Indicative Impacts of Vehicular Idling On Air Emissions

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URBAN emissions .info

(UEinfo) was founded in 2007 with the vision to be a repository of information, research, and analysis related to air pollution. There is a need to scale-up research applications to the secondary and the tertiary cities which are following in the footsteps of the expanding mega-cities. Advances in information technology, open-data resources, and networking, offers a tremendous opportunity to establish such tools, to help city managers, regulators, academia, and citizen groups to develop a coordinated approach for integrated air quality management for a city.

UEinfo has four objectives: (1) sharing knowledge on air pollution (2) science-based air quality analysis (3) advocacy and awareness raising on air quality management and (4) building partnerships among local, national, and international airheads.

This report was conceptualized, drafted, and designed by the members of UEinfo.

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The definition of "idling" is when the engine of a vehicle is still running, when

- the vehicle is parked[1]
- the vehicle is stopped at red light[2], and
- the vehicle is stopped in a traffic congestion.

In the burgeoning cities, the number of personal vehicles is increasing at a rate higher than the rate at which the necessary infrastructure can be provided. A major crisis situation is the "**congestion**" due to the number of vehicles on road, which is more severe during the rush hours.

In most of the cities, the three situations presented in the definition are increasingly becoming a common site.

The traffic corridors experience the most the highest ambient concentrations not only due to the increasing vehicular activity but also due to growing idling times at the junctions. By introducing awareness for "**idling stops**", the impacts and returns could be immediate, by drastically reducing the exposure times.

The "idling stops" *aka* "stopping the engine when in any of the three situations" are effective for not only saving fuel, but also for protecting environment with less cost (lesser emissions) and with immediate return (health benefits).

Quantifying the impacts of idling or idling stops is not a straight forward equation, as it includes a variety of parameters including the types of vehicles on the road, age of the vehicles, vehicular combustion and emission control technology, the traffic load on the roads leading to the congestion times, and hence forth. A survey is essential to understand the prevailing conditions and to conduct a thorough analysis along the corridors.

This paper attempts to present an indicative analysis of the idling on the roads using an average set of emission factors and consumption patterns; and to estimate the share of idling on vehicular emission totals on a per vehicle basis.

[1] Idling does not directly contribute to driving a vehicle. People usually leave the engine running in order to charge battery, keep the air conditioner running, warm up the engine, and to avoid switching the engine on and off frequently.

[2] Such stops also do not contribute to driving the vehicle, but the engine keeps running to prepare for the next run.

20 Things you should know about idling

1. **Idling gets you nowhere** – and it can be costly. Excessive idling wastes over $100 a year per vehicle, and generates needless greenhouse gas emissions.
2. Idling produces **more emissions per minute** than driving.
3. Engine exhaust (diesel and gas) contains more than **40 hazardous air pollutants**.
4. Traffic areas around **schools** – where vehicles are often left idling – show significantly **higher pollution levels outside (and inside) their buildings**.
5. Contaminants in vehicle emissions have been directly related to **respiratory health effects**.
6. **Children are more sensitive** to air pollution than adults. In part because they are exposed to more emissions with every breath – children inhale more air per pound of body weight than grown-ups.
7. **Ten seconds of idling uses more fuel** than turning off the engine and restarting it.
8. If every driver **stopped idling**, a significant fuel savings can be achieved and prevent air emissions from entering the atmosphere.
9. **Idle-Free Zones (schools and hospitals)** are an effective way to increase awareness.
10. In winter once a vehicle is running, the **best way to warm it up is to drive it**.
11. Our estimate on the **road idling is approximately 15-20 minutes** in the developing country cities.
12. Driving a vehicle cuts warm-up time in half. It **reduces fuel consumption** too.
13. **Every 10 minutes of idling costs you at least one-tenth of a litre in wasted fuel** – and up to two-fifths of a litre for heavy duty vehicles.
14. Excessive idling can be **hard on your engine**. Because the engine isn't working at peak operating temperature, fuel doesn't undergo complete combustion. This leaves fuel residues that contaminate engine oil and make spark plugs dirty.
15. **Restarting a car many times has little impact** on engine components such as the battery and the starter motor. The wear on parts that restarting the engine causes is recovered several times over in fuel savings.
16. For a diesel engine, idling actually lowers the coolant temperature faster than shutting off the engine. In other words, **switching off the engine keeps the engine warm longer**.
17. A **poorly tuned engine uses up to 15 percent** more energy when idling than a well-tuned vehicle.
18. Using a **block heater is a more efficient and effective** way to warm the engine than idling.
19. Idling your vehicle with the **air conditioner on can increase emissions by 13 percent**.
20. Many schools have already reduced harmful vehicle emissions around schools, through programs such as "Turn Your Key – This School is Idle-Free".

Based on the material presented
@ http://www.climatechangeconnection.org/Solutions/20Thingsyoushouldknowaboutidling.htm

Formulas & Averages

The impacts of idling are estimated for an average fleet, presented in SIM-02-2008 "vehicular emissions inventory" and estimates idling times.

Equation 1: Driving Emissions

Emissions (gm/day) = Vehicle km traveled (km/day) *
Emission factor (gm/km)

Equation 2: Idling Emissions

Emissions (gm/day) = Average idling time (min/day) *
Fuel consumed while idling (lit/hr) *
Emission factor (gm/km) *
Fuel efficiency (km/lit) /
60 (min/hr)

The tables presented below are average numbers, based on a variety of the source material and authors interpretations. **USE WITH DISCRETION**.

2Ws = 2 wheelers; 3Ws = 3 wheelers; LDV = light duty vehicles; HDT = heavy duty trucks;

The analysis presented in a framework mode is NOT representative of any particular city, but is a scenario analysis on a PER VEHICLE basis.

Table 1: Average Emission Factors (gm/km)

	Gasoline			Diesel				CNG			
	2Ws	3Ws	Cars	Cars	LDV	HDT	Bus	3Ws	Cars	LDV	Bus
PM_{10}	0.10	0.20	0.10	1.00	1.25	2.00	1.50	0.10	0.05	0.02	0.02
$PM_{2.5}$	0.05	0.08	0.03	0.60	0.50	1.00	0.80	0.05	0.02	0.01	0.01
SO_2	0.02	0.02	0.07	0.40	0.30	1.00	1.00	0.00	0.00	0.00	0.00
NO_x	0.15	0.10	0.20	1.25	2.00	10.0	10.0	0.35	0.20	3.50	2.50
CO	2.50	8.00	5.00	2.00	2.50	3.50	3.50	3.50	1.00	3.50	3.50
CO_2	40	80	200	250	500	850	850	70	100	450	450
HC	1.50	5.00	1.00	0.40	0.20	1.00	1.00	0.15	0.02	0.10	0.10

"**Emission Factors**", by definition, represent the release of a pollutant due to combustion of fuel, with common units of **gm/veh-km**, under a variety of conditions, e.g., loaded and unloaded; idling; cold starts; and cruising. An emission factor is typically established based on testing a number of vehicles (with varying age and mix) under conditions listed above, to arrive at an average number. Table below presents an average set of emission factors for major vehicular categories for three fuel types (LDV = light duty commercial vehicles)

Not all the cities in the developing world are equipped with testing facilities, which cost millions of dollars for establishment, operation, and maintenance. ***Where available, a considerable number of tests are being performed to establish these emission factors and where not available, cities are expected to make a close fit based on the mix of the vehicles and technology in use.***

For further research, emission databases include:

1. United States Environmental Protection Agency's AP-42 Handbook
   @ http://www.epa.gov/ttn/chief/ap42/
2. MOVES (Motor Vehicle Emission Simulator)
   @ http://www.epa.gov/otaq/ngm.htm
3. Emission Factor Database by National Atmospheric Emissions Inventory of UK
   @ http://www.naei.org.uk/emissions/index.php
4. Air Pollutant Inventory Program of SEI
   @ http://www.sei.se/gapforum/tools.php
5. Emission Factor Database by Central Pollution Control Board of India
   @ http://cpcb.nic.in/Source_Apportionment_Studies.php
6. Emission Factor Database by DIESEL Program of PCD Thailand & the World Bank
   @ http://www.pcd.go.th/info_serv/en_air_diesel.html
7. Harmonizing Emissions Analysis Tool by ICLEI
   @ http://heat.iclei.org
8. COPERT by European Environmental Agency
   @ http://lat.eng.auth.gr/copert/
9. IPCC Guidelines for GHG Inventory
   @ http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html
10. GAINS of IIASA
    @ http://www.iiasa.ac.at/rains/gains.html
11. TREMOVE for European Countries
    @ http://www.tremove.org/index.htm
12. EMEP Corinair Emissions Inventory Guidebook
    @ http://reports.eea.europa.eu/EMEPCORINAIR3/en/page011.html
13. Transport Emissions Analysis for Hanoi by WRI/EMBARQ
    @ http://embarq.wri.org/en/ProjectCitiesDetail.aspx?id=8

Access to local fleet specific emissions factors for inventory development is ideal.

A frequently asked question is the applicability of the borrowed or average emission factors. Emissions factors not only depend on the engine type, which could be common for many countries, but also local fuel quality, maintenance programs, road conditions, driving cycles, and driver's behavior. This only increases the uncertainty of these factors established in a laboratory setting, where reality is assumed and simulated.

Make an average based on where tests are done vs. the technology in use, make appropriate corrections using the examples listed above (add deterioration factors, if necessary), and when the local factors are established, re-check the analysis.

Table 2: Average Vehicle Kilometers Traveled (km/day)

	Gasoline			Diesel				CNG			
	2Ws	3Ws	Cars	Cars	LDV	HDT	Bus	3Ws	Cars	LDV	Bus
	50	200	40	40	150	200	250	200	40	150	250

Vehicle kilometers traveled (VKT), is a survey data, most commonly evaluated in the units of "kilometers traveled per day". There is no single established method to obtain this data, but to survey. Possible approximations are

1. Public transport buses, operating on fixed or non-fixed routes, operate at an average speed is 30 km/hr for 8 hours a day, which accounts for 240 km per day.
2. Public transport buses operating on long distance routes, travel in and out of the city, which means distance traveled in the city limits is the distance between the depots to the city limits.
3. Passenger vehicles, on average operating at 30-40 km/hr for 1-2 hours on the road. A quick survey among the colleagues, work places, or on road for a day or two will provide an approximate VKT for this category.
4. Another possibility for passenger vehicles is the information from the vehicle registrations, the distance traveled over a year(s) will give an idea of average VKT's per day.
5. Commercial small trucks in the city, again operating at 30-40 km/hr for 8 hours a day, will provide an estimate.
6. Motorcycles (2Ws) are expected to travel at speeds higher than the other modes and for short time periods; unless you are in the cities like Bangkok, Hanoi, or HCMC, where 2 Ws are extensively used for commercial purposes and as small distance taxis.

Please note that these approximate numbers (theories) are for conditions observed in the developing countries, where the congestion levels are on the rise and doesn't allow the vehicles to operate at speeds observed in the developed countries.

Table 3: Average Idling Time (min/day)

	Gasoline			Diesel				CNG			
	2Ws	3Ws	Cars	Cars	LDV	HDT	Bus	3Ws	Cars	LDV	Bus
	20	40	20	20	30	40	40	40	20	30	40

For **Idling time**, any estimate made for this parameter drives the rest of the calculations. The numbers presented in this table are based on a short survey on a couple of corridors. A full scale survey covering all the major corridors and traffic junctions is necessary in order to develop more reliable statistics.

In the table, a higher value is assumed for the buses because of their multiple trips and the amount of time they spend on the road, compared to the 2Ws or Cars, which depend on the usage type (work or personal). These assumptions also depend on the local travel conditions. Similarly, 3Ws which spend more time on the major and the feeder arteries.

Table 4: Average Fuel Efficiency (km/lit)

	Gasoline			Diesel				CNG			
	2Ws	3Ws	Cars	Cars	LDV	HDT	Bus	3Ws	Cars	LDV	Bus
	60	25	12	14	4	3	3	25	12	3	3

"**Fuel efficiency**", defined as "kilometers traveled per a liter of fuel", is a survey data and probably the easiest of the data to obtain either directly from the manufacturers or conducting a quick survey among the users from each mode of transport.

Similar to the other parameters, this is also dependent on the vehicle technology. For example, a hybrid vehicle is known to provide approximately double the fuel efficiency compared to its gasoline or the diesel counterpart. The numbers presented are an indicative estimate.

Table 5: Average Fuel Consumed While Idling (lit/hr)

	Gasoline			Diesel				CNG			
	2Ws	3Ws	Cars	Cars	LDV	HDT	Bus	3Ws	Cars	LDV	Bus
	0.5	1	1	1	2	3	3	1	1	2	3

For **Idling Fuel Consumption**, best source of information will be manufacturers, who routine conduct the fuel efficiency tests on the various vehicles. The numbers presented are an indicative estimate.

Table 6: Average Driving Emissions (gm/day/vehicle type)
= Table 1 * Table 2

	Gasoline			Diesel				CNG			
	2Ws	**3Ws**	**Cars**	**Cars**	**LDV**	**HDT**	**Bus**	**3Ws**	**Cars**	**LDV**	**Bus**
PM_{10}	5	40	4	40	187.5	400	375	20	2	3	5
$PM_{2.5}$	2.5	16	1.2	24	75	200	200	10	0.8	1.5	2.5
SO_2	1	4	2.8	16	45	200	250	0	0	0	0
NO_x	7.5	20	8	50	300	2000	2500	70	8	525	625
CO	125	1600	200	80	375	700	875	700	40	525	875
CO_2	2000	16000	8000	10000	75000	170000	212500	14000	4000	67500	112500
HC	75	1000	40	16	30	200	250	30	0.8	15	25

Table 7: Average Idling Emissions (gm/day/vehicle type)
= Table 3 * Table 5 * Table 1 * Table 4 / 60

	Gasoline			Diesel				CNG			
	2Ws	**3Ws**	**Cars**	**Cars**	**LDV**	**HDT**	**Bus**	**3Ws**	**Cars**	**LDV**	**Bus**
PM_{10}	1.0	3.3	0.4	4.7	5.0	12.0	9.0	1.7	0.2	0.1	0.1
$PM_{2.5}$	0.5	1.3	0.1	2.8	2.0	6.0	4.8	0.8	0.1	0.0	0.1
SO_2	0.2	0.3	0.3	1.9	1.2	6.0	6.0	0.0	0.0	0.0	0.0
NO_x	1.5	1.7	0.8	5.8	8.0	60.0	60.0	5.8	0.8	10.5	15.0
CO	25.0	133.3	20.0	9.3	10.0	21.0	21.0	58.3	4.0	10.5	21.0
CO_2	400	1333	800	1167	2000	5100	5100	1167	400	1350	2700
HC	15.0	83.3	4.0	1.9	0.8	6.0	6.0	2.5	0.1	0.3	0.6

Table 6 and Table 7 indicate the grams of pollutant released per day per for the vehicle kilometers traveled or the amount of idling time.

Note that the calculations are sensitive to the parameters and the end results will be different with any of the parameters changed from the assumed scenario.

The numbers are indicative on a PER VEHICLE basis for the assumed scenario of driving and idling cycles.

Table 8: Average Percentage of Idling Emissions (%)
= Table 7 / (Table 6 * Table 7) %

	Gasoline			Diesel				CNG			
	2Ws	3Ws	Cars	Cars	LDV	HDT	Bus	3Ws	Cars	LDV	Bus
	17%	8%	9%	10%	3%	3%	2%	8%	9%	2%	2%

The percentage contributions of idling in Table 8 are same for all the pollutants.

At an individual level, the percent emissions due to idling per day for 2Ws and Cars, is proportionally high due to their less VKT's compared to trucks or Buses.

The 2Ws and Cars may seem to emit less, because they travel less, which means they idle less, but when multiplied with the number of vehicles on road, their portion of total emissions is high and their impact on local air pollution (and human health[3]) is very evident, along with the trucks and buses.

Idle Chat

Idling in any situation is bad. If the vehicle is idling for more than 30 seconds, it is advised to turnoff the engine, but the stop-and-go culture on the roads (especially in the expanding cities) is so prevalent that the drivers tend to oversee the personal loss as long as the vehicle is moving – in terms of the fuel loss and the exposure to additional air pollution.

However, as a more practical guideline, balancing factors such as fuel savings, overall emissions and potential component wear on the starter and battery, 60 seconds (ONE MINUTE) is the recommended interval. The drivers will save money on fuel that should more than offset any potential increase in maintenance costs from any wear and tear on starter or battery.

Countries around the world are concerned with the impact of transportation on the environment and human health. Messages to reduce unnecessary idling are therefore a key component of many national climate change programs.

In Europe, the recommended guidelines for turning engines off are 10 seconds in Italy and France, 20 seconds in Austria, 40 seconds in Germany and 60 seconds in the Netherlands. In the United States, the Environmental Protection Agency's Smartway[4] and Drive Wise[5] programs both recommend turning the engine off if stopped for more than 30 seconds.

[3] Presentation by Dr. Cohen @ http://www.baq2008.org/spa-cohen
[4] Drive Smart - http://www.epa.gov/otaq/smartway/vehicles/buy-and-drive-smart.htm
[5] Drive Wise - http://www.epa.gov/air/actions/drive_wise.html

Mobile Signals to Identify Congestion Zones in Urban India

Recently, a company based in Bangalore, the Mapunity, partnered with India's largest cell phone network, Bharti Airtel, to gain access to records of every transaction on its system. Main goal of this venture was to devise solutions to urban traffic, at least qualitative real-time messages to inform the passengers on urban congestion levels and possible alternatives to avoid idling.

Methodology: Cell phones constantly relay data to local towers, even when they're not in use, so Mapunity can track the location of as many as 3 million (per city) in real time, giving the company a minute-by-minute snapshot of the city's traffic. When too many people crowd a given intersection, a red dot shows up on a map posted on the company's website. This information is also accessible by phone using designated codes for various junctions.

TheseTraffic Information Systems are currently available for Bangalore, Hyderabad, New Delhi, Chennai, Indore, and Pune.

It is important to note that this information service NOT an indication of how many people or how many vehicles are on the road, but providing an indicator for traffic density along the corridors, in real time.

Sometimes the corridors are congested not because of the number of cars or motorcycles on the road, but due to poor traffic management.

This innovative approach (as part of the intelligent transportation systems (ITS), uses the mobile signals to track congestion and use that information, to guide the traffic flows via better traffic light coordination or inform the passengers before they plan their road trip (even saving 10 mins and idling on the road, means fuel saved and less air pollution to worry about).

At the institutional level, this information is very valuable in designating the congested vs non-congested corridors; which might help better coordinate bus service, where available and necessary.

The information gathered, irrespective of the uncertainties involved (since this method is using only one mobile network, not being able to fully differentiate between signals along the road with vendors or concentrated signals in a bus at a junction, some of which can be avoided over an averaging period) will provide qualitative assessment of the traffic flows in the city, information on rush hours, traffic speeds, and (over time) a database of information to analyze the traffic patterns for better urban planning.

Based on the material presented @ http://www.mapunity.com
ITS @ http://www.expresscomputeronline.com/20080804/technology01.shtml

www.urbanemissions.info