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ASSESSMENT OF VOC EMISSION AT THE TRAFFIC INTERSECTIONS OF CENTRAL ZONE OF SURAT CITY

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***Abstract*— Due to urbanization there is growth in population and due to which the number of vehicles increases which will lead to increase in air pollutants like CO, CO_2, SO_x, NO_x, PM, VOCs, etc. VOCs (Volatile Organic Compunds) emission affects the human health and environment and also the BTEX compounds i.e. Benzene, Toluene, Ethyl-Benzene, Xylene will lead to chronic diseases in human body. Traffic volume study has been considered and temporal variations will be considered. The assessment of VOC emission will be carried out at the major intersections of Surat city. To assess the amount of VOCs and BTEX compounds with the help of TIGER VOC Detector. The maximum results of (1) Post-monsoon were recorded in evening at Chowk; TVOC (0.1-1.6)ppm, Benzene (0.1-0.6)ppm, Toluene (0.1-0.3)ppm, Ethylbenzene (0.1-0.4)ppm, Xylene (0.2-1)ppm and (2) Winter were recorded in evening at Bhagal; TVOC (0.1-1.5)ppm, Benzene (0-0.5)ppm, Toluene (0-0.2)ppm, Ethylbenzene (0-0.2)ppm, Xylene (0-0.4)ppm. The winter results were comparatively less as compared to Post-Monsoon results. All the benzene results were recorded very high as compared to the standard permissible limit of 5ppb by NAAQs (National Ambient Air Quality Standards).**

Keywords— **BTEX compounds; meteorological variation; temporal variation; traffic intersection; VOC Emission;**

I. INTRODUCTION

Due to development and industrialization in the country air pollution got aggravated at higher extent. The use of petroleum products in highways, railways and marine transport has been a tremendous increase. Due to which combustion residues of gasoline and oil emerged as new factors in air pollution community. Examples toxic air pollutants include benzene, which is found in gasoline, Methylene chloride found in paint strippers and many other pollutants like dioxins, toluene, asbestos and metals such as cadmium, mercury, chromium and lead.

Motor vehicles emit many pollutants which EPA classifies as known (eg. Benzene) or probable human carcinogens (eg. acetaldehyde, formaldehyde). Some toxic compounds are present in gasoline (eg. benzene) are emitted to the atmosphere when gasoline evaporates or passes through the engine as unburned fuel. Benzene comes from incomplete combustion of gasoline such as toluene and xylene that are chemically similar to benzene and also formaldehyde, acetaldehyde, diesel particulate matter and 1–3 butadiene which are not present in fuel but by-products of incomplete combustion. Vehicular sources contribution is about 63% of the total pollutants which are emitted to atmosphere (ISEST, 2000). [24]

These materials, known as pollutants, have several adverse effects on human health and the ecosystem. Transportation is a major source of air pollution in many countries around the world due to the high number of vehicles increasing on the roads. An increase in purchasing power means that more people can now afford cars and this is bad for the human health and environment. Vehicular pollution has grown at an alarming rate due to growing urbanization and industrialization in India.

The other important factors of vehicular pollution in the urban areas are type of vehicle, 2-stroke engines, poor fuel quality, old vehicles, inadequate maintenance, congested traffic, poor roadconditionand old automotive technologies and traffic management system.

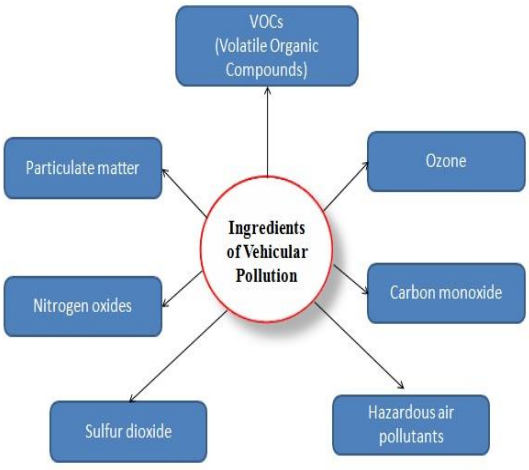

Fig.1. Pollutants responsible for Vehicular Pollution [25]

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These are some of the consequences of pollution:

(i) Global warming
(ii) Poor quality of air
(iii) International reputation
(iv) Health
(v) Tourism
(vi) Smog and acidic rain

VOCs (Volatile Organic Compounds)

The gases from certain solid or liquid which are emitted to the atmosphere are known as Volatile Organic Compounds (VOCs). In VOCs there are varieties of chemicals, some of them are short term and some are long term adverse health effects. VOCs are consistently higher indoor then outdoors but main outdoor source is Automobiles. Thousands of products or a wide array emits VOCs. Many of the organic chemicals are used as an ingredient in household products i.e. paints, varnishes, wax, etc. Fuels are major sources of VOCs made up of organic chemicals.[24]

Health effects by VOCs are-

(1) Acute Health effects

Eye irritation and watering, Throat irritation, Nose irritation, Headache, Nausea, Vomiting, Dizziness and Asthma

(2) Chronic Health effects

Cancer, Kidney damage, Liver damage and Damage to the Central nervous system

Table 1- Priority Volatile Compounds [24]

1,3 Butadiene	Toluene	Vinyl Chloride
Acrylonitrile	Maleic anhydride	Toluedine Isocyanate
Epichloro hydrine	Phosgene	Benzene
Ethylene oxide	Propylene oxide	Caprolactum
Phthalic anhydride	Carbon tetrachloride	Hydrogen cyanide

BTEX are the most commonly occurring chemicals. These types of VOCs are evidently carcinogenic for human beings. Due to health related aspects of BTEX compounds, it is becoming extremely important to show their presence and to determine the prevailing concentrations in the ambient air and environment.

Various Toxicological and carcinogenic effects of BTEX compounds are

(1) Effects of benzene

A long term exposure to benzene causes leukemia (blood cancer) in human beings. For animals, leukemia, some type of tremors and lymphomas are observed. WHO estimates 4 in 1 million risk of leukemia (blood cancer) on exposure to benzene concentration of 1µg/m^3 (0.31 ppb).[24] Benzene exposure leads to genetic change, increased proliferation of bone marrow cells and occurrence of certain chromosomal aberrations in animals as well as humans. Also some non-cancer effects are associated with benzene exposure are blood disorders, effects of bone marrow, anemia and reduction in ability to clot the blood, damage to immune system and acts as a reproductive toxicant.

(2) Effects of toluene

Toluene in comparison of benzene is less toxic and dangerous and may cause drowsiness, impaired coordination etc. High dose of toluene exposure can produce liver and kidney damage and hyperplasia of bone marrow, depression in central nervous system and anemia.

(3) Effects of ethyl-benzene

Acute ethyl benzene exposure may be marked by respiratory effects such as throat irritation, eye irritation and chest constriction. A neurological effect like dizziness is observed.

(4) Effects of xylene

Acute xylene exposure may be marked by dizziness, weakness, nausea, breathing difficulty, headache, vomiting and loss of coordination. In severe exposure, tremors, visual blurring, irregularities in heart beats, loss of consciousness and paralysis.

VOC Measurement methods

VOCs can be measured in two ways. They are as follows:

a) Through VOC meter/ analyzer
b) Through Gas Chromatography method.

a. **VOC Meter:**

Fig.2. Tiger VOC detector

The Tiger VOC detector is an innovatory handheld gas detection instrument for the swift and precise detection of volatile organic compounds (VOCs) within the severest of environments. Tiger integrates Ion Science patented photo ionisation detection (PID) sensor technology along with humidity resistance and anti-contamination design, which proves to dramatically extend run time in the field.

A vigorous Tiger VOC detector provides a dynamic detection range of 0 to 20,000 parts per million (ppm) with a minimum sensitivity of 0.001ppm (1 ppb).

b. Gas Chromatography (Standard Procedure)

i. Organize a gas sampling tube packed with an activated charcoal.

ii. Expose the tube at two ends to link it with a sample pump and pulling air
through the tube with pump. Thus airborne chemicals becomes stuck on the
sorbent surface.

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iii. Low flow sampler is used to convey the sampling by keeping the tubes in
vertical situation to avert the chance of channeling leading to under sampling.
iv. For ambient air, the sampling flow rate could be in the series of 20-100 ml/min
(±2%)
v. Sample is rejected if revolution beats 10%. Then cap the tube with push-on
covers and is led to a laboratory for investigation.
vi. The tubes are appropriately stored enveloped in aluminium foil in a silica gel
multi-tube storage basin in a hygienic environment.

OBJECTIVES OF THE STUDY

- To collect the baseline like data traffic volume study and meteorological parameters (Temperature, wind direction, wind speed and relative humidity).
- To assess the amount of VOCs also determine the quantity of BTEX compounds.
- To assess the temporal variations of VOC emission due to vehicular pollution at major traffic intersections of Central zone of Surat city.

II. METHODOLOGY

A. Selection of the study area

Surat is the 8th largest city and 9th largest metropolitan area of India which is having an area of about 327 sq.km with a total population of 6.1 million by the 2018 census. Areas of Surat have a mass concentration of 14000 persons/sq.km. Surat is a city of tropical climate and abundant amount of rainfall.[26]

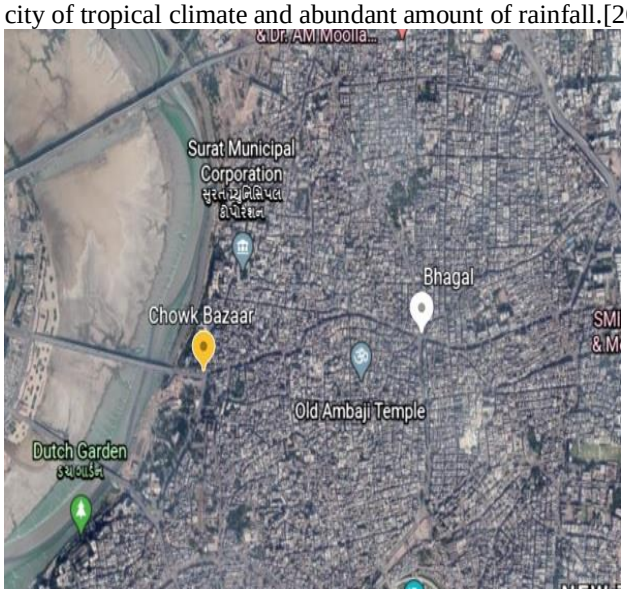

Figure 3 : Location of Study Area

B. Methodology flowchart

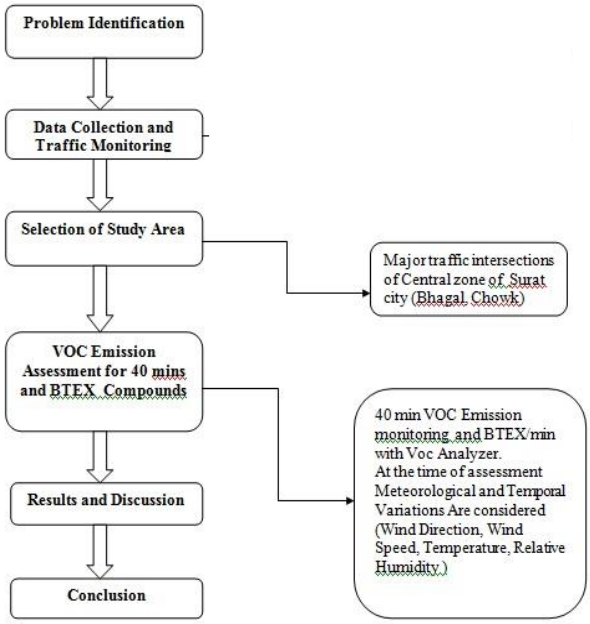

Fig.4. Methodology of Study (Flowchart)

C. VOC Monitoring Sites (major traffic intersections of central zone of Surat city)

There are two major traffic intersections where monitoring is being carried out -

- Bhagal Char Rasta
- Chowk Char Rasta

Both monitoring sites are highly populated and these sites have highest traffic flow and always having congestion problems at the intersection. At these intersections the stoppage time of vehicles is a bit higher so because of which there is excess amount of VOC emission.

D. Sampling Schedule

The sampling schedule was prepared to carry out the measurement of VOCs emission effectively from the selected sampling locations of major traffic intersections.
Sampling is done between 8:00-10:00 A.M in morning and 16:00-18:00 in evening.

E. Standards, permissible limit and instrumentation

Table 2 -List of standards of the parameters

Sr. No.	Parameters measured	Permissible Limits (as per NAAQS)	Instrumentation
1.	Total VOC (TVOC)	NE	Tiger VOC Meter

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2.	Benzene (B)	5 ppb	
3.	Toluene (T)	NE	
4.	Ethyl benzene (E)	NE	
5.	Xylene (X)	NE	
6.	Meteorological Parameters- Temperature Relative Humidity Wind Speed and Direction		• Thermometer • Hygrometer • Anemometer

NAAQS: National Ambient Air Quality Standards
NE: Not Established

- 1hour traffic count at each intersection at peak hours of morning and evening.
- Meteorological data collected

Table 3 - Meteorological data at the time of Monitoring

POM	L	T	M P			
			T °C	WD	WS MPH	RH %
Post-monsoon	B	M	26	E	3	62
		E	31	W	6	49
	C	M	27	E	4	65
		E	30	W	7	46
Winter	B	M	21	E NE	9	45
		E	28	N	9	41
	C	M	22	E NE	9	44
		E	29	N	9	39

POM – Period of Monitoring
L- Location
(B-Bhagal, C- Chowk,)
T- Time
(M- Morning, E- Evening)
MP- Meteorological parameters
(T ºC - Temperature, WD- Wind Direction, WS- Wind Speed, RH- Relative Humidity)

III. RESULT AND ANALYSIS

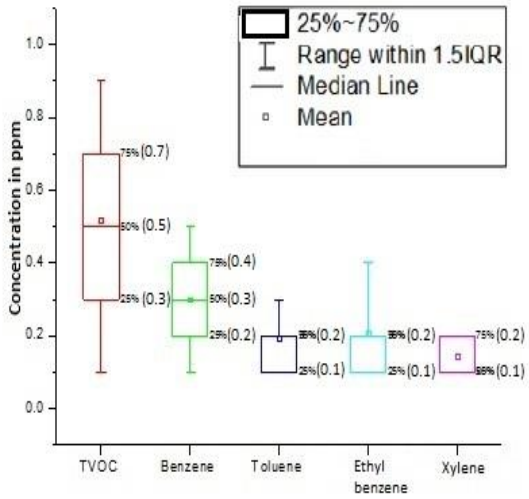

Fig.5. Graphical representation of variation in concentration of TVOC and BTEX at Bhagal Char Rasta (Morning) for Post-Monsoon

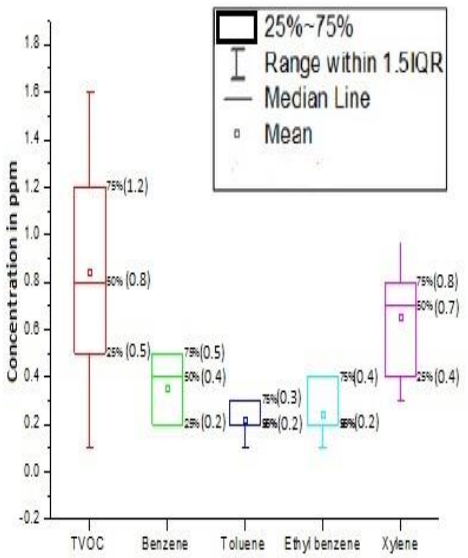

Fig.6. Graphical representation of variation in concentration of TVOC and BTEX at Bhagal Char Rasta (Evening) for Post-Monsoon

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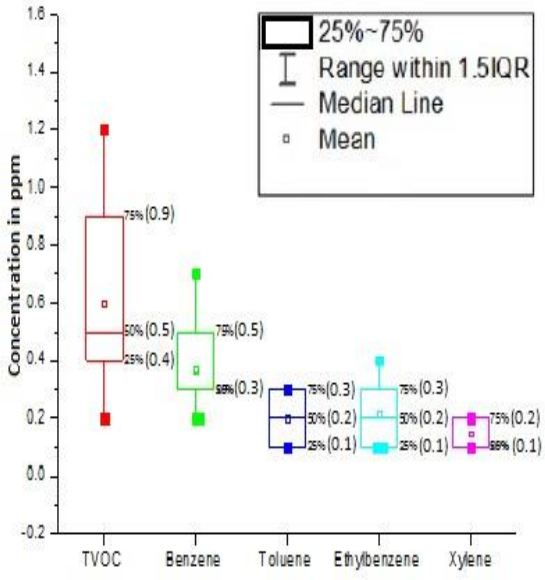

Fig.7. Graphical representation of variation in concentration of TVOC and BTEX at Chowk Char Rasta (Morning) for Post-Monsoon

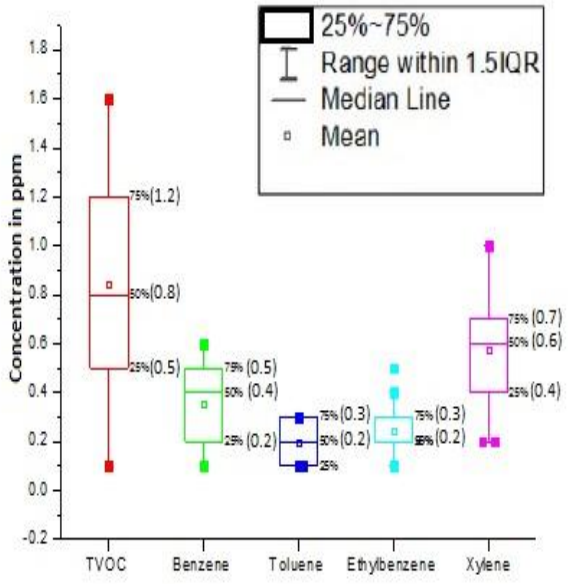

Fig.8. Graphical representation of variation in concentration of TVOC and BTEX at Chowk Char Rasta (Evening) for Post-Monsoon

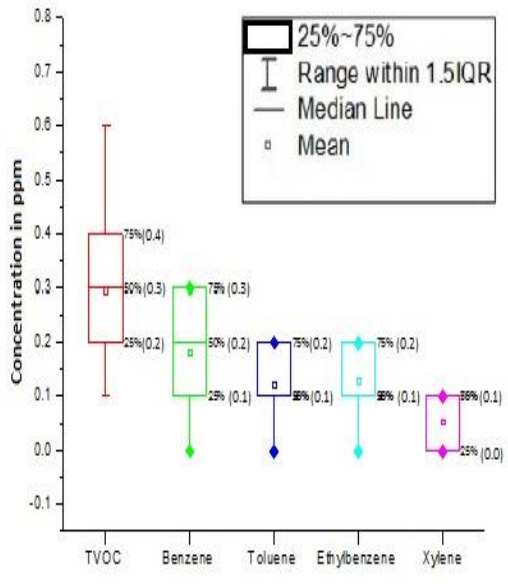

Fig.9. Graphical representation of variation in concentration of TVOC and BTEX at Bhagal Char Rasta (Morning) for Winter

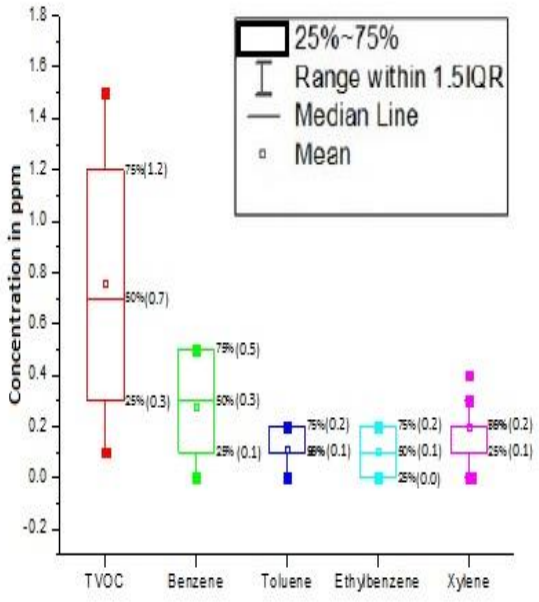

Fig.10. Graphical representation of variation in concentration of TVOC and BTEX at Bhagal Char Rasta (Evening) for Winter

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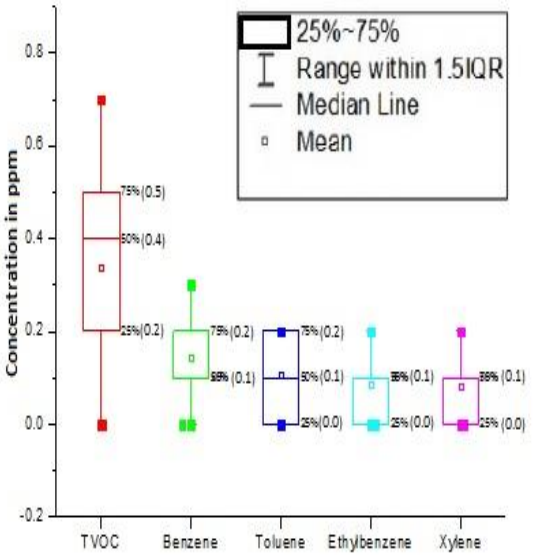

Fig.11. Graphical representation of variation in concentration of TVOC and BTEX at Chowk Char Rasta (Morning) for Winter

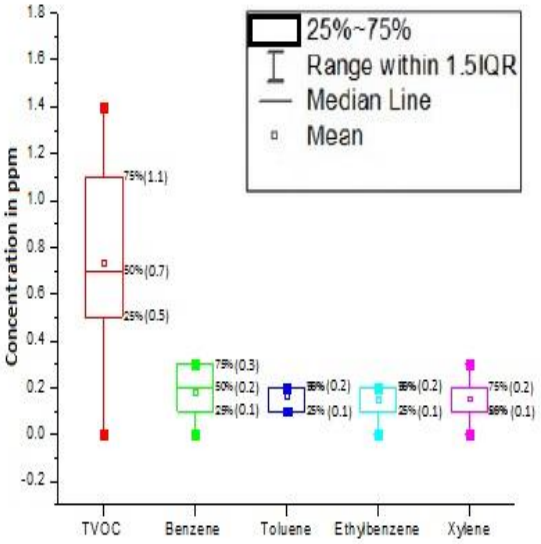

Fig.12. Graphical representation of variation in concentration of TVOC and BTEX at Chowk Char Rasta (Evening) for Winter

IV. CONCLUSION

- The maximum values for TVOC and BTEX were measured when temperature is high and Relative Humidity is less.
- There is more emission when the vehicles are in a stoppage time at the intersection.
- The instrument for VOC measurement must be placed opposite to the wind direction so that there will be accurate assessment.
- From morning to evening as temperature increases and relative humidity decreases the increase in the amount of VOC emission is observed.
- The maximum results of (1) Post-monsoon were recorded in evening at Chowk; TVOC (0.1-1.6) ppm, Benzene (0.1-0.6) ppm, Toluene (0.1-0.3) ppm, Ethylbenzene (0.1-0.4) ppm, Xylene (0.2-1) ppm.
  (2) Winter were recorded in evening at Bhagal; TVOC (0.1-1.5) ppm, Benzene (0-0.5) ppm, Toluene (0-0.2) ppm, Ethylbenzene (0-0.2) ppm, Xylene (0-0.4) ppm.
- The results in winter are comparatively less than Post-monsoon because of more wind speed and relative humidity and lower temperature.
- The results of benzene were recorded very high as compared to the standard permissible limit of 5ppb by NAAQs (National Ambient Air Quality Standards).

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