International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 05 | May 2019 www.irjet.net p-ISSN: 2395-0072

Estimation of vehicular emission at major road corridors in Thiruvanthapuram city

Soumyajohnson[1], P kalaiarasan[2], R Sathikumar[3]

[1]*PG Student (M.Tech- Environmental Engineering and Management), Department of Civil Engineering, UKF Engineering College, Kollam, Kerala, India*

[2]Environmental engineer, Directorate of Environment and Climate Change, Trivandrum

[3]*HOD, Department of Civil Engineering, UKF Engineering College, Kollam, Kerala*

Abstract - *Transportation systems are increasing everywhere and the improvements in technology are insufficient to counteract growth. Traffic events such as interruptions and congestions occur on urban roads causing higher vehicular emissions resulting in air-pollution hotspots. The main motive of the present study is to gain understanding the vehicular emission activity in study areas and recommend the mitigation measures on reduction of emission. And also evaluate the status of pollution in Kerala. It also gives an idea of the future air quality status of the stations selected for the study. IRC is playing a very important role in the development of transportation system in India. Based on IRC guidelines we classify the traffic volume. This study investigates emissions from passenger cars, two wheelers, three wheelers, two axle and multi axle truck and others moving with a traffic fleet during these events. CO2, CO, NOX, SO2, HC, CH4, PM are the exhaust emission of pollutants were analysed. With this goals in mind, we study a systematic study in Thiruvanthapuram city at twenty four different locations at peak hours. Correlation study is done in highly polluted area and ranking the corridors. Finally, we obtain the distribution of vehicular emission in to air pollution is Palayam to over bridge. Also recommended some mitigation measure to those areas on reduction of emission from vehicles.*

***Key Words*: Emission Factor, Vehicular Emission, Projection, Correlation, Air pollution,**

1. INTRODUCTION

Air is an important and vital component of earth's environment and slight change in its composition can have varied effects on growth and development of organisms on this planet Air pollution is concerned, both developed and developing countries are at risk. The main sources of air pollution are the vehicular and industrial sector. Starting from 14th century, when coal was introduced as a fuel, atmospheric pollution becomes social problem. Air itself is a mixture of gases containing Nitrogen (=78.09%), Oxygen (=20.95%), Argon (=0.93%) & Carbon Dioxide (=0.03%), water vapor, Traces of neon, Krypton, Helium, Hydrogen, Xenon and ozone's.

In short everything that we do to become an advanced and prosperous community, puts an ever increasing amount of unwanted and harmful foreign material into the life giving atmosphere, some of them are as follows:

1) Burning of fuels.
2) The propulsion of trains, ships, automobiles, planes, rockets, the extensive refineries for oils and minerals.
3) Chemical and other industry exhaust

1.1 NECESSITY OF STUDY

In major Indian cities, the ambient CO levels along the roads of commercial zones have reached alarming levels indicating that though the number of vehicles in major cities is comparatively smaller, the intensity of pollutants can be compared to that of any other metropolis in the world. This can be attributed to the age of vehicles with poor maintenance, poor road conditions and lack of traffic planning. Moreover the automobiles leave the emission at the ground level resulting in greater impact on the air quality.

2 MATERIALS AND METHOD

2.1 STUDY AREA

Thiruvananthapuram, the capital city of Kerala located in the south-western tip of India, situated between north latitudes 8° 17' to 8° 54' and east longitudes 76° 41' to77° 17'.As per the Census report 2011, the district has a population of 16, 87,406 of which 815,200 are males and 872,206 are females. The number of monitoring stations in this city can be selected based on the background information collected on sources and emissions, population which can be used as indicators of region variability of the pollutant concentration. Knowledge of existing air pollutants levels and patterns within the area are essential for deciding

the number and distribution of sampling stations. The study has been done in the Thiruvananthapuram city, which has been divided into 24 road corridors, and also cover almost all the direction sectors of district.

Table -1: study areas

	Road corridors
Trivandrum	Vellambalam- ampalamukk
	Killipalam – Karamana
	Palayam – general hospital
	East fort – over bridge
	Over bridge - Thampanoor
	Thampanoor – Panavila
	Vellayambalam - Vazhuthacaud
	Palayam – over bridge
	PMG – LMS
	LMS – Vellambalam
	Karamana – Poojapura
	Kazhakuttom - Sreekariyam
	Sreekariyam – Ulloor
	Ulloor – Kesavadasapuram
	Kesavadasapuram – Pattom
	Pattom – Plamoodu
	Ulloor – medical college
	Medical college – Pattom
	Pattom – kavadiyar
	Vellayambalam - Sasthamangalam
	Killipalam – Attakulangara
	Attakulangara – Manacaud
	Medical college - Pettah

2.2 Methodology

A time series database has been created collating secondary data obtained from Kerala State Planning board the period between 2001 and 2018 and these are used for the method to forecast the future air quality status as well as the vehicular emissions of our districts. The air quality data included concentration of various parameters like carbon dioxide, carbon monoxide, hydrocarbon, Sulphur dioxide, Nitrous oxide, Particulate Matter and methane these are the pollutants used for calculating emissions by using emission factor method in respective corridors. The vehicular emission is calculated using the emission factor method wherein the number of various categories of vehicles as well as the emission factor of that particular category is being considered. All these data are then correlate with vehicular emission in to air pollution in that area and analysed the area where pollution is maximum.

2.3 Analysis of Air pollution in Kerala

The need of this study is known about currently status of the pollution in Kerala and status of upcoming years. All the 14 districts of Kerala were selected for the study. This data were collected in economic review. Within each district, datas were collected from the period of eighteen years from 2010 to 2018 and they are as follows Thiruvananthapuram, Ernakulum, Kollam, Alappuzha, Kottayam, Kozhikode, Kannur, Kasargode, Pathanamthitta, Idukki, Thrissur, Palakkad, Malappuram and Wayanad. The monthly and yearly averages of different pollutants such as CO2, CO, NOX, CH4, SO2, HC, PM.

2.4 Vehicular emission

The huge increase in number of vehicles has always resulted in a significant increase in the emission load of various pollutants. Type of pollutants emitted by vehicles varies significantly by the category of vehicles and the type of fuel used for propulsion, say petrol driven or diesel run engines. With the traffic volume data which is collected both as primary and secondary data, emission of various pollutants are calculated. The traffic volume data included the categorized number of various vehicles over a specific time period in the study area. The level of emission from different categories of vehicles would be different. This is identified using a term called emission factor.

In general the vehicular emission can be estimated using following equation:

Vehicular emission = no. of vehicle × emission factor× distance

The vehicular emission depends upon the type, age and condition of vehicle, congested traffic condition of pavement, acceleration, idle or deceleration of vehicle, capability of driver and traffic management systems.

Table – 2; Emission Factor in use vehicles (g/km)

Emission Factor/ pollutant	CO2	CO	NOX	CH4	SO2	HC	PM
Bus	515.2	3.6	12	0.09	1.4	0.6	0.9
Omni bus	515.2	3.6	12	0.09	1.4	0.6	0.9
2 wheeler	26.6	2.2	0.19	0.2	0.013	0.05	1.42
LMV(P)	60.3	5.1	1.28	0.2	0.03	0.2	0.14
Cars/jeep	223.6	1.98	0.2	0.2	0.05	0.03	0.25
Taxi	208.3	0.9	0.5	0.01	10.3	0.07	0.13
Truck And trailor	515.2	3.6	6.3	0.09	1.4	0.3	0.87
LMV(G)	515.2	5.1	1.3	0.09	1.4	0.2	0.14
Trailor and tractor	515.2	5.1	1.3	0.09	1.4	0.2	0.14
Others	343.9	3.9	3.9	0.1	1.9	0.2	0.5
Auto Rickshaw (P)	62.41	1.37	0.2	0.2	0.03	2.53	0.045
Auto Rickshaw (G)	131.61	0.41	0.51	0.09	1.4	0.14	0.091

2.5 CORRELATION OF VEHICULAR EMISSION INTO AIR POLLUTION

The unit of estimated vehicular emission is in kg/km and it is based on the quantity of emission generated by the vehicles but the air quality levels are in either µg/m3 or mg/ m3 or PPM i.e. in volume basis. Based on finding the vehicular emission, the corridor which is high is taken as to correlate the vehicular emission into air pollution, the volume of air for dispersion of pollutants has to be determined. It depends on various meteorological parameters such as wind speed, wind direction, relative humidity, atmospheric pressure and ambient temperature.

In this study, the volume of air is determined using following equation and the influence of meteorological parameters on dispersion is not considered.

$$V = L \times W \times H$$

Where;

V – Volume of air (m3)
L – Length of corridor (m)
W – Width of corridor (m)
H – Mixing height (m)

The mixing height for the criteria pollutants may be varied for each pollutants based on its characteristics like density, stability etc. In this study, the mixing height for the pollutants such as CO2, CO, NO2 and PM are assumed as 500m, 150m, 1250m and 500m respectively based on its characteristics. The width of the corridor is considered as 50m for all corridors and the distance of 2.7, 1.1, 0.9 and 1.9 km for Sreekariyam – Ulloor, Killipalam – Karamana, Pattom – Plamoodu and Palayam – Over bridge respectively presumed for air volume determination.

The uniform mixing height calculation is not having any resemblance with monitored values. Also, it indicates that the characteristics of gases may be varied from different pollutants.

Table -3: Ambient Air Quality Data

		Concen-tration			
Sl.no	Para Meter	Sree kariyam	Killi palam	Plam modu	MG road
1	PM_{10} $\mu g/m^3$	75.96	182.23	83.23	129.08
2	CO_2 PPM	459.40	445.36	445.63	453.50
3	NO_2 $\mu g/m^3$	25.42	52.19	21.53	47.47
4	CO mg/m^3	0.97	3.95	1.21	1.21

3. RESULT AND DISCUSSION

As per IS 5182, the Ambient Air Quality (AAQ) monitoring was conducted by Kerala State Pollution Control Board (KSPCB) at four locations namely Sreekariyam, Killipalam, Plamoodu and MG Road respectively. The categorized number of registered vehicle for a period of 2010 to 2018 that was collected from economic review.

3.1 AIR POLLUTION IN KERALA

The emission values obtained between the years 2010 to 2018 were projected to obtain the emission in the future year 2030 and 2040. Here also trend line method is used for projection.

Table – 3: Projection of Pollutants in Kerala

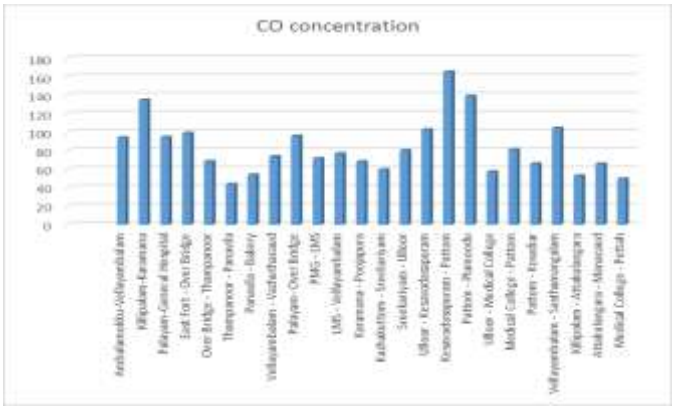
	CO2 (g/km)	CO	NOX	CH4	SO2	HC	PM
2010	865.219771	13.23255787	4.0882407	1.0277685	12.55822	1.632914	5.244985
2011	1261.91216	17.84135924	15.08200428	10.677766	6.316302	2.4253	6.599562
2012	1239.35625	18.52217355	6.32569075	1.3592482	17.21441	2.09368	6.912901
2013	1145.86424	19.11526628	5.1608729	1.5112905	16.32541	2.149449	8.020747
2014	1291.59283	20.65865327	5.32118179	1.6401457	19.91539	2.331719	8.495892
2015	1443.72844	22.96569897	5.96760712	1.8115193	22.00639	2.582504	9.37287
2016	1543.70927	26.53850117	6.3707193	2.5486882	24.41178	2.820628	11.55339
2017	5986.05874	29.03702157	7.24307151	2.1333582	25.05575	2.513936	11.36089
2018	1727.1254	28.82189985	6.48547589	2.2724759	28.80796	2.458218	12.02393

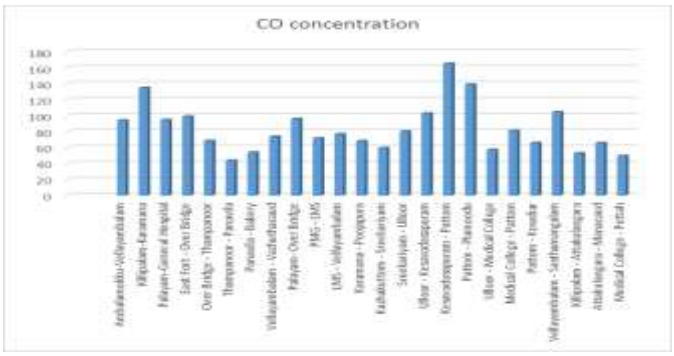
2030	3200	51	10.4	4.7	56.2	4.2	19
2040	4400	72	13.9	6.6	78	5.4	25

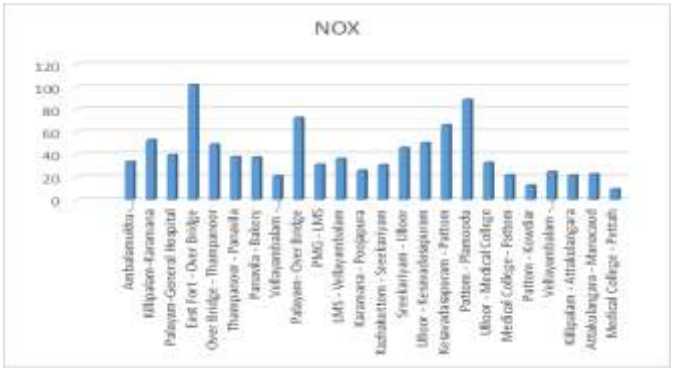
3.2 VEHICULAR EMISSION DATA

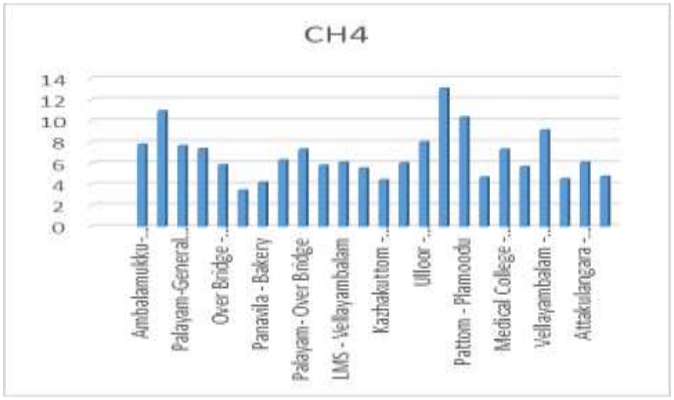
From the motor vehicle department, the categorized vehicle volume data is collected. The data collected included the number of vehicles under various categories. The emission of various pollutants from these vehicles is calculated using the emission factor method. Each vehicle is characterized with its own emission factors that vary with respect to various pollutants.

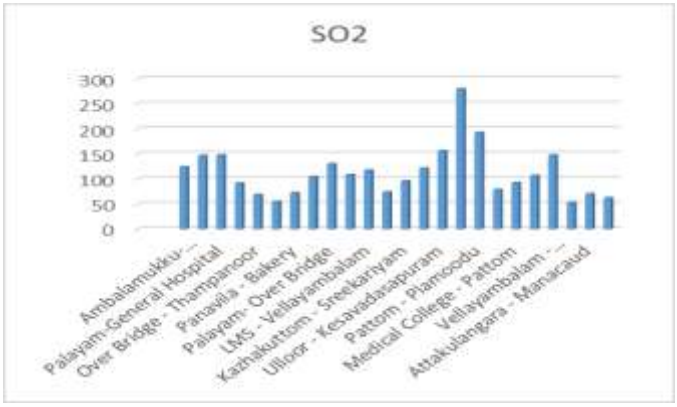
Fig 1: Emission of Pollutants

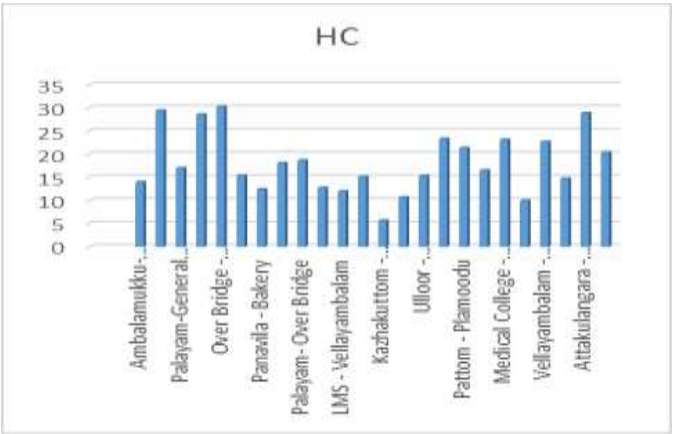


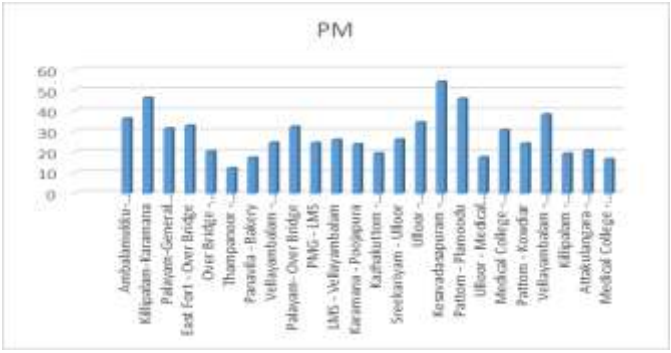





CH4
14
12
10
8
6
4
2
0
Ambalamukku -...
Palayam-General...
Over Bridge -...
Panavila - Bakery
Palayam - Over Bridge
LMS - Vellayambalam
Kazhakuttom -...
Ulloor -...
Pattom - Plamoodu
Medical College -...
Vellayambalam -...
Attakulangara -...


SO2
300
250
200
150
100
50
0
Ambalamukku -...
Palayam-General Hospital
Over Bridge - Thampanoor
Panavila - Bakery
Palayam- Over Bridge
LMS - Vellayambalam
Kazhakuttom - Sreekariyam
Ulloor - Kesavadasapuram
Pattom - Plamoodu
Medical College - Pattom
Vellayambalam - ...
Attakulangara - Manacaud


HC
35
30
25
20
15
10
5
0
Ambalamukku -...
Palayam-General...
Over Bridge -...
Panavila - Bakery
Palayam - Over Bridge
LMS - Vellayambalam
Kazhakuttom -...
Ulloor -...
Pattom - Plamoodu
Medical College -...
Vellayambalam -...
Attakulangara -...


PM
60
50
40
30
20
10
0

3.3 DISPERSION OF POLLUTANTS IN AIR

To correlate the vehicular emission into air pollution, the volume of air for dispersion of pollutants has to be determined in the various mixing height.

Table -4: volume of dispersion of pollutants in air

road	500m	750m	1000m
Sreekariyam – Ulloor	22928.4	15286.05	11456.2
Killipalam – Karamana	18490.9	12327.7	8790.55
Pattom-Plamoodu	12057.7	8038.25	6028.6
Palayam- over bridge	24952.6	16407.4	12476.25

After the analysis, ranking the four corridors with respect to pollutant concentrations. Palayam – over bridge is highly altered area with high dispersion of pollutant concentration.

4. CONCLUSION

This study uses air quality data from twenty four air pollution monitoring stations in capital of Kerala, as well as emission factor methods is to examine the air quality variables with the expectation of truly reflecting the difference of air quality surrounding of each monitoring station. The vehicular emission is showing an increasing trend in Kerala. From the projected data, it is clear that there is an increasing trend in the concentration of pollutants. It also gives an idea of the future air quality status. The ambient air quality of particulate matter concentration at Killipalam and M.G Road was higher than prescribed permissible limit (100 µg/m3) of Central Pollution Control Board and the average concentration of other pollutants were within the allowable limit. Then correlate the vehicular emission into air pollution, the volume of air for dispersion of pollutants has to be determined in the various mixing height. Finally ranking the cluster, Palayam to over bridge seems to be having higher dispersion of pollutants.

5. MITIGATION MEASURES

Thus the corridor need proper attention. Air pollution is more is identified and proper preventive measures are taken to avoid such a hazardous situation. Air pollution is one of the serious threats that we are facing now a days. The main causes of the air pollution are the automobile exhaustion. Since the vehicular emissions is the major cause for deterioration of urban ambient air quality, it is necessary to prevent it for the future days. Some of the improvement methods include improvement in fuel quality, expansion of urban public transport systems and promotion of integrated traffic management systems. Promotion of the Ethanol Blended Petrol and Bio-diesel has been taken up in some of the places. Also Ethanol Blended Petrol has been introduced as a new pollution limiting fuel that is suggested by the Ministry of Petroleum and Natural Gas.

ACKNOWLEDGEMENT

The author wishes to express her gratitude towards, Govt. of Kerala, NATPAC, and Director of directorate of Environment and Climate Change for providing data for this project

REFERENCES

[1] K.T. Bency et al, “A study on the air pollution related human diseases in Thiruvananthapuram city” Kerala Department of Geography, University of Madras and Faculty of Environmental Studies, York University. Pages 15 – 22.
[2] Amogh P. Kumar, et al,” An analysis of air pollution in Kerala” Jr. of Industrial Pollution Control 34(1) (2018) pp 1917-1921.
[3] Josna J Dcruz, et al, “Air Quality Study of Selected Areas in Kerala State,” International Research Journal of Engineering and Technology (IRJET Volume: 04)
[4] T Subramani, ”Study of Air Pollution Due To Vehicle Emission in Tourism Centre,” International Journal of Engineering Research and Applications (IJERA) Vol. 2, Issue 3, May-Jun 2012, pp.1753-1763