In-Vehicular Air Pollution by Aromatic Compounds Due to Back Diffusion

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Abstract : *In this era of smart city and modern means of transport, like AC Vehicles which is mainly preferred nowadays to avoid outside pollution has also got an adverse effect on human health due to emission of harmful aromatic compound gases like Toluene, Benzene and other aromatic compounds by the phenomenon of Back Diffusion inside the vehicle. In this case synthetic materials inside vehicles like seat cover, plastic when comes in contact with sunlight starts emitting aromatic compounds mainly toluene which affects the health of the people sitting inside the vehicle. In this project we have analyzed the rate of emission of aromatic compound toluene inside the vehicle both AC and Non-AC and have made a comparative study on this. MQ135 sensor senses the presence of aromatic compound inside the vehicle and if there is an emission of aromatic compound in an alarming rate, then through the sensor data we can understand it. In this paper we have used MQ 135 sensor which will be kept inside a moving vehicle or can be carried on hand. We have used Arduino UNO R3 with which the sensor is connected and from Arduino we are fetching the data into the laptop or the computing device and storing the sensor data for analytical purpose. The rate of emission of aromatic compounds depends also upon the temperature of the atmosphere out there. It also depends upon, that for how long the vehicle has been used, in newer vehicles; the rate of emission is comparatively lesser than the old vehicles. Aromatic compounds can also prove to be quite hazardous as after a certain level of concentration they can be carcinogenic, and can even cause damage to our central nervous system.*
Keywords: Aromatic Compounds, Back Diffusion, In-Vehicular Pollution, MQ135, Synthetic Material.

I.   INTRODUCTION

Vehicles mean something that helps us for travelling from one place to another place. In India they use fuel mainly from non-renewable sources of energy which includes Petrol, Diesel, LPG, and CNG which are the sources of pollution in our environment. LPG and CNG run vehicles cause comparatively lesser amount of pollution in comparison to the vehicles that run on Diesel and Petrol [1]. So to avoid these pollutions, people nowadays try to avail AC vehicles and think that if they ride on these vehicles they can avoid the pollution outside that can have an adverse effect on health. In general not many are aware of the phenomenon of Back Diffusion. In Back Diffusion, when sunlight falls on synthetic materials like rubber and plastic, aromatic compound gases come out, and if a person stays exposed to this for a longer duration of time then that can be quite injurious to health. The detailed study has showed that the rate of emission of these organic compounds is comparatively higher in NON-AC vehicles [2].

Vehicles which are on road have old rubber seats, machine parts and they comparatively emit more amount of aromatic compounds than in comparison to the vehicles that are on road for near about 3-4 years [3]. But in the latter case, though there is not much significant emission of gases, but the person who travel on these vehicles for longer period gets faces effect by certain types of symptoms like headache, nausea and if this continues in long run can lead to cancer, damage to central kidneys, nervous system [4]. So nowadays we also find that in many vehicles like Volvo buses or in many vehicles they come with cotton seat covers to reduce these emissions and also the paints that are used inside the vehicles nowadays are of certain category so that there is a minimization of emission of aromatic compounds from those paints.

II.   STATE OF ART REVIEW

The font size for the big concern of this era is environmental pollution. Researchers and different government agencies are now started to identify and measure different types of pollutant. Toluene is a member of the BTEX group of pollutants. BTEX is used to specify the group of chemicals related to benzene and also known as volatile organic compounds (VOCs). The main sources of BTEX into the environment are the

petroleum and chemical industries, different combustion processes. These types of pollutants are used in the manufacture of chemicals, rubber and plastics, in solvents, and in paints and lacquers. It is estimated that production of toluene all over the world is near about 10 million tones [5, 6]. Aromatic compounds like Toluene and benzene have major industrial uses as a solvent, carrier, or thinner in the paint, rubber, printing, cosmetic, adhesives and resin industries, as a starting material for the synthesis of other chemicals and as a constituent of fuels [7]. It is very difficult to estimate rate of emissions toluene on a country-by-country basis as because total use and source distribution varies widely. Since petrol use accounts for more than 90% of toluene production, it is the largest source of emissions [8]. But average concentration of aromatic compounds like toluene varies from place to place [9].As per observation, the average concentrations of toluene in air in rural areas are generally less than 5 μg/m3, while that in urban area are in the range 5−150 μg/m3. The concentration of toluene is higher in industrial area [10]. A similarity was found in type of pollutants from vehicle exhausts and the type of pollutants found in the city, and as per a survey 14 US urban sites, indicated in total a 24 hours average concentration of 4.5 ppb [11]. Through survey it has been found that aromatic compound levels in indoor environments are expected to be significantly higher than outdoor levels, because in those situations it involves non occupational use of paints and thinners, and also where tobacco smoke is present [12]. Nowadays research has concentrated to find out the rate of pollution caused by different vehicles. Authors in [13] have proposed an exhaustive study to measure the emission of benzene type of pollutant from vehicles especially in urban areas.

III.   MOTIVATION

But a very limited number of researches are going on to differentiate the measurement of benzene types of pollutant like toluene emission from AC and NON-AC car [14]. This motivates us to measure the emission of toluene from AC and NON-AC car. We have selected toluene as our research parameter as recent study has revealed that aromatic compounds like toluene causes clastogenic effects in pokeweed-mitogen-stimulated peripheral blood lymphocytes of printers [15] and it is one of the major constituent for pollution. Exposure to harmful aromatic compounds like toluene can lead to Genotoxicity. Exposure of toluene in printers was also highly correlated with an excess of chromatid breaks in peripheral lymphocytes compared to controls. Absorption of toluene is mainly taken in by our respiratory tract and is measured between 0.16 and 1.6mg/minute [16, 17, 18] and the average quantity of toluene that gets retained in our body are near about 85% [13, 14]. Studies on rats have revealed that inhalation of toluene effects brain constituents and other morphological and biochemical parameters. High concentration of 2000 ppm can cause ataxia, prostrations and tremors when the rats were exposed for 7days and causes irreversible changes in brain if exposed for longer period of time [19, 20]. A variety of studies have suggested that toluene is only minimally toxic to the liver and kidney and when rats were exposed to toluene at concentrations of 30 and 300 ppm for 6 hours/day, 5 days/week for one month, there was minimal histological changes and had no effect on AST, liver weight, or mixed function oxidases, serum alkaline phosphatase was elevated at 300 ppm [10].

An extensive database on human exposure to toluene indicated malfunctioning of the Central Nervous System (CNS) is of primary concern. Deficits in neurobehavioral functioning have been viewed as precursors of more serious indications of CNS toxicity [21]. They can cause a fatal fetal development retardation, skeletal anomalies, low birth weights and developmental neurotoxicity, fetal development retardation, skeletal anomalies, low birth weights and developmental neurotoxicity. It also affects the reproduction system of human beings.

IV.   PROPOSED MODEL

The proposed system checks the level of aromatic compounds inside a vehicle. Vehicles are categorized into two types, one is AC vehicle and other is NON-AC vehicle to measure the difference between the rates of toluene emission. Both AC and NON-AC vehicles are surveyed. This survey reveals that the amount of toluene emission from AC vehicle is less compare to NON-AC vehicle.

V.   IMPLEMENTATIONS

The proposed model is implemented using MQ 135 gas sensor and Arduino UNO Micro-controller. MQ 135 sensor senses the concentration of toluene in the air and sends the analog value through the analog port of the device to the A0 port of the Arduino. Arduino transmit this data to the Laptop for analysis. This sensor is getting refreshed i.e., sensing new data from air after every 30 seconds. Inside the Arduino a small program is written to convert the analog signal to its equivalent PPM (Parts per Million) value. Each sensor gives analog value ranging 0 to 1023. This analog value (d1) is converted back to their analog voltage (Vout) using the following equation 1

$$V_{out} = 5.0 \times d_1 / 1023 \tag{1}$$

Various gases are usually represented by PPM or parts per million is the mass of chemical per unit

volume of water also the same as mg/L. The following equations 2 and 3 are required to convert the data from V_{out} to PPM value. Each sensor represents its sensitivity characteristic using Rs/Ro and PPM value, where Rs is the resistance of target gas with different concentration and Ro is the value of sensor resistance in clean air.

$$R_s / R_o = (V_c - V_{out})/V_{out} \ , whereV_c = 5V \qquad (2)$$

Now, to find the concentration of gas present in clean air is given by the power series equation 3

$$y = a \times x^b \qquad (3)$$

where a and b are constants; y represents the concentration of gas in PPM and x represents the corresponding resistance values calculated by the equation 2.
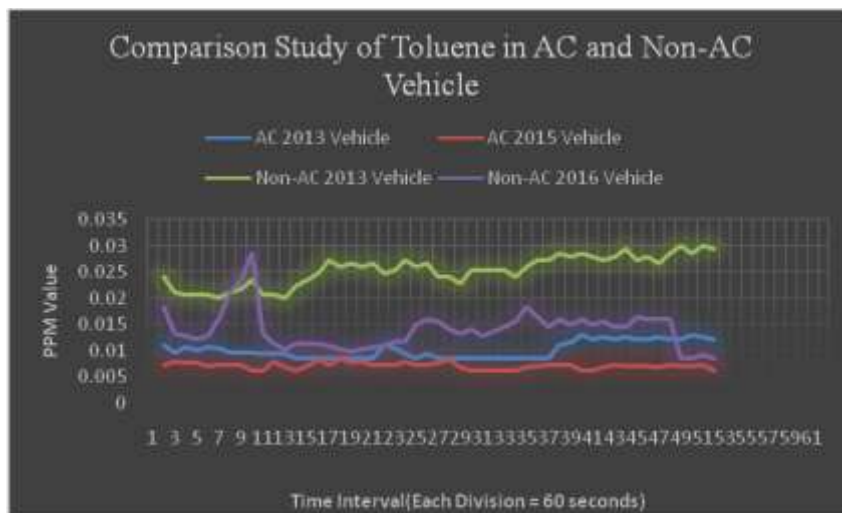
VI.   RESULTS

The following charts will give us the graphical comparison on the rate of emission of toluene in various vehicles. The readings are taken by travelling in each of these vehicles for near about 30 minutes.
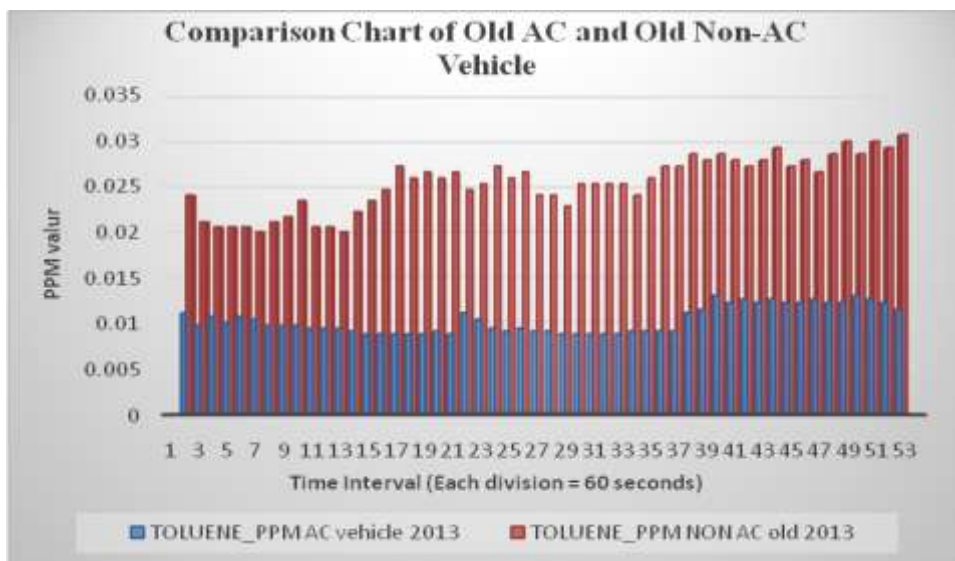
Figure 1 Toluene comparison chart (PPM) of five years old AC and Non AC vehicle
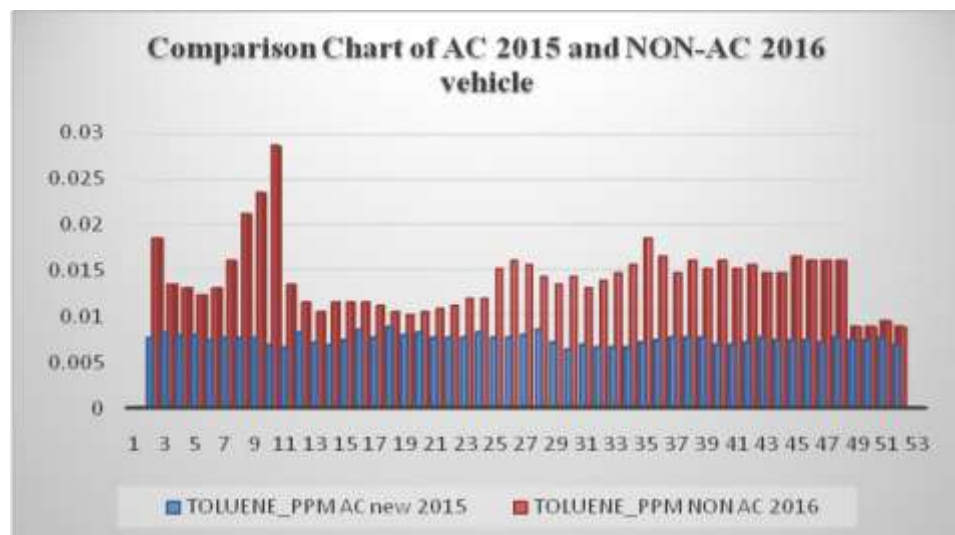
Figure 2 Toluene comparison chart (PPM) of new AC and Non AC vehicle

Figure 3 Comparison study of toluene (PPM) in AC and Non AC vehicle

Both fig.1 and fig.2 show that the rate of emission of toluene is comparatively less in AC vehicles than in NON-AC vehicle and hence we can conclude that the general public should avail AC Vehicles like AC buses, AC vehicle to minimize the effects of these gases on them. The fig. 3 clearly shows that vehicles used in 2013 emit more toluene than vehicles used in 2015. This result shows that people should change old vehicles and should use new vehicles.

VII. CONCLUSION

The rate of emission of toluene is not significant enough, but still we need to take care and look after it, because after remaining exposed to these gases for a long duration of time a person's health may get affected. The government need to install these type of devices inside the vehicles, which after a certain duration of time will send an average value about the rate of emission of gases in the environment to a nearby server for analytical purpose, and if the average value is below the critical level then it is well and fine but if we find that the average value is above a critical level for a certain gas, consistently for a certain span of time then that specific vehicle is required to be warned for engine maintenance and if found that the engine is more than 10 years old immediately the vehicle is required to be discarded. Government should also start may new AC Busses on the road in place of non-ac vehicle as the rate of emission of gases on these vehicles are comparatively very less and they are comparatively less polluting than those old vehicles. Government should give subsidy to these vehicles, so that the pinch of pocket of those common people is not much, in fact the government should try to deploy these vehicles on the road more and more and ensure that the fare on those vehicles is nominal i.e., which can be paid by a common man.

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