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Diurnal Concentration of Carbon Monoxide (CO) as an Indicator of Vehicular Pollution in Urban area of Surat City, Gujarat, India

Juned S. Miyajan[1]* and Hemangi H. Desai[2]

[1]TIFAC CORE, Sarvajanik College of Engineering & Technology, Surat (INDIA)
[2]Shree Ramkrishna Institute of Computer Education & Applied Sciences, Surat (INDIA)
E-mail: [1]jmiyajan@gmail.com, [2]hemangal4@yahoo.co.in

Abstract–*Carbon monoxide (CO) is toxic trace gas and an indicator of vehicular pollution. The problem of increased level of Carbon monoxide (CO) in urban area where foremost source is vehicles and industries. With the rise in population, income level and ever increasing industrial and commercial activities the transportation sector is poised for a substantial growth in terms of number of commercial, passenger and heavy motor vehicles added every year. Total vehicular load has increased to 15.35 lacks as per recorded data of RTO till March 2014. Observing this status, a study of diurnal concentration of Carbon monoxide (CO) in ambient air of the Surat city was conducted at different traffic point of Ring road and Rajmarg of Surat. Carbon monoxide (CO) was monitored for short term (i.e. for 24 hours at 2 hours interval) at six sampling station. From the data obtained the trend of change in diurnal concentration of Carbon monoxide (CO) was investigated.*

Results indicate that concentration of Carbon monoxide (CO) was increasing with respect to increase in vehicular activity at all the sampling station. Higher concentrations of Carbon monoxide (CO) were recorded for Sahara Darwaza, Delhi Gate and Majura Gate study location. T The frequency of the crossing the permissible limit during 24 hours is less than 6% for the 24 hours study period.. For Sahara Darwaza and Delhi Gate frequency of the crossing the permissible limit is 25% and 8.3% respectively. The average concentration of carbon monoxide for 24 hours found to be maximum 3411.9 µg/m^3, 3128 µg/m^{3}and 3343 µg/m^{3}respectively for Sahara Darwaza, Delhi Gate and Majura Gate.

Keywords: *Carbon monoxide (CO), Toxic, Air pollution, Surat city, Vehicular Emission.*

1. INTRODUCTION

High level of the air pollutant in urban area of the large cities Air pollutants are emitted by different anthropogenic sources mainly vehicular traffic, industry, power plants, trade and domestic fuel. Increase in mass population, commercial and domestic activities and increase in numbers of vehicles results in remarkable rise in air pollutants concentration in ambient air of the urban area in large cities of developing countries like India.[1] Changes in the composition of the urban atmosphere are caused largely by traffic- induced pollutants. These are mainly carbon monoxide (CO), nitrogen monoxide (NO), dust, nitrogen dioxide (NO_2), ozone (O_3) and other photo oxidants like PAN etc.[2, 3] Air pollution in urban area is major due to vehicular sources has assumed very high importance in present era because of large number of cases of morbidity and mortality occurring in various large cities in different parts of the world. Amongst various pollutants present in vehicular exhaust gases, CO is the most important due to its highest concentration in comparison to other gaseous pollutants and also, because of its adverse physiological effects on human beings at various carboxyhaemoglobin (COHb) levels in blood.[4,5] Due to this, many studies are being conducted worldwide, which measure concentrations of the CO emitted in exhaust of the on-road automobiles and also, various new possible technological solutions with or without traffic-management-initiatives are being investigated.[6] To control emission of lead, carbon monoxide and particulate matter from the badly maintained automobiles, Motor Vehicles Act, 1988, has been passed by the Indian parliament. The exhaust standards framed under Central Motor Vehicle Rules 1989 was came in to implementation from July 01, 1989. According to a study, gasoline powered vehicles emit 23 kg of CO per 100 liters of fuel burnt.[4,7]

Carbon monoxide (CO) is a toxic, colourless, odourless and tasteless gas. It is the by-product of incomplete combustion of carbon-containing materials. CO has a very high affinity for hemoglobin and on inhalation, combines selectively with hemoglobin of the blood (Hb) and forms carboxyhaemoglobin (COHb), thereby reducing the oxygen carrying capacity of the blood. High CO level is potentially deadly and fatal to human life as CO is a very dangerous asphyxiates.[2] The adverse health effect of high concentration of CO includes headaches, sore eyes, runny nose, dizziness, vomiting and loss of consciousness. The Malaysian Code of Practice recommends that CO exposure must not exceed 10 ppm to ensure a healthy and safe environment. The concentration of CO should be low at the range of 0.01–3 ppm[8]

The CO concentration above 10 ppm is significantly associated with SBS symptoms such as dizziness, fatigue and headache. The concentration of CO is

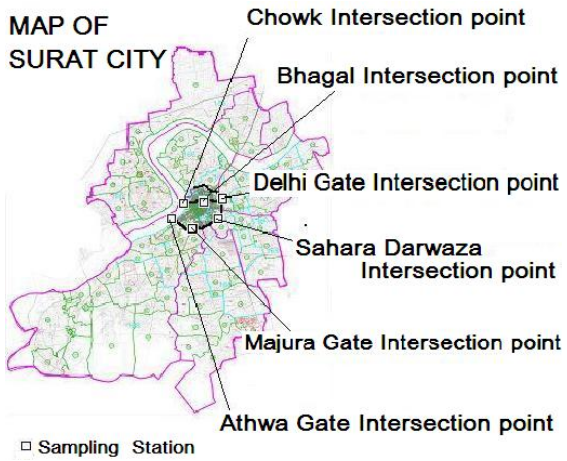

Fig. 1: Study Area; Surat

found in the range of 0–3 ppm.[9,10] In India permissible limit laid by NAAQS for Carbon monoxide in ambient air is 4 ppm (i.e. 4000 µg/m^3) for 24 hours.[11] Researcher has reported concentration of carbon monoxide maximum average up to 4214 µg/m^3 at Chopati Garden, Varacha and minimum average value up to 1331 µg/m^3 at Amba Wadi-Dumas in Surat city during early morning in January,2011.[2] Because of changes in traffic patterns it was reported that the CO concentrations are usually lower at weekends than on weekdays and follow a different diurnal pattern [12,13]

2. MATERIAL AND METHODS

Study Area: Surat is situated on the west coast (21.17^{o}N Latitude and 72.83^{o}E Longitude) of India in the state of Gujarat. Surat is the second largest commercial hub in the State. Surat is mainly known for its textiles and diamond cutting & processing industries. Nowadays, It is emerging as a potential hub for IT \ TeS sector in Gujarat. Hajira and Magdalla Ports in the city provide logistic support to the industrial operations min the state with foreign countries. Surat is one of the most dynamic city of India with one of the fastest growth rate due to immigration from various part of the country. Area within Municipal limits is distributed in seven Zones. Total area which comes under the SMC is 326.52 Sq.Km.[12] In case of Surat City, the population is expected to rise to 5.53 million by the end of 2015-16 and 6.88 million by the end of 2020-21.

Table 1: Sampling Stations

Sampling station on Raj Marg		Sampling station on Ring Road	
S-1	Chowk Int.point	S-4	Athwa Gate Int.point
S-2	Bhagal Int.point	S-5	Majura Gate Int.point
S-3	Delhi Gate Int.point	S-6	Sahara Darwaza Int.point

With the rise in population, income level and ever increasing industrial and commercial activities the transportation sector is poised for a substantial growth in terms of number of commercial, passenger and heavy motor vehicles added every year. The compounded 5 yearly growth rate of vehicles added in the city is estimated to be 34.14 %. [13] Total vehicular load has increased to 15.35 lacks as per recorded data of RTO till March 2014.[14]

Table 2: Data of No's of vehicle registered at RTO, Surat (YOY data)

YEAR	TOTAL NOS OF VEHICLE REGISTERED
2000-01	53327
2001-02	57233
2002-03	77961
2003-04	85869
2004-05	106976
2005-06	121461
2006-07	123975
2007-08	102760
2008-09	78373
2009-10	98082
2010-11	137778
2011-12	170264
2012-13	159334
2013-14	162168
TOTAL	1535561

3. SAMPLING AND EXPERIMENTS

Air sample were manually collected in rubber bladder using dragger pump at interval of every 2 hours for 24 hours. During sampling, 12 samples were for each location and transported o laboratory for analysis. Monitoring was done as per the instructions of the manual. After the sampling was completed the analysis of the air pollutant sample were done and the conclusion and interpretation of it was taken out. Methods were adopted as outlined by Bureau of Indian Standard (BIS) guideline.[15]

Table 3: Air pollution data for the different sampling station.

Time	Traffic point of Ring Road			Traffic point of Rajmarg		
	S-1	S-2	S-3	S-4	S-5	S-6
5:00-7:00	1352	1978	1789	1456	1894	2393
7:00- 9:00	1980	2479	3480	1909	2465	3893
9:0-11:00	1832	2785	3872	2260	2203	4559
11:00-13:00	2430	3388	3360	1980	1709	3360
13:00-15:00	2614	2914	2989	1867	2019	2914
15:00-17:00	1920	2630	2630	1780	1918	2820
17:00-19:00	1190	2435	2812	1333	1873	3249
19:00-21:00	2980	3327	3685	1908	3343	5566.3
21:00-23:00	2374	3168	3357	1790	2209	4423
23:00-1:00	1956	2634	4420	1678	2236	3620
1:00 - 3:00	1364	1090	2920	1901	1752	2211
3:00 - 5:00	1802	1230	2230	990	1680	1935

*NAAQS permissible limit for CO is 4000 µg/m^3

4. DISCUSSION

The investigation of the data revealed that at all the sampling station; 24 hours average concentration of carbon monoxide (CO) is below the permissible limit of 4000 µg/m^3. The frequency of the crossing the permissible limit during 24 hours is less than 6% for the 24 hours study period.

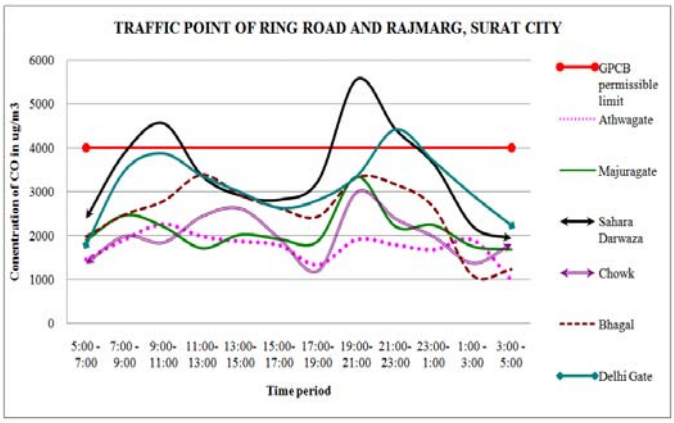

Fig: 2: Concentration of Carbon monoxide at all sampling Location

Fig.2 shows during early morning hours concentration of carbon monoxide (CO) is low at all the sampling station ranges between 1352 µg/m^3 to2393 µg/m^3 and remain stable. As vehicular activity increase during morning hours (i.e. 7:00 to 9:00) concentration of the carbon monoxide (CO) starts to increase. During morning hours concentration is high at all the sampling station due to heavy traffic rush between as peak hours (9:00 to 11:00). Continuous rise in concentration of carbon monoxide (CO) was observed during peak hours. Maximum value recorded during study period 4559 µg/m^3, is above permissible limit of 4000 µg/m^3 at Sahara Darwaza and minimum 1832 µg/m^3 at Chowk Intersection point. During noon hours (13:00-15:00) concentration of the carbon monoxide (CO) follows decreasing pattern ranges between minimum 1780 µg/m^3 to maximum 2820 µg/m^3 as movement of vehicles is low during this period. For 15:00-17:00, vehicular movement decreases which results in linear pattern of decrease in concentration of carbon monoxide (CO) ranges between 1867 µg/m^3 to 2989 µg/m^3.

From evening (17:00-19:00) vehicular movement again starts to increase. During this time period increase in concentration of carbon monoxide (CO) was observed. Traffic movement reaches to high by late evening hours (19:00-21:00). During this time period concentration of carbon monoxide (CO) reaches to its peak second time during 24 hours.

It is clear from this **Fig.2** that the morning peak which is between 6:00 and 8:00. However, in the three curves, evening peaks are significant.

Maximum value 5566.3 µg/m^3 recorded at Sahara Darwaza during night hours (19:00-21:00) exceeds the NAAQS permissible limits.(**Fig.2**) During night hours (21:00-23:00) to late night hours (23:00-1:00) concentration of CO tends to decrease to low from its peak at all the sampling station.

During the sampling common observation were illustrated about the driving pattern and vehicle use of civilian of the Surat. It is observed that the use of privet vehicle is at its peak in absence of effective mass transport. Though Surat is a city of flyover bridges and wide roads, improper management of traffic leads to results in high level of vehicular pollution.

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