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Effect of CO Concentration Generated by Traffic near Mid-Block Road Kanpur

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Abstract: *Traffic emits a lot of vehicular exhaust that has a number of gases included into it, gases like CO_2 (carbon dioxide),SO_2 (sulphur dioxide),NO_2 (nitrogen dioxide) and CO (carbon monoxide) are emitted through the vehicles causing many health related issues and creating air pollution also the emission of these gases causes a acid rain which gradually effects over the environment , all among the gases CO is considered as most deadly because its emission not only causes health related but also causes death due to its toxic free radical mechanism, CO is emitted due to the incomplete combustion of fuel, and mostly this gas comes out as a result of high traffic volume or in the peak hours of traffic when there is a lot of congestion throughout the traffic, due to increasing population and increased number of vehicles on the road this cycle of pollution due to CO has increased causing death at a large scale. Due to the more and more vehicular movement the congestion has increased, this has adversely affected the urban areas and causing pollution levels increased. Due to more demands of vehicles like two-wheeler and four-wheeler, in Kanpur city the air pollution levels are higher so the CO levels are higher in the urban areas of Kanpur The study presents emission factors and global warming CO has become the main issue it comes and it will be the decreasing the level of CO from exhaust gases of two wheeler and four wheeler motorcycle by adsorption technology. They have high Temperature and high combustion produces a lot of unburned fuel fumes. They will be effect in the global warming and the climatic change and pollutants and particular matters from the deposited the substance of and have a global climatic change. This work has adequate potential to dominate in pollution control and techniques because it uses charcoal powder that was used for experimentation. The exhausted gases result in the formation of more and more CO in the atmosphere causing damage to respiratory system also it increases the temperature of the atmosphere, Kanpur city is situated at higher altitude near river Ganges the pollution level in some areas like Jajmau, Taat Mil, Naubasta etc., are at a very high amount the congestion over these areas are too much also the normal passenger vehicles like auto rickshaws, tempo taxi etc. are mainly three wheeler which emit a lot of exhaust causing a drastically increase in the pollution. Our study is concerned areas in Kanpur city where there is low, moderate and high traffic at the peak hours also this study deals with the solution of exerting lesser exhausted gases so that less pollution is caused and lesser release of CO could occur, we are dealing with CO that is also considered as one of the most toxic gases the CO also works as greenhouse gas which traps the heat thus increasing the earth's temperature.*

Index Terms **- carbon monoxide, peak hours, traffic density Traffic, Design, PCU**

I. INTRODUCTION

Kanpur is known among the most polluted cities of India and holds 18th rank in the world in pollution index with an index of 90.46, transportation sector alone, release of the economy releases traffic pollutant problems are particularly acute in a number of major cities amount of fuel used in and increasing in much faster than the actual growth emission of pollutant from the vehicles causes a great effect on health even in some cases it causes illness and death. In vehicles CO level was commonly reported the increasing traffic density the various examined and the fraction of time stopped and driving at low speed or in stop and go traffic with frequent increases slow speed resulting in higher exhaust emission and higher consumption of fuel it also effects lower inter vehicle distance implementation of motor vehicles emission standards and emission and maintenance program. The time lag between the changes in CO concentration inside a moving vehicle. In the traffic source of work moving side to side and they can done to and it will have to formation and high volume. Transportation sector alone utilizes most of the fossil fuels such as petrol, kerosene, diesel and methanol. Considering all major anthropogenic sources categories, with exception of agriculture, the transportation sector of our economy releases about one-third of the total emission of volatile organic compounds(VOCs), Nitrogen Oxides(NOx), and Lead(Pb) and more than two-third of Carbon Monoxide(CO). The CO and VOCs, (almost all the hydrocarbons) and products of inefficient and incomplete combustion of fuel and fossil fuels contains purely hydrocarbons thus the problem of Traffic. Pollution and air toxicity increases due to emission of these gases in breathable air, especially in cities where traffic jam is a common experience as considerable amount of fuel is used while cars are trapped in traffic congestion. As congestion in town and cities increases and traffic slows down, emissions are increasing much faster than the actual growth in vehicles. Thousands of motorized vehicles ply the major roads and streets of Kanpur city daily. The same is true of many other countries of the world. In this, the vehicles consume millions of liters of petrol daily. The combustion of transportation fuels by these vehicles releases several contaminants into the

atmosphere, including carbon monoxide (CO) petrol and diesel engines, both internal combustion engines, are the only engines in wide use in the world's automotive transportation system. And they are the major source of urban air pollution.

2. OBJECTIVES OF THE PROPOSED STUDY

The main objective of this project is to check and monitor the level of carbon monoxide (CO) in Kanpur city urban area mid-block in this project we have selected 10 major areas which are categorized as per heavy, moderate and low traffic regions during peak hours, during peak hours major problem arises that is emission of heavy exhaust from two wheeler to 32 wheeler vehicles these vehicles are taken vehicles are taken as under our areas of consideration because the exhausted gases may cause major emission of carbon monoxide(CO) as earlier experiments have shown that it is toxic and it can cause a major respiratory problem. In the project we will analyze the traffic density in the areas that is under the traffic consideration during peak hours the main objective is a survey based analysis by counting the number of vehicles in the areas taken and categorized by low, moderate and high traffic regions although the continuous monitoring shows briefly the polluted regions have higher CO levels but for making a suitable account of why the levels of CO concentration are increasing it is necessary to do a detailed survey of the categorized area. Meanwhile selecting each region as a survey based on use of vehicle in the areas also remedial actions that should be taken to reduce the CO pollution. The emission factor is a key parameter in the calculation of vehicle pollutant emission, which is also called emission of unit mass, and it is the average emission under the influence of various factors according to the national standard, namely, Automotive Emission-Terms and Definitions. Vehicle exhaust emission is affected by many factors, including the features of vehicles (such as vehicle type, technical level, emission control devices, and operation condition), urban road conditions, maintenance frequency.

3. RESEARCH METHODOLOGY

3.1 The methodology includes a model of vehicle exhaust emission this puts forward an establishment of relation between traffic flow and vehicular exhaust this projects is survey based so, there is a survey being made on the street of Kanpur taking the most traffic prone area of Kanpur i.e., *Ghantaghar* midblock *Dipty ka Paraw* for the traffic volume survey the survey was based on vehicle counting and making up a chart that have all the traffic counting related data there was a category of vehicles that included two wheelers, four vehicles, auto rickshaw, heavy load carrying vehicles, light load carrying vehicles, cycles and other vehicles the following factors are taken under consideration on which this project is based upon by making a relation between traffic flow and vehicle exhaust we can easily calculate the permissible limits of CO emission.

3.2 Factors Affecting CO Emission in Urban Areas:-

- ✓ **Traffic Density:** - it is defined as the number of vehicles occupying a given length of a roadway, highway, traffic density plays a major role in regulating CO level in major urban areas of Kanpur because Kanpur is one of the major populated cities in Uttar Pradesh and eventually has many numbers of vehicles, the traffic density is calculated for each recorded count by dividing the vehicle count by corresponding segment length. This survey is conducted along selected road section at least twice per hour.
- ✓ **Vehicle Speed:** - as the name suggests the speed of vehicle plays a major role in regulation and control of CO emission in the traffic driving at low traffic driving at low speed or in stop-and-go traffic with frequent idling increases commuter exposure for several reasons. Vehicle speeds are too often changed when there is a heavy traffic in the peak hours vehicular speed is taken on an account of low emission at high speed and high emission at low speed.
- ✓ **Weather conditions:** - Motor vehicle emissions are usually the highest during the first few minutes of vehicle operation because emissions combustion efficiency improves as engine temperature rises. Indeed, the magnitude of the engine start-up emission is a function of initial engine temperature, with highest emission being experienced when ambient temperature is lowest (i.e., in winter). Weather conditions such as ambient air and pattern of CO dispersion in the micro-environment immediately outside a vehicle, Atmospheric pressure, presence of rainfall, and depth of inversion layer are other weather parameters with potential influence on in-vehicle CO levels.
- ✓ **Vehicle characteristics:** - vehicle age, type, and make are potential determinants of in-vehicle CO exposure. Body cracks associated with older models favor in-vehicle pollutants penetration and increase the probability of occurrence of a self-polluting effect.

3.3 TRAFFIC FLOW ANALYSIS

The traffic flow data has been derived after doing a traffic volume survey this data is survey based and the peak hours are considered in the survey a peak hourly flow has been determined in the evening between 6:30pm-7:30pm, after calculating number of vehicles made a calculation of the PCU level that countered the percentile share of each vehicle into the survey. Below given data is analyzed through traffic volume survey conducted in *Dipti ka Paraw*, situated before *Ghantaghar* Kanpur, this area is taken in consideration because it is the mid-block before Ghantaghar during the survey the vehicles are categorized into different categories and survey was conducted in every 15 minutes slots as per the guidelines, in every 15 minute slot vehicles are counted and then every four 15 minute slot is added as to get an hourly flow of the traffic.

The traffic flow analysis is further calculated by using PCU it stands for (Passenger Car Unit) this plays a major role in calculation related to peak hour analysis also the impact that a mode of transport has on traffic variables (such as headway, speed, density) compared to a single car.

Table 1: Shows traffic volume survey data

Time (Pm)	Car/Van/ Jeep	Auto Ricksha	Bike	Bus	Bus	HCV	LCV	Cycles	Others	Total No. Vehicles
4:00-4:15	56	198	281	6	1	2	24	18	4	590
4:15-4:30	36	116	240	9	0	4	13	10	2	430
4:30-4:45	48	210	325	10	2	7	22	12	3	639
4:45-5:00	54	150	390	12	6	9	25	12	1	659
5:00-5:15	185	133	399	8	3	9	29	40	1	807
5:15-5:30	197	210	415	5	9	3	21	22	1	883
5:30-5:45	174	175	424	8	14	10	25	17	5	852
5:45-6:00	229	215	481	12	23	9	25	40	2	1036
6:00-6:15	238	210	553	14	34	2	31	30	3	1115
6:15-6:30	176	280	429	11	12	6	15	75	0	1004
6:30-6:45	312	280	683	8	34	11	25	50	2	1405
6:45-7:00	226	310	593	15	43	10	27	60	7	1291
7:00-7:15	272	131	659	11	29	7	25	90	1	1225
7:15-7:30	266	190	560	8	12	4	20	90	1	1151
7:30-7:45	202	220	467	6	6	3	15	30	4	953
7:45-8:00	286	123	558	10	13	2	25	35	2	1054
SUM	**2957**	**3151**	**7457**	**153**	**241**	**98**	**367**	**631**	**39**	**15094**

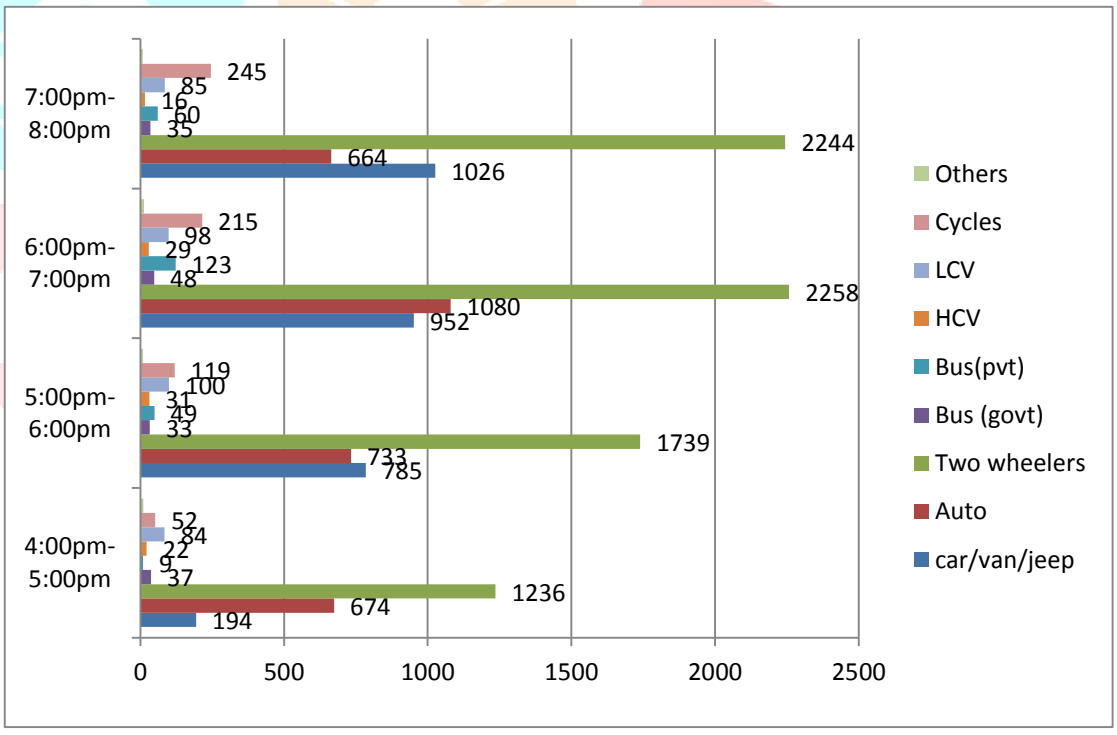
The highlighted data shows the peak hourly flow of the total number of vehicles in the traffic flow and now as we have got the data regarding total number of vehicles and distinguished it into various types of considered vehicles, next step is to determine hourly flow of the traffic for this purpose we have to calculate number of vehicle in each s15 min slot starting from 4pm and ending at 5pm now next slot would be taken from 4:15pm to 5:15pm after that 4:30pm to 5:30pm similarly we can get hourly share of each mode of vehicle also termed as MODE SHARE.

Table 2: shows number of vehicles according to 15 minutes slots

Time (Pm)	Car Van jeep	Auto	Bike	Bus (Gov.)	Bus (Pvt.)	HCV	LCV	cycle	Others	Total
4 – 5	194	674	1236	37	9	22	84	52	10	2318
5 – 6	785	733	1739	33	49	31	100	119	9	3598
6 – 7	952	1080	2258	48	123	29	98	215	12	4815
7 - 8	1026	664	2244	35	60	16	85	245	8	4383

From the data analyzed in the above table we can easily understand the major contribution of the vehicles during the traffic flow if we can understand the major role of a single unit of the vehicle that has played the major role in the pollutant emission then we have come to a conclusion that mostly two wheelers majorly bikes have contributed in high number in the traffic, as we can relate that Kanpur possess higher number of two wheelers. By using the data above us have plotted a graph regarding the hourly share of vehicles in the traffic.

Graph 1: shows number of each category of vehicle according to hourly traffic flow.



Further after counting and calculating the total number of vehicle here is an important aspect of traffic flow and based on the relationship between speed and traffic flow under a certain level of road capacity, the mathematical model of speed and traffic flow is established. Then, with speed as an intermediate variable a model is established to describe the relationship between traffic flow and vehicle exhaust emissions under certain level of urban road capacity constraints. Although the model is based on a two way road, as long as the speed of vehicles remains the same on the section road network or the entire road network, the model still applies. Thus, this model provides a theoretical basis to measure the exhaust emission within a certain region and effectively to control them. Generally, urban road traffic covers all sorts of motor vehicles, and the ratio of motor vehicles is related to the road grades and urban area. The traffic flow is normally distributed to time. If the influence of road intersections is not considered, vehicle's speed on main lines is mainly related to the traffic flow.

Table 3: shows percentile share of each category of vehicles

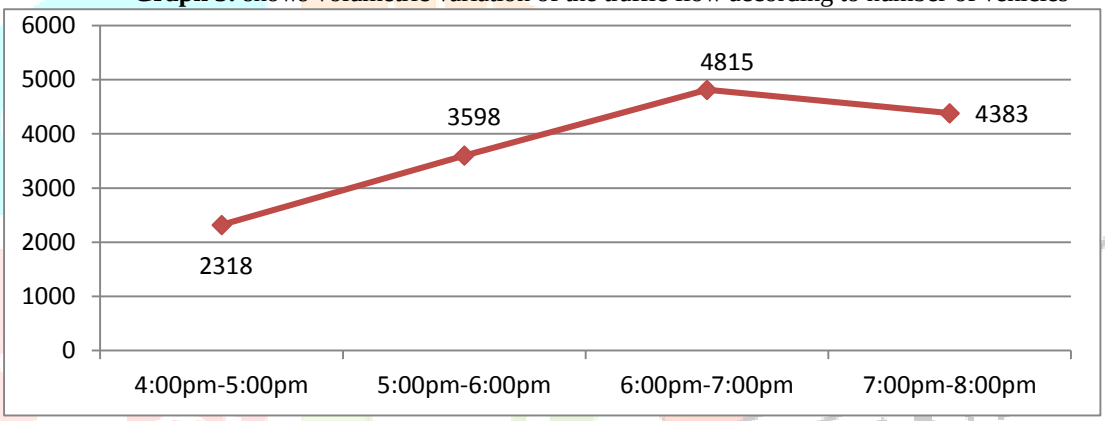
Car/van/jeep	Auto	Two wheelers	Bus (Gov.)	Bus (Pvt.)	HCV	LCV	cycle	others
19.63%	20.78%	49.5%	0.98%	1.60%	0.63%	2.43%	4.18%	0.23%

Table 4: shows volume variations according to the hourly share of vehicles

Time	Total
4:00PM – 5:00PM	2318
5:00PM – 6:00PM	3598
6:00PM – 7:00PM	4815
7:00PM – 8:00PM	4383

Below graph is a representation of above table and highlighted value shows peak hour.

Graph 3: shows volumetric variation of the traffic flow according to number of vehicles



The basic approach for establishment of relationship between traffic flow and traffic vehicular exhaust is calculated by taking traffic density, speed as a bridge between so the studies have been made accordingly a model that has been concerned in the traffic flow and traffic speed relationship establishment is the Green shields model, it has been studied that there is a relation between these two entities the basic idea was hypothetical that a linear relationship existed between speed and density which is expressed in as follows:-

Traffic flow (q) = Traffic Density (k) x Space mean speed (ū)

The above equation shows a relationship between traffic flow, traffic density and the space mean speed of the vehicles this relationship was given as per Greenshield's model.
From the above data we get the values of peak 1 hour volume and next data is for peak 15 minutes after the calculation of the peak hour and peak 15 minute we can easily calculate the data for the percentile of how much busy is the road is by calculating peak factor of the vehicles we can use the formula as given in the IRC: 106 – 1990;

Peak factor=PCU of peak 1 hour (6:30pm to 7:30pm) ÷ 4*(PCU for peak 15 minutes)

- On putting the values from above table we get:

Peak factor = 5460 / (4 x 1558.85)

Peak Factor = 0.88 = 88%

From the above results we get to know that the road is busy for 88% which is extremely busy route for the traffic analysis.

Table 4: shows the parameters that have been calculated as per the formulations.

Time [PM]	No. of vehicle	Length of road [Km]	Traffic Density [veh/Km]	Headway [m]	Travel/avg Speed [Km/hr]	$\bar{U}_i$	V
4 - 5	2318	0.5	4636	0.215	0.5	4559	29.5
5 - 6	3598	0.5	7196	0.140	0.5	7076	29.5
6 - 7	4815	0.5	9630	0.104	0.3	7106	29.6
7 - 8	4383	0.5	8766	0.114	0.4	7097	29.6

3.4 Steps taken in calculating the vehicular exhaust:

There was a selected speed ranges in the condition of low speed, medium speed, and high speed to analyze the relationship between the acceleration and exhaust emissions in order to eliminate the impact of the speed. The division of speed range is as follows:

1. Low speed – (10, 20) Km/h
2. Medium speed – (30, 40) Km/h
3. High speed – (50, 60) Km/h

Parameters such as speed, acceleration, slope, and wind resistance, so it can greatly improve the accuracy. Following function is helpful in calculating vehicular exhaust relative to the speed it is as follows:

$$E_{CO} = 167.154 + [1.1a + 9.81(a \tan(\sin\Theta))-5.29]\, v + 0.0662v^2 + 0.0003v^3$$

Here, V denotes speed, a denotes acceleration and denotes road gradient in radians and taking ruling gradient as 1 in 150

Calculative results of acceleration taken into considerations

- Derived date:

Acceleration (a) = 1 m/s^2
Travel speed (V) = 8.194 m/s
Gradient of the road (Θ) = 1 in 150 = 38.196°
Time = 4pm to 5pm
Putting all the values in the function we get:
E_{CO} = 138.28ppm

- Derived date:

Acceleration (a) = 2 m/s^2
Travel speed (V) = 8.194 m/s
Gradient of the road (Θ) = 1 in 150 = 38.196°
Time = 5pm to 6pm
Putting all the values in the function we get:
E_{CO} = 147.25ppm

- Derived date:

Acceleration (a) = 3 m/s^2
Travel speed (V) = 8.194 m/s
Gradient of the road (Θ) = 1 in 150 = 38.196°
Time = 6pm to 7pm
Putting all the values in the function we get:
E_{CO} = 158.67ppm

- Derived date:

Acceleration (a) = 2 m/s^2
Travel speed (V) = 8.194 m/s
Gradient of the road (Θ) = 1 in 150 = 38.196°
Time = 7pm to 8pm
Putting all the values in the function we get:
E_{CO} = 147.25ppm

4.0 RESULTS

The results of the experimentations are given in the table below the table shows all the required data for the vehicular exhaust emissions, the results are as follows:

Table 5: Shows the results of the vehicular exhaust emission via, acceleration

Time (PM)	Acceleration (m/s^2)	Travel Speed (m/s)	Gradient (Θ)	E_{CO}
4pm – 5pm	1	8.194	1 in150	138.28
5pm – 6pm	2	8.194	1 in150	147.25
6pm – 7pm	3	8.194	1 in150	158.67
7pm – 8pm	2	8.194	1 in150	147.25

The above table has been made on behalf of acceleration change that is positive acceleration with a constant travel speed of the vehicle with the time variance can only be seen in the CO emission in ppm (parts per million), more the concentration more will be the factor of emission from the traffic generating pollutants.

Table 11: shows the deceleration rate of the traffic flow

Time (PM)	Deceleration (m/s^2)	Travel Speed	Gradient(Θ)	E_{CO}
4pm – 5pm	- 1	8.194	1 in150	118.52
5pm – 6pm	- 2	8.194	1 in150	108.65
6pm – 7pm	- 3	8.194	1 in150	98.76
7pm – 8pm	- 2	8.194	1 in150	108.65

The above results shows a typical studies that in a traffic when the average speed is calculated as per the Greenshield's model and for each hourly traffic density the average speed calculated is same then, by the help of deceleration change we can determine the vehicular exhaust emission and after that we can come to a discussed parameter of Carbon monoxide (CO) concentration, now with the brief studies of the impact of acceleration on the traffic and exhaust we can easily plot a graph which can help us to easily understand the level of concentration of CO when acceleration is increased by a similar rate also with the help of the data given above its easy to understand that on increasing the acceleration rate of the vehicle more CO is emitted with the vehicle tailpipe.

CONCLUSION

This project deals with the model based relationship establishment between traffic flows, acceleration, average speed etc; from the studies and survey based approaches there were following conclusions made in the project:

- In the project different types of vehicles were observed under the flow rate and traffic volume survey,
- Traffic survey conducted in the area of consideration was the busiest route in the peak hour flow of the traffic.
- Based on traffic survey we came to know two important aspects of the traffic in the area of survey firstly the peak factor was 88% that means the road was busy with a peak factor of 88% in the time of surveying,
- Secondly, the ratio of service volume and concentration of vehicles on the road was greater than 1 that means the road considered is congested and important action shall be taken to redesign the road for better comfort and lesser traffic exhaust emission from the tailpipe of the vehicles.
- For, the purpose of establishment a model known as Greenshield's model was studied and applied for knowing the average speed, traffic flow and traffic density.
- In this model, carbon monoxide (CO) is selected for vehicle exhaust emission evaluation. Based on the relationship between vehicle speed and vehicle exhaust emission factors.
- A mathematical model of total emission and road speed is established. And based on the relationship between speed and traffic flow under a certain level of road capacity, the mathematical model of speed and traffic flow is established.

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