# Assessment of VOC Emission at West Zone Transfer Station of Surat City

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## Abstract

Municipal Solid Waste Management is associated with the control of generation, collection, storage, transfer and transport, processing and disposal of solid wastes. Concentration of VOC emissions were measured at major transfer stations of Surat city located in residential areas due to human health and environmental effects as well as on site vehicular activities. VOC are hazardous to human health and also contribute to ozone formation at ground level, responsible for climatic changes as well. VOC emissions were measured considering the spatial and temporal variations and its dispersion will be evaluated using a soft computing technique. A VOC meter was used to carry out VOC measurement which a simple handy tool is becoming popular nowadays. With further refinement, the quantitative analysis of TVOC emission by the VOC analyzer will become an easier, faster and more economical technique than the currently used standard methods.

**Keyword- Municipal Solid Waste Management, VOC Measure, Spatial and Temporal Variations, Dispersion Model**

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## I. INTRODUCTION

Rapid urbanization and industrialization has brought about serious air pollution problems and has impacted human health in major Asian developing countries. Air pollutants like particulate matter (PM), oxides of nitrogen (NOx), carbon monoxide (CO), sulphur dioxide (SOx) and volatile organic compounds (VOCs) pose a serious health hazard and serious concern for agriculture and global climate as well. Among the gaseous air pollutants, VOCs are the key components both in polluted and remote regions of the troposphere. In tropospheric photochemistry, VOCs play a key role due to the high abundance of water vapor and intense solar radiation flux. However, several VOCs categorized as class 1 carcinogens, including benzene, formaldehyde and acetaldehyde, have resulted in cancer. In addition, exposure to other VOCs including toluene, ethylbenzene and trichloroethylene, may have bad impacts on human health.

Fast development of urban population in many urban cities and Asian countries have resulted in an increased solid waste generation rate; and has made solid waste management a critical issue. Financial improvement, urbanization, and enhancing expectations for everyday comforts in urban communities, have prompted increase in the amount of generated waste. In general a 1% increase in population is associated with 1.04% increase in solid waste generation and 1% increase in capita income is associated with 0.34% increase in total solid waste generation.

Transfer station is a facility which is used to store waste temporarily in regions nearby urban areas. WTS have bad influences on neighborhoods and personnel like noise and emissions of bad odors relating to solid waste and oil of the transfer vehicles. The aim of this research is to assess VOCs emission from WTS in Surat and to depict VOCs dispersion modeling based on relative softwares. Most of the earlier studies emphasized on the dispersing VOCs in landfill or waste treatment plants, but not in the WTS.

Daily practices being carried out at study locations of Surat City are as follows:

- Primary collecting vehicles sent to the Elevated platform through ramp.
- Chutes are provided at Elevated Platform to receive the MSW from where it will be unloaded by primary collection vehicles.
- Secondary transport vehicle is kept underneath the chutes.
- MSW unloaded from primary collection vehicles will be transferred into the closed container provided with compactor system.
- The chute portion of transfer station is covered on the top with FRP sheet and whole structure is kept closed with concrete louvered blocks.
- Transportation of container will be carried out on Hook lifting vehicles.
- Containers are fully closed with leak proof door opening system.

## II. INDIAN SCENARIO OF VOCS

India has been a leading giant among developing nations and has a lots of pressure from different domestic and international forums to formulate principles and regulations towards VOC control along with many other footsteps. A rapid increase in the growth of

number of registered motor vehicles underlines the importance of a detailed understanding of the VOC emission contribution from traffic.

*A. Analytical Methods*

VOCs measurement in ambient air is often difficult, because of the different types of VOCs and their potential concern, variety of techniques for sampling and analysis, and the lack of standardized and documented methods. VOCs sampling methods vary from each other according to the techniques, type of sorbent used, extraction method, analysis and identification technique. In India, the most widely used method for VOCs sampling are pre-concentration on sorbent tubes or whole air (grab sampling) sample taken in canisters or tedlar bags or real time monitors.

*B. Standard Method EPA TO-17*

Method TO-17 is used to analyze samples for volatile organic compounds collected on multi-bed sorbent tubes, which are thermally desorbed and cryo-focused on the capillary column and then analyzed by GC/MS. The range of compounds analyzed by the method depends on the selection of the sorbent cartridge. EAS follows the method recommendation that the calibration and QC criteria for Method TO-17 follow the TO-15 method.

| *Tube name* | *Compounds* | *Packing* | *Desorption Temperature* |
|---|---|---|---|
| *Tenax TA* | *BTEX*<br>*Diesel Range Organic* | *Tenax TA* | *300ºC* |
| *Carbotrap 300* | *General VOC* | *Carbopak C*<br>*Carbopak B*<br>*Carboseive SIII* | *325ºC* |
| *VOC* | *General VOC* | *Tenax TA*<br>*Carboxen 1000 Carboseive SIII* | *325ºC* |

*Table 1: TO-17 Sorbent Cartridge Selection Guide*
*(Source: www.easlab.com/QC/EPA%20TO17%20Volatile%20Organic%20Compounds.pdf)*

TO-17 tubes can also be sampled passively using special adapters. The tubes are desorbed and analyzed in the same manner as the normal TO-17, and the TO-17 QC criteria is used.

| *Final Volume* | *Flow Rate* | *Time* |
|---|---|---|
| *500 ml* | *100 ml/min* | *5 min* |
| *480 ml* | *1 ml/min* | *8 hours* |
| *720 ml* | *0.5 ml/min* | *24 hours* |

*Table 2: TO-17 Recommended Sampling Times*
*(Source: www.easlab.com/QC/EPA%20TO17%20Volatile%20Organic%20Compounds.pdf)*

## III. PARAMETERS AND INSTRUMENTATION

The parameters to be measured at major municipal solid waste transfer stations of Surat City are as follows:

| *Sr. No.* | *Parameters to be measured* | *Permissible Limits (as per OSHA)* | *Instrumentation* |
|---|---|---|---|
| *1.* | *Benzene (B)* | *1 ppm* | *VOC Meter* |
| *2.* | *Toluene (T)* | *100 ppm* | |
| *3.* | *Ethylbenzene (E)* | *100 ppm* | |
| *4.* | *Xylene (X)* | *100 ppm* | |
| *5.* | *Total VOC (TVOC)* | | |
| *6.* | *Meteorological Parameters-*<br>*Temperature*<br>*Relative Humidity*<br>*Wind Speed and Direction* | | *IMD* |

*Table 3: List of parameters to be measured and instrumentation*

OSHA: Occupational Safety and Health Administration
IMD: Indian Meteorological Department

## IV. STUDY AREA

Surat covers 326.515 sq. km of area. Surat had a population of 4.6 million at the 2011 census. It is the eighth largest city and ninth largest metropolitan area of India. Surat has a density of 13680 persons/sq.km. In Surat City (in year 2015), 1575 M.T. MSW generate per day. Out of them, 1499.44 M.T. /day waste was collected (Average of 01/04/13 to 31/03/14) by Surat Municipal Corporation (SMC). There are 7 zones in the Surat city, namely North, East, West, South, Central, South-East and South-west. Each zone has a municipal solid waste transfer station.

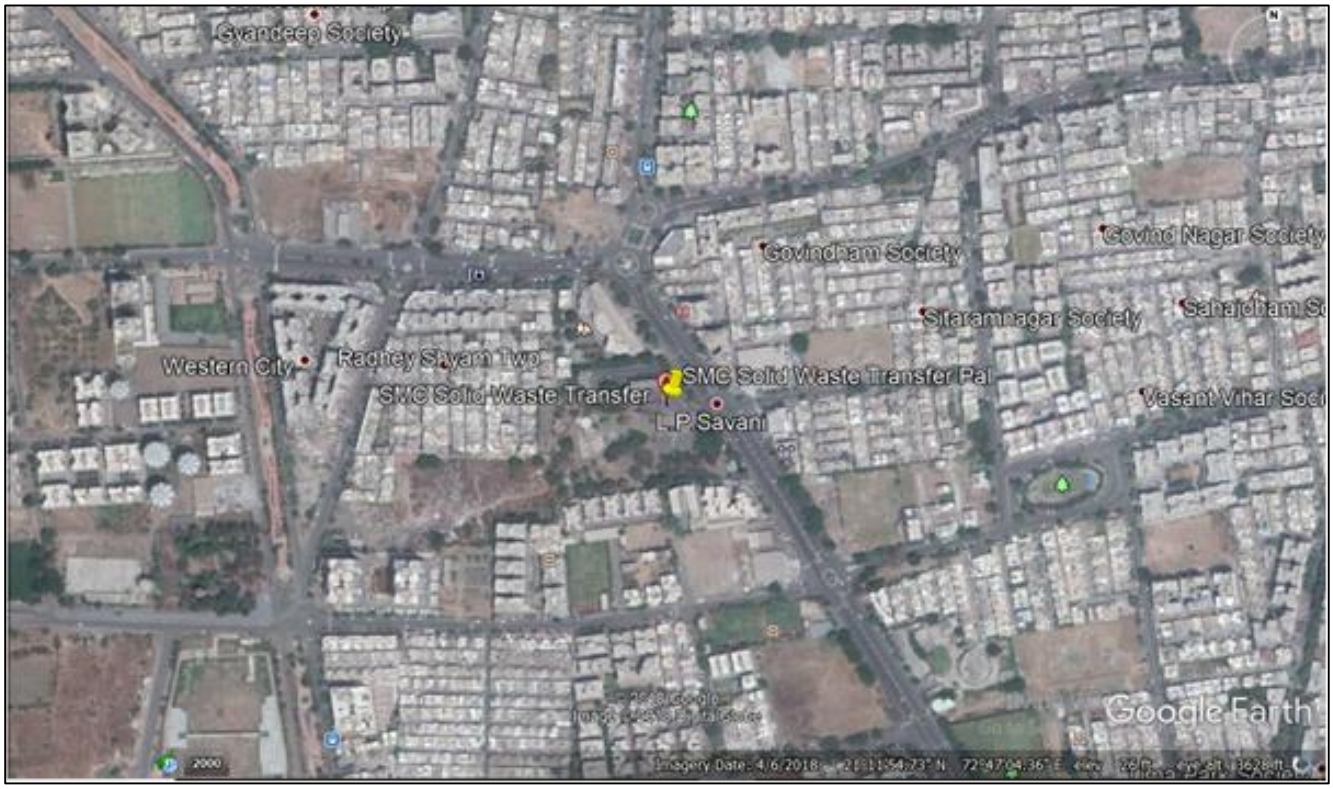


Fig. 1: Location of VOC monitoring site

*A. VOC Monitoring Site*

The various transfer stations has different localities surrounding it. Based on the localities one major transfer station located in Pal was selected as it is purely located in residential area. It is surrounded by school on one side and residential localities on another side. Pal transfer station is located in the west zone with proposed capacity of 150 MT and average MSW collection of 223.197 MT.

Fig. 2: Measurements of VOC emission during compaction process

## V. RESULTS AND DISCUSSIONS

The VOCs emissions at Pal Transfer Station were measured using a VOC meter at different sampling locations based on the activities being carried out at the transfer stations daily.

| *Parameters Measured* | *Readings* | *Time* | *Concentration (in ppm)* |
|---|---|---|---|
| *Benzene* | *Maximum* | *10:47:13 am* | *0.9 ppm* |
| | *Minimum* | *10:45:18 am* | *0.0 ppm* |
| | *Average* | | *0.4 ppm* |
| *Toluene* | *Maximum* | *10:54:00 am* | *0.9 ppm* |
| | *Minimum* | *10:55:40 am* | *0.1 ppm* |
| | *Average* | | *0.4 ppm* |
| *Ethylbenzene* | *Maximum* | *10:57:13 am* | *0.9 ppm* |
| | *Minimum* | *10:57:03 am* | *0.1 ppm* |
| | *Average* | | *0.4 ppm* |
| *Xylene* | *Maximum* | *11:03:55 am* | *6.0 ppm* |
| | *Minimum* | *11:02:45 am* | *0.1 ppm* |
| | *Average* | | *0.9 ppm* |
| *TVOC* | *Maximum* | *10:12:50 am* | *14.0 ppm* |
| | *Minimum* | *10:09:15* | *0.2 ppm* |
| | *Average* | | *3.3 ppm* |

*Table 4: BTEX and TVOC concentrations at Pal transfer station*

The above table shows the concentrations of BTEX and TVOC. Also these concentrations varies with different activities being carried out at the transfer stations. The readings were taken at the place of unloading of vehicles, wastewater stream at hopper bottom, waste gathered in loaded vehicles and during the compaction process in the compaction unit. The variations in the readings is due to the ongoing continuous compaction process i.e. volume reduction of municipal waste. When the piston moves forward, the gas is released and at that point, the maximum VOC emission is obtained. Less or no traces of VOCs are found when piston moves backwards. So the maximum concentrations were found at the Compaction Unit of the transfer station where the municipal solid waste is compacted (volume reduction).

The readings collected shows that all VOCs are under limit as per OSHA standard permissible limit at the West zone transfer station of Surat City.

| *Time Interval* | *Temperature* | *Relative Humidity* | *Wind Speed* | *Wind direction* |
|---|---|---|---|---|
| *10:00am – 12:00pm* | *30.4ºC* | *65 %* | *6 km/hr* | *W* |
| *12:00pm – 2:00pm* | *31.0ºC* | *61 %* | *8 km/hr* | *SW* |

*Table 5: Meteorological Parameters*

The above data were obtained from the site of Indian Meteorological Department of India collected at the Magdalla Center of Surat City.

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