Idealing of Vehicle at Traffic Signals Lead to Fuel Wastage and Emission

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Abstract

Study carried out in Indore, which is largest city of Madhya Pradesh, with 2.17 million people living there. It is the 14th largest city in India and 147th largest city in the world. With numbers of population and vehicles increasing day by day also increases the load on traffic. Result in excess fuel consumption and pollution. For quantifying the excess fuel consumption and pollution load to the environment by motor vehicles during idling at Traffic signal, studies were carried out at different traffic signal squares of Indore. The selected traffic signal crossings were Mhownaka, Palasia, Regal, Bhowarkua, Gurudwara, Bangali, Vijay nagar, Patlipura, Nehru square and Navlakha. Study reveals that about 3,750 liters of fuel being consumed daily in idling of vehicle. Impatient drivers, old unreliable vehicles and traffic signals not equipped with timer are resulting in addition of 8,662.5 kg of CO2 in atmosphere. Using signal timers and implementing laws against vehicle idling will reduce Wastage and emission.
Keywords: Fuel Wastage, Bharat stage III, CO2 Emission, Traffic Signal, Vehicular Pollution

I. INTRODUCTION

India where population is the root of many problems is also directly linked with fuel consumption. And with increase in affordability index due to economic growth has led to higher aspiration amongst people (especially a need for increased comfort). With the poor public transport, people are moving towards private transportation. The increased use of private transportation has ted to unexpected pressure on the transportation infrastructure. With high numbers of vehicle on signals, waiting time increases. All of these factors cumulatively lead to a situation of heavy traffic congestion at traffic signals and intersections. This results in a very slow traffic movement even when the traffic lights switch green. With no Self-start in vehicle, old and non-reliable vehicles or impatient vehicle owners waiting to zealously seize any opportunities for small advancements leave their engines idling which leads to fuel wastage.

An idling vehicle is not only using up valuable fuel and damaging vehicle's engine, but also causing danger to the environment and a risk to the health of many others[6]. Idle cars produce emissions that have been found to negatively affect respiratory health. Idle vehicles emit pollutants like carbon dioxide. An engine that idles for 10 minutes yields 90 grams of this gas and consumes 0.14 liters of fuel[6]. At idle condition, engine speed gets increases. Engine speed badly affects the environment too. For raising the engine speed from 600 to 1050 rpm, the NO_x, and CO_2 emission increases by 2.5, 2 & 5 times (in grams/ hour) while idling[7]. American Truck Association states that one hour of idling per day for one year results in the equivalent of 64,000 miles in engine wear when adding up all the contributing factors[6].

India been a decked behind other countries in following pollution norms, where Bharat Stage III presently followed by many cities. With higher sulphur content in emission, in coming year the people will suffer not only from health risk but also no place to walk on road. It is just because, in India, the vehicular population in the year of 1951 was just 0.31 Million, in 2009 figure reached up to 115 Million[10] and by 2040, the projected populations of highway vehicles and two-wheelers would be 206 million to 309 million. The Projected fuel demands by the transportation sector of 404 million to 719 million metric tons (8.5-15.1 million barrels per day) and corresponding annual CO_2 emission would be 1.2-2.2 billion metric tons [9]excluding fuel wastage at idling. All these consequences, when cumulated by the gross number of cars, contribute to nationally significant financial costs, environmental pollution and energy consumption figures. [8]There is the need to measure the amount of idling at various traffic junction, so that the cumulative magnitude of the problem of idling can be established and steps can be taken to prevent vehicle idling. The purpose of the study is to assess the idling profile of vehicles and to provide an estimation of CO_2 emission presently in Indore city.

II. MATERIAL AND METHODS

A. Study Area:

The geographical location of Indore is 22.2° - 23.05° North Latitude and 75.25° - 76.16° Longitude. It is the largest city of the Central-Indian state of Madhya Pradesh with an area of 3898 square kilometer, and is situated in the Malwa region. The location of Indore is just south of the Satpura range, at an altitude of 553 meters above sea level. Indore has an area of 214 square kilometers. Indore is located 190 kilometers away from the State Capital, Bhopal, connected with National Highway no.03.

1) *Indore Pollution Index*[14:]

- Indore is No. 1 city in the country with maximum suspended particles in air.
- Indore is 4th city in the country with maximum sulphur dioxide in air.
- Indore is 5th most polluted city in the country.
- In Indore 2,500 people get admitted in hospital due to problem related to air pollution.
- In Indore 1,800 die due to air pollution.
- More than 13 lakh registered vehicles on road in Indore.
- Registration of 4.5 lakh vehicle has already expired.

The selected study areas are given in Table 1.

B. Observation:

The traffic volume survey was conducted to analyze the incoming and outgoing traffic at road junctions (refer table. 1). The survey was carried out for a period of 14 hours per junctions with 15 minute intervals (i.e. once every half an hour) [1].

The traffic count covered two wheeler, private cars, public transport services (Auto-rickshaw, Tata Magic, Maruti van and Mini bus), city buses and transport vehicles such as trucks[1].

The squares were selected where traffic signals were found working. Many squares like Rajiv Gandhi, Bada Ganpati, Mari Mata, Nagar Nigam bus depot and Rajwada squares were not taken into account as there were no traffic signals.

In Table. 2, red signals mentioned were in working condition when one signal go Green.

Table -1: Study areas

S. No.	*Study Area*
1.	*Mhownaka signal crossing*
2.	*Palasia signal crossing*
3.	*Regal signal crossing*
4.	*Bhowarkua signal crossing*
5.	*Gurudwara signal crossing*
6.	*Bangali signal crossing*
7.	*Vijay nagar signal crossing*
8.	*Patlipura signal crossing*
9.	*Nehru square signal crossing*
10.	*Navlakha signal crossing*

Table – 2:
Number of signals & time of red signals at different signal crossing

S. No.	*Traffic Signals*	*Time of Red signals (in second)*	*Time of Green signals (in second)*	*No. of red signals at a time*
1.	*Mhownaka*	*160*	*34*	*4*
2.	*Palasia*	*105*	*35*	*3*
3.	*Regal*	*45*	*30*	*4*
4.	*Bhowarkua*	*120*	*46*	*3*
5.	*Gurudwara*	*60*	*60*	*2*
6.	*Bangali*	*60*	*35*	*3*
7.	*Vijay nagar*	*32*	*36*	*3*
8.	*Patlipura*	*20*	*16*	*3*
9.	*Nehru square*	*16*	*18*	*5*
10.	*Navlakha*	*135*	*40*	*4*

C. Fuel Consumption per Unit Time:

Table – 3:
Idle fuel consumption (ml. /h for Diesel / Petrol and gm. /h for CNG)

S. No.	*Vehicle type*	*Fuel consumption*	*Remark*
1.	*Motor cycle 100cc*	*162*	*4-Stroke*
2.	*Motor cycle 120cc*	*191*	*4-Stroke*
3.	*Motor cycle 150cc*	*205*	*4-Stroke*
4.	*Motor cycle 180cc*	*241*	*4-Stroke*
5.	*Maruti van*	*695*	*Petrol*
6.	*Maruti van*	*563*	*MPFI*
7.	*Tata Indica 1000cc*	*590*	*Diesel*
8.	*Tata sumo*	*717*	*Turbo*
9.	*Esteem*	*740*	*MPFI*
10.	*LCV*	*810*	*Diesel*
11.	*HCV*	*920*	*Diesel*
12.	*Auto rickshaw*	*522*	*CNG*
13.	*Taxi*	*1080*	*CNG*
14.	*Bus*	*3210*	*Diesel*
15.	*Truck*	*942*	*Diesel*

D. CO_2 Emission:

Table – 4:
Data for calculation of CO_2 Emission

Fuel type	*Kg of CO_2 per unit of consumption*
Grid electricity	*43 per kWh*
Natural gas	*3142 per tons*
Diesel fuel	*2.68 per liter*
Petrol	*2.31 per liter*
Coal	*2419 per tons*
LPG	*1.51 per liter*

Source: EPA Report-2011

E. Idle Emission Rates:

The following tables present idle emission factors expressed as grams per hour (g/hr) and grams per minute (g/min) of idle time. Table 5 presents idling emission rates for gasoline-fueled and diesel cars, light-duty trucks, and heavy-duty vehicles, and motorcycles.

Table – 5:
Idling emission rate

Pollutant	*Units*	*LDGV*	*LDGT*	*HDGV*	*LDDV*	*LDDT*	*HDDV*	*MC*
VOC	*g/hr g/min*	*2.683 0.045*	*4.043 0.067*	*6.495 0.108*	*1.373 0.023*	*2.720 0.045*	*3.455 0.058*	*19.153 0.319*
THC	*g/hr g/min*	*3.163 0.053*	*4.838 0.081*	*7.260 0.121*	*1.353 0.023*	*2.680 0.045*	*3.503 0.058*	*21.115 0.352*
CO	*g/hr g/min*	*71.225 1.187*	*72.725 1.212*	*151.900 2.532*	*7.018 0.117*	*5.853 0.098*	*25.628 0.427*	*301.075 5.018*
NOx	*g/hr g/min*	*3.515 0.059*	*4.065 0.068*	*5.330 0.089*	*2.690 0.045*	*3.705 0.062*	*33.763 0.563*	*1.625 0.027*
$PM_{2.5}$	*g/hr g/min*	*N/A^1 N/A^1*	*N/A^1 N/A^1*	*N/A^1 N/A^1*	*N/A^1 N/A^1*	*N/A^1 N/A^1*	*1.100 0.018*	*N/A^1 N/A^1*
PM10	*g/hr g/min*	*N/A^1 N/A^1*	*N/A^1 N/A^1*	*N/A^1 N/A^1*	*N/A^1 N/A^1*	*N/A^1 N/A^1*	*1.196 0.020*	*N/A^1 N/A^1*

Source EPA420-F-08-025 October 2008

F. Percentage of Vehicle Idling at Traffic Signals:

During the observation it was found that 100% heavy vehicles keep their engines idle. 93% of three wheeler were idling because many were not having self-start and remaining impatience drivers were looking for a chance to escape even when the signal is red. Highest percentage of idle vehicle were found between 12 noon to 4, as less number of traffic police are present and people don't kill the engine in search of escaping chance.

Palasia square being all time busy route was not equipped with the traffic timer. Stoppage time of 105 seconds was observed, 80% engines were found idle, while remaining use to start before 45 sec by judging themselves that the signal may go green.

Detailed percentage of idle vehicle is given in table 6. Average percentage of whole day is taken for different categories of vehicles.

All the percentage are approximation which is based on the observation so as to quantify total number of vehicle idling.

Table – 6:
Percentage of vehicles with running engines while waiting for green signal

Square	*Four wheeler*	*Three wheeler*	*Two wheeler*	*Heavy Vehicles*
Mhownaka	*73*	*87*	*83*	*100*
Palasia	*87*	*85*	*92*	*100*
Regal	*93*	*95*	*98*	*100*
Bhowarkua	*78*	*82*	*72*	*100*
Gurudwara	*72*	*78*	*82*	*100*
Bangali	*82*	*89*	*79*	*100*
Vijay nagar	*93*	*97*	*94*	*100*
Patlipura	*92*	*97*	*95*	*100*
Geeta-bhavan	*88*	*87*	*78*	*100*
Nehru square	*97*	*99*	*97*	*100*
Navlakha	*73*	*82*	*68*	*98*

Regal, Patnipura and Nehru square were having high number of engine idle, but still it was not the most polluted area as the stoppage time were very less. Palasia was found as one of the most polluted area. No traffic signal timer, shorter roads resulting in high waiting lines are the reasons.

For knowing the average number of vehicle idle on each square, number of vehicle on square is taken from Table 7 and percentage of idle vehicle from table 6. Value of idle vehicle is obtained (shown in table 8).

Table – 7:
Total number of vehicle on square[1]

S. No.	*Square*	*Two wheeler*	*Car*	*PTS*	*BUS*	*Total*
1.	*Mhownaka*	*21,501*	*1,719*	*3,601*	*350*	*27,171*
2.	*Palasia*	*7,965*	*47,938*	*13,953*	*6,332*	*76,188*
3.	*Regal*	*2,536*	*1,495*	*1,574*	*209*	*5,814*
4.	*Bhowarkua*	*30,816*	*8,486*	*3,874*	*1,288*	*44,464*
5.	*Gurudwara*	*10,323*	*1,102*	*2,780*	*110*	*14,315*
6.	*Bangali*	*25,590*	*8,548*	*2,189*	*1,470*	*37,797*
7.	*Vijay nagar*	*34,272*	*11,983*	*3,680*	*1,770*	*51,705*
8.	*Patlipura*	*41,404*	*5,124*	*5,521*	*701*	*52,750*
9.	*Nehru square*	*1,06,688*	*24,100*	*19,031*	*3,231*	*153,050*
10.	*Navlakha*	*27,053*	*8,622*	*4,969*	*1,775*	*42,419*
	Total	*308,121*	*119,117*	*61172*	*17,236*	*505,673*

III. RESULT AND SUGGESTIONS

Computational tables/sheet have made and estimated fuel consumption been calculated with the help of data collected by the survey. The loss of fuel wastage per vehicle (in milliliter) is determined for each of the signals crossing/intersection separately. For estimation of loss of fuel, following self-generated formula have been used i.e. Amount of fuel wastage = (no. of vehicle on square) X (percentage of no. of vehicle idle) X (time of red signal) X (idle fuel consumption factor in ml/sec). The monetary loss of fuel for each vehicle has been calculated by multiplying fuel loss with the normal cost of fuel at present.

Table – 8:
Number of Idle Vehicles and fuel wastage per day at Different Traffic Signals in Indore

S. No.	*Square*	*Total vehicle in Idling condition per day*	*fuel wastage by two wheeler (Liter)*	*fuel wastage by Car (Liter)*	*fuel wastage by PTS and BUS (Liter)*	*Total fuel wastage (Liter) (approx.)*
1.	*Mhownaka*	*23,051*	*158.6296*	*37.855*	*180.604*	*377*
2.	*Palasia*	*63,236*	*42.7455*	*821.088*	*605.253*	*1469*
3.	*Regal*	*42,908*	*6.2132*	*10.974*	*23.9*	*41*
4.	*Bhowarkua*	*36,905*	*147.9168*	*148.92*	*172.238*	*496*
5.	*Gurudwara*	*11,881*	*28.2162*	*8.9262*	*47.155*	*84*
6.	*Bangali*	*33,072*	*67.387*	*78.8553*	*63.392*	*209*
7.	*Vijay nagar*	*49,634*	*57.27232*	*66.865*	*52.489*	*176*
8.	*Patlipura*	*50,640*	*43.704*	*17.6778*	*37.453*	*98*
9.	*Nehru square*	*150,372*	*91.989*	*70.131*	*108.29*	*270*
10.	*Navlakha*	*34,041*	*137.97*	*159.31*	*250.371*	*547*
	Total(approx.)	*495,740*	*781.98*	*1420.20*	*1539*	*3750(approx.)*

In this study, average fuel wastage per day has been calculated in Indore at selected square, which is approximately more than 3,750 liters per day. There are many more cross-roads where traffic congestion takes place which will surely add up the number of fuel consumption and pollution emission.

From table 4, emission calculations were made and it was found that around 8,662.5 kg of CO_2 emission takes place per day. At the time of this study, sum of time of all vehicle idling was found to be 5900 hrs. Extended idling not only wastes fuel and causes reduction in fuel economy but also excessive idling can create engine wear and carbon soot buildup in the engine and components as Idling produces sulphuric acid which can eat engine's surfaces and components[12].

Idling emission rate is shown in Table 5, which tells that the exhaust fumes released during idling from gasoline and diesel engines contain harmful pollutants including nitrogen oxides, carbon monoxide, volatile organic compounds, and fine particles leading to much more respiratory infections and chronic bronchitis, and trigger asthma attacks, as compared to switched off and restarted engines.

It has been found that 10 seconds of idling is equivalent to restarting the vehicle[13]. So it can be concluded that if the vehicle is made to stop for more than 10-15 seconds, turn-off the engine.

The study reveals unacceptable patterns of vehicular idling and slow traffic movement in Indore city needs rectification through appropriate traffic management, encouraging lane driving, restricting pedestrians traffic to the footpaths, construction of overhead footbridge and extending.

All the traffic points should be provided with the digital timer for red and green signal, so that people can know the waiting period at the traffic points, so that they can turn off their vehicles. There is strong need for the general public education regarding the traffic rule and importance of switching off their vehicles at the time of idling.

There must be law made to restrict vehicle idling for more than five minutes, like "Massachusetts Anti-Idling Law". Which impose punishment if vehicle found idle for more than five minutes[13].

REFERENCES

[1] www.embarq.org_sites_default_files_Study-Para-Transit System-Indore-City_0.pdf
[2] Bansal N. Patel S., Panchal S. (2010), Traffic congestion and fuel wastage due to idling vehicles at crossroads. National Journal of Community Medicine Vol. 1(1) ISSN: 0976-3325
[3] K P Tiwari , R N Singh, J B Balwanshi Fuel wastage and emission due to idling of vehicles at road traffic signals.
[4] http://en.wikipedia.org/wiki/Indore
[5] http://www.citypopulation.de/India-MadhyaPradesh.html
[6] http://www.streetdirectory.com/travel_guide/22317/mileage_and_fuel/how_letting_your_vehicle_idle_can_cost_you_big_money_at_the_pump.html
[7] Brodrick Christie-Joy and Harry A. Dwyer, Farshchi Mohammad , Harris D. Bruce and Foy G. King Jr (2002), Effects of Engine Speed and Accessory Load on Idling Emissions from Heavy-Duty Diesel Truck Engines , Journal of Air & Waste Management Association, volume 52.
[8] http://pollutionfree.wordpress.com/2010/01/10/intelli gent-traffic-lights-and-idling/.
[9] http://www.renault.com/en/groupe/renault- dans-lemonde/pages/renault-en-inde.aspx
[10] The Road Transport Year Book (2007-09) Ministry Of Road Transport and Highway, New Delhi, Transport Research Wing, Govt. Of India, 2011 Volume-I
[11] http://www.epa.gov/otaq/consumer/420f08025.pdf
[12] https://sustainability-ornl.org/documents/ORNL%20Idle%20Reduction%20Guide.pdf
[13] https://www.mtholyoke.edu/ehs/vehicle
[14] Times of India (http://timesofindia.indiatimes.com/city/indore/Air-you-breathe-claims-1800-lives-every-year/articleshow/38410059.cms)