

Program For Estimation Of Emission For Different Vehicle Category

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Abstract—Human activities generate three broad sources of air pollution: stationary or point, mobile, and indoor. In developing countries such as India especially in the rural area, indoor air pollution from using open fires for cooking and heating may be a serious problem. Industries, power plants etc. are the cause of stationary air pollution. But in urban areas both developing and developed countries, it is predominantly vehicular pollution that contributes to overall air quality problem.

Keywords—Automobile, pollution, Emission factor, Different source of pollution, Program for estimation of Emission.

INTRODUCTION

The pollution from vehicles is due to discharges like CO, unburned HC, Pb compounds, NO_x, and Suspended Particulate Matter (SPM) mainly from the tail pipes. The Hindustan times, a leading Indian daily has conducted a survey and forthcoming results suggests a rise of 8-10 % in motorized vehicles in the major metropolitan cities of the country which would cause a large amount of air pollution in India.

The first Indian emission regulations were idle emission limits which became effective in 1989. These idle emission regulations were soon replaced by mass emission limits for both petrol (1991) and diesel (1992) vehicles, which were gradually tightened during the 1990's. Since the year 2000, India started adopting European emission and fuel regulations for four-wheeled light-duty and for heavy-duty vehicles. Indian own emission regulations still apply to two- and three-wheeled vehicles.

India has notable successful initiatives are: conversion of public transport from diesel to CNG in Delhi, shifting from leaded to unleaded Petrol in India. Still the pollution problem in urban cities may continue due to increasing vehicular population, which is outpacing any such measure and road network development.

TABLE 1.1: DIFFERENT POLLUTANTS EFFECTS ON HUMAN HEALTH

POLLUTANT	EFFECT ON HUMAN HEALTH
Carbon monoxide (CO)	Affects the cardio vascular system, exacerbating cardiovascular disease symptoms, particularly angina; may also particularly affect fetuses, sick, anemic and young children, affects nervous system impairing physical coordination, vision and judgments, creating nausea and headaches, reducing productivity and increasing Personal discomfort.
Nitrogen Oxides (NO _x)	Increased susceptibility to infections, pulmonary diseases, impairment of lung function and eye, nose and throat irritations.
Carbon dioxide (CO ₂)	Headache, sweating, increased blood pressure, coma, convulsions etc.
Hydrocarbon (HC)	Brain damage, coma, Dizziness

Emissions from Petrol Vehicles

Two wheelers in India using petrol are mainly of three types: 4-stroke, 2-stroke and without gear. The incomplete combustion of petrol due to an imbalance in the air-fuel ratio leads to emissions of CO and HC especially from 2-stroke engines. The NO_x, however, are formed due to high combustion temperature and availability of oxygen and nitrogen in the combustion chamber, whereas aldehydes result from the partial oxidation of HC. Table 1.2 shows the various sources of emissions in different cases.

Vehicle Norms in India

Emission norms for all categories of petrol and diesel vehicles at the manufacturing stage were introduced for the first time in India in 1990 and were made stricter in 1996. When the 1996 norms were introduced, it resulted in certain

models being withdrawn from the market. With Stage I India 2000 emission norms coming into place, the cost of developing suitable technology has remained high.

For two-/three-wheelers the emission norms are recommended to be the same in the entire country

For new vehicles:

Bharat Stage II norms throughout the country from April 1, 2005

Bharat Stage III norms to be applicable preferably from April 1, 2008 but not later than April 1, 2010.

For reducing pollution from in-use vehicles:

New pollution under control (PUC) checking system for all categories of vehicles to be put in place by April 1, 2005

Inspection & maintenance (I&M) system for all categories of vehicles to be put place by April 1, 2010

Performance checking system of catalytic converters and conversion kits installed in vehicles to be put in place by April 1, 2007

Available studies on Indian traffic

ARAI (The Automotive Research Association of India) draft report (2007) on "Emission factor development for Indian vehicle" have detailed studies on the identification of factors responsible for vehicular emission, reduction measures, improving fuel quality and achieving desired ambient air quality. Effects of different transport fuel parameters are summarized in the draft report, 2007. Study mentions about the pollutants discharged from transport sector evaluated for the years 2000, 2005, 2010.

Total emission from any pollutant (E_{total}) was related as a sum of hot (E_{hot}) and cold emissions (E_{cold}). $E_{total} = E_{hot} + E_{cold}$

Total Emission from any pollutant (E_{total}) under different driving conditions related with respect to urban (E_{urban}), rural (E_{rural}) and highway ($E_{highway}$) driving emissions.

$E_{total} = (E_{urban}) + (E_{rural}) + (E_{highway})$

Calculation of the total emission is made by combining each vehicle category with appropriate emission factors.

Gokhale and Pandian (2007) developed a semi empirical box model for predicting the emissions generated from road side and at intersections. The emission rate is not only affected by the increase in the vehicular population but also by the constantly changing traffic flow patterns and the vehicle driving modes.

Available International literature:

Trozzi, et al., (1996) have taken into account the Emission with speed frequency distribution which is related to traffic conditions.

$E_{ijl} = h_{jl} v_{jl} [1 + B_{jl}(Q_{ijl} - 1)] [\sum_{k=1.13} d_{jkl} F_{ijkl}^{hot}]$ [refer page xii for abbreviations]

Ahn, et al, (2002) considered instantaneous speed and acceleration levels and developed a model which estimated the vehicle fuel consumption and Emissions. That model can be integrated into traffic network simulators to make better policies, traffic signal coordination.

Ning, and Cheung, (2004) have done experimental studies regarding emission of vehicles in idle condition. Pollutant Concentration is high under idle condition due to poor combustion condition inside the engine cylinder. Haan, and keller, (2000) in their study developed the instantaneous emission modeling. their studies concluded that no general statistical model could be identified which completely resolves the influence of driving 'dynamics' on emission level, the only possible method to ensure that the emission matrix is representative for the 'dynamics' level in question seems to be by Conducting measurements.

Anilovich and hakkert, (1996), have done survey of vehicle emission in Israel related to vehicle age and concluded that there is explicit co relation between the emission and the vehicle age. The measurement showed that sample demonstrates poor compliance that worsens with the age. The analysis conducted indicates that maintenance of vehicle engines and test performance must be improved with respect to vehicle emission control.

Program for estimation of emission for different vehicle category

Program Input: Vehicle type, Vehicle velocity, Engine Size, Distance run

Program Output: CO % (by Vol.), CO₂ % (by Vol.), HC ppm, NOx ppm\

C++ Code:

```
#include<iostream.h>
#include<conio.h>
void main()
{
double nox, hc, type, vel, dist, es;
double co, co2;
cout<<"\nEnter the vehicle type\n1 two wheelers\n2 cars\n";
cin>>type;
if(type==1)
{cout<<"\nEnter the engine size 100cc, 150cc, 180cc only \n"; cin>>es; cout<<" cc\n";
cout<<"\ndistancerunned (Age)\n"; cin>>dist; cout<<" km\n";
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cout<<"\nEnter velocity for which Emission is to be estimated\n"; cin>>vel;cout<<" km";
if(es==100)
{ if(dist<2000)
{ co=-0.0037*vel+0.1734; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.0316*vel+3.8587; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=0.1115*vel+5.5333; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-3.967*vel+187.33; cout<<"\nHC is "<<hc<<" ppm\n";
}
else if(dist>=2000&&dist<5000)
{ co=-0.0054*vel+0.3107; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.0817*vel+3.0147; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=1.0764*vel+2.8; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-0.3988*vel+64.867; cout<<"\nHC is "<<hc<<" ppm\n";
}
else if(dist>=5000&&dist<10000)
{ co=-0.0102*vel+0.6464; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.082*vel+3.398; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=1.4255*vel-2; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-0.5321*vel+71.13; cout<<"\nHC is "<<hc<<" ppm\n";
}
else if(dist>=10000)
{ co=-0.0171*vel+0.8991; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.0632*vel+4.45; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=0.8667*vel+26.667; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-0.3782*vel+36.2; cout<<"\nHC is "<<hc<<" ppm\n";
}
}

else if(es==150)
{ if(dist<2000)
{ co=-0.0056*vel+0.2751; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.127*vel+2.85; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=1.214*vel+35.4; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-2.0618*vel+151.8; cout<<"\nHC is "<<hc<<" ppm\n";
}
else if(dist>=2000&&dist<5000)
{ co=-0.0211*vel+1.0475; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.0825*vel+5.268; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=2.7285*vel-21.9; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-1.1952*vel+127.47; cout<<"\nHC is "<<hc<<" ppm\n";
}
else if(dist>=5000&&dist<10000)
{ co=-0.0251*vel+1.185; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.137*vel+2.9; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=3.11*vel-26.26; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-1.0606*vel+118.07; cout<<"\nHC is "<<hc<<" ppm\n";
}
else if(dist>=10000)
{ co=-0.0229*vel+1.1273; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.1412*vel+2.7; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=3.195*vel-33.26; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-0.1515*vel+17.47; cout<<"\nHC is "<<hc<<" ppm\n";
}
}

else if(es==180)
{ if(dist<2000)
{ co=-0.0179*vel+0.9723; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.0263*vel+4.2047; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=1.6048*vel+4.0667; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-1.9018*vel+177.4; cout<<"\nHC is "<<hc<<" ppm\n";
}
}

```

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}
else if(dist>=2000&&dist<5000)
{co=-0.0212*vel+1.0101; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.066*vel+5.588; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=2.8109*vel-23.4; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-1.7988*vel+151.87; cout<<"\nHC is "<<hc<<" ppm\n";
}
else if(dist>=5000&&dist<10000)
{co=-0.0203*vel+1.0167; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.1438*vel+2.5987; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=3.8048*vel-22.33; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-1.2424*vel+141.27; cout<<"\nHC is "<<hc<<" ppm\n";
}
else if(dist>=10000)
{co=-0.0096*vel+1.1945; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.1414*vel+2.6367; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=4.5588*vel-39.26; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-0.7745*vel+81.6; cout<<"\nHC is "<<hc<<" ppm\n";
} } }
else if(type==2)
{ cout<<"\n Enter the speed for which exhaust has to be estimated\n";
cin>>vel;cout<<" km";
co=-0.0537*vel+6.0438; cout<<"\nCO is "<<co<<" % by volume\n";
co2=0.1152*vel+6.3151; cout<<"\nCO2 is "<<co2<<" % by volume\n";
nox=4.24*vel+9.8571; cout<<"\nNOx is "<<nox<<" ppm\n";
hc=-4.4932*vel+438.49; cout<<"\nHC is "<<hc<<" ppm\n";
}
getch(); }

```

CONCLUSION AND FUTURE SCOPE

This study has presented the relationship between different vehicle characteristics such as speed, age, engine size and the emissions of two wheeler and cars. The study showed that at Congested flow there is large emission of CO, which increases with the engine size and vehicle age. Air/Fuel ratio also plays a major role. If air is deficient during combustion results in large amount of CO and HC in the exhausts.

In order to have low emission of hazardous gases regular servicing of vehicles is recommended. Use of new technologies in the coming generation vehicle should be implemented by government. For example, use of Catalytic convertor, now days, in most of the cars have reduced a lot of emission.

The relationship developed may be useful in understanding the emission level of two wheelers vehicles and cars under different flow and speed conditions.

The Future Scope of research may include the emission categorized under vehicle load (as more load with less engine size or vice versa will result in more emission), and with the road quality (as rough road and Smooth road will have effect on engine emission).

Further study also may include estimation of exhaust at the junction which may be done by converting the output from this study to emission factor (gm/km).

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