FUEL WASTAGE AND EMISSION DUE TO IDLING OF VEHICLES AT ROAD TRAFFIC SIGNALS

K P Tiwari [1], R N Singh[2], J B Balwanshi [3]

[1]*Assistant Professor, Mechanical Engineering, IIST- Indore, M P, India,* ***kamta.k.tiwari@gmail.com***
[2]*Professor, School of Energy & Environmental Studies, DAVV- Indore, M P, India,* ***rnsingh.seema@gmail.com***
[3] *Research Scholar, School of Energy & Environmental Studies, DAVV- Indore, M P, India,* ***jai764u@yahoo.com***

Abstract

Among the different city of Madhya Pradesh, Indore is one of the biggest one. It has very heavy traffic during day time. Since numbers of vehicles are increasing day by day, which ultimately increase the length of stopping period of vehicles at most of the signals. Situation becomes worst in peak traffic hours. Resulting excess fuel consumption and pollution load to the atmosphere. For quantifying the excess fuel consumption and pollution load to the environment by motor vehicles studies was carried out at different traffic signal squares of Indore. The selected traffic signal crossings were Palasia Main, Palasia-1st signal crossing, Gurudwara signal crossing, Bangali signal crossing, Bhowarkua signal crossing, regal signal crossing, and Mhownaka signal crossing. Study reveals that about 5.9 x 10^5 litre per year petrol & diesel (3.6 x10^5 litre petrol and 2.3 x 10^5 litre diesels) and 1.7x10^5 kg per year of CNG are being wastage by Indore itself. This is resulting addition of 20.2 x 10^5 kg CO_2 in the atmosphere. Extrapolating of these data at Madhya Pradesh state level conclude wastage of 5.6 x 10^6 litre per year petrol plus diesel(3.4 x 10^6 litre from petrol and 2.2 x 10^6 litre from diesel) and 1.6 x 10^6 kg/year CNG. This is resulting addition of about 18.7 10^6 kg CO_2/year. This excess pollution load to the atmosphere and wastage of fuel could be minimising by rescheduling of office/ school timing.

Keywords: F*uel Wastage, CO_2 Emission, Traffic Signal, Vehicular Pollution.*

----------***----------

1. INTRODUCTION

Vehicular pollution and fuel wastage is directly or indirectly linked with the population. Due to increasing population, numbers of vehicles are increasing, which results in increasing fuel consumption. This is also responsible for road traffic problems. Increasing traffic problems not only responsible for degrading of our atmosphere, it is also responsible for wastage of fuels. Traffic signals have become an invaluable tool in ensuring smooth flow of motor vehicles at crossings. Consequently, with orderly flow of traffic, we lose huge quantity of fuel at crossings and creating the pollution for already polluted environment. This is because people often leave the engine of their vehicle running while waiting at signals (Idling). During no load running mode (idling) of the vehicular engine, the air supply is restricted by the nearly closed throttle and the suction pressure is very low. This low pressure condition gives rise to backflow of exhaust pressure, results an increase the amount of residual gases and reducing the fresh mixture inhaled [5]. Idling increases dilution causes the combustion to be erratic, irregular and slow, so obtained, results in poor thermal efficiency and higher exhaust emission. At part load and idling the compression ignition engine presents even more favourable relative fuel consumption than the spark ignition engine [5, 9]. Engine model year, engine speed, and accessory load conditions are also greatly polluted the atmosphere. An engine that idles for 10 minutes yields 90 grams of this gas and consumes 0.14 litres of fuel [13].

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 NOx, and CO2 emission increases by 2.5, 2 & 5 times (in grams/ hour) while idling [4]. 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 [1]. It is expected that, Country like India, rapid expansion, urbanization and industrial development united with fast population growth has directed to bang in the number of vehicles in recent years even doubled in some cities in the last one decade [8]. As for concern the roads infrastructure and traffic flow system yet has not been premeditated to handle such vehicular traffic load, foremost to high volume traffic (congestion) at tiring signal in Indore. This problem is further intensified due to large commercial industries establishment of Pithampur Industrial Area and Dewas Industrial area near Indore city. These all factors lead heavy traffic congestion at traffic signals and crossings. Consequently, very deliberate traffic drives even when the green lights on, particularly for Regal to Palasia. From this study, it is expecting that if an annual growth rate of around 20% in recent years maintained, the Indian car market would be one of the most buoyant in the world and is expected to become the fourth biggest within three years [11]. In the

coming year the people will suffer not only from health risk but also for a 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 [15] 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 CO2 emissions would be 1.2-2.2 billion metric tons [11] excluding fuel wastage at idling. Global consultancy firm Ernst & Young, states that the Indian market will clock the fastest compound annual growth rate (CAGR 14%) between 2009 and 2020, and it would be more than twice that of China and the triad of North America, Europe and Japan [12]. This study shows that two wheelers play crocodile's roll for environment due to enormous fuel wastage (see table.14).
Extremely busy traffic junctions of Indore city were selected. Fuel wastage due to bad traffic systems can be reduced by increasing the new vehicles fuel economy and optimizing the traffic control measures. There has been an approved ban on truck idling in the many counties as part of their clean-air attainment plan. To attain the effectiveness of idling-reduction policies, such as incentives and bans, it will be necessary to estimate the emissions reductions associated with the decreased idling [4]. The objectives of the study are concise as follows:

(i) Quantification of fuel wastage during idling of vehicles at traffic signals.
(ii) Assessment of total fuel wastage in Indore and MP during idling of vehicles at traffic signals.
(iii) Guesstimate of benefits in terms of fuel savings to be accrued by implementing improvement measures

This article provides an estimation of CO2 emission through consumption of extra fuel at the traffic signals, while idling. Indore itself is adding much of CO2 day by day due to idling of vehicles (see table.6) by which atmosphere degrading readily. Vehicle Transportation is one of the major contributors to man-made polluting emissions [16] because India stands 6th position amongst top ten oil consuming countries of the world [2]. During 1990 to 2004, carbon dioxide emissions from the world's transport sector have increased by 36.5% [8].

2. MATERIALS AND METHODS

2.1 Study Area:

The geographical location of Indore is 22.2^{o} - 23.05^{o} North Latitude and 75.25^{o} - 76.16^{o} Longitude. It is the largest city of the Central-Indian state of Madhya Pradesh with an area of 3898 square kilometre, 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 kilometres. Indore is located 190 kilometres away from the State Capital, Bhopal, connected with National Highway no.03.The seven study areas (refer to table.1) were selected on the basis of traffic volume crossing in the Indore city. The selected study areas were:

2.2 Observations

Observation conducted for 12 hours (8.00AM to 10PM) at different traffic signals (refer to table.1) of Indore city and made a survey for a week (Monday to Sunday) to estimate the extra fuel consumption due to idling of the vehicles while waiting for green Signals. Through the observations, the total fuel wasted in a day, month & year at traffic signals were estimated for Indore as well Madhya Pradesh (refer to table.12). For estimating the fuel wastage at traffic signals in Indore, seven traffic signals of varying traffic congestion were selected. These squares are spatially scattered all over the city. A traffic volume computation sheet (refer to table 10&14) was prepared containing detailed classification of vehicles. Eleven types of vehicles including seven non-commercialised and four commercialised vehicles were studied at the traffic signals. Vehicles fuel consumption were classified into two category based on the fuel type and engine size (refer to table.13). To know the category wise traffic volume at the crossing, a 12-hour classified traffic volume survey was conducted at crossing. Numbers of red signals mentioned in table.2 were only in working condition. If the time is more than 12- 15 seconds they can switch off their vehicles (PCRA, New Delhi).

Table.1: Different observation and study areas

S.No.	Study Area
1.	Palasia Main signal crossing
2.	Palasia-1signal crossing
3.	Gurudwara signal crossing
4.	Bangali signal crossing
5.	Bhowarkua signal crossing
6.	Regal signal crossing
7.	Mhownaka 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)	No. of red signals at a time
1	MHOWNAKA	45	4
2	PALASIA MAIN	85	4
3	PALASIA 1	60	3
4	REGAL	45	4
5	BH0WARKUA	60	4
6	GURUDWARA	80	2
7	BANGALI	60	4

2.3 Test Procedure of Idling Fuel Consumption per Unit Time:

For idling Fuel consumption investigations, flow measurement system containing FP 213S detectors DF 210A flow meters by M/s. Ono Sokki, Japan has been employed for 2-wheelers (2-stroke and 4-stroke engine). For four wheeler flow measurement system containing FP 214OH flow detector and DF 210 has been employed. For fuel consumption of gaseous fuels CNG and LPG, vehicle tanks were filled completely and the engines were run at idling conditions. For accurate result, the workout was repeated a number of times to determine the average fuel consumption of these CNG Vehicles during idling. The Idling fuel consumption in millimetre/hour and gram/hour for different vehicles is given in table-3. One idle vehicle emits gases like carbon dioxide and on eliminating idling would cut about 196,000 metric tons of carbon dioxide from passenger cars and trucks alone, calculated from Environmental Protection Agency estimates and Bureau of Motor Vehicles statistics [1, 7].

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

Idling fuel consumption (ml/h and gm/h)			
S.No.	Vehicle type	Fuel consumption	Remark
1	Motor cycle 100cc	162	4-Stroke
2	Motor cycle 125cc	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

2.4 CO_2 Emission, SPM, SO_2 and No_x Level near Main Squares of Indore City.

Since 33 percent of the total vehicles in India are within 23 metropolitan cities, rapid motorization is focused in urban areas, where high population density amplifies the impact of motorization [20]. This leads to high air pollution levels from the transport sector as discussed, with significant exposures and health impacts. Total CO2 emission from well to exhaust in Indian roads from 2005 to those projected in 2035 [8]. CO2 emission due idling of vehicle in Indore have been estimated which shown in table 11.

Sampling of Suspended Particulate Matter (SPM) and gaseous pollutants (SO2 and NO2) was carried out at four selected locations in Indore city using High Volume Samplers (APM 430, Envirotech Instruments Pvt, India) and sampling was conducted as per CPCB manual. The observed value of SPM, SO2 and NOx is given in table-5. The SPM level at Bhowarkua square was observed significantly higher than other three locations such as Palasia main and Palasia1, Mhownaka and Bangali square. Whereas the SPM level at Bangali square was lowest while SO2 and NOx level observed higher than other three location sites.

Table.4: Data for calculation of CO2 Emission:

Fuel type	Kg of CO2 per unit of consumption
Grid electricity	43 per kWh
Natural gas	3142 per tonne
Diesel fuel	2.68 per litre
Petrol	2.31 per litre
Coal	2419 per tonne
LPG	1.51 per litre

Source: EPA Report-2011

Table 5: SPM, SO2 and NOx level at main squares of Indore city

Sampling Stations (crossings)	Average results in gm/m3		
	SPM (gm/m3)	SO2 (gm/m3)	NOx (gm/m3)
Bhowarkua	1446.77	18.74	25.34
Palasia Main &Palasia1	1386.0	16.8	23.77
Mhow Naka	1296.18	15.6	23.58
Bangali	607.19	31.37	42.16

2.5 Percentage of Vehicles with Running Engines While Waiting For Green Signals:

During the observation facts were come that about 90% of idle four wheeler vehicles found in Regal crossing during 8AM to 2PM (refer to table.6) because it is locate at central Indore however during 2PM- 10PM almost 98% of vehicles found in idle condition. Great number of three wheel vehicles was in idle condition at all crossings. About 92% of three wheel vehicles were in starting condition while waiting for green signal during 8AM to 10PM at Palasia Main because Palasia crossing is in all time busy route (AB Road) and many shopping malls and market are situated near the Palasia. Almost all two wheeler at every crossings of Indore found idle. Consequently 80 to 98% two wheeler was in idle condition during 12hrs observation of sevens crossing for seven days (refer to table.6). Limited number of heavy vehicles was found at crossing except Bhowarkua and Bangali crossing which are near transport Nagar but in general, all heavy vehicles (Bus and Truck) found in idle condition.

It observed that Palasia-1 was most crowded crossing where more than 3400 two wheeler (100cc, 125cc, 150cc and 180cc), 1400 three wheeler (auto rickshaw and other goods three wheeler) and 2800 four wheeler (800cc and 1000cc) found idle (refer to table.5) during 8AM to 10 PM per day. In this period of time, 3072 number of two wheeler and 604 numbers of heavy vehicles found idle excluding vehicle in traffic jam. Poor Traffic flow system experienced near the Bengali crossing just because of Bangali square is in Ring Road and connected with Palasia square and Khajrana Ganesh Temple. An effective traffic control needed between 8AM to 10AM& 4PM to 6PM because many numbers of idle vehicles taken into account at that period (refer to table.7, 8). Schools, colleges and offices are opened and closed at this duration

Table.6: Percentage of vehicles with running engines while waiting for green signals

Time	Square	Four wheeler	Three wheeler	Two wheeler	Heavy Vehicles
8AM-2PM	Gurudwara	70	75	77	100
	Bangali	80	87	88	100
	Mhownaka	78	78	89	100
	Palasia Main	81	80	85	98
	Palasia1	87	92	95	100
	Regal Square	90	88	97	100
	Bhowarkua	50	70	80	100
2 PM -10.00 PM	Gurudwara	85	90	95	100
	Bangali	98	96	89	100
	Mhownaka	86	95	98	100
	Palasia Main	97	98	98	95
	Palasia1	95	97	93	100
	Regal Square	97	93	90	100
	Bhawarkua	90	95	97	100

In the morning time, palasia1, Mhownaka and Bangali square are most crowded crossing where more than 700 hundred two wheeler being passed and caused fuel wastage at idling within two hours per day. Three wheelers and four-wheeler were also taken into account in idle condition. Palasia1 is the one of most pollution caused in Indore city. More than that of controlling parameters has to be developed to minimise the fuel wastage and global warming potential in Indore

Table.7: Total numbers of idle vehicles during 8 AM to 10 PM per day at selected squares of Indore city.

Time	Square	Two wheeler	Three wheeler	Four wheeler	Heavy Vehicles
8AM-10PM Per day	Gurudwara	2395	876	1579	153
	Bangali	3072	882	1798	604
	Mhownaka	2821	1159	1991	414
	Palasia M	2590	992	2554	207
	Palasia1	3473	1446	2808	209
	Regal Sq	2536	845	1495	158
	Bhowarkua	2233	807	1451	547

Table.8: Total numbers of idle vehicles per day during 8 AM – 10 AM and 4PM - 6 PM at selected squares of Indore city.

Time	Square	Two wheeler	Three wheeler	Four wheeler	Heavy Vehicles
8AM-10 AM	Gurudwara	622	208	372	38
	Bangali	789	193	415	155
	Mhownaka	739	276	493	138
	Palasia M	704	252	653	49
	Palasia1	927	352	677	57
	Regal Sq	644	229	349	34
	Bhowarkua	604	202	373	140
4 PM -6 PM	Gurudwara	599	195	370	35
	Bangali	716	204	412	153
	Mhownaka	727	269	483	132
	Palasia M	695	255	650	50
	Palasia1	914	357	671	52
	Regal Sq	649	219	339	37
	Bhowarkua	602	193	382	139

3. RESULTS AND DISCUSSION

Computational tables/sheet have made and estimated fuel consumption been calculated with the help of data collected by the survey. Fuel wastage by the type of fuel (CNG, petrol and diesel) was estimated by employing the traffic data generated through the observations/surveys (refer to table 14). The loss of fuel wastage per vehicle (in millilitre) is determined for each of the signals crossing/intersection separately. For 12hour per day observation, this 12hrs duration have broken down in four size of time i.e.8.00AM-10AM, 10AM-2.00PM, 2.00PM-6.00PM and 6.00PM-10PM for seven days (refer to table.10). For estimation of loss of fuel, following self-generated formula have been used i.e. Amount of fuel wastage = (no. of idle vehicle) X (time of red signal) X (idle fuel consumption factor in ml/sec).Vehicular fuel consumption during different hours of the day was calculated separately.

The monetary loss of fuel for each vehicle has been calculated by multiplying fuel loss with the normal cost of fuel (refer to table.13). The price of petrol, diesel and CNG were taken as Rs.78/litre, Rs.50/litre and Rs.35/kg respectively (cost of petrol, diesel & CNG in the month of October 2012). The outcomes of total fuel loss per week at selected crossings are given in Table-9. The results of Substituting off behaviour of motorists during the red light phase at crossings were not taken into account since it was found that almost 98 per cent of the vehicles do not switch off their vehicles at crossings while waiting for the green phase. In previous paragraphs it has been already covered that tables and figures shown, has made for per day, one week, per month and per year for Indore. And with the help of the fuel consumption factor (in ml/sec) all calculations/ results have been made shown in tables 9, 10, 11, 12, 13, and 14. From the recorded data, calculation table got prepared for different traffic signals (ml/h and gm/h) (refer to table.3). More than 40800 total vehicles found in idle condition in a week at Mhownaka

crossing and wastage of fuel (petrol, Diesel and CNG) in amount of 259 litres and it will grow up with 20% hike per annum [11]. Table-9 shows that Palasia main crossing face little less number of vehicle than Palasia-1 but fuel wastage is more than that of Palasia-1due to variety of vehicle and red signal timing is more (refer to table.2). Minimum amount of fuel loss is showing in table.2 at Regal crossing because of less no. of heavy vehicles and small red signals timing. Consequently, small red signal timing directly affect the amount of fuel wastage but poor traffic flow will occur after that situation created like traffic jam. It can be seen from the figures as given in the table.7 that heavy vehicular congestion was relatively more on the crossings which come towards the Bangali square in morning to Evening peak hours, and in the evening peak hour heavy vehicular congestion was seen on the Bhowarkua square (refer to table.8). This was replicated by a greater number of vehicles clearing the signals crossing as compared to the number of vehicles congested in the lane during the red signals, despite the continuous flow of vehicles in the lane. It can be observed that the maximum two wheeler vechilur rush is on the lane from Palasia M to RNT Marg. There is a need to ensure that such gaps in traffic management system are not permitted particularly during market and also on the lane from Regal towards Palasia main.

Table 9: Number of Idle Vehicles and fuel wastage per week at Different Traffic Signals in Indore

S.No.	Traffic Signals	Total vehicle in Idling condition per week (in Hundred)	Total fuel wastage (Litre)
1	MHOWNAKA	408	259
2	PALASIA MAIN	399	493
3	PALASIA 1	503	422
4	REGAL	329	187
5	BHOWARKUA	305	279
6	GURUDWARA	325	339
7	BANGALI	393	338

The substantial vehicular mobbing was seen in all lane/paths also during these peak hours. This leads to idling of vehicles at the Mhownaka, and it leads to wastage of fuel of petroleum to Bhowakua. Many times, there is traffic transgression when vehicles continue to layer even after the Green signal turns Red or some vehicles tell-tale by when the traffic cop is not attentive or involved in conversation with a vehicle. This subsequently leads to traffic jam with immobile or very slow vehicle drive and idling of vehicles due to the heavy vehicular rush peak hours in the Gurudwara and Palasia main (refer to table 14). Table 2, 9 exposes that such a long waiting time leads to immense wastage of fuel and man time. Likewise 50% to 90% of 2-wheeler owners also hold on to their engines switched on while waiting at red signal (refer to table.2). The waiting period for the vehicle is more on the lane from Geeta Bhawan to Sahara Palasia, in the AB Road. In the table no.4 reveals that 50% to 98% of 4 wheeler & 3-wheeler owners keep their engines switched on while waiting at red signals. The study reveals intolerable forms of vehicular idling and slow traffic movement at Regal traffic juncture and needs rectification through appropriate traffic management, encouraging path driving, restricting pedestrian's traffic to the footpaths, construction of overhead footbridge and extending vehicles at cross roads. Extend the opening exit of the over bridge from Regal to Palasia Main for the incoming traffic headed from MG Road to Bangali square. It is clear indication from table.10 that fuel loss due to idling increases normally from Monday to Sunday

Table10: Fuel wastage at traffic signals from Monday to Sunday (in ml)

TRAFFIC SIGNALS		MHOWNAKA	PALASIA M	PALASIA 1	REGAL	BH0WARKUA	GURUDWARA	BANGALI	TOTAL
MON	8AM-10 AM	5927	10534	12537	5010	5905	8014	11177	59104
	10AM- 2 PM	10295	19425	15611	6426	10681	13111	15938	91486
	2PM - 6PM	10701	19387	16162	6772	11400	11928	13673	90022
	6PM-10 PM	11953	25297	15923	10033	15582	18007	17145	113940
TUE	8.00AM-10.00 AM	6199	11360	14379	3824	5960	7672	7410	56805

	10.00AM-2.00 PM	12059	21684	16222	7852	11925	12399	12633	94775
	2.00PM - 6.00 PM	11083	21666	17824	7874	12825	14725	14892	100888
	6.00PM-10.00 PM	11203	19992	18584	7629	11804	14486	14213	97912
WED	8.00AM-10.00 AM	5677	10505	10029	4414	6559	9192	9096	55473
	10.00AM-2.00 PM	9736	18560	15151	5375	8088	9809	12188	78907
	2.00PM - 6.00 PM	11516	20806	15081	7769	12871	14327	14924	97295
	6.00PM-10.00 PM	11121	23010	20643	8996	14047	18722	18734	115271
THU	8.00AM-10.00 AM	6399	10156	9583	5292	8074	9441	8520	57465
	10.00AM-2.00 PM	9408	19611	16500	6328	9775	10838	11350	83810
	2.00PM - 6.00 PM	10652	22492	16862	9055	12983	15261	14382	101687
	6.00PM-10.00 PM	11830	23387	20560	10587	14111	17979	16043	114497
FRI	8.00AM-10.00 AM	5825	9929	9832	4773	6482	9225	7080	53145
	10.00AM-2.00 PM	8594	17030	15326	6536	8544	11727	10182	77939
	2.00PM - 6.00 PM	9783	18753	16050	7481	10783	12377	12393	87620
	6.00PM-10.00 PM	13075	21066	20768	9956	12686	17598	15442	110591
SAT	8AM-10 AM	4909	10150	8934	3035	5082	6016	6100	44226
	10AM- 2 PM	8245	15761	13532	4694	7953	8717	9401	68303
	2PM - 6 PM	9067	18716	15855	5951	9172	10788	11062	80610
	6PM-10 PM	12577	22517	20042	8618	12258	15471	14493	105977
SUN	8AM-10 AM	4029	8450	5953	2109	3116	4751	4531	32939
	10AM- 2 PM	6323	14190	11683	3645	5499	7285	8943	57568
	2PM - 6 PM	8897	12590	11572	5427	8944	10740	9394	67564
	6PM-10.PM	12226	25534	20634	11457	16054	18292	16557	120755
TOTAL		259308	492561	421831	186917	279164	338897	337894	

3.1 Estimation of Fuel Wastage in Indore

According to MPPCB (Madhya Pradesh Pollution Control Board) report- 2010, the total fuel consumption (Petrol /Diesel) estimated 12.2 x 10^7 litres per year. It is observed that the about 45 number of signal crossings in Indore. Fuel wastage at traffic signals play a vital role on environment, fuel emergencies, energy security and delay time in travel. It was attained upon that out of total 45 signalized crossings, 18 intersections are low volume, 12 are medium volume and 15 high volume. The average fuel loss accruing at intersections of varying traffic volumes formed the basis for estimating the fuel loss at signalized intersections in entire city of Indore. In this study, per day average fuel wastage has been calculated in Indore on the basis of idle fuel consumption per unit time and total number of idle vehicles. It is come out from the study that around 1000L petrol, 660L Diesel and 480kg CNG per day is being wastage due to idling of vehicles in Indore (refer to table 12&13). Due to this fuel wastage, 2020 thousand kg of Carbon dioxide is being bleached out per year to environment and increases the greenhouse gases load on it (refer to table11).

Table11: CO2 emission from fuel wastage in Indore and Madhya Pradesh

CO2 Emission	Petrol	Diesel	CNG
CO2Emission per year in Indore (Kg)	8.5 x 10^5	6.4 x 10^5	5.3 x 10^5
Total CO2Emissionsin per year in M.P (Kg)	7.9 x 10^6	5.9 x 10^6	4.9 x 10^6

3.2 Estimation of Fuel Wastage in Madhya Pradesh

According to Govt of Madhya Pradesh report-2012, 50 numbers of districts has been formed including 10 division, 318 Tehsil, city and town 394, and blocks 313 in MP. As on 31st march 2009, the total vehicular population was 951195 in Bhopal, 1444359 in Indore, 635083 in Gwalior, 779183 in Ujjain, more than 900000 in Jabalpur, more than and around 300000 in Sagar, Narmadapuram, Chambal and Rewa and Around 100000 in Shahdol [18]. In this study, author has tried to give an approximation of fuel loss estimation for Madhya Pradesh. This approximation of fuel wastage is based on human population and Vehicular population in all districts & divisions. As per considerations, 45 traffic signals in Indore, & Bhopal, 30 traffic signals in Gwaliar, 20 in Narmadapuram & Chambal, 15 in Ujjain, Jabalpur & Sagar, 10 in Rewa & Shahdol, and remaining 40 district has at least 5 number of traffic signals. So, total number of congested traffic signals (traffic spot) in MP reached about = 425. Table 6 shows that the total CO2 emissions from fuels wastage in Indore and M.P. by petrol, diesel and CNG separately in table11&12.

Table12: Estimated Fuel Wastage Due to Idling at Traffic Signals in Indore and MP.

TRAFFIC SQ	Types of fuel		
	Petrol (L)	Diesel (L)	CNG (kg)
Estimated Fuel Wastage per day in Indore	1.0 x 10^3	6.6 x 10^2	4.6 x 10^2
Estimated Fuel Wastage per month in Indore	3.04 x 10^4	2.0 x 10^4	1.4 x 10^4
Estimated Fuel Wastage per Year in Indore	3.7 x 10^5	2.4 x 10^5	1.7 x 10^5
Estimated Fuel Wastage per day in Madhya Pradesh	9.6 x 10^3	6.2 x 10^3	4.34 x 10^3
Estimated Fuel Wastage per Month in Madhya Pradesh	2.9 x 10^5	1.9 x 10^5	1.3 x 10^5
Estimated Fuel Wastage per year in Madhya Pradesh	3.45 x 10^6	2.23 x 10^6	1.6 x 10^6

Table.13: Estimated Cost of Fuel Wastage Due to Idling at Traffic Signals in Indore and MP

TRAFFIC SQUARE	Types of fuel			Total
	Petrol	Diesel	CNG	
Unit Rate(INR)	78	50	35	
Estimated Cost of Fuel Wastage per day in Indore (INR)	78000	51480	16100	145580
Estimated Cost of Fuel Wastage per month in Indore (INR)	2340000	1544400	483000	4367400
Estimated Cost of Fuel Wastage per Year in Indore (INR)	28080000	18532800	5796000	52408800

Estimated Cost of Fuel Wastage per day in Madhya Pradesh (INR)	746755	309207	151718	1207680
Estimated Fuel Wastage per Month in Madhya Pradesh (INR)	22402644	9276210	4551536	36230391
`Estimated Cost of Fuel Wastage per year in Madhya Pradesh(Lacks)	2688	1113	546	4348

Table.14: Fuel Wastage due to Idling per week (vehicle category wise) in ml.

Fuel wastage Due to Idling per week (vehicle- category wise) in ml.												
Traffic Signals	2-WHEELER (MOTER CYCLE)				4-WHEELER		3-WHEELER (N7)	HEAVY VEHICLE		MARUTI VAN/ TAXI (N10)	AUTO RICKSHAW CNG (N11)	TOTAL
	100 cc (N1)	125 cc (N2)	150 cc (N3)	180cc (N4)	CAR 800cc (N5)	CAR 1000 cc (N6)		BUS (N8)	TRUCK (N9)			
MHOWNAKA	14009	15762	10172	6783	46852	48233	24729	25730	10287	26507	30243	259308
PALASIA MAIN	28442	22809	17615	11281	130848	97804	42385	27408	7028	63668	43273	492561
PALASIA 1	21539	24543	21055	9862	82005	89958	41579	18473	5914	56974	49929	421831
REGAL	13217	13366	10260	4847	35913	35828	16339	12595	1486	19446	23621	186917
BH0WARKUA	16883	14733	10643	6520	44260	47361	21614	22448	38723	26634	29345	279164
GURUDWARA	23586	21378	16313	8467	67656	69386	34495	18804	5018	34308	39486	338897
BANGALI	20931	23274	15437	7677	55013	62760	28705	26527	41226	28973	27370	337894

4. VALUABLE SUGGESTIONS FOR REDUCING VEHICULAR POLLUTION IN INDORE CITY

It was observed that approximately 45-54% vehicles were found idle at different seven squares at 8-10 A.M. and 4-6 P.M. It cannot be totally control but pollution load may be reducing at particular time by shifting the timing of offices or schools. If it would shifted the school time 9 A.M by 7 A.M and at evening 4 P.M by 2 P.M vice versa office time may change. Through this it may reduce pollution up to more considerable extent at particular time and that would be more beneficial for human health. 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 are some other suggestions given below, that may help to reduce the pollution load in Indore city.

1. Vehicular pollution should be checked by Transport Department in regular manner.
2. Public awareness programs should be conducted to raise social consciousness and educate motorists about the health hazards, statutory provisions and control measures viz. engine tuning and maintenance.
3. Phasing out of Old Commercial Vehicles.
4. Mass Rapid Transport System should be constructed.
5. Mobile enforcement teams should be deployed on regular basis at road locations for polluting prosecution of vehicles and vehicles not having Pollution under Control (*PUC*) Certificates.
6. Improvement in Fuel Quality: Leaded petrol should be completely phased out and strictly check it.
7. Automated Switch should be incorporated in vehicle that may cut the fuel supply or ignition OFF vehicle while ideal condition.
8. Carpooling system should be accepted.

CONCLUSIONS

Research results obtained have shown about 5.9 x 10^5 litre per year petrol plus diesel (3.6 x10^5 litre from petrol and 2.3 x 10^5 litre from diesel) and 1.7x10^5 kg per year of CNG are being wasted by Indore city and it is adding about 6.4 x 10^5 kg CO2 from diesel, 8.5 x 10^5 kg CO2 from petrol and 5.3 x 10^5kg CO2 from CNG to the already degraded atmosphere every year. In case of state level (Madhya Pradesh) fuel wastage estimated as 5.6 x 10^6 litre / year from petrol plus diesel (3.4 x 10^6 litre from petrol and 2.2 x 10^6 litre from diesel) whereas 1.6 x 10^6 kg/year from CNG and CO2 emission from petrol approx. 7.9 x 10^6 kg/year, from diesel 5.9 x 10^6 kg/year CO2 and from CNG 4.9 x 10^6 kg/year CO2 emissions. Basically, it is a study survey on quantification of fuel wastage during idling of vehicles at traffic signals, assessment of total fuel wastage during idling of vehicles at traffic signals and guesstimate of benefits in terms of fuel savings to be accrued by implementing improvement measures at the state level. However, on the basis of this method it could be find out the quantification of fuel wastage during idling of vehicles at traffic signals, assessment of total fuel wastage during idling of vehicles at traffic signals for country level or global. It would be helpful in saving the large extent of fuel on global level.

The extra fuel consumption at the traffic signals is much higher because of the irresponsible behaviour of the driver/rider and lack of determination towards stopping the wastage of fuel. It has already been published by some authors that less fuel required starting the vehicle than idling of vehicle. So, on the basis of observations it is suggested that rider should OFF engine while waiting for green signals. Further, the engine may be kept ON for 10-15 seconds without throttling. Frequent throttling increases much more consumption of fuel as well as emissions. However, there is a need of awareness among the people about increment of emissions during due to idle engine and to take care of it this emission, government should take proper action and provide laws, rules and regulation and follow it strictly. Mileage of a vehicle depends on the driver's habit. Smoother and controlled driving results better with mileage of vehicle. Driving habits, also much affect the traffic flow. So, the driving should be smooth, stream-line and constant spacing between the adjacent vehicles.

There is essential need of flyovers and a bridge at high traffic congestion. It would be much helpful in rid to traffic signal problems. Signalization plays an important role in controlling extra fuel consumption. However, the traffic signal technology should be improved or changed according to modern day's traffic requirements. When there is no need of using a vehicle i.e., if going to the near-by place, walking should help a lot in saving fuel. The vehicle problem is much accentuated by the bicycles and the walkers which block these traffic intersections and are simply uncontrollable, resulting in a very sluggish traffic movement even when the traffic lights switch green, as compared to the actual number of vehicles would could have cleared the junction had the walkers been managed more efficiently, say through a overhead foot bridge.

REFERENCES

[1]. 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.

[2]. Parida and Purnima, Gangopadhyay S. (2008), Head and scientist, TPE Division, CRRI, New Delhi

[3]. Rameshwar D (2011), Growth rate of Motor Vehicles in India - Impact of Demographic and Economic Development, Journal of Economic and Social Studies, volume 1.

[4]. 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.

[5]. Mathur M L and Sharma R P (2009): Intarnal Combustion Engines, Dhanpatrai Publication, page no.368.

[6]. CIA's World Fact book (2008).

[7]. EPA report. EPA Staff Technical Report: Cost and Effectiveness Estimates of Technologies Used to Reduce Light-duty Vehicle Carbon Dioxide Emissions 2011.

[8]. Central Pollution Control Board, Ministry of Environment & Forests, Govt. of India : Status Of The Vehicular Pollution Control Programme In India, March, 2010.

[9]. Gill P S.: Automobile Engineering-I. S K Kataria & sons 2010. Volume -I, First Edition Page No. 428

[10]. Arora Salil, Vyas Anant, Johnson Larry R. Projections of highway vehicle population, energy demand, and

CO2 emissions in India to 2040, Natural Resources Forum ©United Nations , February 2011, Volume 35, Issue 1, pages 49–62,
[11]. http://www.renault.com/en/groupe/renault- dans-le-monde/pages/renault-en-inde.aspx
[12]. Sengupta Nandini,: India to drive past China to record world's fastest auto sales growth. The Economic Times ET Bureau Oct 5, 2010, 03.10am IST.
[13]. How Letting Your Vehicle Idle Can Cost You Big Money at the Pump: (http://ezinearticles.com/?)
[14].http://www.thaindian.com newsportal/health/vehicleidling-contributes-to- greenhouse-gasemissions_10058613.html
[15]. The Road Transport Year Book (2007-09) Ministry Of Road Transport and Highway, New Delhi, Transport Research Wing, Govt. Of India, 2011 Volume-I,
[16]. Tips on Fuel conservation in transport sector: Petroleum Conservation Research Association (PCRA) Report, 2009.
[17]. Singh Megha Suri,: Delhi wastes Rs 11.5cr in traffic jams daily. Times of India, Delhi, TNN Oct 15, 2009.
[18]. Government of Madhya Pradesh: Motor transport statistics of Madhya Pradesh-2008- 2009. Publication Year - 2010
[19]. Rail India Technical and Economic Services Limited and Operations Research Group, 1994.
[20]. Mashelkar R.A. India Auto Fuel Policy Report, Report of the Expert Committee on Auto Fuel Policy, 2002. http://petroleum.nic.in/afp_con.htm l