Air Pollution from I.C. Engines & It's Control

Sharad R. Mahajan

Abstract: - The rise in civilization is closely related to the improvement is transportation. In the development of transportation, internal combustion engine play an important role of petrol and diesel engine. This problem is increasing day by day with increasing pollution, & urbanization air pollution has been identified as one of the potential source of air pollution. The Petrol and diesel engine power automobile achieve symbol of our modern technological society but in recent time. The I.C. engine powered vehicle has come under heavy attack due to various problems created by them. One of the various problems is air pollution and this pollution problem facing the developing countries. First of all we know about pure air means it is a mixture of nitrogen and oxygen with some rare gases argon, neon etc. Now air pollution is defined as the addition of any material which will have a dangerous effect of our planet to our atmosphere. This pollution of air problem is very serious such than a one metrologies predicted recently that air could put an end to life on this planet within century. So our aim is to find out the air pollutant from petrol as well as diesel engine and control those pollutants so that we minimize the pollution problem.

The main pollutant from automobile is carbon monoxide (CO), un burnt hydrocarbons (HC). Oxides of nitrogen and lead and particular emissions. Automobiles are not only sources of air pollution but also other sources like electric generation power stations (Which mainly emit sulpher oxides and nitrogen oxides) and industries processing. In advanced countries like USA the air pollutant by automobile is about 50% of total air pollutant. It is true that the pollutant from car say half kgf for single days driving. Day by day the pollutions are increased due to number of vehicles increases and hence air pollution by vehicles are also increased. The paper deals with the types of pollutants, its sources and how to control emissions from an automobile.

Index Terms— internal combustion engine, air pollution, carbon monoxide, Oxides of nitrogen, unburnt hydrocarbons.

I. INTRODUCTION

The life of a human being is precious. Certainly, to live a comfortable life you need to have good surrounding. At least all the basic needs like air, water, food etc. are the essential elements to cherish. We are always selective when it comes to food. We certainly think of hygiene and end up eating as well as preparing good food in clean places. Similarly one should have the same attitude towards the environment. We breathe air, true, but what kind of air? We are not very bothered about its composition. The only things we do are good for a weekend outside the city and say we are in search of fresh air. We then come back & then survive for another week.

Have we ever thought of this? We all know that in cities like Mumbai, Delhi, Calcutta, etc. two thirds of the air we breathe its pollutant the cause of this is unwanted gases emitted by industries and automobiles flying on the roads. The emissions are very harmful to human beings. All these emissions should be controlled but how? Let us talk about the emissions from automobiles and ways to control them.

II. AUTO EMISSION

The power that propels automobiles comes from the combustion chamber. That is where hydrocarbons in fuel meet air. Ideally, oxygen in the air should convert all the hydrocarbons in the fuel in to water and carbon dioxide. But, in reality, combustion also produces unburned hydrocarbons, oxides of nitrogen, carbon monoxide and water.

Air pollution is not caused by private cars alone. Buses and trucks are operated on highly toxic diesel oil. There are two and three wheeler two-stroke engines, which constitute about two thirds of the vehicular population in the major cities and we are responsible for emitting 70 percent of pollutants in the air. According to a study 97 percent of the buses and trucks emit excessive pollutants, three wheelers contribute about 88 percent, privately owned two-wheelers about 51 percent, and only about 12 percent of private cars were found to be polluting. Governments in foreign countries ensure that after cars leave the factory gates, they will continue to have low emissions for a specified period of time.

Sample tests are carried out at prescribed intervals (every third vehicle is checked). If emissions are found to be increasing due to fault in the technology, the manufacturer has to rectify the defects at his own expense. In some cases, the manufacturer is even ordered to recall all the cars of the particular batch and rectify the problem.

Using non-standard fuel also greatly adds to vehicular air pollution. Are you aware that the 'unleaded petrol' supplied today in our country has a lead content of 0.13 percent? This is 2.5 times higher than international standard which stands at 0.005 percent. Also, additives like Benzene, Toluene and Zylene, which on added to the petrol at the refinery stage have only resulted in increase in Benzene content in the atmosphere. The same thing applies to the highly injurious sulpher content in the diesel. A scientific study carried out by the California Air Resources Board indicates that excessive exposure of diesel exhaust causes cancer. This means that Delhi alone could have 3,000 or more cases of cancer due to diesel pollution. Thus the quality of unleaded petrol and diesel has to be improved on an urgent basis. In addition, alternative fuels, viz. methanol, ethanol, bio-diesel and CNG (Compressed natural Gas), notably for buses and vans, should be used for cutting down dangerous carbon monoxide emissions. The responsibility for providing better quality petrol and diesel depends entirely on the government which controls their production in this country.

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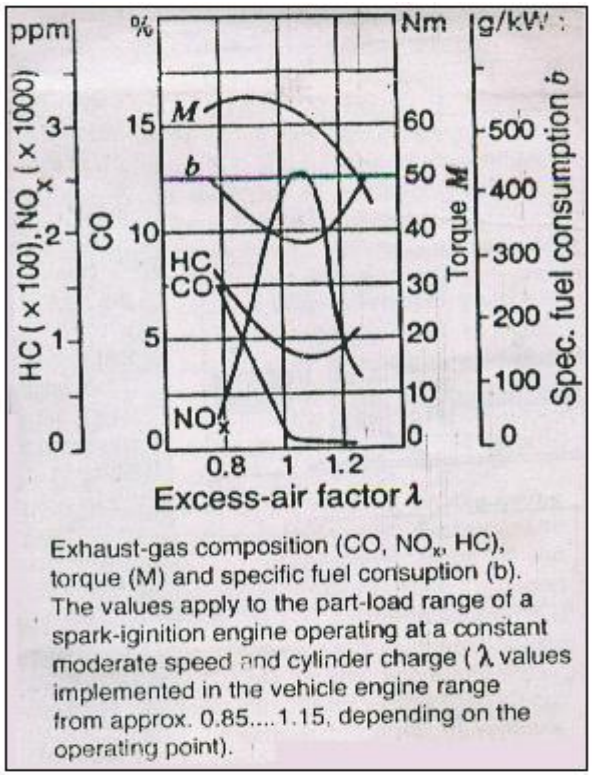
Dr.Sharad R.Mahajan. Principal, S G.M.College of Engineering, Mahagaon, Shivaji University, Kolhapur, India.



Exhaust-gas composition (CO, NO_x, HC), torque (M) and specific fuel consuption (b). The values apply to the part-load range of a spark-iginition engine operating at a constant moderate speed and cylinder charge (λ values implemented in the vehicle engine range from approx. 0.85....1.15, depending on the operating point).

Graph1: Excess air factor λ

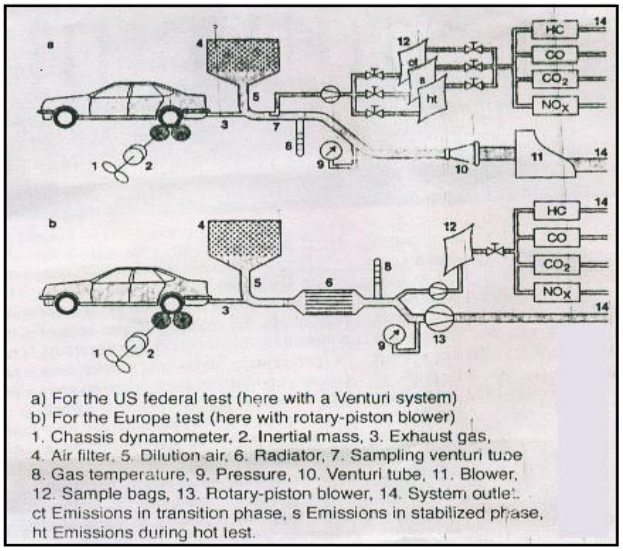
Bad and unregulated traffic flow is also a cause of increased in order to determine a vehicle's emission levels, the emissions of the vehicles must be tested in an emission test cell under conditions which simulate actual driving conditions. Compared to on-road driving, the operations in the test cell offers the advantage of allowing test to be conducted at predefined speeds without having to consider traffic flow.

The vehicle to be tested is parked with its drive wheels on rollers whose rotational resistance can be adjusted to simulate friction and aerodynamic drag. Masses are added or removed to simulate the weight of the vehicle. The Blower mounted in front of the vehicle provides the necessary cooling. The measurement of the emission levels is based on the simulated driving pattern that progresses through a defined driving cycles incorporating various vehicle speeds. The exhaust gases produced during this driving cycle are collected for the analysis of the pollutants masses at the end of the cycle. The methods of collecting the exhaust gases and the process for determining emissions have largely been standardized in various countries. Regulations governing exhaust emissions are supplemented by the limits placed on evaporative losses from the fuel system.

On diesel vehicles, determining the quantity of the particulate productions is the most important thing.

Two standard methods are used – the filter method specifies the quantity of the exhaust gases drawn through a filter element. The degree of the filter discoloration then provides an indication of the amount of the particulate contained in the exhaust gas.

In the absorption method the capacity of the exhaust gas in indicated by the degree to which it blocks the passage of beam of light that shines through it. The measurement of diesel engine smoke is relevant only if the vehicle is under load, since it is only when engine is under load that the emission of significant levels of particulate matter occurs.



a) For the US federal test (here with a Venturi system)
b) For the Europe test (here with rotary-piston blower)
1. Chassis dynamometer, 2. Inertial mass, 3. Exhaust gas,
4. Air filter, 5. Dilution air, 6. Radiator, 7. Sampling venturi tube
8. Gas temperature, 9. Pressure, 10. Venturi tube, 11. Blower,
12. Sample bags, 13. Rotary-piston blower, 14. System outlet
ct Emissions in transition phase, s Emissions in stabilized phase,
ht Emissions during hot test.

Fig. 1: Test Setup

The two different testing procedures are used simultaneously – first measurement under full load is carried out in which chassis dynamometer is tested with the specified test course as given in fig:1. Secondly measurements are made under conditions of acceleration for pedal depressions calculated and the load applied by the flywheels masses of the accelerating engine taken in to account. The results vary according to both the test procedure and the type of the test vehicular air pollution and are given in Table 1

Table 1 : Composition and Temp. Of diesel exhaust gas

Exhaust gas components and Temperature		At idle	At maximum Output
Nitrous Oxide (NOx)	Ppm	50…200	600…2500
Hydrocarbons (HC)	Ppm, C1	50…500	<50
Carbon Monoxide (CO)	Ppm	100…450	350…2000
Carbon Dioxide (CO2)	Vol. %	…3.5	12…16
Water Vapor	Vol. %	2…4	…11
Oxygen	Vol. %	18	2…11
Nitrogen, etc.	Vol. %	Residual	Residual
Smoke Number, passenger cars		SZ=M 0.5	SZ=2…3
Exhaust Gas Temperature downstream of exhaust valve	°C	100…200	550…750

This cannot be ignored. Studies have also revealed that a stationary vehicle, with its engine switched on, emits seven times more smoke that a vehicle moving smoothly on the road. Thus a traffic flow has to be made smooth by reducing congestion on roads due to encroachments and wrongly parked cars.

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Constructing better roads and maintaining them properly will help. As we have seen, apart from containing vehicular pollution, the above measures will improve the cost-economics of fuel consumption.

The playing of very old vehicles is another factor in the increase of the air pollution. Therefore, such vehicles have to be phased out in planned manner. In the meantime retrofitting old vehicles with emission control devices could be carried out. All these could mean a higher cost of transportation for individuals. This will also affect economy as a whole. But it's your choice, whether you want to spend more to get clean air to fight the illness caused by the air pollution. The implementation of Euro 1 and Euro 2 norms has not come a day too soon. A petrol driven four-wheeler which adheres to Euro 2 norms, depending upon its engine capacity, would emit two to three times less carbon monoxide and three to four times lower levels of hydrocarbons and nitrogen oxides than the currently stipulated levels.

Depending upon gross vehicle weight, its diesel counterpart would be required to meet emission norms that compare to present levels, and are 1.2-2 times sticker for carbon monoxide; double this value for nitrogen oxides (NOx). Notably for the first time in India, emission norms have also been set for particulate matter. The ability of Indian automobile manufacturers to produce vehicles that adhere to Euro 2 norms raises an important question. Why not implement this standard for entire country?

Notwithstanding the gains achieved by the introduction of these new vehicles emission norms, the issue of pollution by the existing fleet of old-technology vehicle still remains. Estimates show that 70 percent of the cars are from the pre-catalytic converter era. It has been established that catalytic converters substantially reduce emissions of carbon monoxide and hydrocarbons. Similarly the current set of diesel vehicles on tour roads emit large amount of particulate matter, NOx and sulpher dioxide. Of great concern are the fines, respirable particles of 10 and 2.5 microns (PM 10 and PM 2.5) which carry toxic heavy metals with them. It is time for our government to set standards to particularly address PM 10 and PM 2.5 emissions. The answer may lie in control technologies such as particulate traps, oxidation catalysts, and NOx catalytic controls. Further given the poor maintenance of vehicles in India, there is a tendency for vehicles to pollute as they get older. The solution is to check and produce periodic fitness certification for all such vehicles, and accordingly plan a line of action. These norms were set for regulating vehicular emissions in Europe. The norms are expressed in terms of the weight of the pollutants such as carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NOx) and particulate matter (PM) emitted per kilometer of vehicular run. These ceilings have been fixed for various categories of the vehicles. For instance, there are particular emission levels for petrol driven vehicles and other for diesel driven vehicles. Euro 1 norms have been applicable from the year 2000 and Euro 2 from 2002.(Table no. 2)

The environment is major area of concern, today the world over. The problem has attacked attention in our country too, as is evident from the concern voiced by the public and recent judgments of the Supreme Court. The Air quality has deteriorated because of toxic substance from many sources like industries, automobiles and refrigeration / air-conditioning equipment , to name a few. All combine to lead the human race towards environmental disasters like acid rain, photochemical smog, ozone layer depletion and other ecological imbalances. Human beings are the immediate victims – suffering from head ache, dizziness, eye irritation brain damage respiratory problems, cancer, kidney damage and cardiac- related deaths.

The first ever step to control emissions was taken in California in the year 1964, by specifying emission control systems on cars. In the same year, emission control norms were being setup in the Europe and Japan. In the subsequent two decades, norms became more comprehensive the implementation procedure was fine – tuned and structural frame work was created. The current decade has seen these norms being tightened, and also the adoption of a long term agenda. Europe introduced the Euro series of norms.

Table no. 2

Euro I	Euro 2 1992	Euro 3 1995	Euro 4 2000	2004
NOx	8	7	< 5	< 3
CO	4.5	4	2.5	1
HC	1.1	1.1	0.7	0.5
PM	0.36	0.15	< 0.10	< 0.10

The first piece of legislation in India to control pollution was the Air Pollution Act of 1991. The permissible levels of gaseous automobile exhaust emissions were tightened in 1996. India follows the European standards for emission norms and is given in Table no. 3 and Table no.4. For commercial vehicles with diesel engines, the norms are based on the European legislation.

Table no. 3

Pollution Limits for Conformity		
	Type Approval	Production
CO (g / Kw.hr)	4.5	4.9
HC (g / Kw.hr)	1.1	1.23
NOx (g / Kw.hr)	8	9.0
PM(g/Kw.hr) For engines with power exceeding 85 Kw	0.36	0.4
PM (g/Kw.hr) for engines with power not exceeding 85 Kw	0.36	0.4

The Indian government had set April 2000 as the date to implement the next set of emission standards that will apply to all vehicles manufactured on or after that date. The new vehicles brought out by the Indian auto industry have brought down emission levels by as much as 80 percent as compared to 1989, but it is the older vehicles in use that are the main culprits. The industry has acquired, developed, and adapted new technology, and reengineered itself to produce increasingly cleaner vehicles- Low emission Vehicles (LEVs) in 1996, and Ultra Low Emission Vehicles (ULEVs) by 2000. Total emissions have come down from 360 tones per day to 70 tones per day. During the control period, new vehicle emissions from Emission Control Vehicles (ECV), Low Emission Vehicles (ULEVs) are as outlined below.

A rigorous maintenance schedule by the owner and genuine certification by authorized service stations would be the key elements of any such effort.

Even with the best of the maintenance standards, older vehicles may still cause an unacceptable level of pollution. The Motor Vehicles Act of 1988 and the Central Motor Vehicles Rules of 1989 place no limit on the age of vehicles plying on the Indian roads and there is also a lack of any provision that addresses the issue of the scrapping of old commercial vehicles being challenged in a court of law.

Moreover, the courts directive does not apply to old personal vehicles. Perhaps the public debate over the scrapping of old and polluting vehicles, commercial or personal should be initiated. The time has also come to shift part of the air pollution debate to the prevailing fuel quality standards. Oil refineries here still produce diesel with high levels of sulpher, and leaded petrol is, even now, a reality.

More ever, fuel adulteration is rampant. For vehicles to confirm to Euro I and II norms, it is imperative that petrol and diesel adhere to specific fuel properties. Substituting lead in petrol by octane boosters would increase the octane value and reduce emissions of toxic substances such as benzene, toluene, and xylene.

Table no. 4

EURO NORMS							
PROGRESSION OF EURO NORMS FOR PASSENGER CARS IN EUROPE (G / KM)							
Description	Effective year of implementation		CO	HC	NOX	HC +NO	Particulate matter
	Europe	India					
Petrol							
Euro 1	1993	2000	2.72	--	--	0.97	--
Euro 2	1996	2003	2.20	--	--	0.50	--
Euro 3	2000	N.A.	2.30	0.20	0.125	--	--
Euro 4	2005	N.A.	1.0	0.10	0.08	--	--
Diesel							
Euro 1	1993	1996	2.72	--	--	0.97	0.14
Euro 2	1996	2000	1.06	--	0.566	0.71	0.080
Euro 3	2000	N.A.	0.64	--	0.50	0.56	0.050
Euro 4	2005	N.A.	0.50	--	0.25	0.30	0.025
For indirect injection engines and direct injection engines level of emission standards are different .Euro 3 and 4 standards in Europe have not received final approval. The Norms presented here are based on the proposals, which are presently making the rounds in official European bodies.							

Further, increased use of clean substitute fuels such as oxygenated blends, compressed natural gas, and propen in fleet vehicles like buses, taxies, three wheelers should be prompted. Thus the crucial role of oil refineries in improving air quality cannot be overstated. The solution lies in collaboration between automotive & oil companies. The European Program on Emission, Fuels and Engine technology has recognized this view, which addresses the vehicle and fuel systems as a whole.

III. CONCLUSION

Imposition of specific norms, rules and regulations are all dependent on government policies. What is our duty in controlling these emissions, for we play our vehicles on the roads? Firstly, we should obey the rules, regulations, and norms set by the government so that we lend a helping hand in fighting the consequences of pollution. Secondly, we should take care of our vehicles and see that the emission levels meet the limits. This can be done by properly maintaining the vehicle and for that you need to go through the service manual or consult an expert.

Here are some guidelines:

1) Engine Oil- Replace engine oil at regular intervals (every 5000 km). Use the specific grade of oil recommended by the manufacturer depending on the type of the vehicle-either petrol or diesel.
2) Filters- Oil filters; fuel filters and air filters of branded quality should be used and replaced at intervals.
3) Engine should be tuned properly. The air-fuel mixture should be adjusted accordingly.
4) In the case of diesel engines see that the fuel injection pump works properly. Servicing of the fuel injection pump and fuel injectors at regular intervals is advised.
5) Get your emission levels checked regularly. Expert professionals or authorized service stations should be consulted for better knowledge of your vehicle.

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AUTHORS PROFILE

Prof. Mahajan Sharad R. completed his B.E. In Automobile Engineering, M.E. In Energy Systems, From Karnataka University and Ph.D. In Mechanical Engineering. Presented and published 14 national level papers and 7 international journals. Taught various subjects in Automobile Engineering. He is having 24 years of teaching experience .