

A study of Vehicular pollution

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Abstract- *The rapid urbanization has also resulted in a tremendous increase the number of motor vehicles. The vehicle fleets have even doubled in some cities in the last one decade. As the number of vehicles continues to grow and the consequent congestion increases, vehicles are now becoming the main source of air pollution. Although, the air quality can be improved through a combination of technical and non-technical measures, legislative reforms, institutional approaches and market-based instruments, there are certain unique challenges which the country has to face in tackling the problem of urban air pollution. Improvements are required right from the improvement in the fuel quality, formulation of necessary legislation and enforcement of vehicle emission standards, improved traffic planning and management. This paper discusses towards the development of vehicular pollution control device which could control the pollution & report online to the controlling agency about pollution emissions about any vehicle.*

Keywords - pollution, vehicular emissions, air pollution

I. INTRODUCTION

Transportation involves the combustion of fossil fuels to produce energy translated into motion. Pollution is created from incomplete carbon reactions, unburned hydrocarbons or other elements present in the fuel or air during combustion. These processes produce pollutants of various species, including carbon monoxide, soot, various gaseous and liquid vapour hydrocarbons, oxides of sulphur and nitrogen, sulphate and nitrate particulates, ash and lead. These primary pollutants can, in turn, react in the atmosphere to form ozone, secondary particulates, and other damaging secondary pollutants. Combustion also produces carbon dioxide, the primary greenhouse gas. The share of fossil fuel used in the transport sector varies widely from region to region and city to city. A number of factors can be identified as influencing the amount of emissions attributable to the transport sector, and an effective strategy will need to take all these factors into account. They include: The amount that vehicles are used in a given country or metropolitan area; The age of the vehicle fleet and the technology used within it; The extent to which vehicles are properly maintained; The availability of appropriate fuels and the extent to which they are used properly; and Atmospheric, climatological and topological conditions. Air pollution is one of the serious environmental concerns of the urban areas. The health related problems such as respiratory diseases, risk of developing cancers and other serious ailments etc. due to poor air quality. Air pollution is a phenomenon by which particles (solid or liquid) and gases contaminate the environment. Such contamination can result in health effects on the population, which might be either chronic (arising from long-term exposure), or acute (due to accidents). Other effects of pollution include damage to materials (e.g., the marble statues on the Parthenon are corroded as a result of air pollution in the city of Athens), agricultural damage (such as reduced crop yields and tree growth), impairment of visibility (tiny particles scatter light very efficiently), and even climate change (certain gases absorb energy emitted by the earth, leading to global

warming). Point sources of air pollution include stationary sources such as power plants, smelters, industrial and commercial boilers, wood and pulp processors, paper mills, industrial surface coating facilities, refinery and chemical processing operations, and petroleum storage tanks. Examples of nonpoint sources of air pollution include: on-road mobile sources such as cars and trucks; nonroad mobile sources such as construction and recreation equipment engines; and natural sources such as windstorms and fires. Exposure to air pollution is associated with adverse effects on human health including respiratory problems and lung diseases. Air pollution can also significantly affect ecosystems. Not all pollutants are a result of human activity. Natural pollutants are those that are found in nature or are emitted from natural sources. For example, volcanic activity produces sulfur dioxide, and particulate pollution may derive from forest fires or windblown dust. Anthropogenic pollutants are those that are produced by humans or controlled processes. For example, sulfur dioxide is produced by fossil fuel combustion and particulate matter comes from diesel engines. Air pollutants also are classified as: Primary & Secondary. Primary pollutants are those that are emitted directly into the atmosphere from an identifiable source. Examples include carbon monoxide and sulfur dioxide. Secondary pollutants are those that are produced in the atmosphere by chemical and physical processes from primary pollutants and natural constituents. For example, ozone is produced by hydrocarbons and oxides of nitrogen (both of which may be produced by car emissions) and sunlight. Automotive vehicles emit several pollutants depending upon the type of quality of the fuel consumed by them. The release of pollutants from vehicles also include fugitive emissions of the fuel, the source and level of these emissions depending upon the vehicle type, its maintenance etc. The major pollutants released as vehicle/fuel emissions are, carbon monoxide, nitrogen oxides, photochemical oxidants, air toxics namely benzene, aldehydes, 1-3

butadiene, lead, particulate matter, hydrocarbon, oxides of sulphur and polycyclic aromatic hydrocarbons. While the predominant pollutants in petrol/gasoline driven vehicles are hydrocarbons and carbon monoxide, the predominant pollutants from the diesel based vehicles are Oxides of nitrogen and particulates.

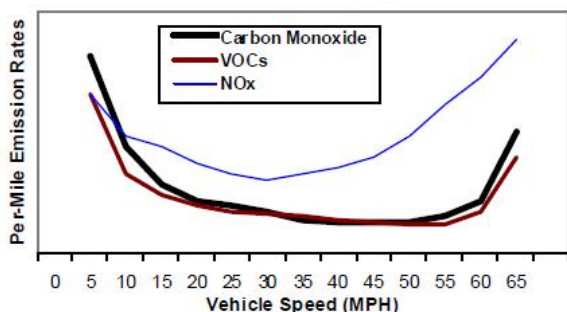


Figure 1: This figure shows how typical vehicle emissions are affected by speed⁴

II. LITERATUE REVIEW

Indian economy reached to a landmark of 8.5% GDP in 2010-11. This has put India into the group of one of the fastest growing major economy after China. The service sector emerged as one of the main driving force in country's high GDP.

History of The Events- The sequence of events covering the various measures /initiatives /action taken for vehicular pollution prevention and control in the past 27 years are as follows:

1985: an expert committee was consisting of the Secretary, Department of Environment (Now MoEF) under the chairmanship of director ARAI with Member Secretary from CPCB. The committee recommended mass emission norms and in-use emission norms for different categories of vehicles along with testing method (The recommendations of the committee were notified later under Environment (Protection) Act 1986 during 1990).

1990: under Section 25 of Environment (Protection) Act 1986, Environment (Protection) Second Amendment Rule 1990 was notified where mass emission norms and in-use emission norms were prescribed for the first time in the country.

16th May'1991: CPCB constituted a committee to evolve mass emission standards for motor vehicles for year 1995 and 2000 under the chairmanship of Prof. H.B. Mathur. The terms of reference of the committee were:

- To suggest the emission standards for 2, 3 & 4 wheelers to be implemented from year 1995 and 2000 with respect to carbon monoxide, hydrocarbons and oxides of nitrogen.
- To identify the nature of changes required in engine design and types of devices to be installed to meet the suggested standards.

1991: Idle CO Limits for Gasoline Vehicles and Free Acceleration Smoke for Diesel Vehicles, Mass Emission Norms for Gasoline Vehicles.

1992: Mass Emission Norms for Diesel Vehicles.

1992: MoEF brought out two documents namely, National Conservation Strategy & Policy Statement on Environment and Development and Policy Statement for

Abatement of Pollution which identified that ambient air quality trends with respect to SPM in metro cities were higher than the prescribed limits especially during summer time. The levels of nitrogen di-oxide are increasing in urban centers with growth in vehicular emissions. For prevention and control of vehicular pollution and for development of environmentally compatible transport system, the following steps to be taken:

- Improvement in mass transport system to reduce increasing consumption of fuel, traffic congestion and pollution;
- Improved transport system based on bio-energy and other non-polluting energy sources
- Rail transport and pipelines transport instead of road transport, where ever possible, by appropriate freight pricing so as to reduce congestion, fuel consumption and environmental hazards;
- Improvement in traffic flow through proper maintenance of roads, updated traffic regulation and strict enforcement of prescribed standards;
- Enforcement of smoke emission standards for containing vehicular exhaust, at the manufacturer and user level;
- Phasing out of use of lead in motor spirit; and
- Regulation from environmental safety in transportation of hazardous substances

1992: the committee recommended emission norms for vehicles applicable from 1995 and 2005 with technological options for meeting these norms. It also recommended redrafting the Indian standards to specify the fuel parameters affecting the emissions and make commercial fuel available. The lead free petrol has to be made available in limited quantity by 1995 and all commercially available petrol will have to be lead free by the year 2000. The recommendations of the committee were also deliberated at MoEF where 1995 norms were reviewed & postponed to 1996 and submitted to Ministry of Road Transport & Highways (MoRTH) for notification.

1992: a policy for providing clean fuels for power plants and motor vehicles were prepared by CPCB during its Board meeting and recommended to MoEF for Ministry of Petroleum and Natural Gas (MoPNG) to take necessary action. During May 1994 a draft specification for motor gasoline and diesel was proposed by CPCB and submitted to MoEF.

January'1994: Low leaded fuel (0.15 g/l) was made available by MoPNG for metro.

17th June'1994: A meeting on fuel and fuel quality of automobiles was held under the chairmanship of the Hon'ble Shri. Kamal Nath, the following were the decisions:

- From April 1, 1995 unleaded petrol (i.e. petrol with lead content less than 0.013 g/l) will be supplied in metropolitan cities, along with leaded petrol as at present.
- All new vehicles (4 wheelers) sold in metros after 1st April 1995, will have to be equipped with catalytic converters.
- Diesel supplied in metro cities will have only 0.5% sulphur content as compared to 1% at present, from 1st April, 1996.
- All 2 stroke engine 2 – wheelers and 3 wheelers will have to meet notified norms of emission by 1st April, 1996, if

not, production of 2 stroke engines not meeting the norms will have to cease.

- Norms for year 2000 were discussed and it was decided to finalize these within six months, after some more discussions. Thus there will be adequate time for technical changes in design, etc.
- Fiscal mechanism was discussed-price differentials for different types of fuels.
- Also administrative mechanism such as staggering peak--etc., were also discussed.
- Fuel standards comments from IIP, Dehradun within 15 days.

21st October'1994: Hon'ble Supreme Court passed following order:

- Petrol with 0.15 g/l TEL to be made available by December 1996 to entire country.
- Lead free petrol to be made available at selected outlets in 4 metro cities by April 1995.
- New vehicles (Petrol driven) should be equipped with catalytic converter by April 1995.

20th January'1995: MoEF has constituted a committee to finalize fuel quality specification for motor gasoline and diesel. The recommendations of the committee with respect to emission related fuel quality specification were later notified under EPA.

April 1995: it was made mandatory for fitment of catalytic converters in new petrol passenger cars sold in the four metros of Delhi, Calcutta, Mumbai and Chennai along with supply of Unleaded Petrol (ULP) was affected. Availability of ULP was further extended to 42 major cities and now it is available throughout the country.

June 1995: Bureau of Indian Standards incorporated the emission related specifications and prescribed fuel quality specifications. Based on MoEF recommendations and Supreme Court order, unleaded Petrol was made available in four metro cities during June 1995 and passenger cars are made to fit catalytic converter.

20th April'1996: the fuel quality specifications were notified under EPA Act and directives were issued by CPCB to various refineries under Section 5 of EPA for compliance of the specifications. In the same year revised ambient air quality standard were notified.

1996: Revision of Mass Emission Norms for Gasoline and Diesel Vehicles, mandatory fitment of Catalytic Converter for Cars in Metros on Unleaded Gasoline.

May 1997: a policy paper on control of automobile exhaust pollution was prepared by CPCB which recommended:

- Introduction of Inspection and maintenance programme for in-use vehicles
- Phasing out of 15 years old vehicles
- Improving Public Transport system by introducing high capacity bus system on dedicated pathways
- Introduction of fleet of alternate fuel vehicles

August 1997: mass emission norms for vehicles (equivalent to Euro-I norms) with effect from 1.4.2000 were notified under Motor vehicle Act.

August 1997: MoEF brought a white paper on pollution in Delhi. To implement the recommendations of white paper, MoEF constituted "Environmental Pollution Control Authority" on January 1998 on the directions of the Supreme

Court. The important directions issued by the Hon'ble court on 26.7.1998 are as follows:

- Augmentation of public transport to 10,000 buses by 1.4.2001
- Elimination of leaded petrol from NCT Delhi by 1.9.1998
- Supply of only pre-mix petrol by 31.12.1998 for two stroke engines of two wheelers and autos
- Replacement of all pre-1990 autos and taxis with new clean vehicles on clean fuels by 31.3.2000
- No 8-year-old buses to ply except on CNG or other clean fuels by 1.4.2000
- Entire city fleet (DTC & Private) to be converted to single fuel mode on CNMG by 31.3.2001
- New ISBTs to be built at entry point in North and south west to avoid pollution due to entry of Interstate buses by 31.3.2000
- GAIL to expedite and expand from 9 to 80 CNG supply outlets by 31.3.2000
- Two independent fuel testing laboratories to be established by 1.6.1999
- Proper inspection and maintenance facilities to be set up for commercial vehicles with immediate effect
- Comprehensive inspection & maintenance programme to be started by transport department and private sector by 31.3.2000.
- CPCB/DPCC to setup a few more monitoring stations and strengthen the air quality monitoring stations for monitoring critical pollutants by 1.4.2000. The Hon'ble Court also directed that the time frame as fixed by Environment Pollution (Prevention & Control) Authority should be strictly adhered to by all the authorities.
- Some of these orders have led to phasing out of diesel commercial vehicles especially buses and petrol three wheelers will be replaced with CNG vehicles in Delhi.

1998: Cold Start Norms Introduced.

September 1998: lead in petrol was phased out in Delhi while during February 2000 lead in petrol was phased out from petrol all over the country.

November 1998: EPCA brought up the issue of phasing out of diesel private vehicles in Delhi. CPCB recommended to EPCA that these vehicles should meet Euro-II norms otherwise they should not be allowed to ply. During the hearing in Supreme Court, the court ordered that Euro-I norms has to be made applicable for private non-commercial vehicles registered after June 1999 in Delhi. This led to introduction of Euro-II norms for other categories of vehicles and in other cities of the country. CPCB constituted a working group to formulate the transport fuel specifications for the year 2005 under the chairmanship of Dr.P.K. Mukhopadhyay, Ex-Director IOC (R&D). The terms of reference of the working group were as follows:

- To recommend the fuel specifications of automotive commercial fuels (gasoline and diesel) for the year 2005
- To recommend the reference fuel quality specifications at the testing stage
- To recommend technology to be adopted to meet the fuel quality specifications recommended for the year 2005
- To draw-up a strategy for monitoring the fuel quality at petrol pump stations to check adulteration

As per decision taken by the committee of secretaries Ministry of Petroleum and Natural Gas constituted an inter-ministerial task force on auto fuel specifications and

vehicular emission standards on August 14, 2000 under the chairmanship of the chairman CPCB. The committee in its report submitted to MoPNG on 31.3.2001 recommended the road map for introduction of Bharat stage –II norms in entire country along with fuel quality specifications.

2000: India 2000 (reference Euro 1) emission norms have been implemented all over the country.

2000: Modified IDC (Indian Driving Cycle)

2001: The Hon'ble Supreme Court of India, in the matter of CWP No. 13029 of 1985, passed the orders on 05.04.2001, regarding formulation and implementation of action plans for control of pollution in cities namely Kanpur, Lucknow, Varanasi, Agra, Jharia, Patna, Jodhpur, and Pune & Faridabad.

2001: Bharat stage-II (reference Euro 2) emission norms have been implemented in NCR, Mumbai, Kolkata and Chennai.

May 2002: the Hon'ble court has also asked the union of India to prepare a scheme for compulsory switch over to CNG/LPG as automotive fuels in the cities those are equally or more polluted than Delhi. Later CPCB identified these cities as Ahmedabad, Kanpur, Kolkata and Pune.

2003: the Hon'ble Supreme Court Court vide its order dated 16.8.2003 directed Union of India and State Government to prepare action plan for lowering the rate of RSPM level for cities of Kanpur, Ahmedabad, Sholapur, Bangalore, Lucknow, Chennai, Hyderabad, Mumbai, Kolkata. Hon'ble Supreme Court also asked respective State Boards to place the proposed action plans before EPCA.

2003: Bharat stage-II (reference Euro 2) emission norms have been implemented in 11 megacities (Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Secunderabad, Ahmedabad, Pune, Surat, Kanpur and Agra).

2004: new PUC norms have been implemented for in-use vehicles.

2005: Bharat stage-III (reference Euro 3) emission norms have been implemented in NCR & 11 megacities, while Bharat stage-II norms have been implemented all over the country.

2010: Bharat Stage IV (reference Euro 4) emission norms have been implemented in NCR & 11 megacities, while Bharat stage-III norms have been implemented all over the country.

The major literature and technology gap found during the literature survey is that the vehicles are manufacture as per standards, but after that if the vehicle emits pollutants more than the standard permitted level there is no check if the owner is having the pollution slip. And it is being observed that the pollution booths that they only provide a fake pollution certificate against the charges taken by them. Hardly a few could be find that are testing the pollution level and issuing the pollution certificate. There is a need of integration of various technologies to take the precaution measures for the upcoming decades against ever increasing pollution rate. As it is better to prevent then cure. It has been observed that usually the police check the vehicle's pollution certificate, but as per our opinion the police should check the pollution level of the vehicle instead of the pollution certificate.

III. CONCEPT DESIGN/ NOTE

The concept design of “pollution lock” composed of hardware & software, to be installed in new produced vehicles by the vehicle/ engine producer. It will be similar to the central remote locking, the difference is that alike remote control of central locking, the pollution lacking will be done by the software installed based on the sensors feedback to the software. It will be a smart operating system that will work on artificial intelligence. This pollution lock will stop the engine working on emission of pollutants above the permitted standard level. This concept is based on the integration of mechanical, electronics and computer engineering. For any emergency the vehicle should be equipped with the catalytic converters. This information about pollution should be conveyed to the driver/ operator via any meter or sound (device) beep. The working principle of pollution lock will be similar to the governors for the speed controls. The sensor box fitted with sensors is Sensing & measuring pollutant level from the exhaust pipe. The sensor sensed level of the pollutants is send continuously to the microcontroller. The microcontroller is having a installed program with a number of set of instructions. An electrically operated control valve to be build up inside the fuel pump, which will allow the fuel supply based on the electrical signals from the microcontroller. Based on the controller instructions the control valve will allow or block the fuel supply. If the pollutant level is below the permitted level, the control valve will permit the fuel supply to fuel pump. And if the pollution level will raise the controller via an electronic circuit will close the control valve and the fuel supply will be blocked till further instructions from the microcontroller. Conceptual design of pollution remote sensing device (PRSD)- To develop the conceptual design of “Pollution Remote Sensing Device (PRSD)” that will check the pollution of running vehicle without stopping the vehicle as the speed is checked by the highway patrolling police on highways. There are two concepts for development of pollution checker: Pollution check gate as like toll tax on highways & smart card system Pollution check gate (PCG) - In this concept the pollution check post has to be developed at the toll tax on highways. The toll gate will be equipped with pollution check equipments, the fitted sensors will be fitted at the toll gate, which will analyze the pollutants level in the emissions of the particular vehicle. For development of pollution check along with the toll gate will not be a typical task. It will be a cheaper concept too. The work that needs to be done is that the pollution analyzing sensors set up need to be installed along with the toll tax. The printer printing the toll tax credits will print the pollutants level also. This information collected by the pollution analyzing sensor set-up will be made online to the traffic police so that the vehicle could be identified. This will be similar to the concept of paying the toll tax, sales tax. In the fashion sales tax department checks the sales tax certificate/ slip, in the similar way the pollution department will check the pollution slip of the toll tax. The problem will arise when the vehicle is not crossing the toll gate. For that type of vehicles the second concept will work. On an estimated average approximation (observation only, no proof data), 50% of the total vehicle population of that area crosses the toll gate daily. This check will drastically reduce the vehicular pollution rate. For the development of pollution analyzing set up, there will be one box set up, which will produce the beam of charged particles, from one end, on the

other end is the receiver of the charged particles beam. This intensity beam of charged particles at the receiver will be reduced on passing through the specified pollutants. The difference between the intensity of the beam produced and the intensity of the beam received, the pollutants level in the emissions will be calculated by the calibrated scale. This value of the specified pollutants will be send to the toll tax collecting personnel device, from where the pollutant level will be printed on the toll tax slip. The same information will be made available to the police & pollution check people for necessary action. Pollution remote sensor detector (PRSD) - For the vehicles not going through the toll gates, the PRSD will be developed. In this system a sensor box similar to the sensor box in the pollution lock will be required to install and set up on the vehicle. The research work can bring the cost of this sensor box to several hundred from the initial cost of several thousands. This information of the sensor box will be sending to a smart card, via wireless/ wired connection. The smart card will display some color coding. The pollution meter reading machine (RSD) will read the color coding of the smart card, in the similar way as the smart card system on the toll gates reads the smart cards for the toll tax.

IV. CONCLUSION & RESULTS

As a conclusion of the literature survey, proposed concepts, the conclusion is: The pollution level can be under control; The proposed objectives were reached; The pollutant emission can be controller and monitored; This pollution lock can serve the purpose of thief lock i.e. anti thief system for vehicles.

V. FUTURE SCOPE OF WORK

For the future scope of work, the following work is proposed: Development of pollution lock; Development of pollution sensor box at a cheap price; Development of RSD (remote sensing device) for pollutants; Development of a beam of charged particles to sense the different types of pollutants

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