausts present in the environment. The device is found to be cost effective. A further investigation has to be taken-up for the performance efficiency of absorbers over a time.

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