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Thanking you

Yours faithfully
For SGS India Pvt Ltd.

**S. Suresh Kumar**
**Manager – Technical (Environment Services)**

# A REPORT ON
# MEASUREMENT OF VOLATILE ORGANIC COMPOUNDS AT TARAPUR INDUSTRIAL AREA
# IN MAHARASHTRA STATE


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# LIST OF ANNEXURES

## 1.0 INTRODUCTION:

Volatile Organic Compounds (VOCs) mostly industrial solvents which are used in Chemical Industries (Pharmaceuticals, Pesticide, Dye & Dye Intermediates & other Chemicals) are emitted in to the environment in most of the industrial estates. Some of them being known carcinogens can be identified as Hazardous Air Pollutants and needs special attention. Ambient air levels of VOC is required to be monitored primarily because of their role in adverse impacts on human health as well as ecology, and also on the adverse impact on atmospheric factors relating to other environmental changes (Ozone Layer Depletion etc) i.e. increases in levels of troposphere (ground-level) ozone and decreases in levels of stratospheric ozone. Most of the chlorinated VOCs may contribute for 35 – 55% of outdoor air borne cancer risk.

Tarapur is one of the critically polluted areas identified in Maharashtra by Central Board because of huge pollution caused by industries. The action plan for the problem area had been prepared and various efforts have been made to implement the action plan. The time targeted action plan was prepared to solve pollution related problems of the area. The industrial area Tarapur, which is mostly having chemical industries, attracts public complaints and receives attention from media primarily because of effluent problem as well as strong odour & colour in final discharge from the industrial estate. The odour nuisance may be because of raw materials used in the processes like Sulphur based compounds, some organic compounds and finished products.

Presently, criteria pollutants (SPM, RSPM, $SO_2$ and $NO_x$) are monitored regularly and other pollutants like $NH_3$, $Cl_2$, Acid mist etc are monitored occasionally to know ambient air quality in critically polluted areas as well as in other industrial areas and major cities. The CPCB, West Zone Office, Vadodara has carried out VOC monitoring as a step towards knowing which VOCs as Hazardous Air Pollutants (HAPs) are found in the ambient air in Chemical Industrial Area of Tarapur. The study is carried out in order to prioritize some potential HAPs for development of standards and subsequently enforcement.

## 2.0 ABOUT VOCs

- Volatile Organic Compounds are organic chemical compounds which volatile at the temperature 25$^{o}$C and vapour pressures greater than 0.14mmHg.

- significantly vaporize at normal ambient conditions and enter the atmosphere

- Most compounds with less than about 12 carbon atoms.

- This includes any organic compound (any compound containing carbon) other than those compounds determined to have negligible photochemical reactivity. These compounds are referred to as 'exempt VOCs'.

The following some compounds are not volatile organic compounds

(1) carbon monoxide (2) carbon dioxide; (3) carbonic acid; (4) metallic carbides or carbonates; (5) ammonium carbonate; (6) methane; (7) ethane;

**CLASSIFICATION OF THE VOC BY BOILING POINT**

WHO classification of VOC, based on boiling points is as given below

- VVOC : Very Volatile Organic Compounds : < 0 upto 50 – 100$^{o}$C
- VOC : Volatile Organic Compounds : 50–100 up to 250 – 260$^{o}$C
- SVOC : Semi Volatile Organic Compounds : 250 – 260 up to 380 – 500$^{o}$C
- POM : Polycyclic Organic Materials : > 380$^{o}$C

VOCs are organic substances which are volatile and are photo chemically reactive. It includes a long list of individual substances, many of which are toxic. The followings are the effects of VOCs

- Precursor to ground level ozone
- Precursor to secondary fine particulate
- Human health impacts
- Nuisance effects, such as odours

The VOCs are categorized as follows:

- **Highly harmful:**

  Highly harmful VOCs are the substances such as Benzene, Vinyl Chloride and 1,2 dichloroethane pose serious health risks to humans.

- **Class A VOCs:**

  Class A VOCs are the VOCs which may contribute substantially to the creation of photochemical ozone, depletion of stratospheric ozone or global warming. These are considered as having a medium degree of harmfulness. Examples include carbon tetrachloride, 1,1,1-trichloroethane, trichloroethylene and trichlorotoluene.

- **Class B VOCs:**

  Class B VOCs are the remaining majority of VOCs are considered as having a lower degree of harmfulness than class A VOCs. However these VOCs are also regulated substances whose releases must be prevented or minimized. Examples include butane and ethyl acetate.

## 3.0 METHODOLOGY:

CPCB, West Zone Office, Vadodara had employed M/s. SGS India Private Ltd., Chennai for sampling at Tarapur Industrial Estate in Gujarat.

The background information and dry data about industrial estate were collected from MPCB and MIDC. The ambient monitoring locations were worked out on the basis of dry data collected and preliminary survey of the industrial estate. Locations for collection of effluent samples were identified on the basis of industrial effluent flow pattern and effluent management scheme of the industrial estates. Industries were selected from the inventory available with MPCB. Collection of relevant information from industries and detailed information of plant premises was carried out to finalise the important locations for monitoring from fugitive emission point of view.

The VOC monitoring study was carried out at ambient environment, selected industries, CETPs / effluent sumps. The monitoring covered following:

*VOC monitoring at*

- Ambient air quality monitoring was conducted across the industrial estate at five locations which covers up, down and cross wind directions and center of the industrial estate.

*VOC Monitoring at Industries for*

- Fugitive emission samples was collected near to the source
- Wastewater samples was collected from the inlet of the ETP
- Hazardous waste samples was collected in a composite manner from the available stock of distillation residue, spent carbon, ETP sludge etc.,

*VOC Monitoring at CETP and Effluent sumps of Industrial Estate*

- Samples were collected from the inlet sump and equalization tank of CETP. Samples were also collected from effluent collection sumps located in Industrial estates for handling and management of industrial effluents.

The list of 60 VOCs which are identified for the sampling and analysis is enclosed as **Annexure–I** and important physical properties of all 60 VOCs is enclosed as **Annexure – II.**

VOCs monitoring was carried out in association with the officials of CPCB and MPCB and analysis was carried out in M/s. SGS Laboratory, Chennai.

## 4.0 OBJECTIVE:

The Objectives of the study are as below:

- To identify and quantify the VOCs presence in the ambient air, surface water
- To identify and quantify the VOCs presence in the air (fugitive emission), raw wastewater and hazardous waste in the industrial units mostly

pharmaceuticals, Pesticides, Dye & Dye Intermediates and other Chemicals.

- To prioritize the most toxic and most predominant VOCs in the Ambient air
- To generate the database for future monitoring and subsequent standard development for enforcement
- To develop a protocol for sampling and analysis method for VOCs in Indian context
- To address the complaints received from Public/NGOs

## 5.0 LIMITATIONS OF THE STUDY

This study is an attempt to develop the baseline data and profiles of the VOCs present in ambient air, industrial effluents discharges and hazardous waste generated. The methods adopted for sampling and analysis are developed by overseas international institutions and methods standardized for Indian conditions are not developed and notified yet. Considering the fact, the total numbers of samples are optimized to cover wide range with available infrastructure for handling management and transportation of the samples for analysis.

## 6.0 ABOUT TARAPUR INDUSTRIAL ESTATE:

Maharashtra Industrial Development Corporation (MIDC) has developed one of the largest industrial estates of Maharashtra in Palghar Taluka, at Tarapur. The industrial estate was established in the year 1972. Its proximity to Bombay and location on Bombay-Ahmedabad Western railway with ample availability of infrastructure always attracts industries. The industrial estate, MIDC, Tarapur is located in Thane District of Maharashtra State. It is one of the important industrial zones that developed by Maharashtra Industrial Development Corporation. Tarapur is approachable by road from Bombay and Ahmedabad through National Highway (NH-8). The estate is also connected to Bombay and Ahmedabad by rail. Boisar is the nearest railway station to the site. The Arabian Sea is hardly 5 km from the industrial estate. River Surya is the main source of water for the estate. Most of the industries located in the area are falling in the category of small to medium scale industries. Category-wise numbers of industries in Tarapur are given in following Table:

**INDUSTRY STATISTICS OF TARAPUR**

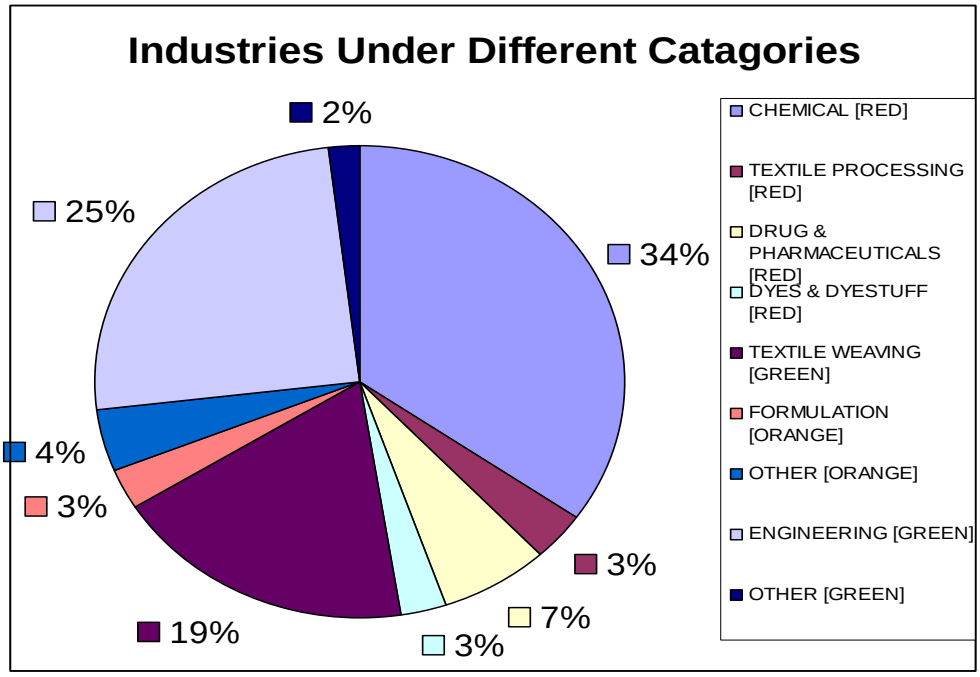
| CATEGORY | LSI | MSI | SSI | TOTAL |
|---|---|---|---|---|
| *RED* | 33 | 58 | 397 | 488 |
| **ORANGE** | 03 | 06 | 64 | 73 |
| **GREEN** | 01 | 11 | 458 | 470 |
| **TOTAL** | **37** | **75** | **919** | **1031** |

* Source : MPCB

The entire industrial estate is spread in about 1130.98 Ha area. The entire industrial estate is divided into number of zones and the chemical industries are mainly housed in N-zone. The numbers of different types of industries are given in following Table:

**TYPES OF INDUSTRIES**

| | |
|---|---|
| CHEMICAL [RED] | 357 |
| TEXTILE PROCESSING [RED] | 34 |
| DRUG & PHARMACEUTICALS [RED] | 68 |
| DYES & DYESTUFF [RED] | 29 |
| TEXTILE WEAVING [GREEN] | 192 |
| FORMULATION [ORANGE] | 28 |
| OTHER [ORANGE] | 45 |
| ENGINEERING [GREEN] | 258 |
| OTHER [GREEN] | 20 |
| TOTAL | 1031 |




## 7.0 METHODS FOR SAMPLING:

### 7.1 Air sampling:

It is decided to follow EPA TO-17 and ASTM -3685 for sampling of Ambient Air Quality and Fugitive emissions using pre and post calibrated personal samplers.

The criteria of choosing the Method TO-17 & ASTM D-3685 for sampling are:

- Many compounds which boils at above 100$^{o}$C also efficiently collected by these methods
- These methods have a flexibility of sampling the gas stream at a high flow rate of 1 lpm and at low flow rate of 0.1 to 0.5 lpm
- These methods have an option of sampling smaller volumes at lower flow rates and should be used when the boiling points of the VOCs of interest are below 35$^{o}$C.
- The target detection limit of these methods is 0.1µg/m$^{3}$.

The selection of the method of sampling and analysis mainly depend on three important common factors.

- *Representation:* the extracted gases must be representative of the gas stream within the ambient air.

- *Integrity:* the extractive system and any sampling media used for grab sampling must be managed and operated in a manner which maintains integrity of the sample. If any of the VOCs are lost or changed during delay between sampling and analysis, then it must be known and understood both the extent and nature of these threats to sample integrity.

- *Validity:* The methods used for sampling and analysis must be valid, unbiased, accurate and precise within the ranges defined by the criteria of acceptance.

## 7.2 Water and Hazardous Waste Sampling:

Wastewater samples were collected from the identified locations of industries, CETP and Industrial estates. The water samples collected in purge & trap amber vials directly with neck full of samples which can avoid any head space formation. After collection the samples were preserved in cooler with proper identification mark and the same is sealed.

The hazardous waste samples were collected from the identified locations of selected industries. Representative samples were collected from various locations, well mixed and sealed in an aluminium foil followed by polythene cover.

## 8.0 SAMPLING PROCEDURE FOR AMBIENT AIR QUALITY AND FUGITIVE EMISSION MONITORING

### 8.1 About Adsorbent Tubes:

Based on the merits and demerits, it was decided to adopt 2 methods for the ambient level of VOCs as well as Fugitive emissions.

*1) Combined Adsorbent Tube- (CAT)*

An integrated method of TO-17 & ASTM 3685 method comprising combined adsorption tube comprising of Tenax – Charcoal and Backup Charcoal by Purge and Trap Method on GC-MS to capture broad spectrum of compounds.

The advantage of ASTM 3685

- Break through volumes can be measured
- Wide spectrum of low molecular weight chlorinated VOCs are captured
- Moisture in atmosphere do not interfere with the analysis
- Repetition of analysis is possible
- Spiking is possible

Disadvantages

- Analyst must have thorough knowledge of matrix
- Contamination is possible, if proper care is not taken
- Availability of the combined tubes is problem

*2) Active Thermal Desorption (ATD)* combination tube: –

Compodium method TO-17 using Tenax and Chromosorb ATD method.

The advantage of method 17:

- No contamination occur since the sample is directly injected
- Wide spectrum of high molecular weight chlorinated and aromatic VOCs are captured
- Easy to capture

Disadvantages:

- Replication is not possible
- Does not cover broad spectrum of VOCs
- Breakthrough is not measurable
- Moisture affects the analysis.

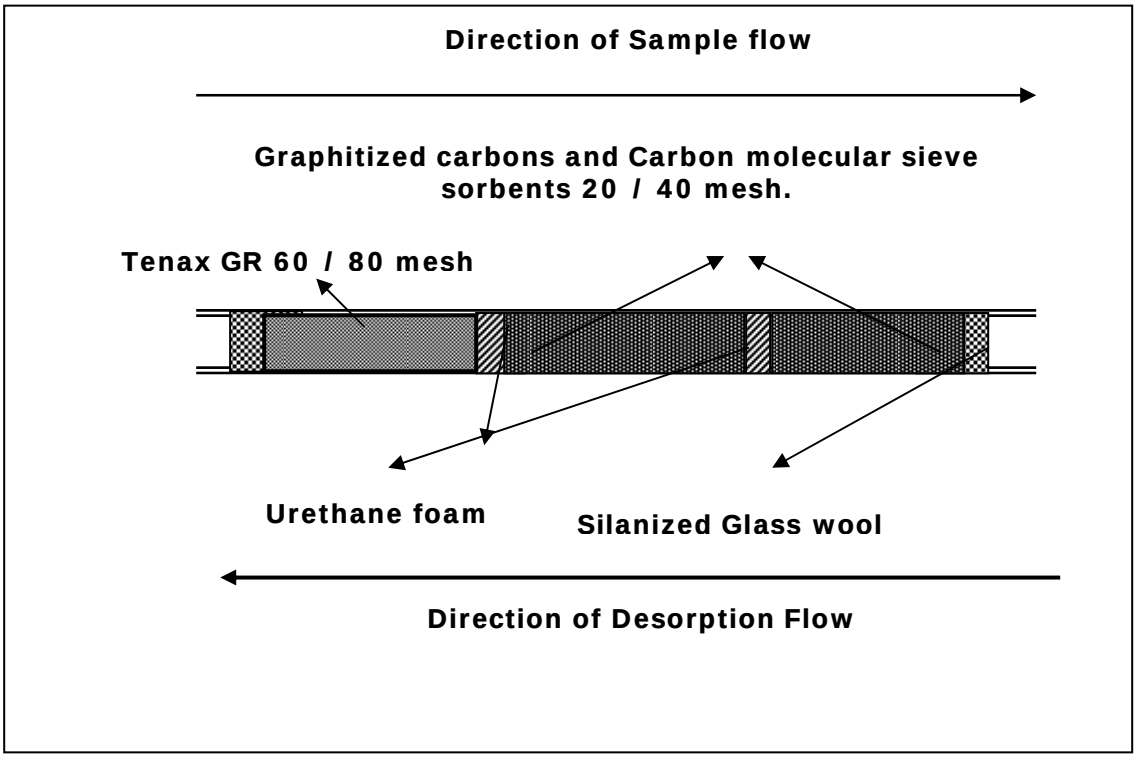
The criteria of choosing the Method TO-17 & ASTM D-3685 for sampling are:

- Many compounds which boil above $100^{o}C$ also efficiently collected by these methods.
- These methods have a flexibility of sampling the gas stream at a high flow rate of 1lpm and at low flow rate of 0.1 to 0.5lpm.

- These methods have an option of sampling smaller volumes at lower flow rates. This should be used when the boiling points of the VOCs of interest are below 35$^{o}$C.
- The target detection limit of these methods is 0.1µg/m$^{3}$.

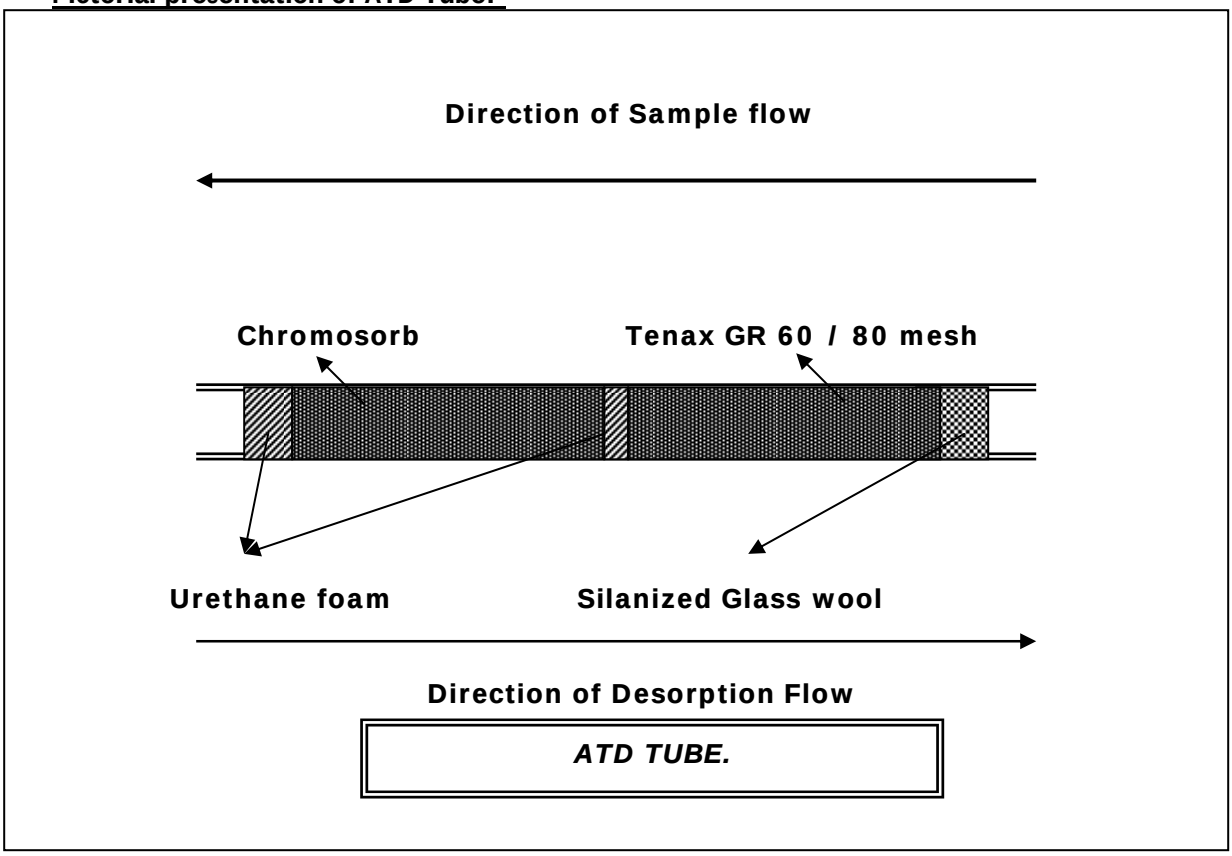
CAT was prepared in house by M/S SGS, Chennai.

**Pictorial presentation of CAT (Tenax:Charcoal:Charcoal tube)**




**Photograph showing use of ATD & CAT tubes in field monitoring**

**Pictorial presentation of ATD Tube:-**




## 8.2 Sampling Preparation:

The steps followed are as given below

- Determined the extent of the sampling effort, the sampling methods to be employed the type and amounts of equipment and allied supplies needed.
- Organized the necessary sampling and monitoring equipment
- Sampling pumps are pre calibrated before sampling with soap bubble techniques.
- Prepared a schedule in consultation with CPCB and SPCB officials
- Performed a general site survey prior to the study, in accordance with the site specific health and safety plan for sampling locations.

## 8.3 Calibration Procedure:

To save time in the field, sampling pumps are pre-calibrated in the laboratory prior to arrival on-site. The calibration is checked in the field prior to and upon completion of sampling.

The steps followed are as given below

- Assembled the calibration train using a calibrated (external) rotameter, sampling pump, a tube holder system and a adsorbent tube. The adsorbent tube is a representative tube from the same lot of tubes that is used for sampling.
- Turned on the pump and adjust the flow using the flow adjust mechanism on the tube holder until the float ball on the rotameter is aligned with the rotameter's pre-calibrated flow rate value.
- Marked to the manifold and pump indicating the pre-calibrated flow rate and sampling media.
- Calibrated sampling system, flow regulator and tubing kept ready before sampling. Broke both ends of the adsorbent tube before sampling and ensured that each opening is at least one half the inside diameter of the tube.
- Kept one field blank at each sampling station and three at laboratory blank with opened both ends of the CAT & ATD tube. These blanks will give if any contamination in field during sampling as well as during the analysis in the laboratory.
- Fixed the CAT and ATD tube into sampling line and placed back-up section nearest to the pump. Position the tube in a vertical position to avoid channeling of air through adsorbent section.

## 8.4 Field Operation:

- Mobilized the pre-calibrated sampling equipment to save the time at the sampling site and fine tuning of the flow should be required.
- Placed the sampling tubes in the breathing zone. The pump and adsorbent tubes are placed on any solid stationary surface.
- Removed the caps of ATD tubes and Cracked the adsorbent tube ends using a glass tube cracker
- To set up the sampling train, Tenax end of the adsorbent tube is open to atmosphere and the charcoal or Chromosorb back up portion is towards the manifold of the sampler. The manifold is attached to the inlet plug on the pump.

- Adjusted time on the pump to required sample time. The sampling flow rate of 0.5 LPM is constantly maintained at all locations. The total timing of sampling is fixed for 360 min for Ambient Air Quality monitoring and 120 min for fugitive emission monitoring.
- Verified regularly the sampling flow using the calibrated rotameter. Recorded the final flow rate on the air sampling data sheet.

## 8.5 Post Operating Procedure:

- Recorded the sampling time on the air sampling data sheet
- Removed the adsorbent tube from the sampling pump
- Covered the adsorbent tubes with teflon tape followed by Caped adsorbent tubes with plastic caps immediately after sampling. Never use rubber caps.
- Placed the sample in a whirl bag labeled with sample ID Number
- Recorded all applicable information on the air sample data sheet (sample volume, ID number, location of the sampling, date and weather parameters)
- Sampled adsorbent tubes are stored in a cooler box (less than $10^{o}C$) and the maximum storage time is one week from the date of sampling.

## 8.6 Sample Storage and Preservation:

1. After sampling the identified samples are capped securely.
2. Samples collected in adsorbent tubes should not be kept in warm places or exposed to direct sunlight. After sealed the samples are kept in a cold storage box.
3. Samples are transported immediately after the sampling is over and stored under refrigeration until they are analyzed which were analyzed within two to four days.

## 8.7 Quality Assurance / Quality Control:

- Data pertaining to the VOCs study are documented on a data sheet
- All instruments are operated in accordance with operating instructions as supplied by the manufacturer.
- Equipment check and calibration activities were carried out before and after sampling.

- For every 20 samples one field blank and lab blank were set aside. These field blanks will be handled in the same manner as the sampling tube (break, seal and transport) except that no air is drawn through the tube.
- At all sampling stations, the samples were collected in both ATD and CAT simultaneously.

### 8.8 Data Validation:

Results of the quality control samples will be evaluated for contamination. This information will be utilized for quality assessment of the environmental sample.

The process flow chart for VOC sampling in ambient air is given at **Annexure - III**

## 9.0 MONITORING:

### 9.1 Ambient Air Quality Monitoring:

### 9.1.1 Selection of Ambient Air Quality Monitoring Locations:

The sampling location is governed by:

- Objectives of study,
- Instrumentation and method involved availability
- Accessibility of the sampling site,
- Obstruction (tall trees, wall etc.,) free environment which can obstruct the free air flow and can reduce pollutant concentrations in ambient air.
- At a height of minimum 5M from ground level so that the interferences by locally generated pollutants are minimized.
- Consideration of up wind – down wind method.
- Security against loss and tampering of instrument.

The meteorological parameters have been studied and accordingly prevailing wind direction is North East to South West with minimum temperature of 14$^{o}$C and Maximum 26$^{o}$C. The relative humidity was found in the range of 32 – 75% and wind speed is ranging from 0.8m/sec to 2.2 m/s. Meteorological data is given in **Annexure-IV.**

### 9.1.2 Ambient Air Quality Monitoring (AAQM) Locations at Tarapur:

**Up wind** : (1) Premises of Dahanu – Palghar Sports Club in the East direction of industrial area.

**Downwind** : (2) Premises of Police Chowki, Near Kumbhawali Naka (T-Zone) in the West of industrial area.

**Cross - wind** : (3) Premises of M/s Galaxy Surfactants, G-59 (G-Zone) in South direction of industrial area.

**Cross - wind** : (4) Premises of M/s Mandhana Dyeing, E-25 (E-Zone) in the North direction of industrial area.

**Centre :** (5) Premises of Tata Steel, A-6 (A-Zone) (almost in the centre of industrial area).

The Ambient Air Quality Monitoring locations at Tarapur is depicted at **Annexure- V**

VOC sampling details viz. Date of sampling, time of sampling, sampling locations, flow rate, sampling duration and volume of air sampled for Tarapur is given in **Annexure- VI (A & B)** respectively.

### 9.2 Monitoring at Selected Industries at Tarapur:

### 9.2.1 Selection of Industries:

Chemical Industries, mainly Pharmaceuticals, Dyes and Dye Intermediates, Pesticide, use variety of solvents (volatile organic compounds) in their processes. These solvents, as pollutants, come into environment along with air, wastewater, and hazardous waste. Therefore some industries at Tarapur Industrial Area, from Pharmaceutical, Dyes, Organic, Fine Chemicals, were selected for VOC Monitoring study.

In Pharmaceuticals, Dyes, Organic & Fine Chemicals Units, chemical synthesis (Reaction, Separation, Purification, Drying) and Extractions are the manufacturing phases responsible for significant emission of VOCs. Some VOCs, mostly chlorinated solvents, are known carcinogens and can be identified as Hazardous Air Pollutants. VOC emissions are generated as fugitive from reactor vents, filtering systems in the separation process, solvent vapours from purification tanks, dryers (including loading and unloading operations) and also from valves, tanks, pumps, and other equipments (e.g. centrifuge). VOCs are also emitted from effluent, Hazardous waste collection and treatment units because of carry over of solvents from the processes.

Following Industries were selected for VOC monitoring:

01. M/s Aarti Drugs Ltd., N-198, MIDC, Tarapur [Pharmaceutical & Bulk Drug]
02. M/s Nirbhay Rasayan (P) Ltd., N-96, MIDC, Tarapur [Dyes]
03. M/s Aarti Drugs Ltd., G-60, MIDC, Tarapur [Pharmaceutical & Bulk Drug]
04. M/s Lupin Ltd., T-142, MIDC, Tarapur [Pharmaceutical & Bulk Drug]
05. M/s Camlin Fine Chemicals Ltd., D-2/1/1, MIDC, Tarapur [Fine Chemicals]
06. M/s Sarex Overseas, N-131, MIDC, Tarapur [Organic Chemicals]

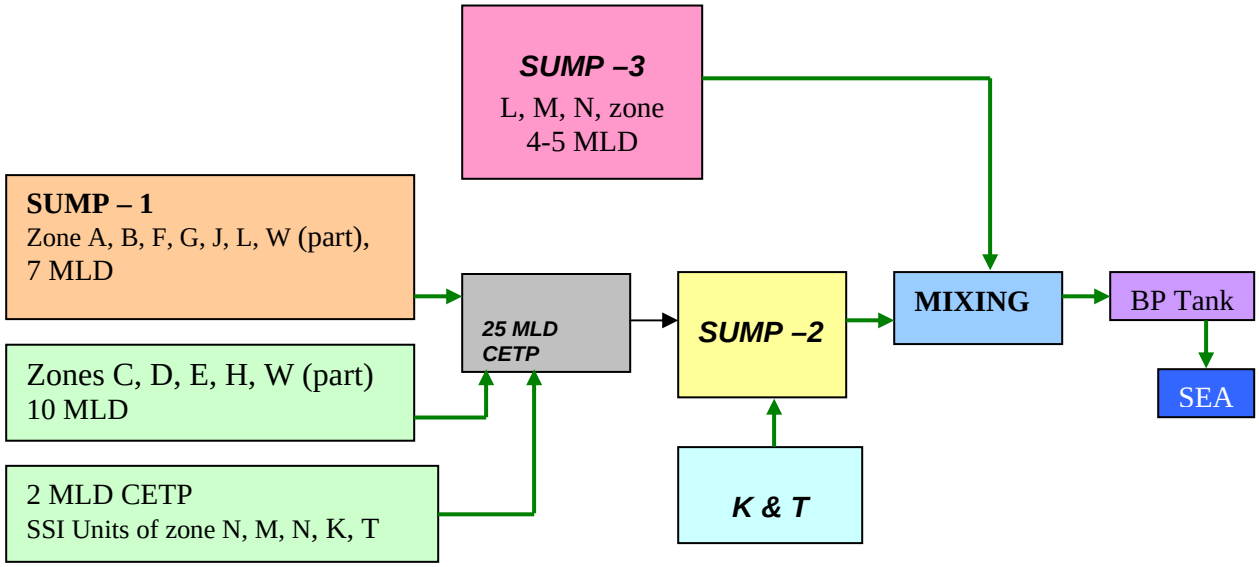
### 9.2.2 Monitoring at Industries:

Monitoring was carried out in three ways i.e. emission monitoring (Fugitive, Ambient), wastewater and hazardous waste.

Emission monitoring was carried out within the Plant area near reactors, centrifuge, dryers, storage tanks etc for fugitive air emission and in the ambient air in the down wind direction. The samples of raw wastewater (Inlet to ETP) and hazardous wastes (ETP Sludge/ Incinerable waste) were collected to find out the presence as well as concentration of VOCs in the wastewater and hazardous waste which find its way in to the environment along with air emission.

## 9.3 Monitoring at Effluent Sumps & New CETP of Tarapur:

The effluent collection, treatment & disposal scheme of the industrial estate is studied & understood before finalizing the VOC monitoring locations. The details of scheme are depicted in following schematic flow diagram, which shows that effluent generated from part of K, L, M, N & T zones is directly discharged in to Sea without treatment in CETP. Chocking and leakage in MIDC drainage lines is one of the major problems in the industrial estate. Stagnation, spillage and flow of industrial effluent in natural drains are commonly seen in the industrial estate. There are leakages from the MIDC drainage lines and manholes.




The effluent generated from different zones of industrial estate is collected in three sumps through drainage system. After collection, effluent is finally disposed in Sea around 500 meters away from coastline. Details of sumps are given below:

**SUMP NO. – 1**

Effluent from A, B, F, G, J, L (Part), W (Part) & S zones is collected in this sump. Total quantity of effluent generated is about 7.0 MLD. Effluent collected in this sump is pumped to 25 MLD CETP (2.5 Kms. away) for further treatment & disposal.

**SUMP NO. – 2**

This sump receives effluent from 25 MLD CETP. Also effluent generated in part of K & T zones (about 1.0 MLD) enter in it after primary treatment only at individual industries level.

**SUMP NO. – 3**

Part of effluent generated in L, M & N zones is collected in this sump. The effluent is primarily treated at individual industries. Total quantity of effluent generated is about 5.0 MLD. This effluent from Sump no. 3 is directly pumped to mixing tank near M/s. SC Enviro Agro Industries Pvt. Ltd., T-137/113 where effluent from other zones, partly after treatment in 25 MLD CETP, also discharged. Thereafter the effluent goes by gravity to BP Tank and ultimately in to Arabian Sea. Pipeline for pumping the effluent collected at sump number 3 to 25 MLD CETP is yet to be commissioned. It is understood that acidic pH of effluent is found in night time.

## 9.4 Status of New Common Effluent Treatment Plant (CETP)

Tarapur Industrial Management Association (TIMA) reportedly formed a separate body named as Tarapur Environmental Protection Society (TEPS) in 2004 exclusively for looking after the matters related to environmental protection and pollution control in MIDC Tarapur. The CETP has designed capacity of 25 MLD with primary, secondary and tertiary treatment facility. The CETP has effluent receiving sump→Equalization Tanks with 04 surface aerators (03 nos. used alternatively to equalize the effluent)→Two parallel sets of flash mixer & clarifier→ Three Aeration Tanks (with diffused aeration system)→ Two clarifiers→One oxidation pond with diffused aeration→ Three parallel sets of Pressure Sand Filter & Activated Carbon Filter in series→Treated effluent sump. The treated effluent is discharged in to Sump No. 2 and finally in Arabian Sea through a closed pipeline. The CETP is not equipped with adequate flow measurement systems at inlet & outlet and sufficient sludge storage facility before sending it to TSDF.

Wastewater sampling for the analysis of VOCs were carried out at Inlet to New CETP, MIDC's effluent collection sumps and Equalization Tanks of selected industrial units. The sampling was carried out to know the contents of VOCs in the wastewater.

## 10.0 METHODS FOR ANALYSIS:

### 10.1 Analysis for Ambient Air Quality & Fugitive Emission Samples:

Method EPA TO-17 (Active Thermal Desorption) and ASTM – 3687 (Purge & Trap) methods of analysis are used for Ambient Air Quality and Fugitive emission samples. EPA TO-17 & ASTM – 3687 Method is described at **Annexure- VII & VIII.** These annexures includes method validation also.

### 10.2 Analysis for Water & Hazardous Waste Samples:

EPA Method 5035A/5035C/8260B is adopted for the analysis of VOCs in wastewater and hazardous waste samples which is described in **Annexure - IX**.

One Set of Chromatogram is given at **Annexure-X**

## 11.0 RESULTS & DISCUSSIONS:

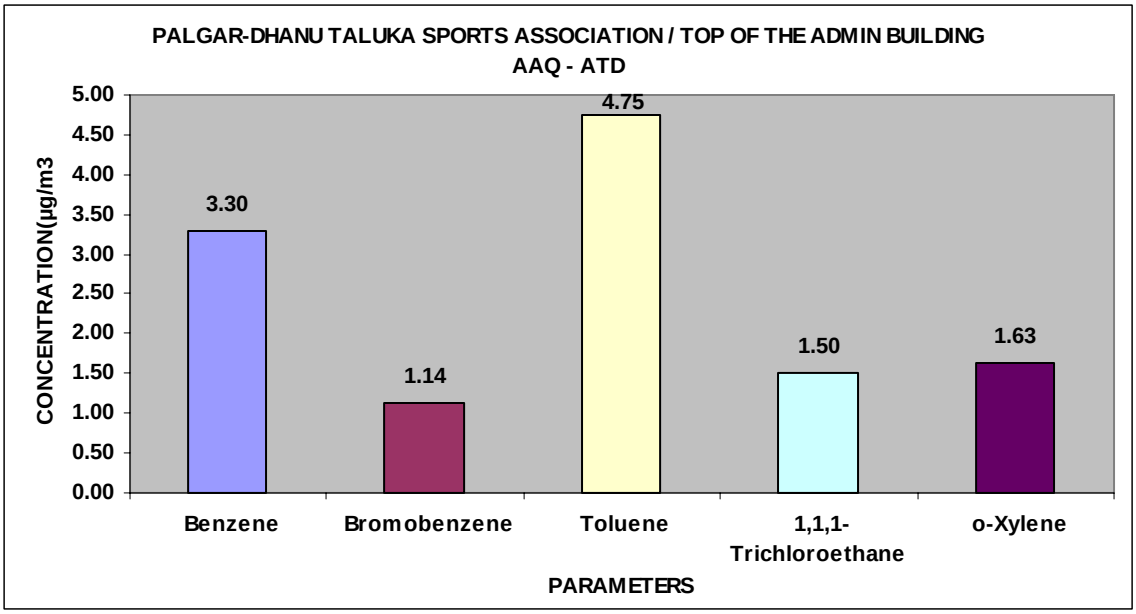
### 11.1 Results & Discussion for Ambient Air Quality Monitoring:-

### 11.1.1 Ambient Air Quality Monitoring and Analysis at Tarapur:

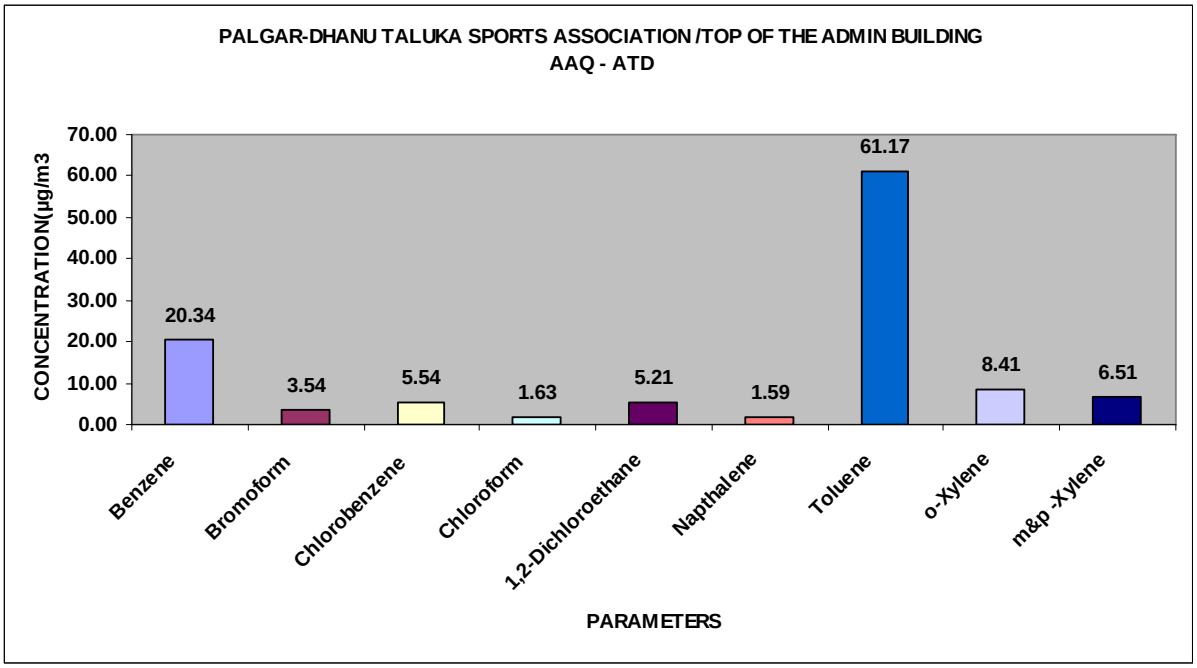
**Station 1:** Premises of Dahanu – Palghar Sports Club in the East direction of industrial area.

This station is located in up-wind direction of the industrial estate. 07 VOCs in first day and 11 VOCs in second day of monitoring found at the location. These numbers include VOCs detected by both the methods (ATD & CAT). The average concentration of VOC in first day of monitoring was found to be 12.32 $\mu g/m^3$ and 41.63 $\mu g/m^3$ by ATD and CAT methods respectively. The average concentration of VOC in second day of monitoring was found to be 113.9 $\mu g/m^3$ and 31.8 $\mu g/m^3$ by ATD and CAT methods respectively. Inversion effect and low wind velocity during night and early morning hours showed higher concentration than day time concentrations.

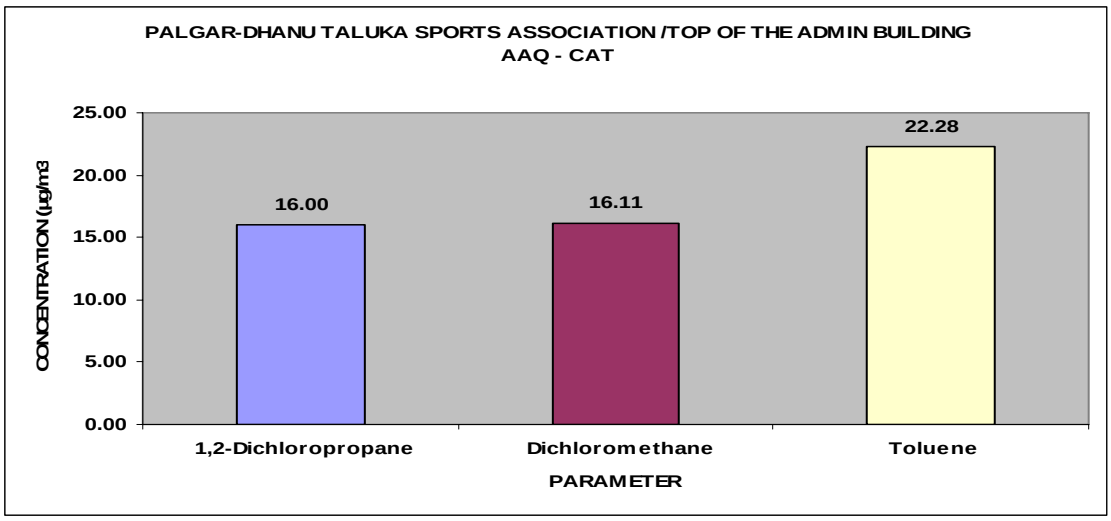
| PALGAR-DHANU TALUKA SPORTS ASSOCIATION /TOP OF THE ADMIN BUILDING | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BY ATD METHOD | | | | | |
| DATE OF SAMPLING :06 & 07.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 06.01.2009 4.0PM0-10.00PM | 06&07.01.2009 11.00PM-5.00AM | 07.01.2009 7.00AM-1.00PM | Average Concentration |
| 1 | Benzene | BDL | 9.79 | BDL | 3.30 |
| 2 | Bromobenzene | BDL | 1.75 | 1.61 | 1.14 |
| 3 | Toluene | 1.30 | 12.89 | BDL | 4.75 |
| 4 | 1,1,1-Trichloroethane | 2.22 | BDL | 2.23 | 1.50 |
| 5 | o-Xylene | 2.31 | BDL | 2.53 | 1.63 |
| **Total VOC =** | | **5.93** | **24.53** | **6.47** | **12.32** |



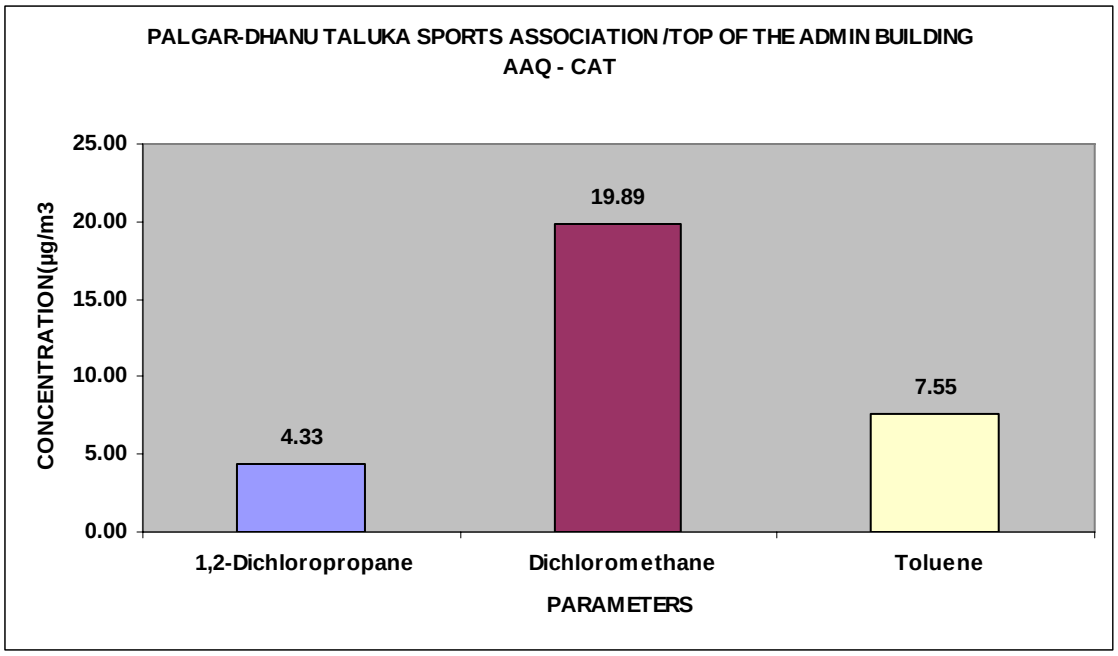
| PALGAR-DHANU TALUKA SPORTS ASSOCIATION / TOP OF THE ADMIN BUILDING | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BY ATD METHOD | | | | | |
| DATE OF SAMPLING :08&09.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 08.01.2009 5.40-11.40PM | 09.01.2009 1.00PM-7.00AM | 09.01.2009 9.15AM-3.15PM | AVERAGE |
| 1 | Benzene | 47.57 | 13.40 | BDL | 20.34 |
| 2 | Bromoform | 5.27 | 5.30 | BDL | 3.54 |
| 3 | Chlorobenzene | 1.26 | 8.18 | 7.17 | 5.54 |
| 4 | Chloroform | 4.88 | BDL | BDL | 1.63 |
| 5 | 1,2-Dichloroethane | 8.84 | 4.65 | 2.14 | 5.21 |
| 6 | Napthalene | 4.26 | 0.51 | BDL | 1.59 |
| 7 | Toluene | 91.10 | 85.53 | 6.88 | 61.17 |
| 8 | o-Xylene | 11.51 | 9.56 | 4.15 | 8.41 |
| 9 | m&p –Xylene | 9.48 | 7.83 | 2.21 | 6.51 |
| **Total VOC =** | | **184.16** | **134.95** | **22.65** | **113.92** |



| PALGAR-DHANU TALUKA SPORTS ASSOCIATION /TOP OF THE ADMIN BUILDING | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BY CAT METHOD | | | | | |
| DATE OF SAMPLING :06&07.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 06.01.2009 4.00-10.00PM | 06&07.01.2009 11.00PM-5.00AM | 07.01.2009 7.00AM-1.00PM | AVERAGE |
| 1 | 1,2-Dichloropropane | 8.67 | 23.33 | BDL | 10.68 |
| 2 | Dichloromethane | 22.00 | 12.22 | 14.11 | 16.11 |
| 3 | Toluene | 11.89 | 32.67 | BDL | 14.87 |
| **Total VOC =** | | **42.56** | **68.22** | **14.21** | **41.63** |



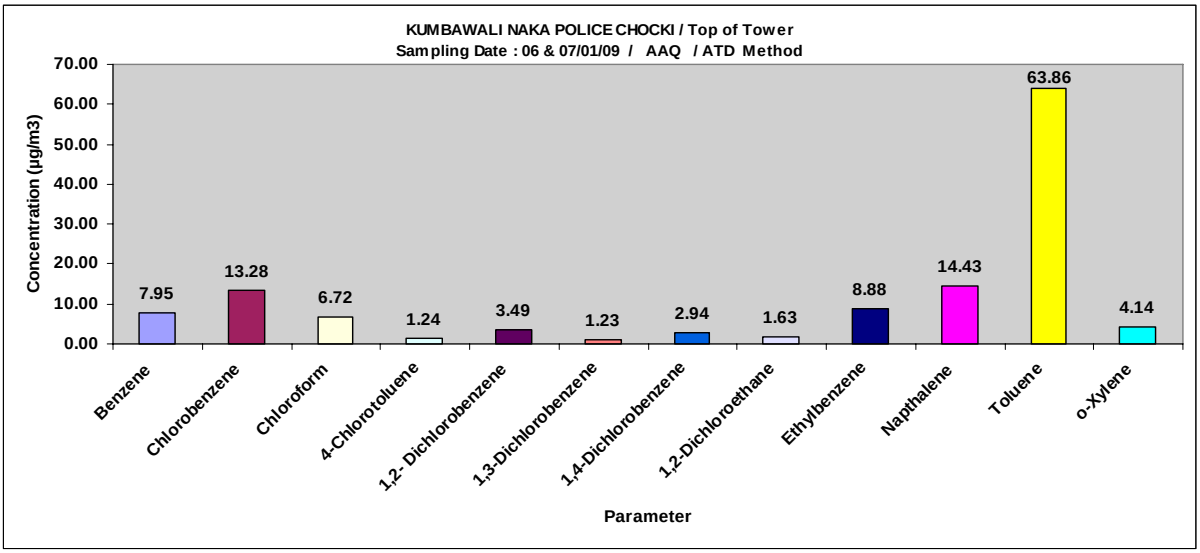

| PALGAR-DHANU TALUKA SPORTS ASSOCIATION /TOP OF THE ADMIN BUILDING | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BY CAT METHOD | | | | | |
| DATE OF SAMPLING :08&09.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m3) | | | |
| | | 08.01.2009 5.40-11.40PM | 09.01.2009 1.00PM-7.00AM | 09.01.2009 9.15AM-3.15PM | AVERAGE |
| 1 | 1,2-Dichloropropane | 12.89 | BDL | BDL | 4.33 |
| 2 | Dichloromethane | 22.00 | 27.56 | 10.11 | 19.89 |
| 3 | Toluene | 22.56 | BDL | BDL | 7.55 |
| **Total VOC =** | | **57.44** | **27.66** | **10.21** | **31.77** |



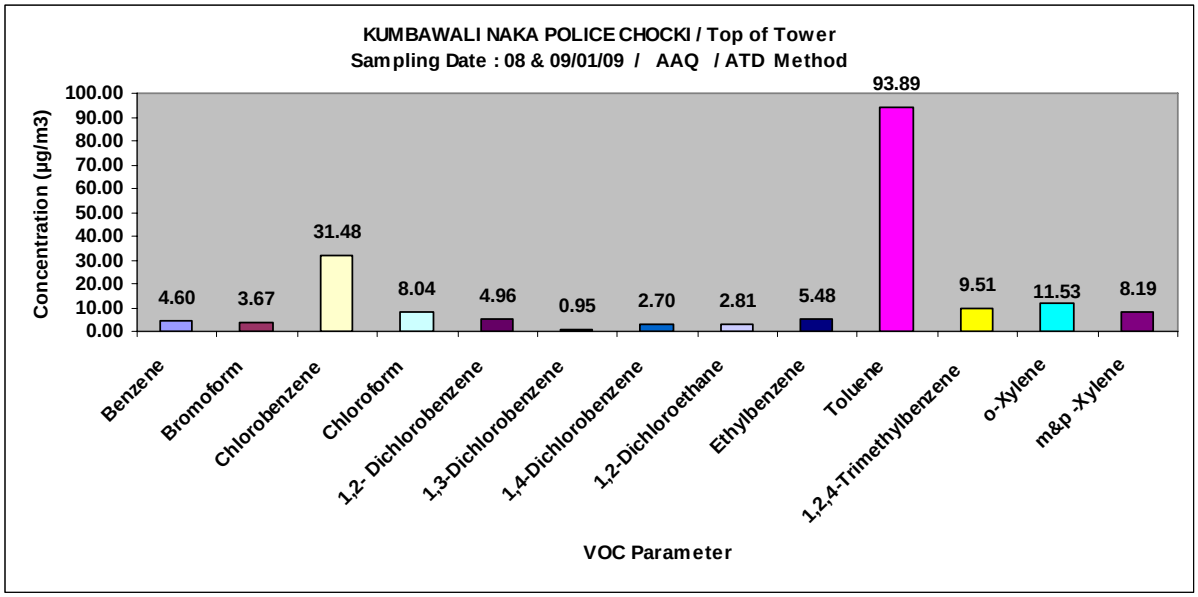

**Station 2:** Premises of Police Chowki, Near Kumbhawali Naka (T-Zone) in the West of industrial area.

The AAQ station-2 is identified as down-wind station as per prevailing wind direction at the time of the study. 14 VOCs in first day and 15 VOCs in second day of monitoring found at the location. These numbers include VOCs detected by both the methods (ATD & CAT). The average concentration of VOC in first day of monitoring was found to be 129.8 $\mu g/m^3$ and 75.7 $\mu g/m^3$ by ATD and CAT methods respectively. The average concentration of VOC in second day of monitoring was found to be 187.8 $\mu g/m^3$ and 34.30 $\mu g/m^3$ by ATD and CAT methods respectively. Benzene, Chlorobenzene, Toluene, Chlorinated alkanes and Naphthalene are having pre-dominant presence among other VOCs at this location. Inversion effect and low wind velocity during night and early morning hours showed higher concentration than day time concentrations. The concentration values at this station found to be higher than station-1 because of down-wind location.

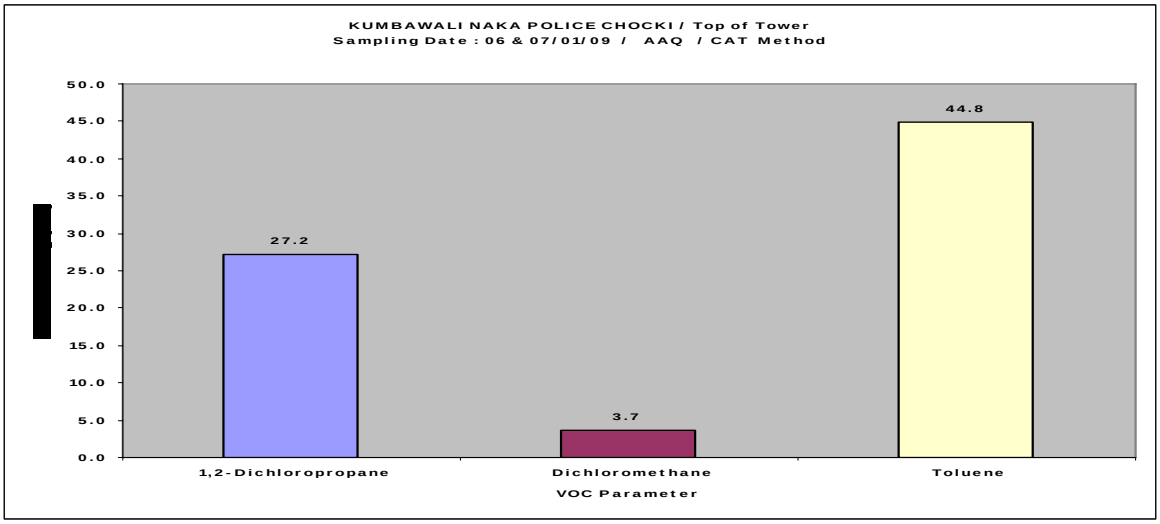
| S.NO | PARAMETERS | KUMBAWALI NAKA POLICE CHOCKI - Top of Tower | | | |
|---|---|---|---|---|---|
| | | Sampling Date : 06 & 07/01/09 / AAQ / ATD Method | | | |
| | | 06.01.2009 3.00PM-9.00PM | 06&07.01.2009 10.15PM-4.15AM | 07.01.2009 6.15AM-12.15PM | Average |
| | | Concentration in µg/m$^3$ | | | |
| 1 | Benzene | 2.92 | 6.47 | 14.47 | 7.95 |
| 2 | Chlorobenzene | 1.87 | 36.19 | 1.78 | 13.28 |
| 3 | Chloroform | 10.54 | 2.99 | 6.63 | 6.72 |
| 4 | 4-Chlorotoluene | BDL | 3.63 | BDL | 1.24 |
| 5 | 1,2- Dichlorobenzene | BDL | 5.77 | 4.64 | 3.49 |
| 6 | 1,3-Dichlorobenzene | BDL | 2.16 | 1.48 | 1.23 |
| 7 | 1,4-Dichlorobenzene | BDL | 4.70 | 4.08 | 2.94 |
| 8 | 1,2-Dichloroethane | BDL | 3.48 | 1.37 | 1.63 |
| 9 | Ethylbenzene | BDL | 6.18 | 20.40 | 8.88 |
| 10 | Napthalene | BDL | BDL | 43.20 | 14.43 |
| 11 | Toluene | 53.85 | 108.69 | 29.05 | 63.86 |
| 12 | o-Xylene | 3.37 | 6.49 | 2.58 | 4.14 |
| | **Total VOC =** | **72.90** | **186.81** | **129.72** | **129.81** |



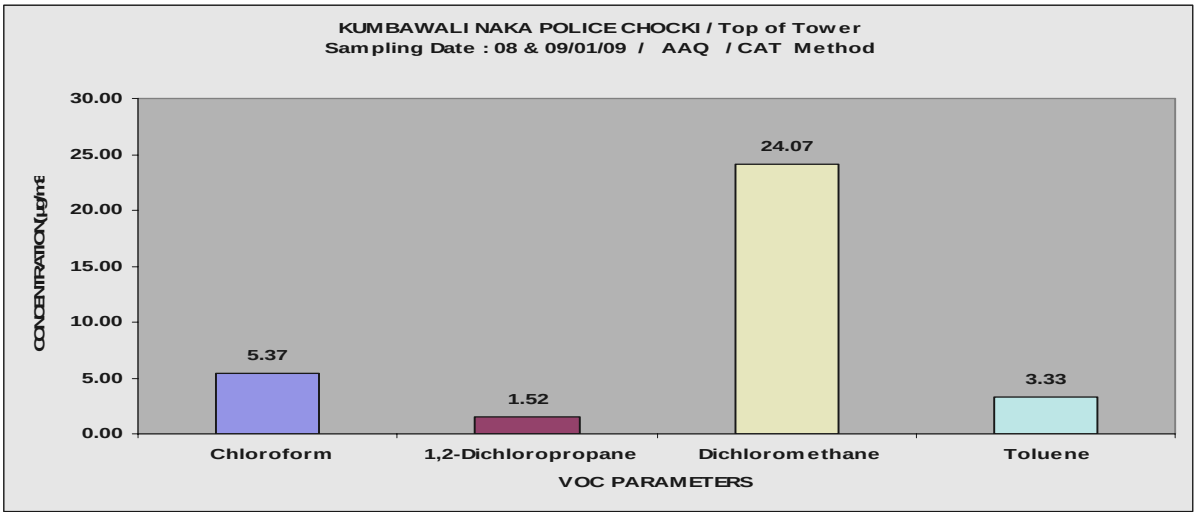
| S.NO | PARAMETERS | KUMBAWALI NAKA POLICE CHOCKI - Top of Tower | | | |
|---|---|---|---|---|---|
| | | Sampling Date : 08 & 09/01/09 / AAQ / ATD Method | | | |
| | | 08.01.2009 5.00-11.00PM | 208& 09.01.2009 12.15 - 6.15AM | 09.01.2009 8.30 - 2.30PM | Average |
| | | Concentration in µg/m$^3$ | | | |
| 1 | Benzene | 3.09 | 10.67 | BDL | 4.60 |
| 2 | Bromoform | 5.32 | BDL | 5.63 | 3.67 |
| 3 | Chlorobenzene | 38.96 | 15.68 | 39.81 | 31.48 |
| 4 | Chloroform | 20.23 | 3.85 | BDL | 8.04 |
| 5 | 1,2- Dichlorobenzene | BDL | 12.09 | 2.73 | 4.96 |
| 6 | 1,3-Dichlorobenzene | BDL | 2.74 | BDL | 0.95 |
| 7 | 1,4-Dichlorobenzene | BDL | 6.08 | 1.96 | 2.70 |
| 8 | 1,2-Dichloroethane | 4.17 | 4.20 | BDL | 2.81 |
| 9 | Ethylbenzene | 2.07 | 11.19 | 3.17 | 5.48 |
| 10 | Toluene | 134.39 | 72.06 | 75.21 | 93.89 |
| 11 | 1,2,4-Trimethylbenzene | 19.13 | BDL | 9.33 | 9.51 |
| 12 | o-Xylene | 18.12 | 5.41 | 11.08 | 11.53 |
| 13 | m&p –Xylene | 12.59 | 4.55 | 7.43 | 8.19 |
| **Total VOC =** | | **258.24** | **148.62** | **156.54** | **187.80** |



| KUMBAWALI NAKA POLICE CHOCKI/AIR MONITORING SAMPLING POINT | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BYCAT METHOD | | | | | |
| DATE OF SAMPLING : 06 & 07.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 06.01.2009 3.00PM -9.00PM | 06&07.01.2009 10.15PM-4.15AM | 07.01.2009 6.15AM-12.15PM | AVERAGE |
| 1 | 1,2-Dichloropropane | 6.56 | 13.444 | 61.67 | 27.22 |
| 2 | Dichloromethane | 7.56 | 3.444 | BDL | 3.67 |
| 3 | Toluene | 23.67 | 50.778 | 60.00 | 44.81 |
| | **Total VOC =** | **37.78** | **67.67** | **121.67** | **75.70** |



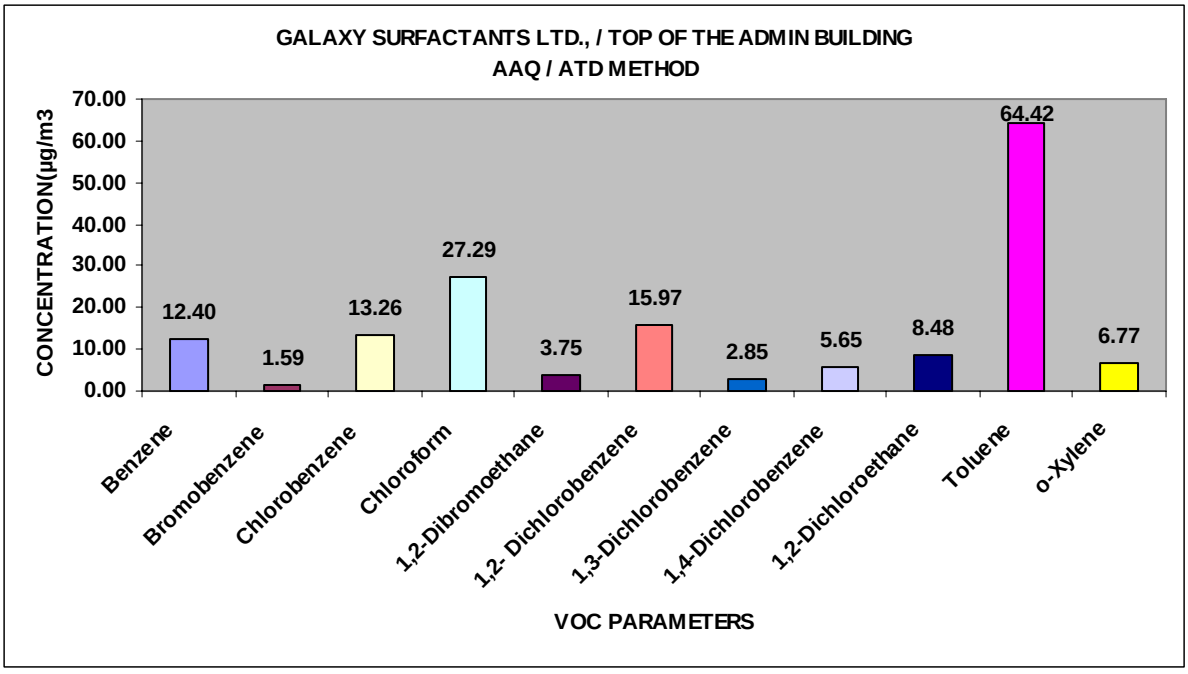

| KUMBAWALI NAKA POLICE CHOCKI/AIR MONITORING SAMPLING POINT | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BYCAT METHOD | | | | | |
| DATE OF SAMPLING : 08 & 09.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 08.01.2009 5.00-11.00PM | 08& 09.01.2009 12.15PM-6.15AM | 09.01.2009 8.30AM-2.30PM | AVERAGE |
| 1 | Chloroform | 16.11 | BDL | BDL | 5.37 |
| 2 | 1,2-Dichloropropane | 4.56 | BDL | BDL | 1.52 |
| 3 | Dichloromethane | 32.89 | 35.33 | 4.00 | 24.07 |
| 4 | Toluene | 10.00 | BDL | BDL | 3.33 |
| | **Total VOC =** | **63.56** | **35.48** | **4.15** | **34.30** |



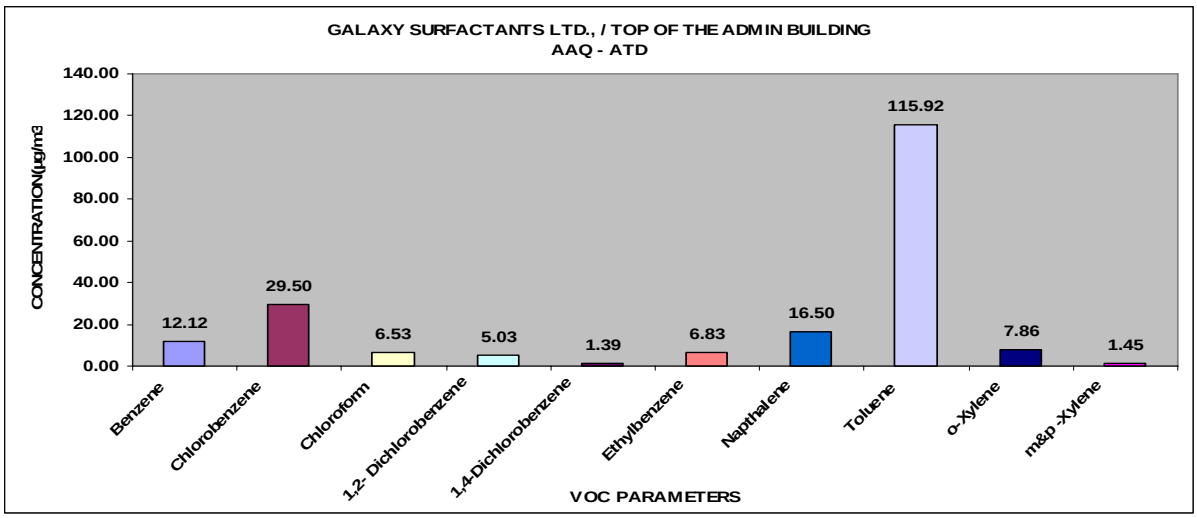

**Station 3 :** Premises of M/s Galaxy Surfactants, G-59 (G-Zone) in South direction of industrial area.

The AAQ station-3 is identified as cross-wind station in southern direction as per prevailing wind direction at the time of the study. 12 VOCs in first day and 12 VOCs in second day of monitoring found at the location. These numbers include VOCs detected by both the methods (ATD & CAT). The average concentration of VOC in first day of monitoring was found to be 162.4 $\mu g/m^3$ and 64.2 $\mu g/m^3$ by ATD and CAT methods respectively. The average concentration of VOC in second day of monitoring was found to be 203.1 $\mu g/m^3$ and 193.7 $\mu g/m^3$ by ATD and CAT methods respectively. Benzene, Chlorobenzene, Ethylbenzene, Chloroform, Toluene, Chlorinated alkanes and Naphthalene are having pre-dominant presence among other VOCs at this location. Inversion effect and low wind velocity during night and early morning hours showed higher concentration than day time concentrations. The concentration values at this station found to be higher than station-1 because of down-wind location.

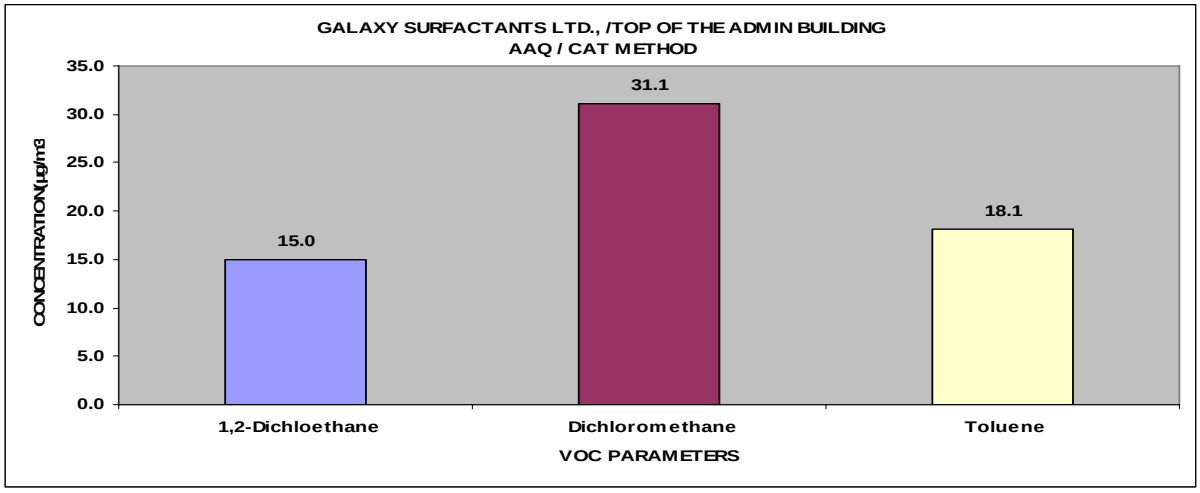
| GALAXY SURFACTANTS LTD., / TOP OF THE ADMIN BUILDING | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BYATD METHOD | | | | | |
| DATE OF SAMPLING : 06 & 07.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 06.01.2009 3.45-9.45PM | 06 & 07.01.09 10.45PM-4.45AM | 07.01.2009 6.45AM-12.45PM | AVERAGE |
| 1 | Benzene | 8.83 | 8.16 | 20.20 | 12.40 |
| 2 | Bromobenzene | 2.93 | 1.79 | BDL | 1.59 |
| 3 | Chlorobenzene | 13.25 | 1.14 | 25.40 | 13.26 |
| 4 | Chloroform | 21.72 | BDL | 60.10 | 27.29 |
| 5 | 1,2-Dibromoethane | 11.16 | BDL | BDL | 3.75 |
| 6 | 1,2- Dichlorobenzene | 27.42 | 5.79 | 14.70 | 15.97 |
| 7 | 1,3-Dichlorobenzene | 8.46 | BDL | BDL | 2.85 |
| 8 | 1,4-Dichlorobenzene | 15.32 | 1.58 | BDL | 5.65 |
| 9 | 1,2-Dichloroethane | 6.58 | BDL | 18.80 | 8.48 |
| 10 | Toluene | 82.67 | 10.09 | 100.50 | 64.42 |
| 11 | o-Xylene | 4.58 | 2.24 | 13.50 | 6.77 |
| **Total VOC =** | | **202.93** | **30.99** | **253.40** | **162.44** |



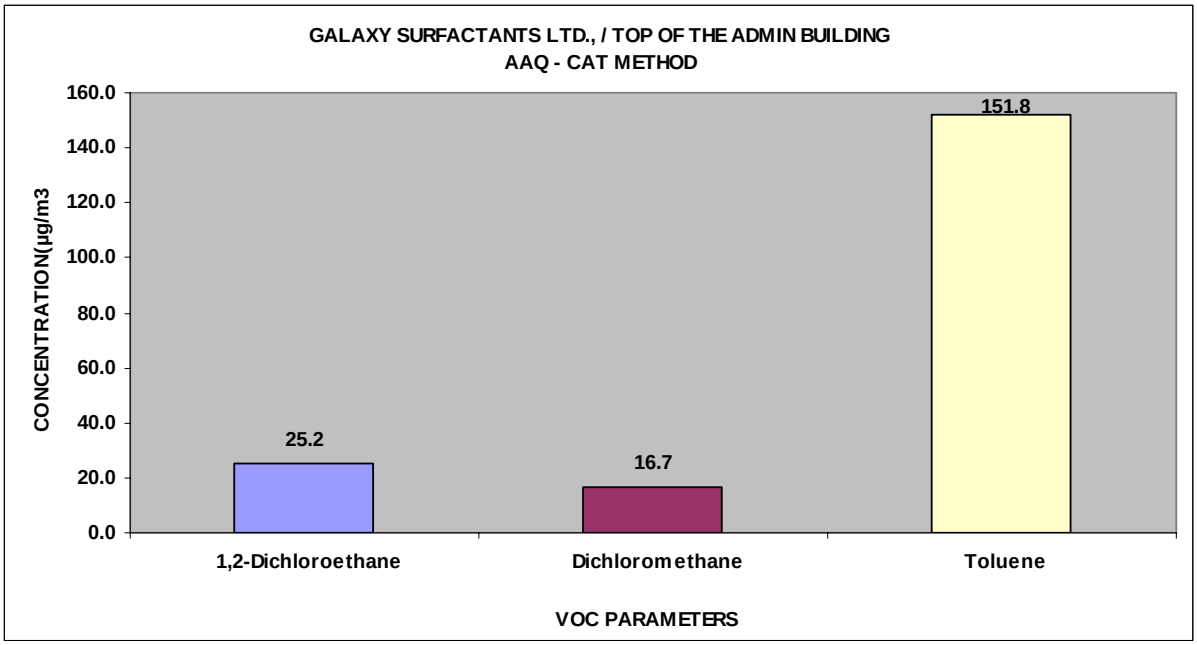
| GALAXY SURFACTANTS LTD., / TOP OF THE ADMIN BUILDING | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BY ATD METHOD | | | | | |
| DATE OF SAMPLING :08 & 09.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 08.01.2009 5.30-11.30PM | 09.01.2009 12.45 - 6.45AM | 09.01.2009 9.0 -3.00PM | AVERAGE |
| 1 | Benzene | 5.19 | 16.70 | 14.47 | 12.12 |
| 2 | Chlorobenzene | 23.99 | 46.70 | 17.80 | 29.50 |
| 3 | Chloroform | BDL | 12.90 | 6.63 | 6.53 |
| 4 | 1,2- Dichlorobenzene | BDL | 10.40 | 4.64 | 5.03 |
| 5 | 1,4-Dichlorobenzene | BDL | BDL | 4.08 | 1.39 |
| 6 | Ethylbenzene | BDL | BDL | 20.40 | 6.83 |
| 7 | Napthalene | 1.89 | 4.40 | 43.20 | 16.50 |
| 8 | Toluene | 173.55 | 103.60 | 70.60 | 115.92 |
| 9 | o-Xylene | 17.59 | 3.41 | 2.58 | 7.86 |
| 10 | m&p –Xylene | 4.24 | BDL | BDL | 1.45 |
| **Total VOC =** | | **226.65** | **198.26** | **184.44** | **203.11** |



| GALAXY SURFACTANTS LTD., /TOP OF THE ADMIN BUILDING | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BYCAT METHOD | | | | | |
| DATE OF SAMPLING : 06 & 07.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 06.01.2009 3.45-9.45PM | 06&07.01.2009 10.45PM-4.45AM | 07.01.2009 6.45AM-12.45PM | AVERAGE |
| 1 | 1,2-Dichloethane | 3.2 | 21.1 | 20.6 | 15.0 |
| 2 | Dichloromethane | 24.6 | 22.0 | 46.7 | 31.1 |
| 3 | Toluene | 4.0 | 38.7 | 11.6 | 18.1 |
| | **Total VOC =** | **31.8** | **81.8** | **78.9** | **64.2** |



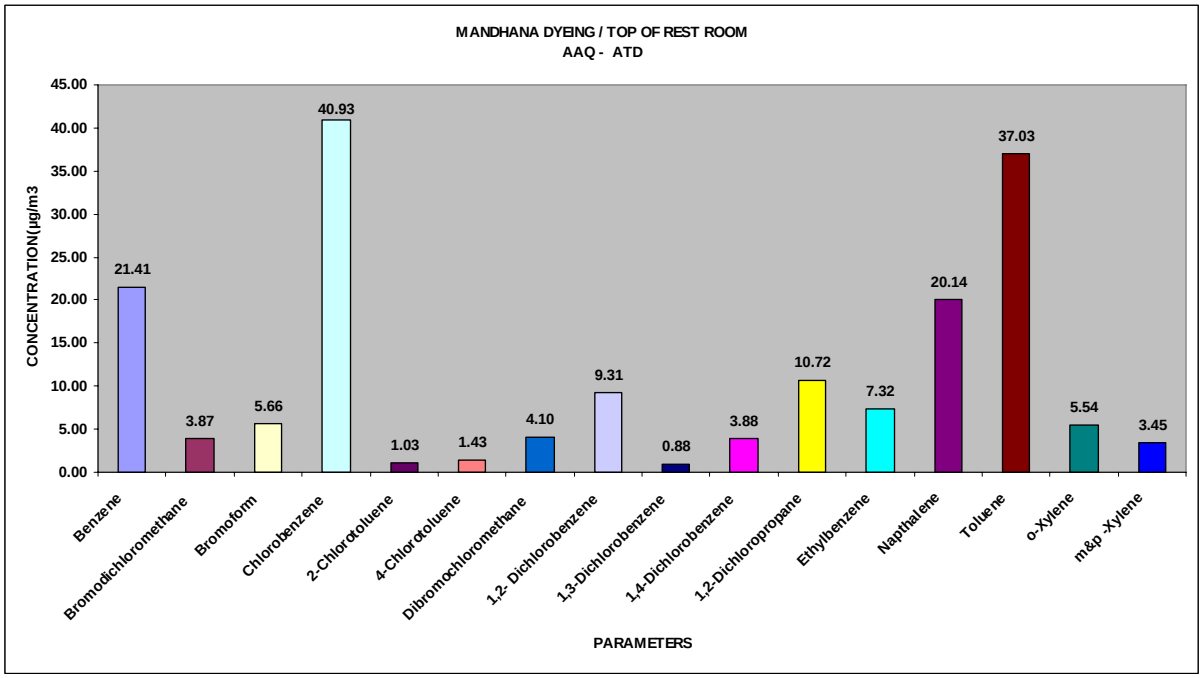

| GALAXY SURFACTANTS LTD., / TOP OF THE ADMIN BUILDING | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BYCAT METHOD | | | | | |
| DATE OF SAMPLING :08 & 09.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 08.01.2009 5.30-11.30PM | 09.01.2009 12.45PM-6.45AM | 09.01.2009 9.00AM-3.00PM | AVERAGE |
| 1 | 1,2-Dichloroethane | 8.2 | 26.6 | 40.7 | 25.2 |
| 2 | Dichloromethane | 18.1 | 13.2 | 18.9 | 16.7 |
| 3 | Toluene | 76.4 | 323.8 | 55.2 | 151.8 |
| | **Total VOC =** | **102.7** | **363.6** | **114.8** | **193.7** |



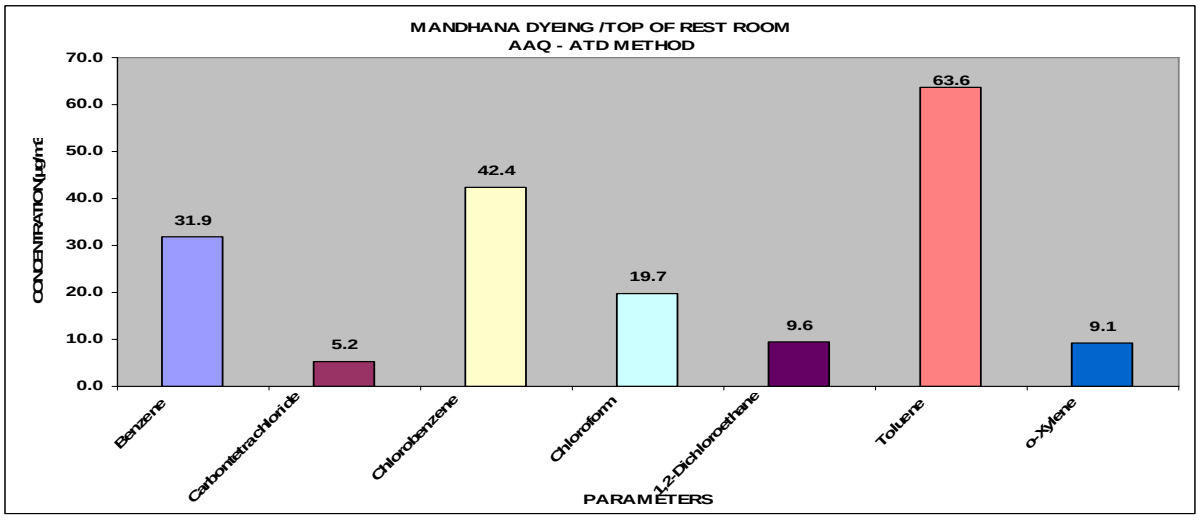

**Station 4:** Premises of M/s Mandhana Dyeing, E-25 (E-Zone) in the North direction of industrial area.

The AAQ station-4 is identified as cross-wind station in northern direction as per prevailing wind direction at the time of the study. 18 VOCs in first day and 8 VOCs in second day of monitoring found at the location. These numbers include VOCs detected by both the methods (ATD & CAT). The average concentration of VOC in first day of monitoring was found to be 176.7 $\mu g/m^3$ and 53.5 $\mu g/m^3$ by ATD and CAT methods respectively. The average concentration of VOC in second day of monitoring was found to be 181.5 $\mu g/m^3$ and 124.59 $\mu g/m^3$ by ATD and CAT methods respectively. Benzene, Chlorobenzene, Ethylbenzene, Chloroform, Toluene, Chlorinated alkanes and Naphthalene are having pre-dominant presence among other VOCs at this location. Inversion effect and low wind velocity during night and early morning hours showed higher concentration than day time concentrations. The concentration values at this station found to be higher than station-1 because of down-wind location.

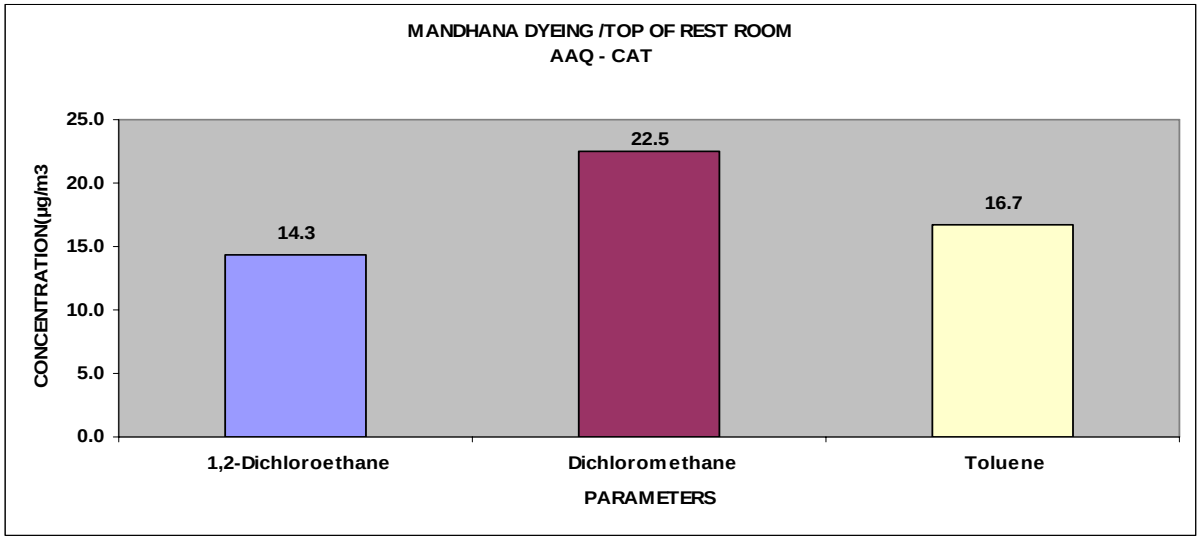
| MANDHANA DYEING /TOP OF REST ROOM | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BY ATD METHOD | | | | | |
| DATE OF SAMPLING :06 & 07.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 06.01.2009 4.30PM-10.30PM | 06&07.01.09 11.30PM-5.30AM | 07.01.2009 7.15AM-1.15PM | AVERAGE |
| 1 | Benzene | 10.60 | 31.34 | 22.30 | 21.41 |
| 2 | Bromodichloromethane | 5.90 | 5.67 | BDL | 3.87 |
| 3 | Bromoform | 5.93 | 5.54 | 5.50 | 5.66 |
| 4 | Chlorobenzene | 29.00 | 23.40 | 70.40 | 40.93 |
| 5 | 2-Chlorotoluene | BDL | 2.99 | BDL | 1.03 |
| 6 | 4-Chlorotoluene | 4.19 | BDL | BDL | 1.43 |
| 7 | Dibromo chloromethane | 6.21 | 6.03 | BDL | 4.10 |
| 8 | 1,2- Dichlorobenzene | 2.30 | 8.74 | 16.90 | 9.31 |
| 9 | 1,3-Dichlorobenzene | BDL | 2.54 | BDL | 0.88 |
| 10 | 1,4-Dichlorobenzene | 1.95 | 6.50 | 3.20 | 3.88 |
| 11 | 1,2-Dichloropropane | 3.18 | 17.50 | 11.50 | 10.72 |
| 12 | Ethyl benzene | BDL | 21.87 | BDL | 7.32 |
| 13 | Napthalene | 7.40 | 52.97 | BDL | 20.14 |
| 14 | Toluene | 39.00 | 54.28 | 17.80 | 37.03 |
| 15 | o-Xylene | 6.57 | 8.00 | 2.06 | 5.54 |
| 16 | m&p –Xylene | 4.43 | 5.88 | BDL | 3.45 |
| **Total VOC =** | | **126.80** | **253.30** | **150.06** | **176.72** |



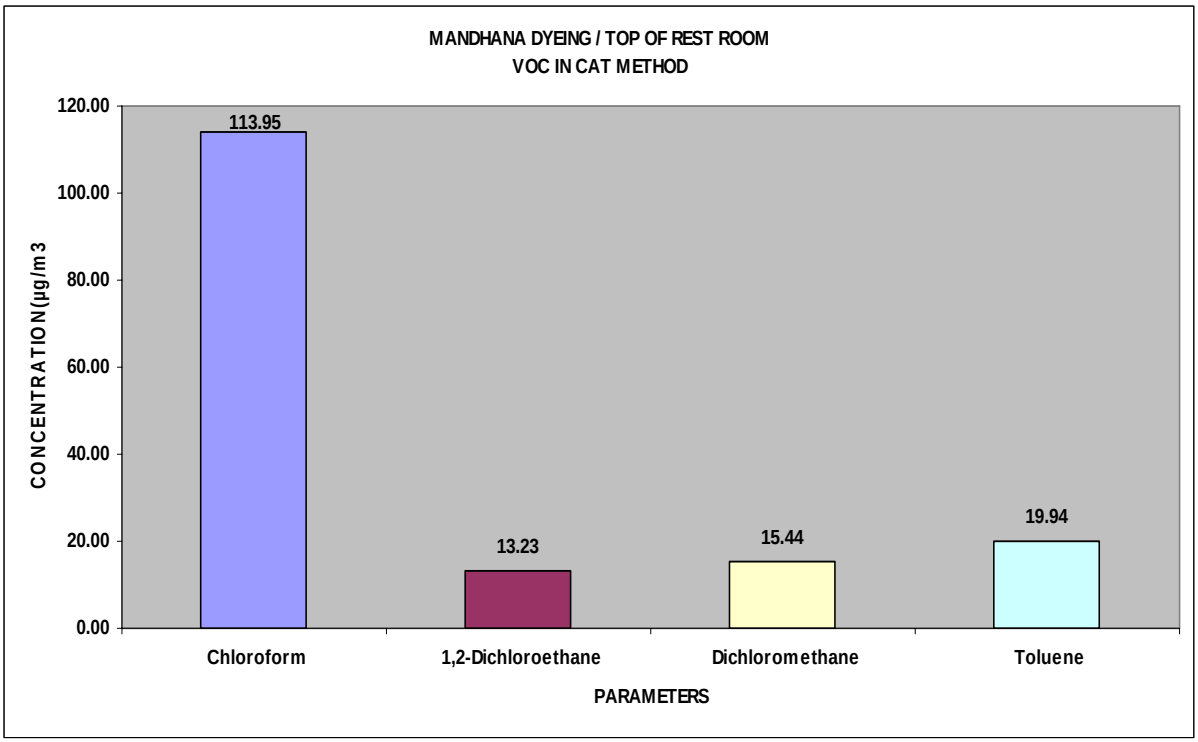
| MANDHANA DYEING /TOP OF REST ROOM | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BY ATD METHOD | | | | | |
| DATE OF SAMPLING :08 & 09.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 08.01.2009 5.50-11.50PM | 09.01.2009 1.15PM-7.15AM | 09.01.2009 9.30AM-3.30PM | AVERAGE |
| 1 | Benzene | 24.2 | 35.0 | 36.4 | 31.9 |
| 3 | Carbontetrachloride | 8.6 | 4.4 | 2.7 | 5.2 |
| 4 | Chlorobenzene | 27.7 | 49.4 | 50.2 | 42.4 |
| 5 | Chloroform | 7.4 | 38.2 | 13.6 | 19.7 |
| 7 | 1,2-Dichloroethane | 4.8 | 10.9 | 13.0 | 9.6 |
| 8 | Toluene | 66.3 | 96.3 | 28.1 | 63.6 |
| 10 | o-Xylene | 19.5 | 4.0 | 3.8 | 9.1 |
| | **Total VOC =** | **158.5** | **238.2** | **147.8** | **181.5** |



| MANDHANA DYEING / TOP OF REST ROOM | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BY CAT METHOD | | | | | |
| DATE OF SAMPLING :06 & 07.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 06.01.2009 4.30-10.30PM | 06 & 07.01.09 11.30PM-5.30AM | 07.01.2009 7.15AM-1.15PM | AVERAGE |
| 1 | 1,2-Dichloroethane | 12.9 | 27.3 | 2.8 | 14.3 |
| 2 | Dichloromethane | 26.2 | 24.6 | 16.7 | 22.5 |
| 3 | Toluene | 21.3 | 22.4 | 6.2 | 16.7 |
| **Total VOC =** | | **60.4** | **74.3** | **25.7** | **53.5** |



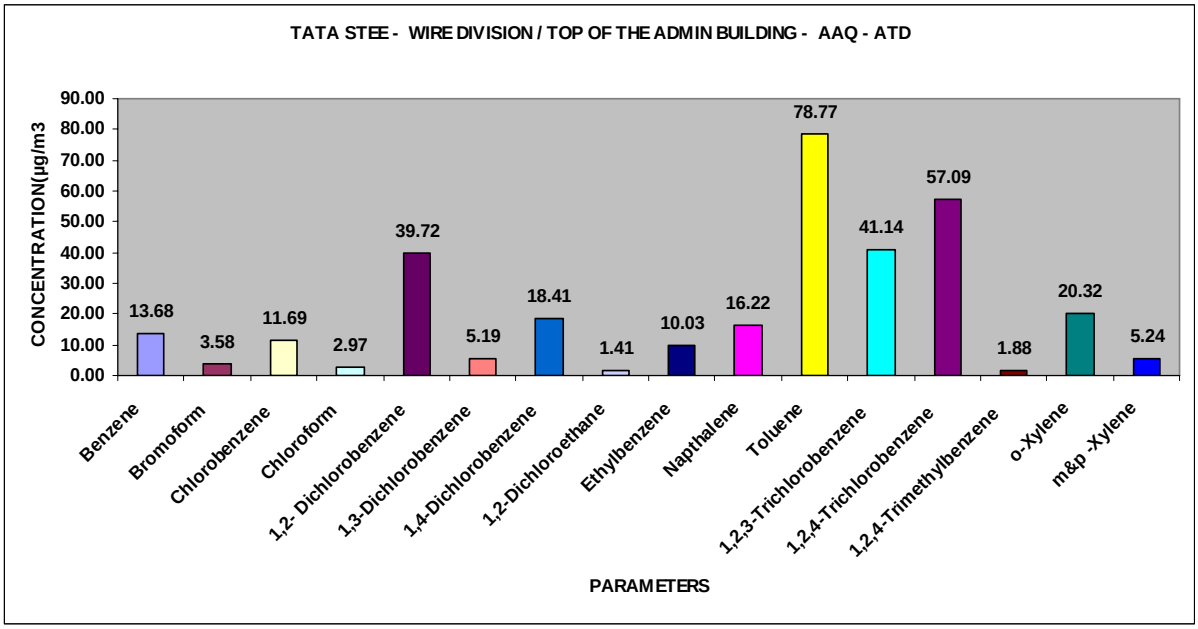

| SAMPLING LOCATION :MANDHANA DYEING /TOP OF REST ROOM | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BY CAT METHOD | | | | | |
| DATE OF SAMPLING :08 & 09.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 08.01.2009 5.50-11.50PM | 09.01.2009 1.15PM-7.15AM | 09.01.2009 9.30AM-3.30PM | AVERAGE |
| 1 | Chloroform | 6.90 | BDL | 221.00 | 75.98 |
| 2 | 1,2-Dichloroethane | 7.00 | 25.30 | 7.40 | 13.23 |
| 3 | Dichloromethane | 3.56 | 29.22 | 13.56 | 15.44 |
| 4 | Toluene | 10.22 | 33.20 | 16.40 | 19.94 |
| **Total VOC =** | | **27.68** | **87.72** | **258.36** | **124.59** |



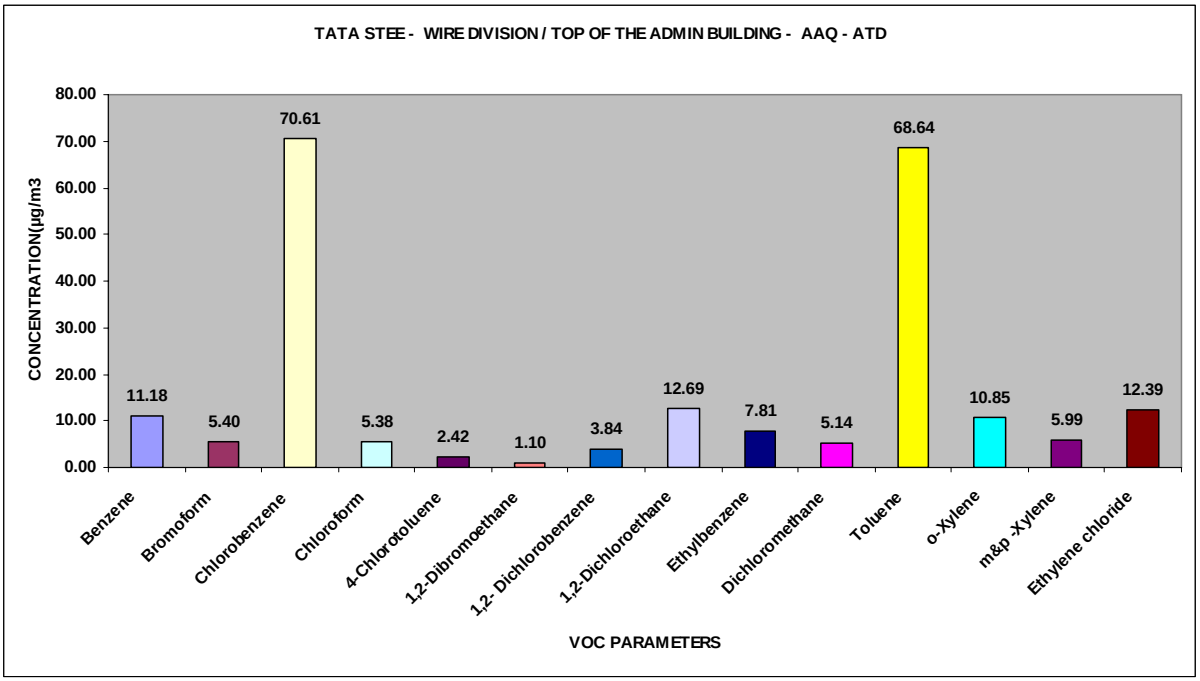

**Station 5:** Premises of Tata Steel, A-6 (A-Zone) (almost in the centre of industrial area).

The AAQ station-5 is identified as centre of the industrial estate. 17 VOCs in first day and 15 VOCs in second day of monitoring found at the location. These numbers include VOCs detected by both the methods (ATD & CAT). The average concentration of VOC in first day of monitoring was found to be 327.3 $\mu g/m^3$ and 23.4 $\mu g/m^3$ by ATD and CAT methods respectively. The average concentration of VOC in second day of monitoring was found to be 223.4 $\mu g/m^3$ and 37.9 $\mu g/m^3$ by ATD and CAT methods respectively. Benzene, Chlorobenzene, Ethylbenzene, Chloroform, Toluene, Chlorinated alkanes and Naphthalene are having pre-dominant presence among other VOCs at this location. Inversion effect and low wind velocity during night and early morning hours showed higher concentration than day time concentrations. The concentration values at this station found to be higher than station-1 because of down-wind location.

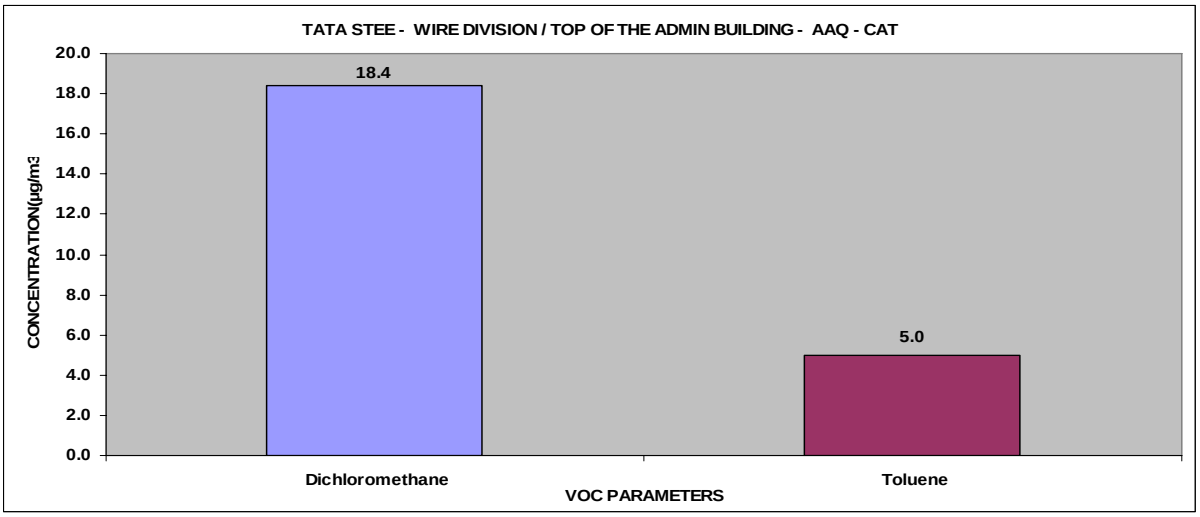
| TATA STEE; WIRE DIVISION/TOP OF THE ADMIN BUILDING | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BYATD METHOD | | | | | |
| DATE OF SAMPLING : 06 & 07.01.09 | | | | | |
| S.NO | PARAMETERS | TATA STEEL LTD; WIRE DIVISION | | | |
| | | Sampling Date : 06 & 07/01/09 / AAQ / ATD Method | | | |
| | | 06.01.2009 3.20 pm-9.20 pm | 06&07.01.2009 10.20pm-4.20am | 3 07.01.2009 6.30am-12.30pm | Average |
| | | Concentration in µg/m$^3$ | | | |
| 1 | Benzene | BDL | 40.94 | BDL | 13.68 |
| 2 | Bromoform | 5.46 | 5.24 | BDL | 3.58 |
| 3 | Chlorobenzene | 32.11 | 1.32 | 1.64 | 11.69 |
| 4 | Chloroform | BDL | BDL | 8.82 | 2.97 |
| 5 | 1,2- Dichlorobenzene | 1.91 | 114.63 | 2.63 | 39.72 |
| 6 | 1,3-Dichlorobenzene | BDL | 15.46 | BDL | 5.19 |
| 7 | 1,4-Dichlorobenzene | 1.21 | 53.97 | BDL | 18.41 |
| 8 | 1,2-Dichloroethane | 0.86 | 0.94 | 2.44 | 1.41 |
| 9 | Ethylbenzene | 21.47 | 8.56 | BDL | 10.03 |
| 10 | Napthalene | BDL | 48.55 | BDL | 16.22 |
| 11 | Toluene | 93.81 | 108.66 | 33.82 | 78.77 |
| 12 | 1,2,3-Trichlorobenzene | BDL | 123.33 | BDL | 41.14 |
| 13 | 1,2,4-Trichlorobenzene | 2.00 | 169.23 | BDL | 57.09 |
| 14 | 1,2,4-Trimethylbenzene | 5.58 | BDL | BDL | 1.88 |
| 15 | o-Xylene | 33.04 | 24.97 | 2.96 | 20.32 |
| 16 | m&p –Xylene | 15.63 | BDL | BDL | 5.24 |
| **Total VOC =** | | **213.33** | **715.90** | **52.80** | **327.34** |



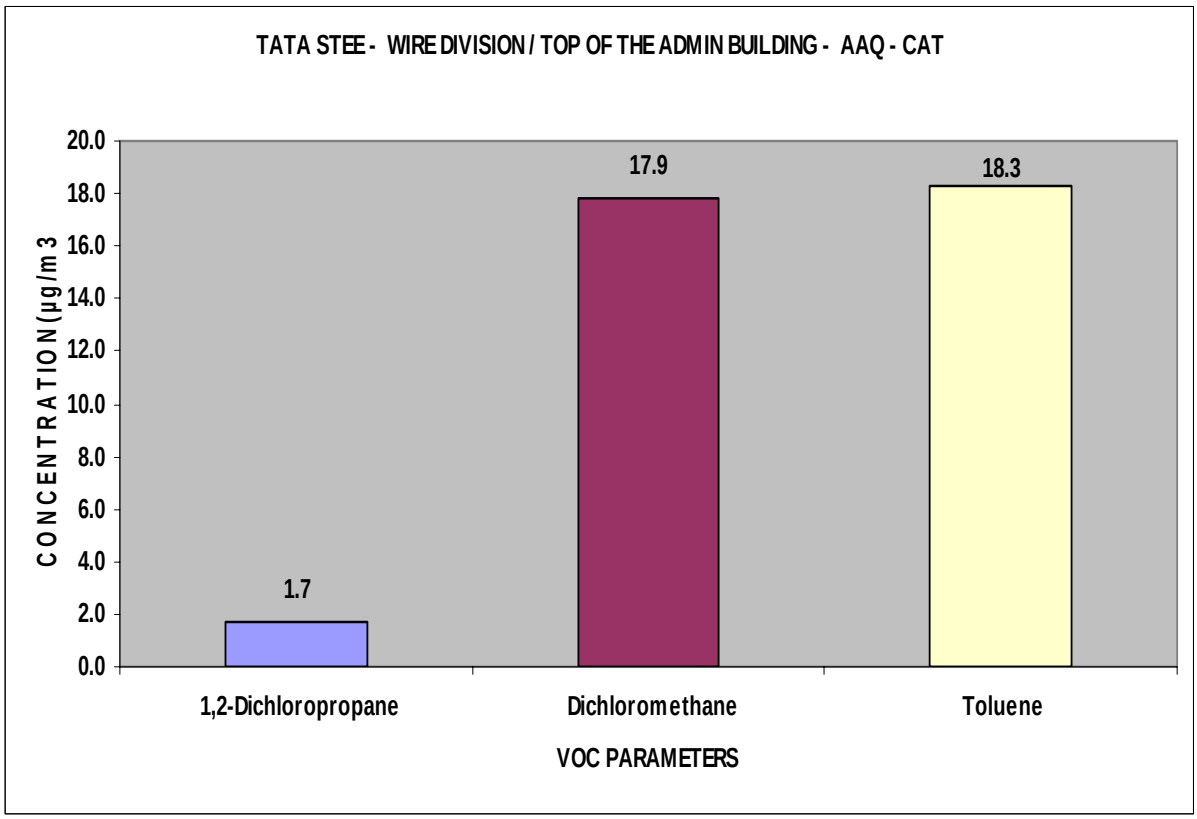
| TATA STEEL WIRE DIVISION/TOP OF THE ADMIN BUILDING | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR - VOC BYATD METHOD | | | | | |
| DATE OF SAMPLING : 08&09.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 08.01.2009 5.15-11.15PM | 08&09.01.2009 12.30PM-6.30AM | 09.01.2009 8.45AM-2.45PM | Average |
| 1 | Benzene | 5.38 | BDL | 28.11 | 11.18 |
| 2 | Bromoform | 5.33 | 5.27 | 5.59 | 5.40 |
| 3 | Chlorobenzene | 100.09 | 77.28 | 34.47 | 70.61 |
| 4 | Chloroform | BDL | BDL | 16.05 | 5.38 |
| 5 | 4-Chlorotoluene | 3.60 | 3.60 | BDL | 2.42 |
| 6 | 1,2-Dibromoethane | 3.20 | BDL | BDL | 1.10 |
| 7 | 1,2- Dichlorobenzene | BDL | BDL | 11.41 | 3.84 |
| 8 | 1,2-Dichloroethane | 12.93 | 16.70 | 8.43 | 12.69 |
| 9 | Ethylbenzene | BDL | BDL | 23.33 | 7.81 |
| 10 | Dichloromethane | 3.07 | 12.29 | BDL | 5.14 |
| 11 | Toluene | 70.59 | 55.06 | 80.28 | 68.64 |
| 12 | o-Xylene | 13.00 | 5.23 | 14.32 | 10.85 |
| 13 | m&p –Xylene | 13.11 | 1.81 | 3.06 | 5.99 |
| 14 | Ethylene chloride | 37.07 | BDL | BDL | 12.39 |
| | **Total VOC =** | **267.53** | **177.54** | **225.26** | **223.44** |



| TATA STEEL WIRE DIVISION/TOP OF THE ADMIN BUILDING | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR – VOC BYCAT METHOD | | | | | |
| DATE OF SAMPLING : 06&07.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 06.01.2009 3.20-9.20PM | 06&07.01.2009 10.20PM-4.20AM | 07.01.2009 6.30AM-12.30PM | Average |
| 1 | Dichloromethane | 5.0 | 31.6 | 18.7 | 18.4 |
| 2 | Toluene | 10.7 | 4.3 | BDL | 5.0 |
| | **Total VOC =** | **15.7** | **35.9** | **18.7** | **23.4** |




| TATA STEEL WIRE DIVISION/TOP OF THE ADMIN BUILDING | | | | | |
|---|---|---|---|---|---|
| SAMPLE DESCRIPTION : AMBIENT AIR – VOC BYCAT METHOD | | | | | |
| DATE OF SAMPLING : 08&09.01.09 | | | | | |
| S.NO | PARAMETERS | CONCENTRATION (µg/m$^3$) | | | |
| | | 08.01.2009 5.15-11.15PM | 08&09.01.2009 12.30PM-6.30AM | 09.01.2009 8.45AM-2.45PM | Average |
| 1 | 1,2-Dichloropropane | 5.2 | BDL | BDL | 1.7 |
| 2 | Dichloromethane | 11.7 | 12.2 | 29.7 | 17.9 |
| 3 | Toluene | 17.6 | BDL | 37.4 | 18.3 |
| | **Total VOC =** | **34.4** | **12.2** | **67.1** | **37.9** |


TATA STEE - WIRE DIVISION / TOP OF THE ADMIN BUILDING - AAQ - CAT
CONCENTRATION (µg/m3
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1.7
17.9
18.3
1,2-Dichloropropane
Dichloromethane
Toluene
VOC PARAMETERS

## AMBIENT AIR QUALITY MONITORING ANALYSIS REPORT: TARAPUR

| Station No | Location & Date of Air Sampling | (Pollutants in micro gram / cubic meters) VOCs Concentration by ATD | | |
|---|---|---|---|---|
| 1 | Premises of Dahanu – Palghar Sports Club in the East direction of industrial area. **(06/01/09 – 07/01/09)** | 5.9 (16:00 Hrs - 22:00Hrs) | 24.53 (23:00 Hrs - 05:00 Hrs) | 6.47 (07:00 Hrs - 13:00Hrs) |
| 2 | Premises of Police Chowki, Near Kumbhawali Naka (T-Zone) in the West of industrial area. **(06/01/09 – 07/01/09)** | 72.9 (22:15 Hrs - 04:15Hrs) | 186.8 (22:15 Hrs - 04:15Hrs) | 129.7 (06:15 Hrs - 12:15Hrs) |
| 3 | Premises of M/s Galaxy Surfactants, G-59 (G-Zone) in South direction of industrial area. **(06/01/09 – 07/01/09)** | 202.9 (15:45 Hrs – 21:45Hrs) | 31.0 (22:45 Hrs – 04:45Hrs) | 253.4 (06:45 Hrs – 12:45Hrs) |
| 4 | Premises of M/s Mandhana Dyeing, E-25 (E-Zone) in the North direction of industrial area. **(06/01/09 – 07/01/09)** | 126.8 (12:15 Hrs – 18:15Hrs) | 253.3 (18:30 Hrs – 00:30Hrs) | 150.0 (07:15 Hrs – 13:15Hrs) |
| 5 | Premises of Tata Steel, A-6 (A-Zone) (almost in the centre of industrial area). **(06/01/09 – 07/01/09)** | 213.3 (15:20 Hrs – 21.20 Hrs) | 715.9 (22:20 Hrs - 04:20Hrs) | 52.8 (6:30 Hrs - 12:30Hrs) |

A A Q M Station in **up wind direction** : Station-1
A A Q M Station in **down wind direction** : Station-2
A A Q M Stations in **Cross wind direction** : Station-3 & 4
A A Q M Stations in **Center of Industrial Estate** : Station-5

| | |
|---|---|
| Land Use Classification | Industrial Zone |
| Sky Conditions | Sunny Sky |
| Ambient Temperature | 32$^{o}$C to 34$^{o}$C |
| Predominant Wind Directions | North East to South West |

**Analytical Methodology Adopted: EPA TO-17**

## AMBIENT AIR QUALITY MONITORING ANALYSIS REPORT: TARAPUR

| Station No | Location & Date of Air Sampling | (Pollutants in micro gram / cubic meters) VOCs Concentration by ATD | | |
|---|---|---|---|---|
| 1 | Premises of Dahanu – Palghar Sports Club in the East direction of industrial area. **(08/01/09 – 09/01/09)** | 184.2 (17:40 Hrs - 23:40Hrs) | 135.0 (01:00 Hrs - 07:00 Hrs) | 22.7 (09:15 Hrs - 15:15Hrs) |
| 2 | Premises of Police Chowki, Near Kumbhawali Naka (T-Zone) in the West of industrial area. **(08/01/09 – 09/01/09)** | 258.2 (17:00 Hrs - 23:00Hrs) | 148.6 (00:15 Hrs - 06:15 Hrs) | 156.5 (08:30 Hrs - 14:30Hrs) |
| 3 | Premises of M/s Galaxy Surfactants, G-59 (G-Zone) in South direction of industrial area. **((08/01/09 – 09/01/09)** | 226.5 (17:30 Hrs - 23:30Hrs) | 198.3 (00:45 Hrs - 06:45 Hrs) | 184.4 (09:00 Hrs - 15:00Hrs) |
| 4 | Premises of M/s Mandhana Dyeing, E-25 (E-Zone) in the North direction of industrial area. **(08/01/09 – 09/01/09)** | 158.5 (17:50 Hrs - 23:50Hrs) | 238.2 (01:15 Hrs - 07:15 Hrs) | 147.8 (09:30 Hrs - 15:30Hrs) |
| 5 | Premises of Tata Steel, A-6 (A-Zone) (almost in the centre of industrial area). **(08/01/09 – 09/01/09)** | 267.5 (17:15 Hrs - 23:15Hrs) | 177.5 (00:30 Hrs - 06:30 Hrs) | 225.3 (08:45 Hrs - 14:45Hrs) |

A A Q M Station in **up wind direction** : Station-1
A A Q M Station in **down wind direction** : Station-2
A A Q M Stations in **Cross wind direction** : Station-3 & 4
A A Q M Stations in **Center of Industrial Estate** : Station-5

| | |
|---|---|
| Land Use Classification | Industrial Zone |
| Sky Conditions | Sunny Sky |
| Ambient Temperature | 32$^{o}$C to 34$^{o}$C |
| Predominant Wind Directions | North East to South West |

**Analytical Methodology Adopted: EPA TO-17**

Change in the concentration of VOCs observed in first and second day of monitoring at almost all stations. Weekly power staggering during half of the monitoring duration of the first day of monitoring, change in batch process steps of the industries, weekly shutdown, and maintenance/repair in the plants/storages/machineries could be the probable causes of the same. Benzene, Toluene, Chlorinated alkanes are having pre-dominant presence among other VOCs at these locations.

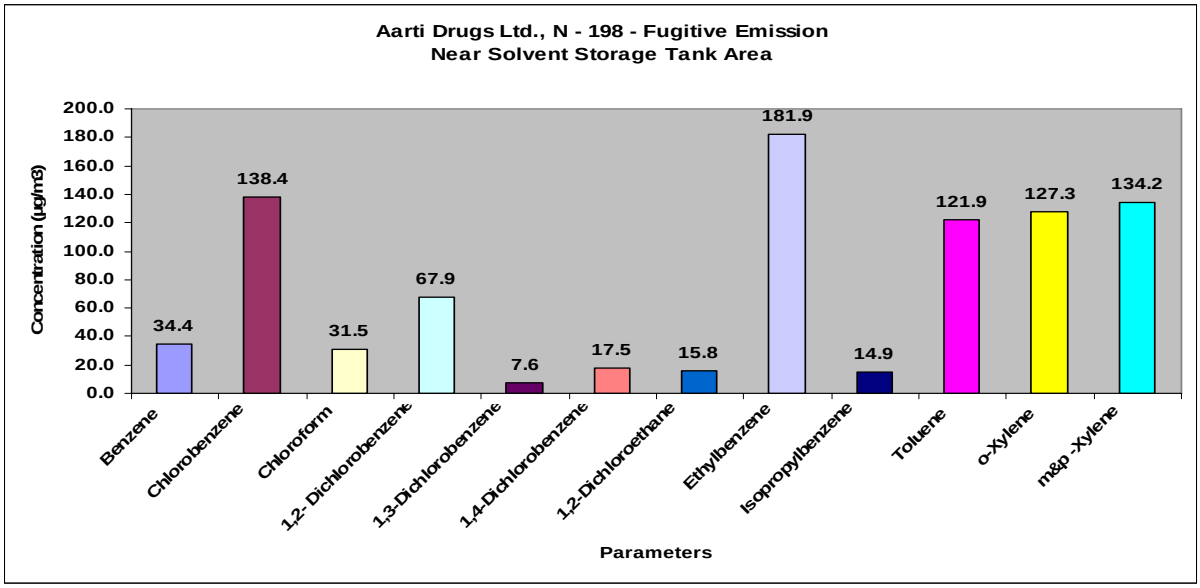
## 11.2 Result of Monitoring at Industries:

### 11.2.1 M/s Aarti Drugs Ltd., (Plot No. N – 198)

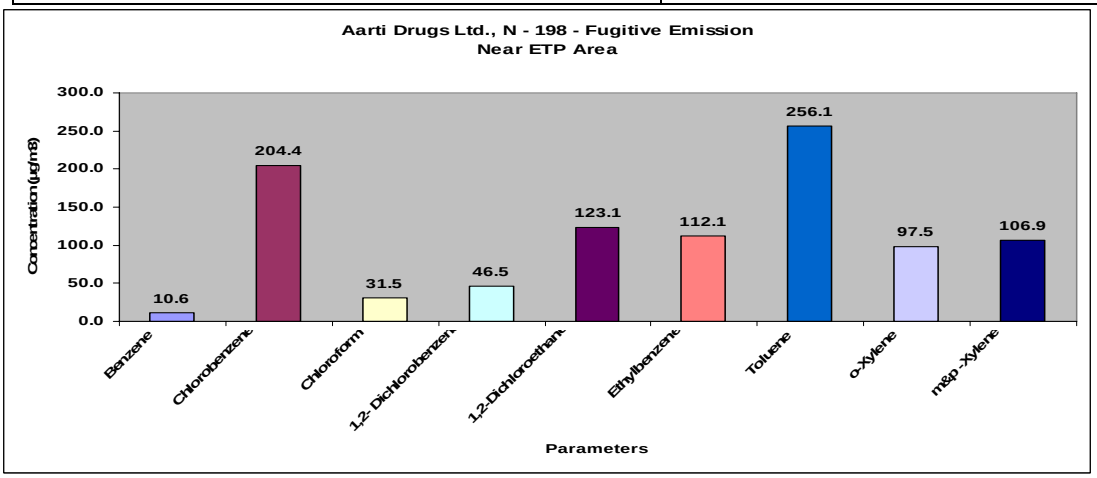
- Bulk Drug Industry
- Major Products: Nimusulide, Tinadazole, Imadazole
- Major Solvents: Monochloro Benzene, Xylene, MIBK etc.,
- Date of sampling : 07.01.09

Samples of fugitive emissions, wastewater and hazardous waste were collected from the unit and analysed for VOCs. The concentration of VOCs in fugitive emission monitoring sample was found to be in the range of 129 to 1275 $\mu g/m^3$. The highest concentration was found at the location near ETP where evaporation from effluent streams takes place at higher rates especially in aeration of the effluent. It is found that fugitive emission concentration is higher in ETP & Solvent Storage area than plant process specifically centrifugal operation area.

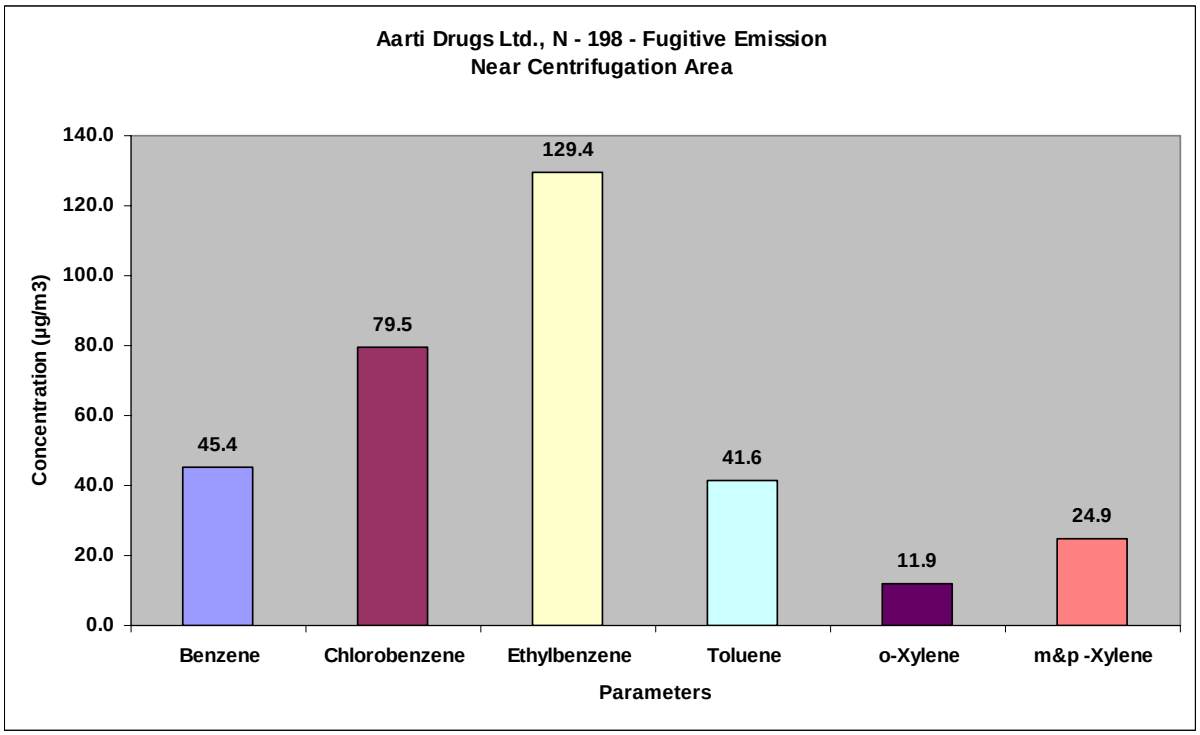
| **Aarti Drugs Ltd., N-198** | |
|---|---|
| **Location : Near Solvent Storage Tanks** | |
| **PARAMETERS** | **RESULTS ($\mu g/m^3$)** |
| Benzene | 34.4 |
| Chlorobenzene | 138.4 |
| Chloroform | 31.5 |
| 1,2- Dichlorobenzene | 67.9 |
| 1,3-Dichlorobenzene | 7.6 |
| 1,4-Dichlorobenzene | 17.5 |
| 1,2-Dichloroethane | 15.8 |
| Ethylbenzene | 181.9 |
| Isopropylbenzene | 14.9 |
| Toluene | 121.9 |
| o-Xylene | 127.3 |
| m&p –Xylene | 134.2 |
| **Total VOC =** | **893.1** |



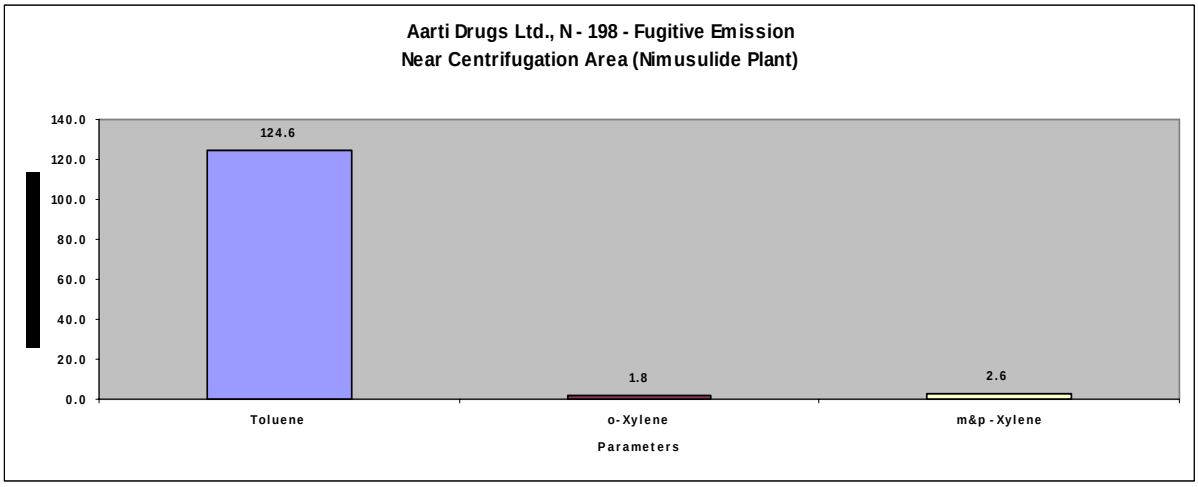

| Aarti Drugs Ltd., N-198 | |
|---|---|
| **Location : Near ETP** | |
| **PARAMETERS** | **RESULTS (µg/m$^3$)** |
| Benzene | 10.6 |
| Chlorobenzene | 204.4 |
| Chloroform | 31.5 |
| 1,2- Dichlorobenzene | 46.5 |
| 1,2-Dichloroethane | 123.1 |
| Ethylbenzene | 112.1 |
| Toluene | 256.1 |
| o-Xylene | 97.5 |
| m&p –Xylene | 106.9 |
| **Total VOC =** | **988.7** |



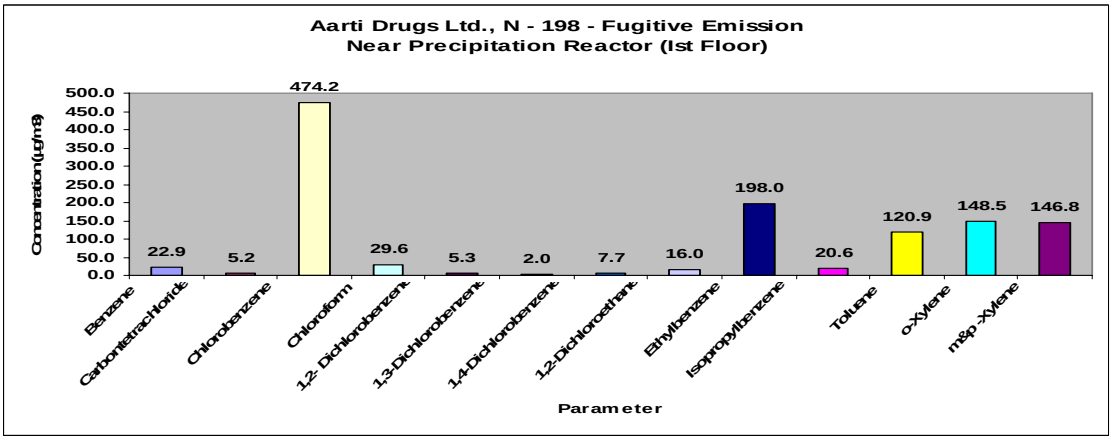
| Aarti Drugs Ltd., N-198 | |
|---|---|
| **Location : Near Centrifugation Area** | |
| **PARAMETERS** | **RESULTS (µg/m$^3$)** |
| Benzene | 45.4 |
| Chlorobenzene | 79.5 |
| Ethylbenzene | 129.4 |
| Toluene | 41.6 |
| o-Xylene | 11.9 |
| m&p –Xylene | 24.9 |
| **Total VOC =** | **332.7** |



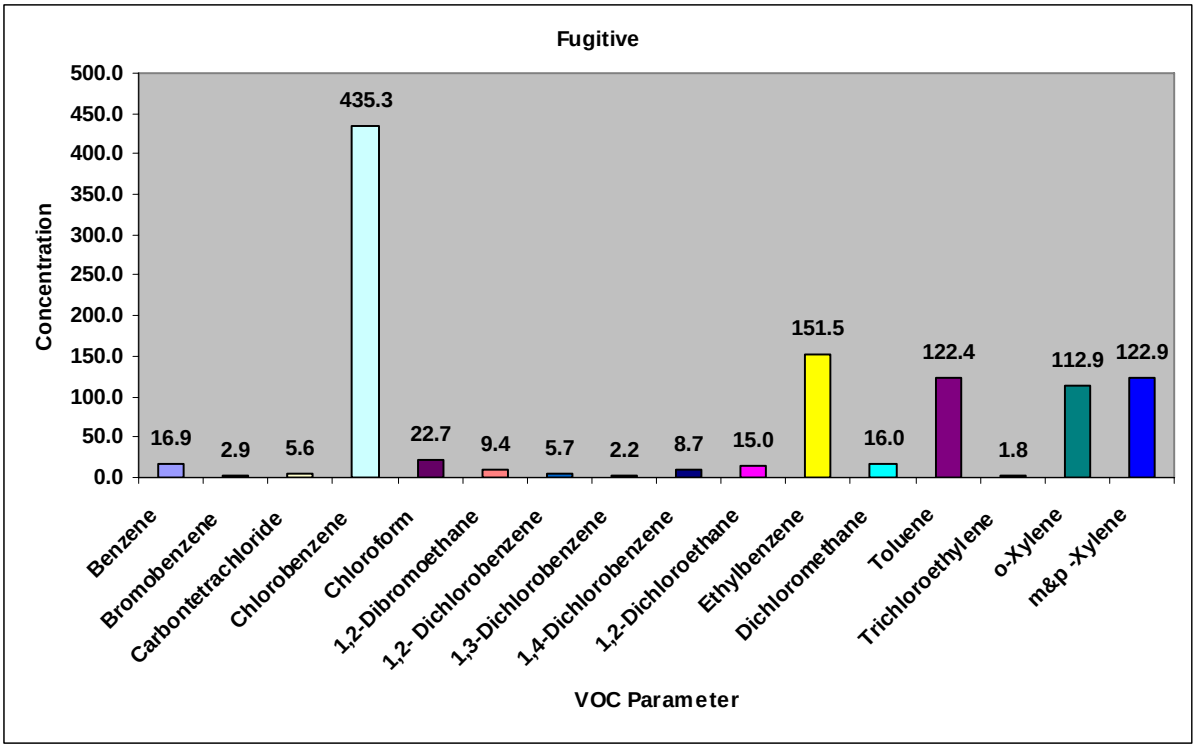

| Aarti Drugs Ltd., N-198 | |
|---|---|
| **Location : Near Centrifugation Area (Nimusulide Plant)** | |
| **PARAMETERS** | **RESULTS (µg/m$^3$)** |
| Toluene | 124.6 |
| o-Xylene | 1.8 |
| M&p –Xylene | 2.6 |
| **Total VOC =** | **129.0** |



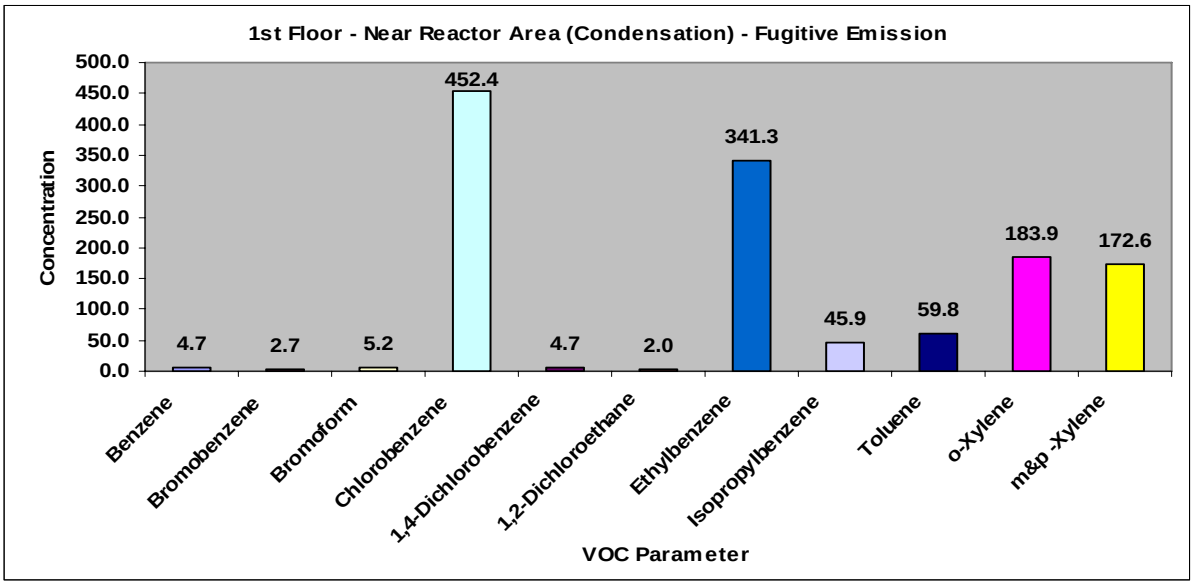

| Aarti Drugs Ltd., N – 198 | |
|---|---|
| **Location : Near Precipitation Reactor - 1st Floor** | |
| **PARAMETERS** | **RESULTS (µg/m$^3$)** |
| Benzene | 22.9 |
| Carbontetrachloride | 5.2 |
| Chlorobenzene | 474.2 |
| Chloroform | 29.6 |
| 1,2- Dichlorobenzene | 5.3 |
| 1,3-Dichlorobenzene | 2.0 |
| 1,4-Dichlorobenzene | 7.7 |
| 1,2-Dichloroethane | 16.0 |
| Ethylbenzene | 198.0 |
| Isopropylbenzene | 20.6 |
| Toluene | 120.9 |
| o-Xylene | 148.5 |
| m&p –Xylene | 146.8 |
| **Total VOC =** | **1197.6** |



| Aarti Drugs Ltd., N-198 - Fugitive emission Monitoring | |
|---|---|
| **Location : Near Dryer - 2nd Floor** | |
| **PARAMETERS** | **RESULTS (µg/m$^3$)** |
| Benzene | 16.9 |
| Bromobenzene | 2.9 |
| Carbontetrachloride | 5.6 |
| Chlorobenzene | 435.3 |
| Chloroform | 22.7 |
| 1,2-Dibromoethane | 9.4 |
| 1,2- Dichlorobenzene | 5.7 |
| 1,3-Dichlorobenzene | 2.2 |
| 1,4-Dichlorobenzene | 8.7 |
| 1,2-Dichloroethane | 15.0 |
| Ethylbenzene | 151.5 |
| Dichloromethane | 16.0 |
| Toluene | 122.4 |
| Trichloroethylene | 1.8 |
| o-Xylene | 112.9 |
| m&p –Xylene | 122.9 |
| **Total VOC =** | **1052.0** |



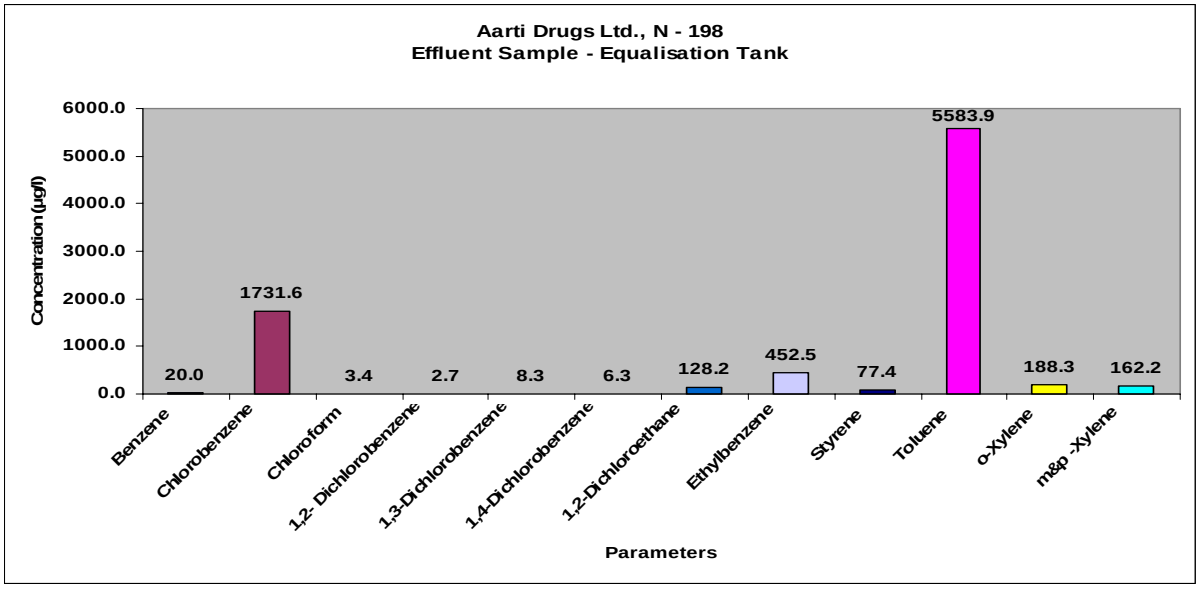
| Aarti Drugs Ltd, Plot No. N- 198 - Fugitive Emission – ATD | |
|---|---|
| **Location : 1st Floor - Near Reactor Area – Tinadazole** | |
| **PARAMETERS** | **RESULTS (µg/m$^3$)** |
| Benzene | 4.7 |
| Bromobenzene | 2.7 |
| Bromoform | 5.2 |
| Chlorobenzene | 452.4 |
| 1,4-Dichlorobenzene | 4.7 |
| 1,2-Dichloroethane | 2.0 |
| Ethylbenzene | 341.3 |
| Isopropylbenzene | 45.9 |
| Toluene | 59.8 |
| o-Xylene | 183.9 |
| m&p –Xylene | 172.6 |
| **Total VOC =** | **1275.1** |




## EFFLUENT WATER SAMPLE ANLAYSIS:

The concentration of VOCs in effluent sample taken from equalization tank of ETP was found to be 8364.8 µg/l. The higher concentration may be due to improper separation of intermediate/solvents/products at different process stages, which also affects the treatment efficiency of the ETP.

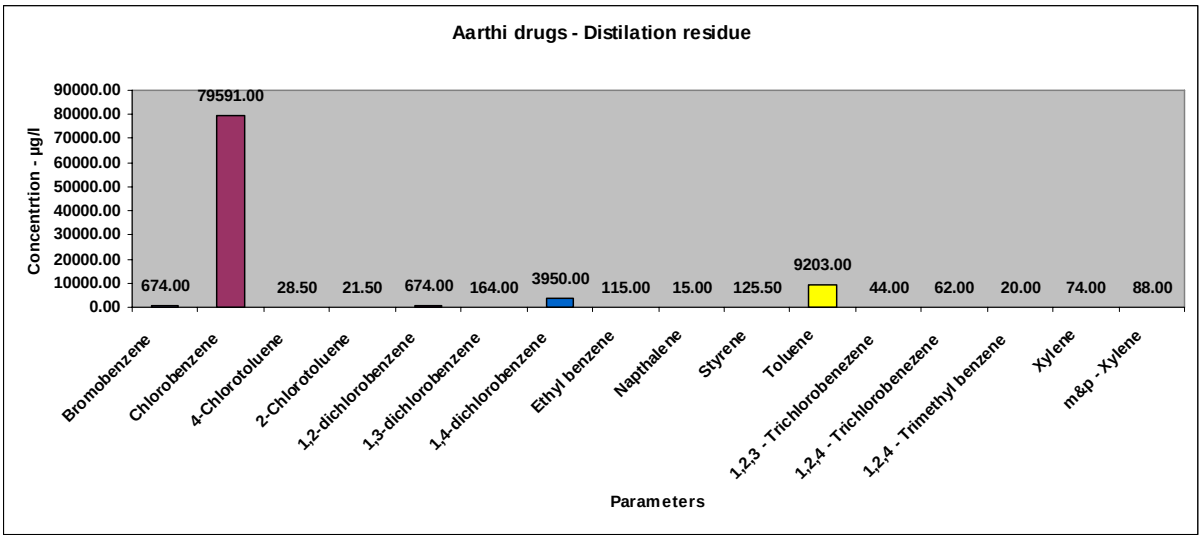
| Aarti Drugs Ltd., N-198 | |
|---|---|
| **Effluent Sample - Equalisation Tank** | |
| **PARAMETERS** | **RESULTS (µg/l)** |
| Benzene | 20.0 |
| Chlorobenzene | 1731.6 |
| Chloroform | 3.4 |
| 1,2- Dichlorobenzene | 2.7 |
| 1,3-Dichlorobenzene | 8.3 |
| 1,4-Dichlorobenzene | 6.3 |
| 1,2-Dichloroethane | 128.2 |
| Ethylbenzene | 452.5 |
| Styrene | 77.4 |
| Toluene | 5583.9 |
| o-Xylene | 188.3 |
| m&p –Xylene | 162.2 |
| **Total VOC =** | **8364.8** |



## HAZARDOUS WASTE ANALYSIS:

The concentration of the VOCs in hazardous waste sample (i.e. mix of spent carbon and distillation residue) was found to be 94849.50 μg/l. The higher concentration reflects the scope for better recover of solvents and plugging the sources of loss.

| Sampling site:M/s. Aarthi drugs ltd, N-198 | | |
|---|---|---|
| Sampling date: 07/01/2009 | | |
| **S.No** | **Parameters** | **Concentration μg/l** |
| 1 | Bromobenzene | 674.00 |
| 2 | Chlorobenzene | 79591.00 |
| 3 | 4-Chlorotoluene | 28.50 |
| 4 | 2-Chlorotoluene | 21.50 |
| 5 | 1,2-dichlorobenzene | 674.00 |
| 6 | 1,3-dichlorobenzene | 164.00 |
| 7 | 1,4-dichlorobenzene | 3950.00 |
| 8 | Ethyl benzene | 115.00 |
| 9 | Napthalene | 15.00 |
| 10 | Styrene | 125.50 |
| 11 | Toluene | 9203.00 |
| 12 | 1,2,3 – Trichlorobenezene | 44.00 |
| 13 | 1,2,4 – Trichlorobenezene | 62.00 |
| 14 | 1,2,4 - Trimethyl benzene | 20.00 |
| 15 | Xylene | 74.00 |
| 16 | m&p – Xylene | 88.00 |
| **Total VOC =** | | **94849.50** |



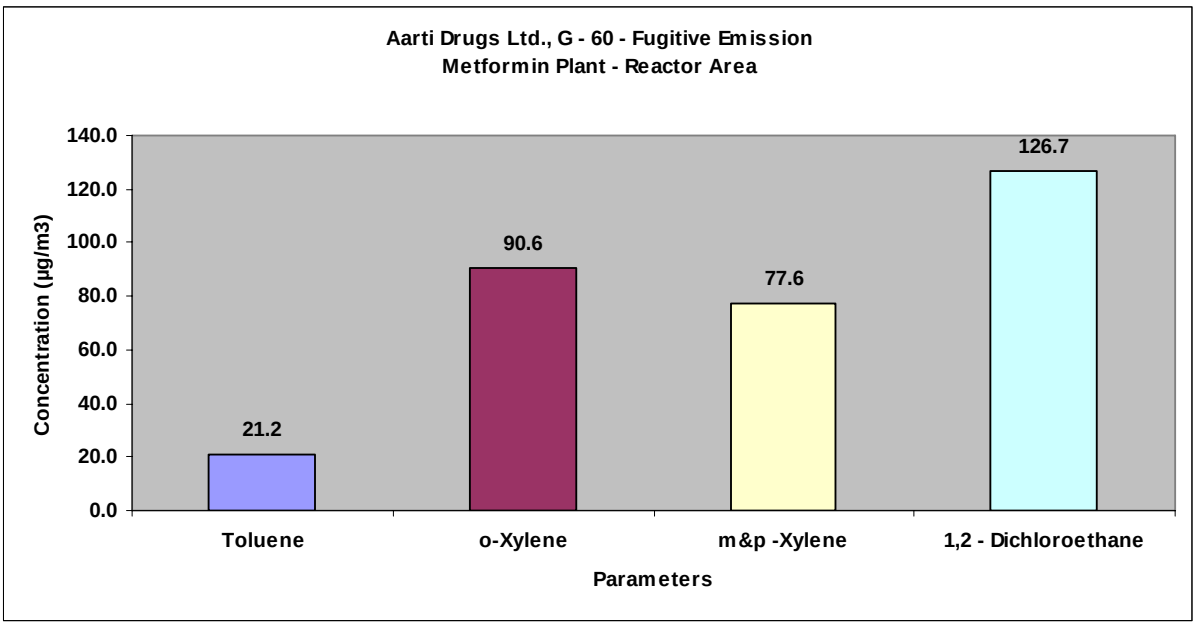
### 11.2.2 M/s Aarti Drugs Ltd, Plot No. G - 60

- Bulk Drug Industry
- Major Product: Diclofenac Sodium, Metformin HCl.
- Major Solvents: Xylene, Toluene, Butanol
- Date of Sampling : 07.01.09

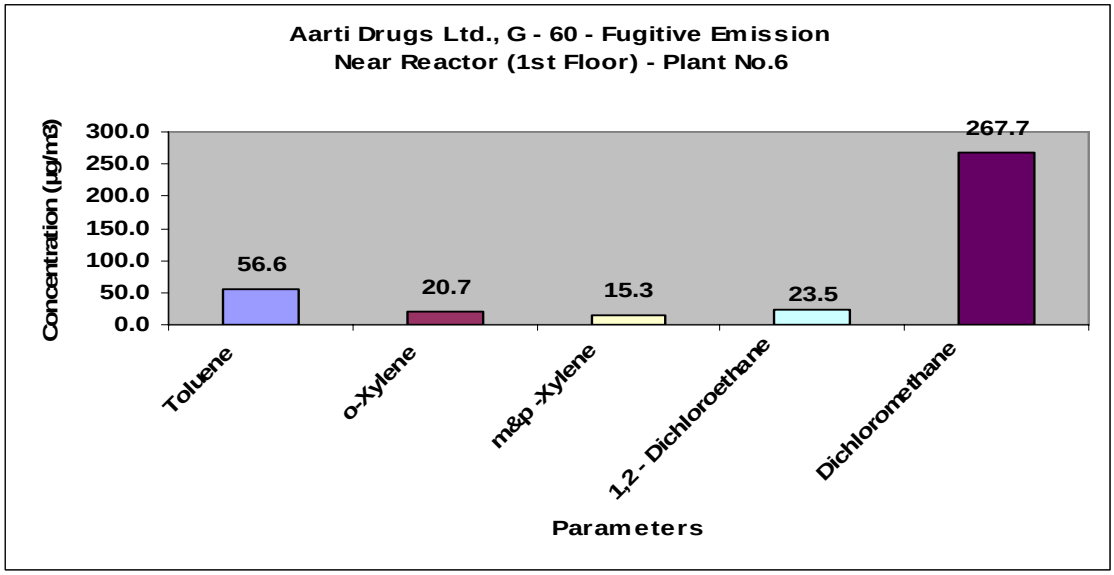
**FUGITIVE EMISSION MONITORING:**

Samples of fugitive emissions, wastewater and hazardous waste were collected from the unit and analysed fro VOCs. The concentration of VOCs in fugitive emission monitoring sample was found to be in the range of 316.1 to 592.4 $\mu g/m^3$. The highest concentration was found at the downwind of the plant.

| Aarti Drugs Ltd., G – 60 | |
|---|---|
| **Location : Metformin Plant - Reactor Area** | |
| **PARAMETERS** | **RESULTS (µg/m3)** |
| Toluene | 21.2 |
| o-Xylene | 90.6 |
| m&p –Xylene | 77.6 |
| 1,2 – Dichloroethane | 126.7 |
| **Total VOC =** | 316.1 |



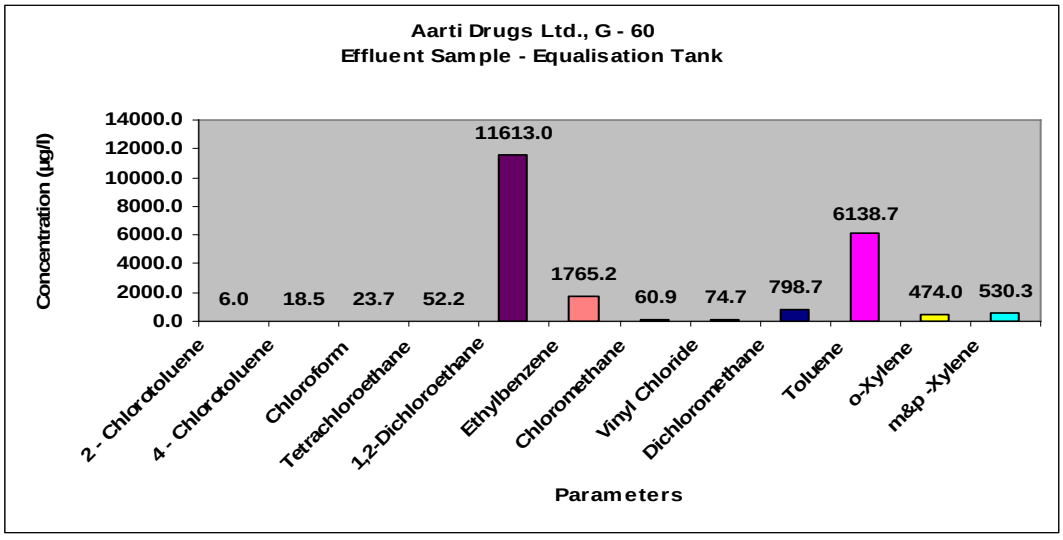
| Aarti Drugs Ltd., G – 60 | |
|---|---|
| Location : Near Reactor Area (1st Floor) -Plant No.2 Diclofenac Sodium | |
| **PARAMETERS** | **RESULTS (µg/m³)** |
| Toluene | 56.6 |
| o-Xylene | 20.7 |
| m&p –Xylene | 15.3 |
| 1,2 - Dichloroethane | 23.5 |
| Dichloromethane | 267.7 |
| **Total VOC =** | **383.8** |




## EFFLUENT SAMPLE ANALYSIS:

The concentration of VOCs in effluent sample taken from equalization tank of ETP was found to be 21555.9 µg/l. The higher concentration may be due to improper separation of intermediate/solvents/products at different process stages, which also affects the treatment efficiency of the ETP. The higher concentration of VOCs also reflects more losses from process and less recovery of solvents.

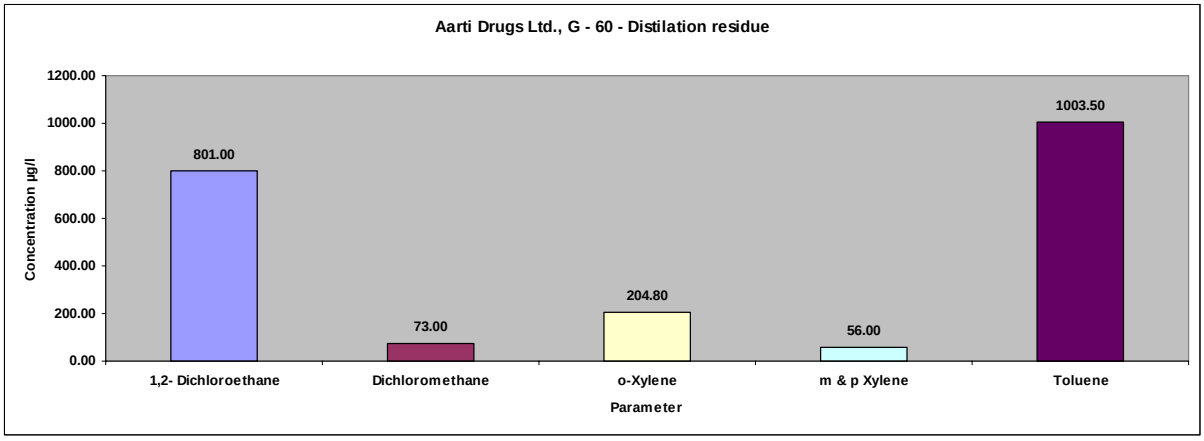
| Aarti Drugs Ltd., G -60 | |
|---|---|
| **Location : ETP sample - Equalisation Tank** | |
| **ARAMETERS** | **RESULTS (µg/l)** |
| 2 – Chlorotoluene | 6.0 |
| 4 – Chlorotoluene | 18.5 |
| Chloroform | 23.7 |
| Tetrachloroethane | 52.2 |
| 1,2-Dichloroethane | 11613.0 |
| Ethylbenzene | 1765.2 |
| Chloromethane | 60.9 |
| Vinyl Chloride | 74.7 |
| Dichloromethane | 798.7 |
| Toluene | 6138.7 |
| o-Xylene | 474.0 |
| m&p –Xylene | 530.3 |
| **Total VOC =** | **21555.9** |



**HAZARDOUS WASTE ANALYSIS:**

The concentration of the VOCs in hazardous waste sample (i.e. reportedly mixed residue of Toluene and Xlene) was found to be 2138.30 μg/l.

| ampling site:M/s. Aarthi drugs ltd - G-60 | | |
|---|---|---|
| Sampling date: 07/01/2009 | | |
| **S.No** | **Parameters** | **Concentration μg/l** |
| 2 | 1,2- Dichloroethane | 801.00 |
| 3 | Dichloromethane | 73.00 |
| 4 | o-Xylene | 204.80 |
| 5 | m & p Xylene | 56.00 |
| 6 | Toluene | 1003.50 |
| **Total VOC =** | | **2138.30** |

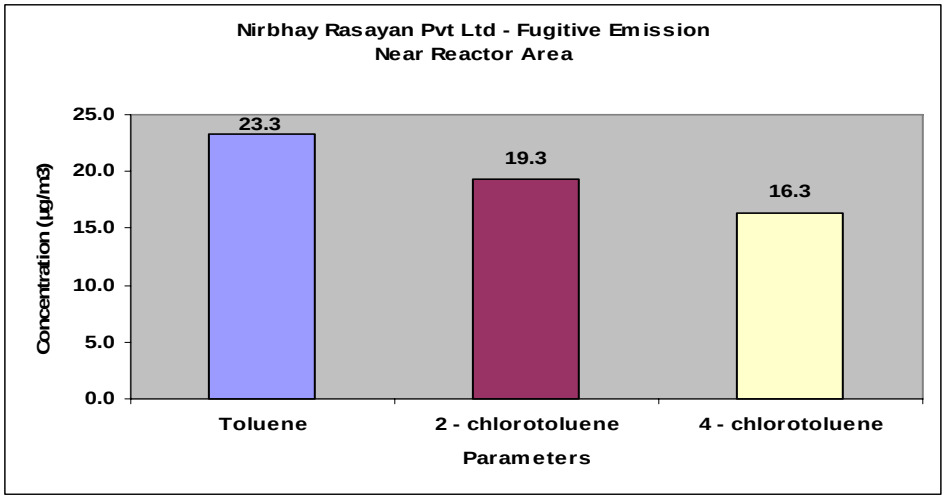



### 11.2.3 M/s. Nirbhay Rasayan Pvt Ltd.,

- Chemical Industry
- Major Products: Dichloro Toluene
- Major Solvents: Toluene
- Date of Sampling : 07.01.09

Samples of fugitive emissions, wastewater and hazardous waste were collected from the unit and analysed fro VOCs. The concentration of VOCs in fugitive emission monitoring sample was found to be 58.9 μg/$m^3$ near plant reactor area. The unit is comparatively smaller than above bulk-drug units and having limited use of solvent in the process.

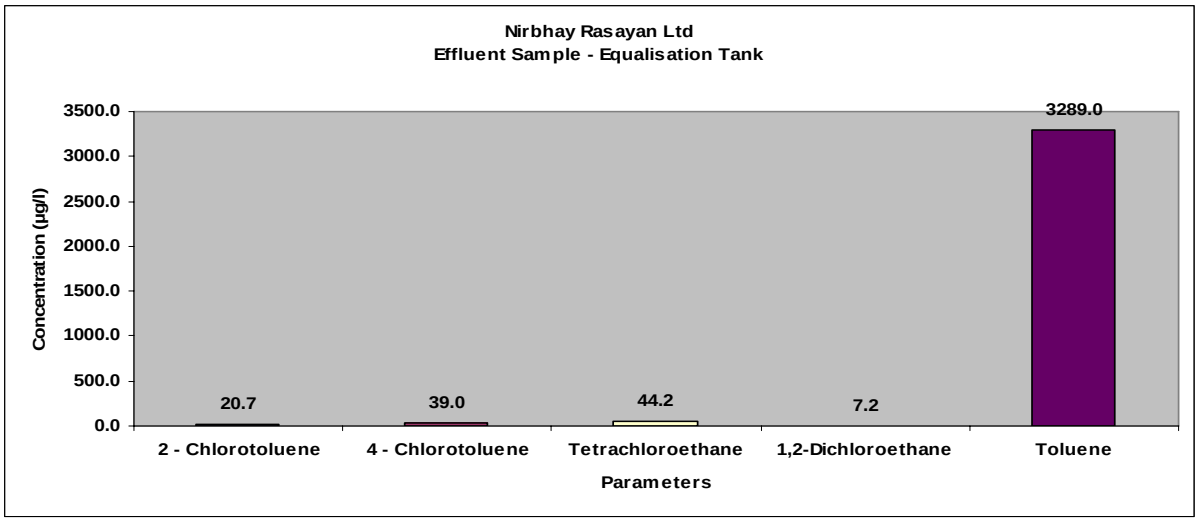
| Nirbhay Rasayan Pvt Ltd | |
|---|---|
| **Location : Near Reactor Area** | |
| **PARAMETERS** | **RESULTS (µg/m$^3$)** |
| Toluene | 23.3 |
| 2 – chlorotoluene | 19.3 |
| 4 – chlorotoluene | 16.3 |
| **Total VOC =** | 58.9 |




## EFFLUENT SAMPLE ANALYSIS:

The concentration of VOCs in effluent sample taken from equalization tank of ETP was found to be 3400 µg/l. The higher concentration may be due to improper separation of intermediate/solvents/products at different process stages, which also affects the treatment efficiency of the ETP.

| Nirbhay Rasayan Ltd | |
|---|---|
| **Location : ETP sample - Equalisation Tank** | |
| **PARAMETERS** | **RESULTS (µg/l)** |
| 2 – Chlorotoluene | 20.7 |
| 4 – Chlorotoluene | 39.0 |
| Tetrachloroethane | 44.2 |
| 1,2-Dichloroethane | 7.2 |
| Toluene | 3289.0 |
| **Total VOC =** | 3400.1 |



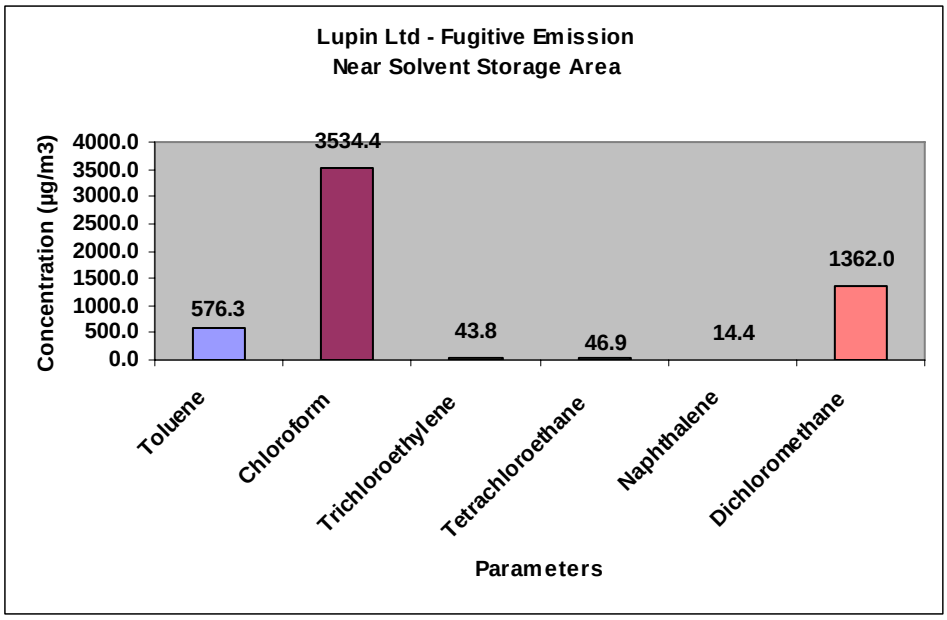

### 11.2.4 M/s Lupin Ltd:

- Bulk Drug Industry
- Products:
- Major Solvents: Toluene, MDC etc.,
- Date of Sampling : 08.01.09

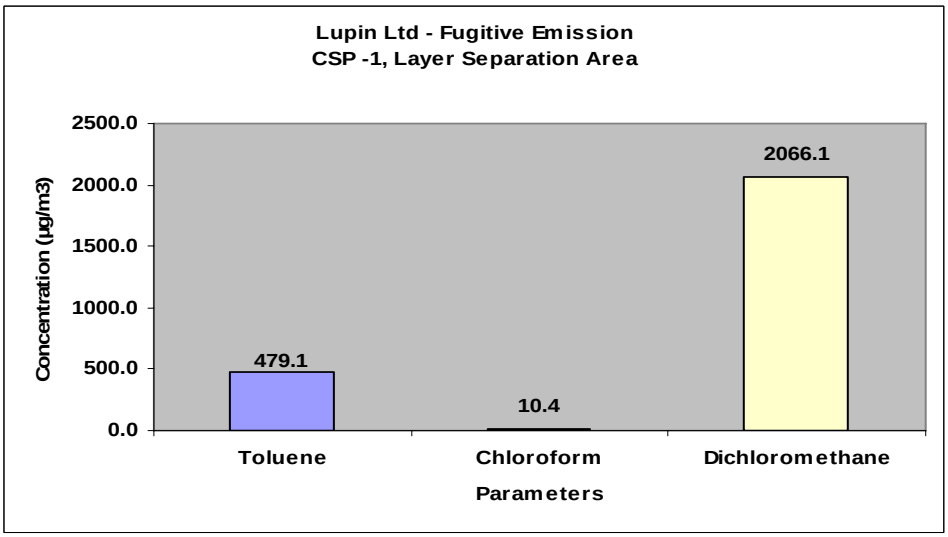
**FUGITIVE EMISSION ANALYSIS:**

Samples of fugitive emissions, wastewater and hazardous waste were collected from the unit and analysed fro VOCs. The concentration of VOCs in fugitive emission monitoring sample was found to be in the range of 521.9 to 5577.8 $\mu g/m^3$. The highest concentration was found at the location near solvent storage area i.e. also downwind of the plant. It is found that fugitive emission concentration is higher near reactor & layer separation area than centrifugal operation area.

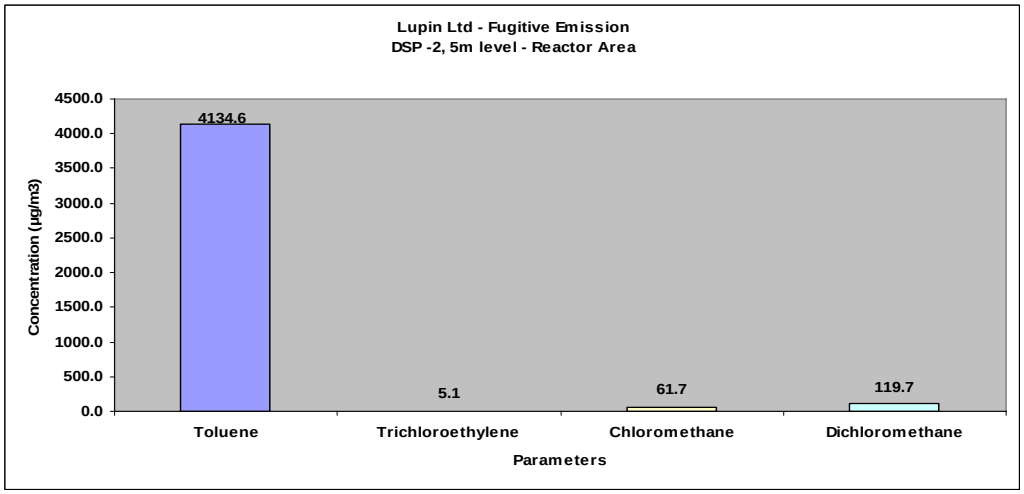
| **Lupin Ltd** | |
|---|---|
| **Location : Solvent Storage area (Down wind)** | |
| **PARAMETERS** | **RESULTS ($\mu g/m^3$)** |
| Toluene | 576.3 |
| Chloroform | 3534.4 |
| Trichloroethylene | 43.8 |
| Tetrachloroethane | 46.9 |
| Naphthalene | 14.4 |
| Dichloromethane | 1362.0 |
| **Total VOC =** | **5577.8** |



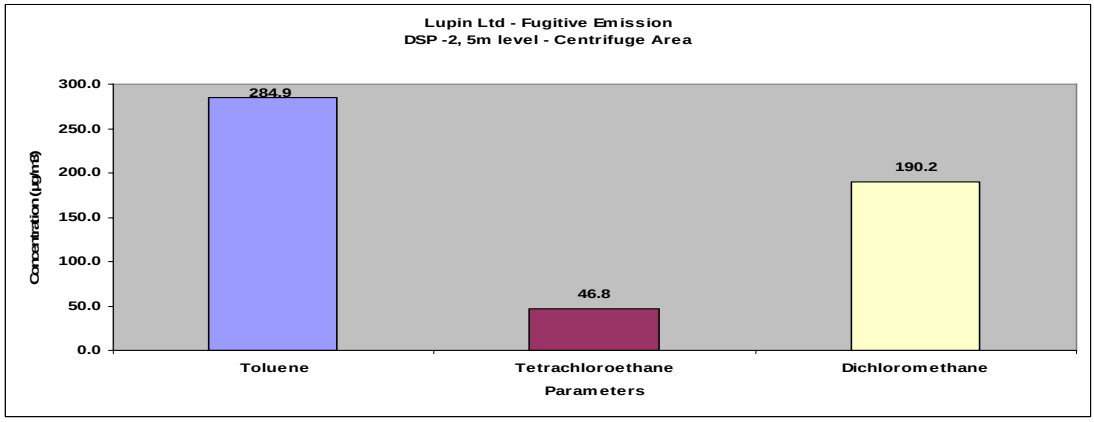

| Lupin Ltd | |
|---|---|
| **Location : CSP -1, Layer Separation Area** | |
| **PARAMETERS** | RESULTS (µg/m$^3$) |
| Toluene | 479.1 |
| Chloroform | 10.4 |
| Dichloromethane | 2066.1 |
| **Total VOC =** | 2555.6 |



| Lupin Ltd | |
|---|---|
| **Location : DSP -2, 5m level - Reactor Area** | |
| **PARAMETERS** | **RESULTS (µg/m$^3$)** |
| Toluene | 4134.6 |
| Trichloroethylene | 5.1 |
| Chloromethane | 61.7 |
| Dichloromethane | 119.7 |
| **Total VOC =** | 4321.1 |



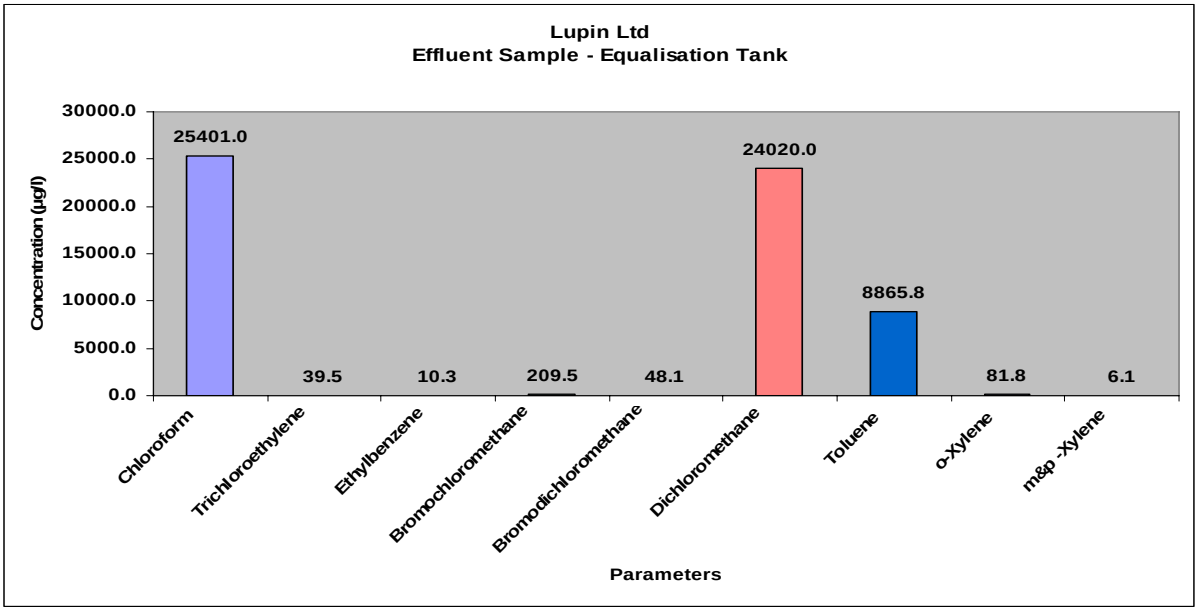

| Lupin Ltd | |
|---|---|
| **Location : DSP -2, 5m level - Centrifuge Area** | |
| **PARAMETERS** | **RESULTS (µg/m$^3$)** |
| Toluene | 284.9 |
| Tetrachloroethane | 46.8 |
| Dichloromethane | 190.2 |
| **Total VOC =** | 521.9 |




## EFFLUENT SAMPLE ANALYSIS:

The concentration of VOCs in effluent sample taken from equalization tank of ETP was found to be 58682.1 µg/l. The higher concentration may be due to improper separation of intermediate/solvents/products at different process stages, which also affects the treatment efficiency of the ETP. The higher concentration reflects the scope for better recovery of solvents and plugging the sources of loss.

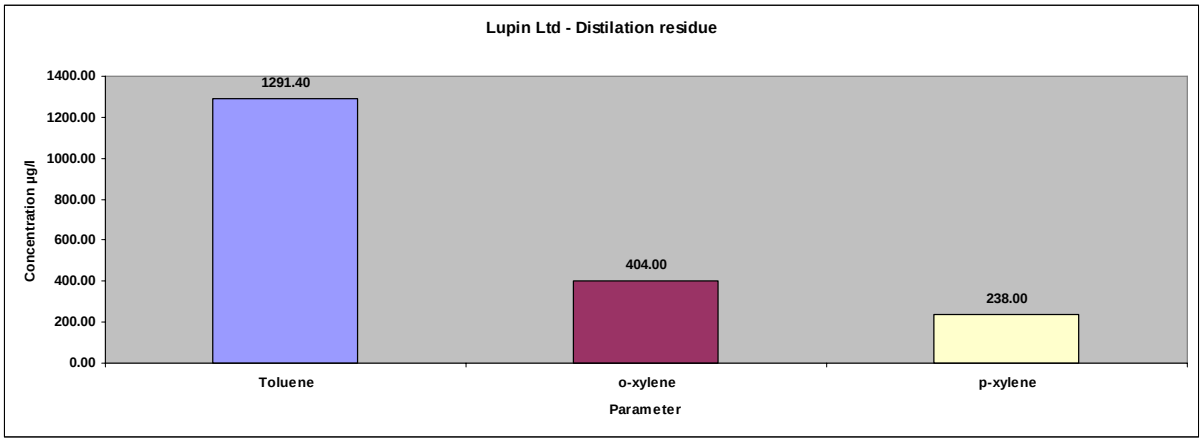
| **Lupin Ltd** | |
|---|---|
| **Location : ETP sample - Equalisation Tank** | |
| **PARAMETERS** | **RESULTS (µg/l)** |
| Chloroform | 25401.0 |
| Trichloroethylene | 39.5 |
| Ethylbenzene | 10.3 |
| Bromochloromethane | 209.5 |
| Bromodichloromethane | 48.1 |
| Dichloromethane | 24020.0 |
| Toluene | 8865.8 |
| o-Xylene | 81.8 |
| m&p –Xylene | 6.1 |
| **Total VOC =** | **58682.1** |



**HAZARDOUS WASTE ANALYSIS:**

The concentration of the VOCs in hazardous waste sample (i.e. available distillation residue of toluene) was found to be 1933.40 μg/l. In this case, the losses with wastewater streams are higher than solvent losses in hazardous waste.

| Sampling site:M/s. Lupin Ltd | | |
|---|---|---|
| Sampling date: 07/01/2009 | | |
| **S.No** | **Parameters** | **Concentration μg/l** |
| 1 | Toluene | 1291.40 |
| 2 | o-xylene | 404.00 |
| 3 | p-xylene | 238.00 |
| **Total VOC =** | | **1933.40** |



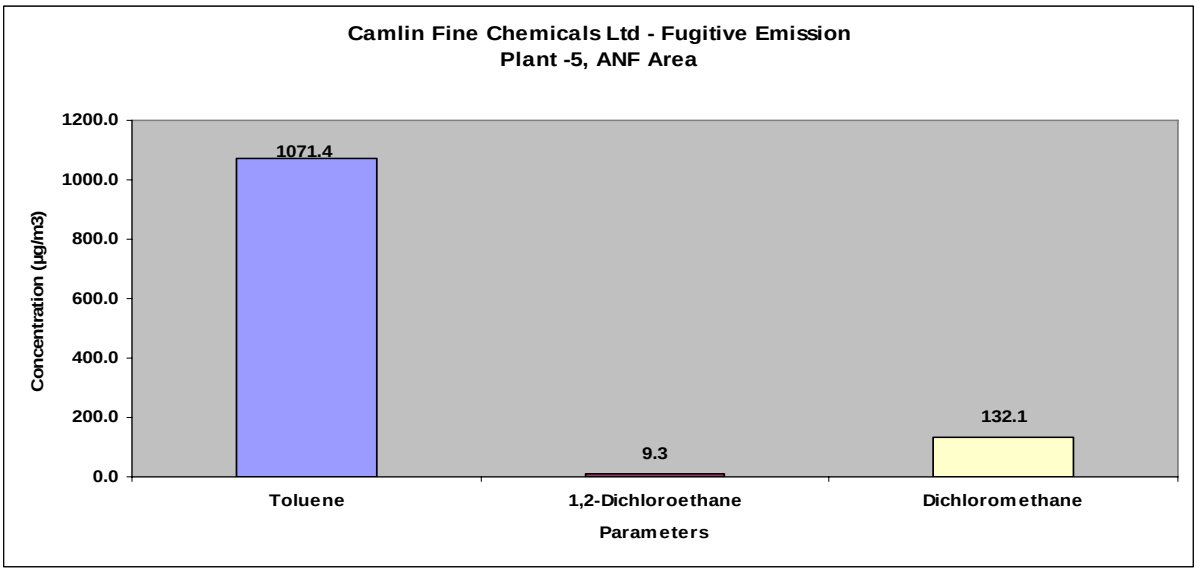

### 11.2.5 M/s Camlin Chemical Ltd:

- Chemical Industry
- Major Products: Food Additives
- Major Solvents: Toluene, Hexane, Acetone
- Date of sampling : 08.01.09

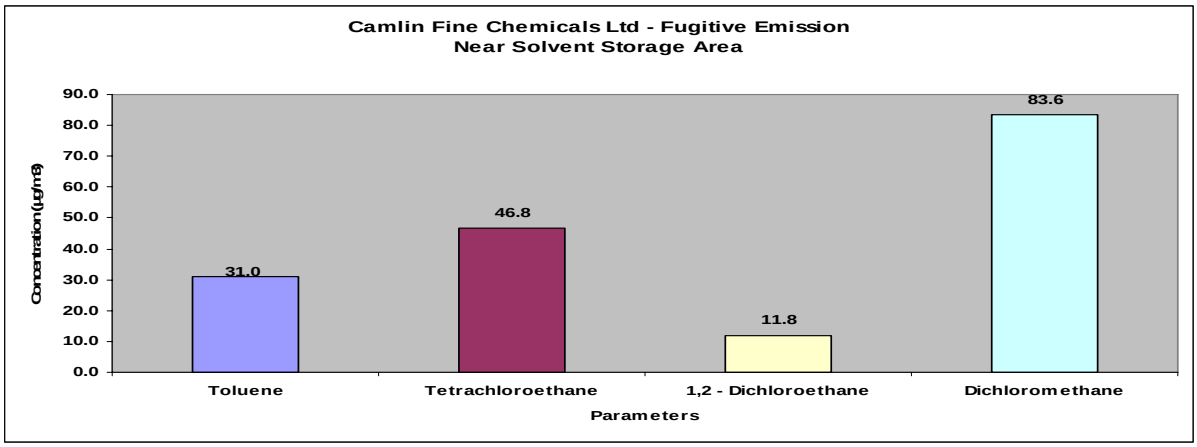
**FUGITIVE EMISSION MONITORING ANALYSIS:**

Samples of fugitive emissions, wastewater and hazardous waste were collected from the unit and analysed fro VOCs. The concentration of VOCs in fugitive emission monitoring sample was found to be in the range of 173.2 to 1212.8 μg/$m^3$. The highest concentration was found at the location near artificial neutch filter area. No VOCs detected in the effluent samples collected from Equalization tank and therefore fugitive emission near ETP also found to be very less.

| Camlin Fine Chemicals Ltd | |
|---|---|
| **Location : Plant - 5, ANF Area** | |
| **PARAMETERS** | **RESULTS (µg/m$^3$)** |
| Toluene | 1071.4 |
| 1,2-Dichloroethane | 9.3 |
| Dichloromethane | 132.1 |
| **Total VOC =** | 1212.8 |




| Camlin Fine Chemicals Ltd | |
|---|---|
| **Location : Near Solvent Storage Area** | |
| **PARAMETERS** | **RESULTS (µg/m$^3$)** |
| Toluene | 31.0 |
| Tetrachloroethane | 46.8 |
| 1,2 – Dichloroethane | 11.8 |
| Dichloromethane | 83.6 |
| **Total VOC =** | 173.2 |



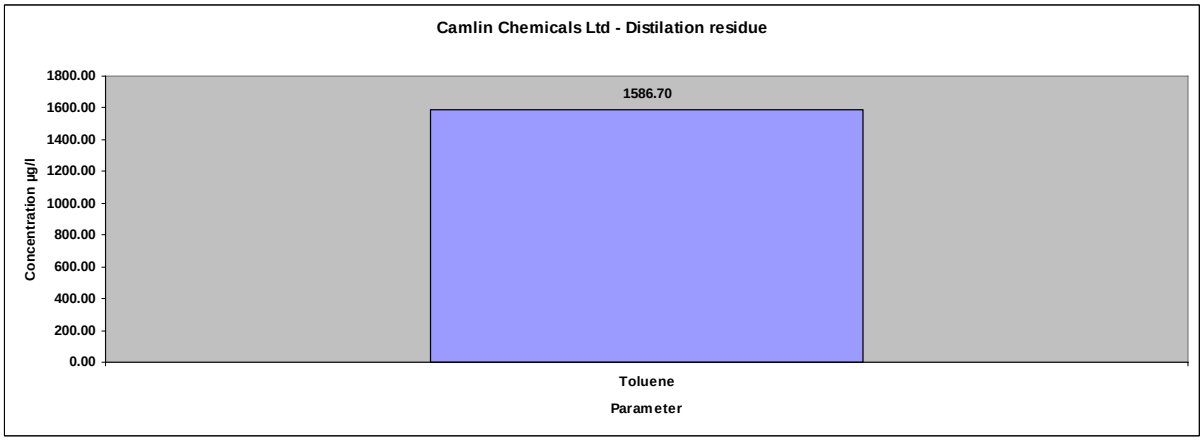

## EFFLUENT SAMPLE ANALYSIS:

Not detected any of VOCs.

## HAZARDOUS WASTE ANALYSIS:

The concentration of the VOCs in hazardous waste sample (i.e. distillation residue) was found to be 1586.7 µg/l.

| Sampling site: Camlin Chemical Ltd | | |
|---|---|---|
| Sampling date: 07/01/2009 | | |
| **S.No** | **Parameters** | **Concentration µg/l** |
| 1 | Toluene | 1586.70 |
| **Total VOC =** | | **1586.70** |

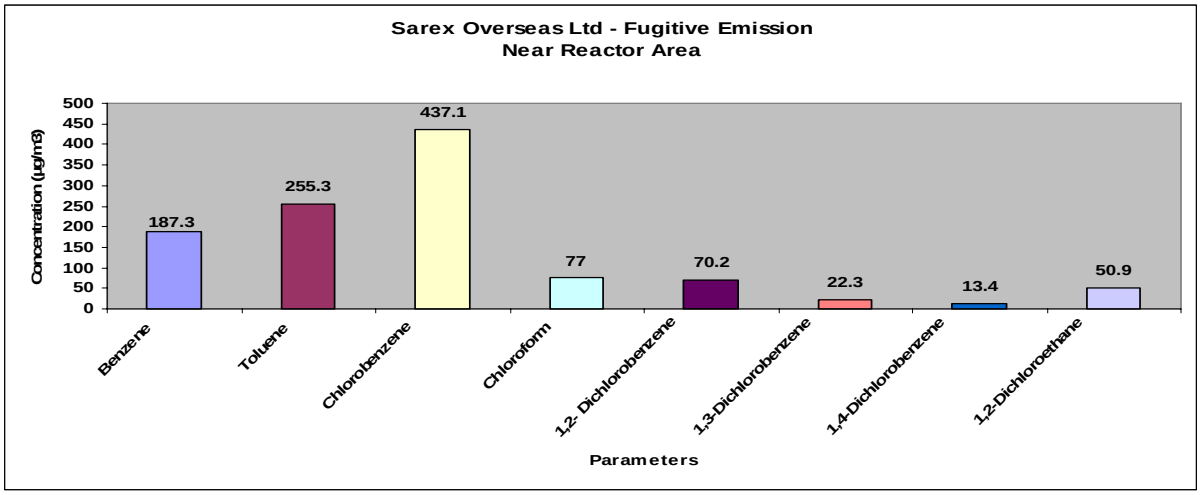


### 11.2.6 M/s. Sarex Overseas Ltd:

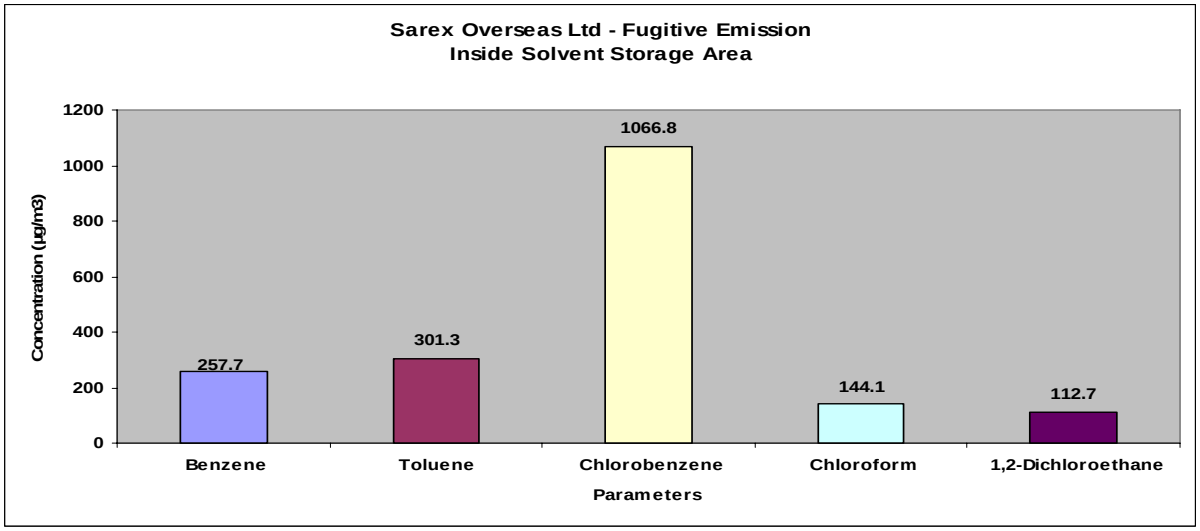
- Bulk Drug Industry
- Major Products:
- Major Solvents: Toluene, Benzene, Monochlorobenzene etc.,
- Date of sampling : 08.01.09

Samples of fugitive emissions, wastewater and hazardous waste were collected from the unit and analyzed for VOCs. The concentration of VOCs in fugitive emission monitoring sample was found to be in the range of 1113.5 to 1882.6 $\mu g/m^3$. The highest concentration was found at the location near Solvent storage area.

| **Sarex Overseas Ltd** | |
|---|---|
| **Location : Near Reactor Area** | |
| **PARAMETERS** | **RESULTS ($\mu g/m^3$)** |
| Benzene | 187.3 |
| Toluene | 255.3 |
| Chlorobenzene | 437.1 |
| Chloroform | 77 |
| 1,2- Dichlorobenzene | 70.2 |
| 1,3-Dichlorobenzene | 22.3 |
| 1,4-Dichlorobenzene | 13.4 |
| 1,2-Dichloroethane | 50.9 |
| **Total VOC =** | **1113.5** |



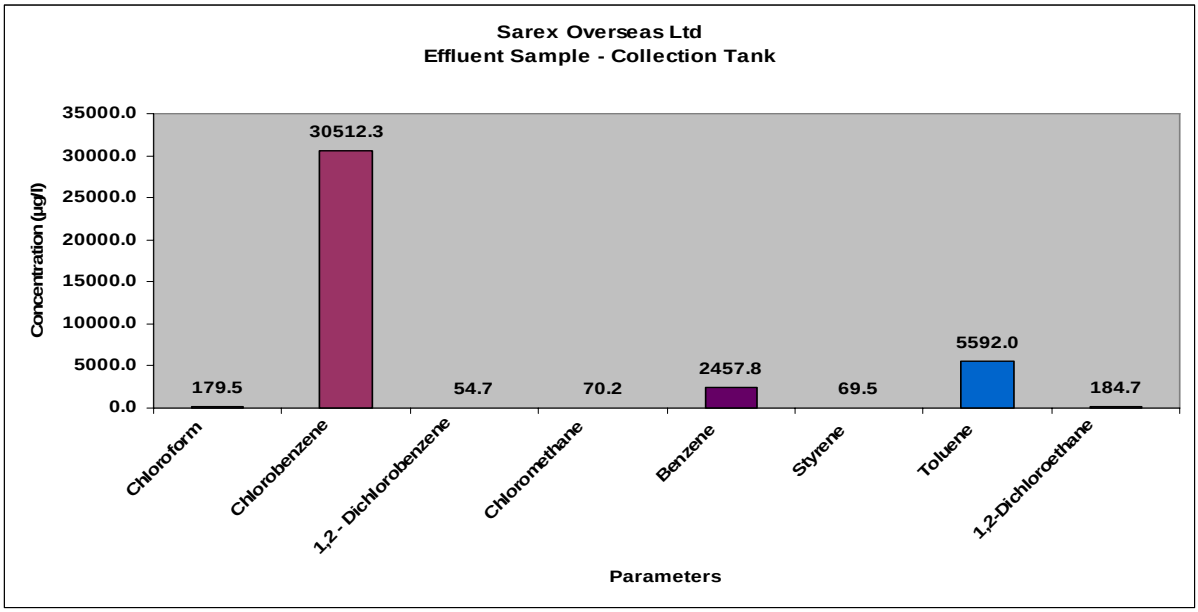
| Sarex Overseas Ltd | |
|---|---|
| **Location : Inside Solvent Storage Area** | |
| **PARAMETERS** | **RESULTS (µg/m$^3$)** |
| Benzene | 257.7 |
| Toluene | 301.3 |
| Chlorobenzene | 1066.8 |
| Chloroform | 144.1 |
| 1,2-Dichloroethane | 112.7 |
| **Total VOC =** | **1882.6** |




## EFFLUENT SAMPLE ANALYSIS:

The concentration of VOCs in effluent sample taken from equalization tank of ETP was found to be 39120.7 µg/l. The higher concentration may be due to improper separation of intermediate/solvents/products at different process stages, which also affects the treatment efficiency of the ETP.

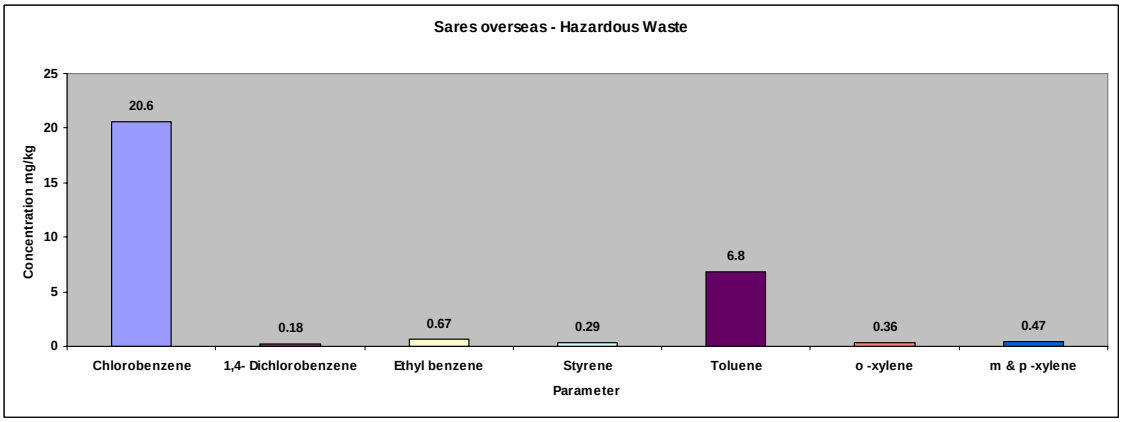
| Sarex Overseas Ltd | |
|---|---|
| **Location : ETP sample - Collection Tank** | |
| **PARAMETERS** | **RESULTS (µg/l)** |
| Chloroform | 179.5 |
| Chlorobenzene | 30512.3 |
| 1,2 – Dichlorobenzene | 54.7 |
| Chloromethane | 70.2 |
| Benzene | 2457.8 |
| Styrene | 69.5 |
| Toluene | 5592.0 |
| 1,2-Dichloroethane | 184.7 |
| **Total VOC =** | **39120.7** |




## HAZARDOUS WASTE SAMPLE

The concentration of the VOCs in hazardous waste sample (i.e. distillation residue) was found to be 29.73 mg/kg.

| Sampling site:M/s.Sares overseas | | |
|---|---|---|
| Sampling date : 08/01/2009 | | |
| S.No | Parameters | Concentration mg/Kg |
| 1 | Chlorobenzene | 20.6 |
| 2 | 1,4- Dichlorobenzene | 0.18 |
| 3 | Ethyl benzene | 0.67 |
| 4 | Styrene | 0.29 |
| 5 | Toluene | 6.8 |
| 6 | o –xylene | 0.36 |
| 7 | m & p –xylene | 0.47 |
| 8 | Chloroethane | 0.36 |
| **Total VOC =** | | **29.73** |



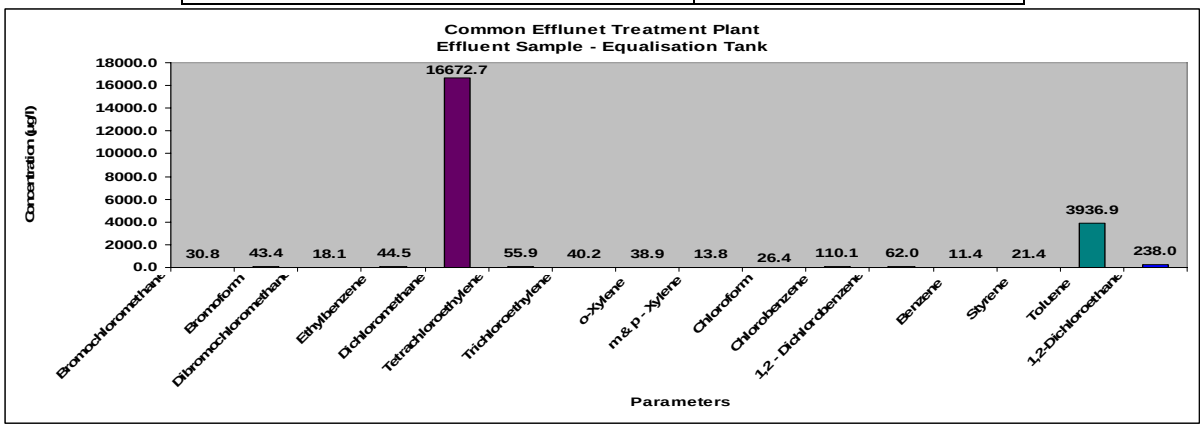
## 11.3 Results of Monitoring at CETPs:

### 11.3.1 Common Effluent Treatment Plant, Tarapur:

*CETP – Equalization Tank Sample*

The concentration of the VOCs in sample collected from CETP's equalization tank was found to be 21364.5µ**!Unexpected End of Formula**g/l. The concentrations of Dichloromethane and Toluene were found to be very high as compared to other VOCs present. Total 16 VOCs detected in the sample.

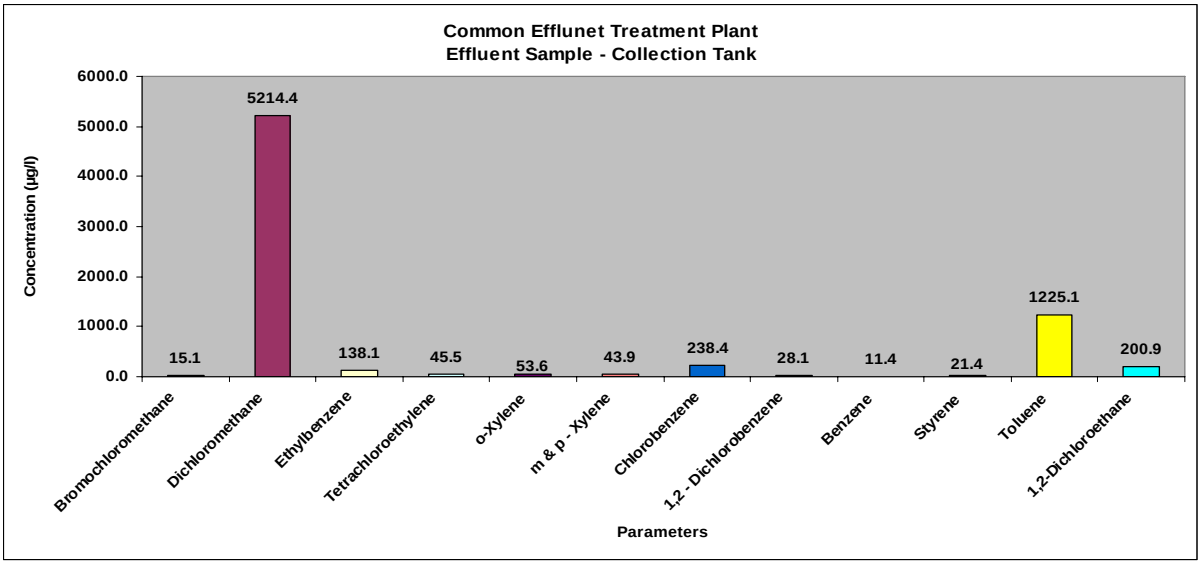
| CETP | |
|---|---|
| **Location : ETP sample - Equalisation Tank** | |
| **PARAMETERS** | **RESULTS (µg/l)** |
| Bromochloromethane | 30.8 |
| Bromoform | 43.4 |
| Dibromochloromethane | 18.1 |
| Ethylbenzene | 44.5 |
| Dichloromethane | 16672.7 |
| Tetrachloroethylene | 55.9 |
| Trichloroethylene | 40.2 |
| o-Xylene | 38.9 |
| m & p – Xylene | 13.8 |
| Chloroform | 26.4 |
| Chlorobenzene | 110.1 |
| 1,2 – Dichlorobenzene | 62.0 |
| Benzene | 11.4 |
| Styrene | 21.4 |
| Toluene | 3936.9 |
| 1,2-Dichloroethane | 238.0 |
| **Total VOC =** | 21364.5 |



## *CETP – Collection Tank*

The concentration of the VOCs in sample collected from CETP's raw effluent collection tank (i.e. effluent receiving sump) was found to be 7235.9 µg/l. The concentration found to be less than present in the effluent in equalization tank as the characteristics of the effluent receiving sumps changes very frequently unlike the equalized effluent. The concentrations of Dichloromethane and Toluene were found to be very high as compared to other VOCs present. Total 12 VOCs detected in the sample.

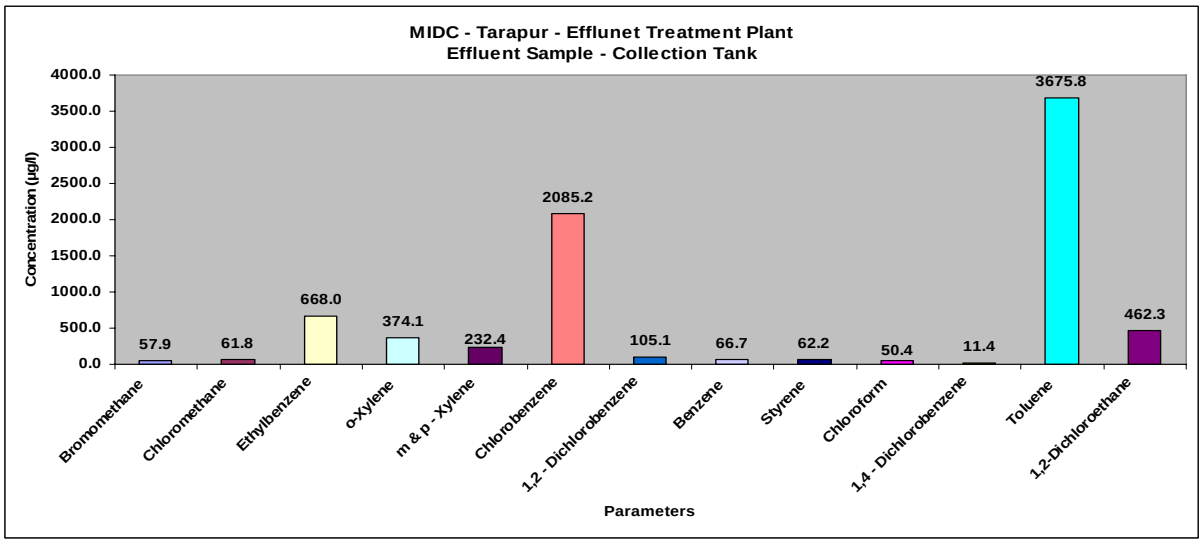
| CETP | |
|---|---|
| **Location : ETP sample - Collection Tank** | |
| **PARAMETERS** | **RESULTS (µg/l)** |
| Bromochloromethane | 15.1 |
| Dichloromethane | 5214.4 |
| Ethylbenzene | 138.1 |
| Tetrachloroethylene | 45.5 |
| o-Xylene | 53.6 |
| m & p – Xylene | 43.9 |
| Chlorobenzene | 238.4 |
| 1,2 – Dichlorobenzene | 28.1 |
| Benzene | 11.4 |
| Styrene | 21.4 |
| Toluene | 1225.1 |
| 1,2-Dichloroethane | 200.9 |
| **Total VOC =** | 7235.9 |



*MIDC Effluent Sump No. 03*

This effluent collection sump of the industrial estate mainly receives the effluent from chemical industries. The characteristic of the effluent from this sump is of more importance as this effluent is directly going in to Sea without treatment in CETP. The concentration of the VOCs in sample collected from Sump No. 03 was found to be 7913.3 μg/l. The concentration found to be more than present in the effluent samples collected from CETP and other MIDC sump. The concentrations of Chlrobenzene and Toluene were found to be very high as compared to other VOCs present. Total 13 VOCs detected in the sample.

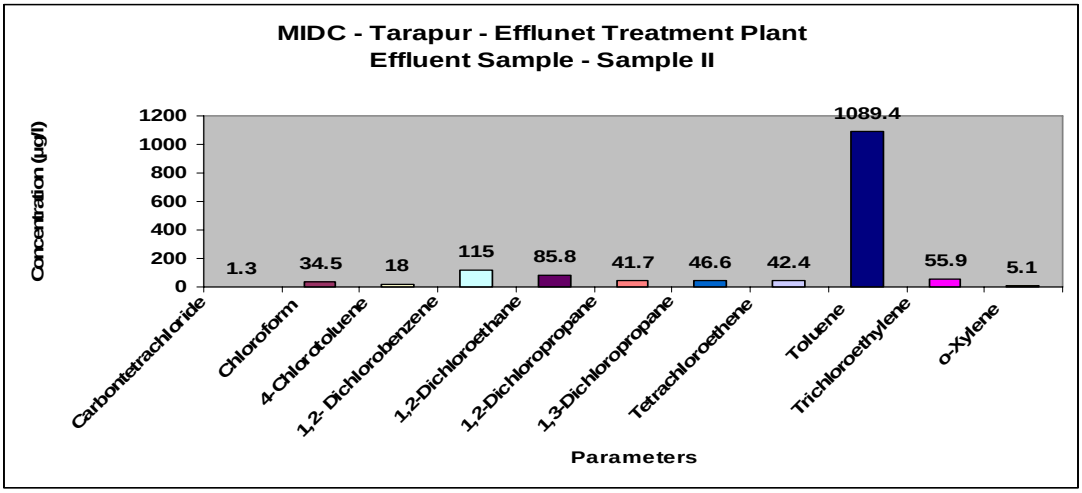
| **MIDC – Tarapur** | |
|---|---|
| **Location : MIDC Effluent Sump No.3** | |
| **PARAMETERS** | **RESULTS (μg/l)** |
| Bromomethane | 57.9 |
| Chloromethane | 61.8 |
| Ethylbenzene | 668.0 |
| o-Xylene | 374.1 |
| m & p – Xylene | 232.4 |
| Chlorobenzene | 2085.2 |
| 1,2 – Dichlorobenzene | 105.1 |
| Benzene | 66.7 |
| Styrene | 62.2 |
| Chloroform | 50.4 |
| 1,4 – Dichlorobenzene | 11.4 |
| Toluene | 3675.8 |
| 1,2-Dichloroethane | 462.3 |
| **Total VOC =** | 7913.3 |




## *MIDC Effluent Sump No. 01*

The concentration of the VOCs in sample collected from Sump No. 01 was found to be 1535.7 µg/l. The concentration found to be less than present in the effluent samples collected from CETP and other MIDC sump. The concentration of Toluene was found to be very high as compared to other VOCs present. Total 11 VOCs detected in the sample.

| **MIDC – Tarapur** | |
|---|---|
| **Location : MIDC Effluent Sump No.1** | |
| **PARAMETERS** | **Concentration µg/l** |
| Carbontetrachloride | 1.3 |
| Chloroform | 34.5 |
| 4-Chlorotoluene | 18 |
| 1,2- Dichlorobenzene | 115 |
| 1,2-Dichloroethane | 85.8 |
| 1,2-Dichloropropane | 41.7 |
| 1,3-Dichloropropane | 46.6 |
| Tetrachloroethene | 42.4 |
| Toluene | 1089.4 |
| Trichloroethylene | 55.9 |
| o-Xylene | 5.1 |
| **Total VOC =** | **1535.7** |




## 12.0 Observation and Findings

- The order of the pollutant in Ambient Air is Benzene, Chlorobenzenes, Chlorinated Alkanes, Xylene and Toluene etc.
- Presence of Benzene, Chlorobenzenes, Chlorinated Alkanes, Toluene and Xylene was observed at almost all the monitored locations.
- Concentration of Chlorobenzene and Toluene observed to be more in almost all the locations among the VOCs detected whereas at some round of monitoring and few locations Naphthalene and Chloroform were also found with more concentration.
- The probable places of loss of VOCs are Centrifuging, filtration, glands, charging material into the reactors, solvent storage area, distillation and ETP area.
- Total 28 VOCs including 24 highly toxic and suspected carcinogenic compounds are found during monitoring at Tarapur. The VOCs found are Benzene, Bromobenzene, Bromoform, Chlorobenzene, Chloroform, 1,1,1 Trichloroethane, 1,2 Dichloropropane, Dichloromethane, 1,2-dichloroethane, 4,Chlorotoluene, 1,2Dibromoethane, Bromodichloroethane, 2-chlorotoluene, 4-Chlorotoluene, Dibromochloroethane, Carbontetrachloride, 1,2-Dichlorobenzene, 1,3Dichlorobenzene, 1,4-Dichlorobenzene, 1,2-Dichloroethane, Ethylbenzene, Napthalene, Toluene, 1,2,3-Trichlorobenzene, 1,2,4-Trichlorobenzene, 1,2,4-Trimethylbenzene, o-Xylene, m&p –Xylene.

- The total VOCs concentration was measured at all locations, in the range of 12.32 ug/$m^3$ – minimum at Station-1 (Dahanu-Palghar Sports Club in east direction and also up-wind location) to 327.34 ug/$m^3$ – maximum at Station - 5 (Tata Steel, A-6 in Centre of the Industrial Estate).
- ATD method found to have reported many compounds which are relevant to the industries used solvents and some have no relevance to solvents used in industries, because of may be the impurities in their used solvents.
- Average concentration of predominant and total VOCs found in first and second day of the ambient air quality monitoring at Tarapur is given in following Table:

| VOCs | Sampling Location | | | | |
|---|---|---|---|---|---|
| | Station-1 Sports Club | Station-2 Kumbhawali Naka | Station-3 Galax Surfactatnts | Station-4 Mandhana Dyeing | Station-5 Tata Steel A-6 |
| | Average µg/$m^3$ | Average µg/$m^3$ | Average µg/$m^3$ | Average µg/$m^3$ | Average µg/$m^3$ |
| Benzene on Day-1 | 3.3 | 7.9 | 12.4 | 21.4 | 13.7 |
| Benzene on Day-2 | 20.3 | 4.6 | 12.1 | 31.9 | 11.2 |
| Chlorobenzene Day-1 | BDL | 13.3 | 13.3 | 40.9 | 11.7 |
| Chlorobenzene Day-2 | 5.54 | 31.5 | 29.5 | 42.4 | 70.6 |
| Naphthalene Day-1 | BDL | 14.4 | BDL | 20.14 | 16.2 |
| Naphthalene Day-2 | 1.6 | BDL | 16.5 | BDL | BDL |
| Toluene Day-1 | 4.7 | 63.9 | 64.4 | 37.0 | 78.8 |
| Toluene Day-2 | 61.2 | 93.9 | 115.9 | 63.6 | 68.6 |
| o-Xylene Day-1 | 1.6 | 4.1 | 6.8 | 5.54 | 20.3 |
| o-Xylene Day-2 | 8.4 | 11.53 | 7.9 | 9.1 | 10.8 |

- The Benzene concentration in AAQ at station – 1 on 2nd day and at station -4 on both the days of monitoring was found exceeding the draft national standard of 15µg/$m^3$.
- The samples collected from industries for VOC analysis with which except effluent sample of M/s.Camlin Fine Chemicals, all are detected some VOCs. Mostly the concentration of VOCs found to be more in wastewater samples against the samples collected for fugitive emission and hazardous waste. The

reasons for comparatively less concentration of fugitive & Hazardous waste could be fast dispersion/dilution of fugitive emissions and loss of VOCs due to evaporation in stored hazardous waste.

- The presence of solvents (VOCs) in the wastewater samples may be due to improper separation of intermediates/products/solvents at different unit process operations, which result in to high organic load in wastewater and difficulty in treatment.
- Generation of Hazardous waste can be minimized by better operating methods and systems as well as solvent recovery with effective condensation with which the concentration of VOC dispersing to atmosphere can be reduced.
- Normally the wastewater generated by the industries contains high VOCs and the industries are doing only primary treatment. During these processes some percentage of VOCs are dispersed into the atmosphere. After primary treatment the industries are pumping their effluent to CETP for further treatments. In CETP during aeration process, most of the VOCs are vaporized and dispersed into the atmosphere. These VOCs are directly impacting the Ambient VOCs concentration.
- Few Industries are following Zero effluents discharge.
- Chlorinated compounds escape at the higher rate in to the atmosphere which may increase the ground level ozone concentration.
- Companies change the products with respect to demand in the market accordingly the solvent type and quantity will also vary. Due to these variations the concentrations of VOC in AAQ, Fugitive, wastewater and solid waste may vary.
- Presence of VOCs in wastewater affects the ambient air quality, efficiency of the effluent treatment system and the quality of the final receiving body. VOCs (Solvents) are emitted in to the environment during various treatment unit operations particularly during aeration in equalization tanks and aeration tanks.
- In case of CETP at Tarapur, the concentrations of Dichloromethane and Toluene were found to be very high as compared to other VOCs present in the influent. Higher concentration of Chlorobenzene and Toluene found in

the effluent sample collected from Sump No.03 of MIDC, which receives effluent from N-zone having chemical industries in predominance. It is observed that substantial amount of VOCs are finding their way in to Sea with effluent discharge from Tarapur industrial estate.

## 13.0 RECOMMENDATIONS

The aspect of VOCs emissions, control and presence in ambient is still primary stage in the country. There is a need for development of common protocol of sampling and analysis based on Indian conditions. So that uniform database can be generated for further course of action on development of standard & technology as well.

There is a need for repeated VOCs monitoring preferably season-wise to know more about occurrence of VOCs, quantification and data generation.

More laboratories should be encouraged to come up with advanced facilities for sampling and analysis of VOCs which, may help in increasing the capabilities and thereby cost of monitoring will reduce.

Buffer zone with green belt around the industrial estates should be ensured to minimize the impact on the surroundings.

The workers in the industrial units should be made aware about effects of VOCs of environment and human health. They should also be properly trained to handle the solvents so as to minimize the escape of VOCs in to atmosphere.

Strategic road-map is required to be prepared for development of standards/guidelines, LDAR programmes for various industrial sectors and creation of awareness on VOCs.

The industries can look more closely in to following aspects for control of VOCs:

- Closed handling system for chemicals;

- Improved solvent recovery by the use of some special condensers and sub cooling system.
- Mechanical seal for chemical handling pumps;
- LDAR system;
- Venting of storages with trap receiver & condenser; and
- Training to the labors and staff.
- Proper system of loading and unloading of solvents
- Proper solvent recovery systems
- Work environment monitoring with respect to VOC has to conduct and compare with Factories act's occupational health standards.

All the emissions emitting sources are to be chanalized through ducts to a common conduit, after advanced condensers and/ or scrubbing with relevant or proper scrubbing, the treated emissions to be let into the air.

## 14.0 CONCLUSIONS

Following conclusions are drawn from the field observations, monitoring results and above discussions:

- There is escape of VOCs from industries through fugitive emissions, effluent discharge and hazardous waste generation but units normally pay least attention to identify & quantify such losses & discharge of VOCs. Limited available analysis facility, absence of emission/discharge standards, no mandatory LDAR programme and cost involved in assessment & control are the major factors on part of the emissions of VOCs from industrial units.

- The Solvents used by the industries are matching with detected in samples. The probable reasons for escape of solvent in to atmosphere are:
  - Inadequate storage facilities for material. (e.g. leakages from store.
  - Use of small carboys for temporary storages of solvents and residues.
  - Inadequate closure of reactor vessels.
  - Crude temperature control methods for process.

- Evaporation from filtration, centrifuge, layer separation due to improper equipment specifications.
- Improper maintenance of pumps, flanges, valves, compressors, condensers, coolers.
- Limited efficiency of reflux condensers.
- Lack of awareness among labors/workers is also responsible on part of escape of VOCs in atmosphere due to human error or negligence.
- Fume extraction systems of all the possible emission sources and that can be treated.

For developing the standard protocol, standards and guidelines for control of VOCs in ambient environment, it is required to generate data-base for substantial time-span in different industrial regions by similar type of studies.

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# Annexure-1

## List of 60 Volatile Organic Compounds (VOC s)

| S.NO | VOC | S.NO | VOC |
|---|---|---|---|
| 1 | Benzene | 31 | Trans-1,3-Dichloropropene |
| 2 | Bromobenzene | 32 | Ethyl Benzene |
| 3 | Bromochloromethane | 33 | Hexachloro-1,3-butadiene |
| 4 | Bromodichloromethane | 34 | Isopropylbenzene |
| 5 | Chloroform | 35 | Para-Isopropyltoluene |
| 6 | Bromoform | 36 | Methylenechloride |
| 7 | n-Butylbenzene | 37 | Naphthalene |
| 8 | Sec-Butylbenzene | 38 | 2-Propylbenzene |
| 9 | Ter-Butylbenzene | 39 | Styrene |
| 10 | Carbon Tetra chloride | 40 | 1,1,1,2-Tetrachloroethane |
| 11 | Chlorobenzene | 41 | 1,1,2,2-Tetrachloroethane |
| 12 | 2-Chlorotoluene | 42 | Tetrachloroethene |
| 13 | 4-Chlorotoluene | 43 | Toluene |
| 14 | Dibromochloromethane | 44 | 1,2,3-Trichlorobenzene |
| 15 | 1,2-Dibromo-3-chloropropane | 45 | 1,2,4-Trichlorobenzene |
| 16 | 1,2-Dibromoethane | 46 | 1,1,1-Trichloroethane |
| 17 | Dibromomethane | 47 | 1,1,2-Trichloroethane |
| 18 | 1,2-Dichlorobenzene | 48 | Trichloroethylene |
| 19 | 1,3-Dichlorobenzene | 49 | 1,2,3-Trichloropropane |
| 20 | 1,4-Dichlorobenzene | 50 | 1,2,4-Trimethylbenzene |
| 21 | 1,1-Dichloroethane | 51 | 1,3,5-Trimethylbenzene |
| 22 | 1,2-Dichloroethane | 52 | Xylene |
| 23 | 1,1-Dichloroethene | 53 | Meta-Xylene |
| 24 | Cis-1,2-Dichloroethene | 54 | Para-Xylene |
| 25 | Trians-1,2-Dichloroethene | 55 | Chloroethane |
| 26 | 1,2-Dichloropropane | 56 | Chloromethane |
| 27 | 1,3-Dichloropropane | 57 | Trichlorofluoromethane |
| 28 | 2,2-Dichloropropane | 58 | Bromomethane |
| 29 | 1,1-Dichloropropene | 59 | Vinyl Chloride |
| 30 | Cis-1,3-Dichloropropene | 60 | Dichlorofluoromethane |

# Annexure-II

| S.No. | Name of VOC | Mol.Wt. | Solubility water. at 20 (ml /100 ml) | Boiling Point C |
|---|---|---|---|---|
| | | | | |
| 1 | **Dichlorofluoromethane**<br>**Name: Fluorodichloromethane**<br>**Formula: CHCl2F**<br>**MW: 102** | 102 | | |
| 2 | **Chloromethane**<br>**Name: Methane, chloro-**<br>**Formula: CH3Cl**<br>**MW: 50** | 50 | 303<br>(Slightly soluble) | -23.7 |
| 3 | **Vinyl chloride**<br>**Name: Ethene, chloro-**<br>**Formula: C2H3Cl**<br>**MW: 62** | 62 | Slightly soluble | -13.37 |
| 4 | **Bromomethane**<br>**Name: Methane, bromo-**<br>**Formula: CH3Br**<br>**MW: 94** | 94 | 1.75 g / 100 g water | 3.56 |
| 5 | **Ethylchloride**<br>**Name: Ethyl Chloride**<br>**Formula: C2H5Cl**<br>**MW: 64** | 64 | 0.574 g / 100 ml | 12.3 |
| 6 | **Name: Trichloromonofluoromethane**<br>**Formula: CCl3F**<br>**MW: 136** | 136 | insol. In water | 23.7 |
| 7 | **Name: Ethene, 1,1-dichloro-**<br>**Formula: C2H2Cl2**<br>**MW: 96** | 96 | Practically insoluble in water. | 31.7 |
| 8 | **Name: Methylene Chloride**<br>**Formula: CH2Cl2**<br>**MW: 84** | 84 | ~ 50 parts water. | 39.75 |
| 9 | **Trans 1,2 Dichloroethene**<br>**Name: Ethene, 1,2-dichloro-, (E)-**<br>**Formula: C2H2Cl2**<br>**MW: 96** | 96 | Insol. In water. | 59.6 |
| 10 | **1,1 Dichloroethane**<br>**Name: Ethane, 1,1-dichloro-**<br>**Formula: C2H4Cl2**<br>**MW: 98** | 98 | Soluble in about 200 parts water. | 57.3 |
| 11 | **Cis 1,2 – Dichloroethene**<br>**Name: Ethene, 1,2-dichloro-, (Z)-**<br>**Formula: C2H2Cl2**<br>**MW: 96** | 96 | insol.in water. | 59.6 |
| 12 | **Bromochloromethane**<br>**Name: Methane, bromochloro-** | 128 | | |

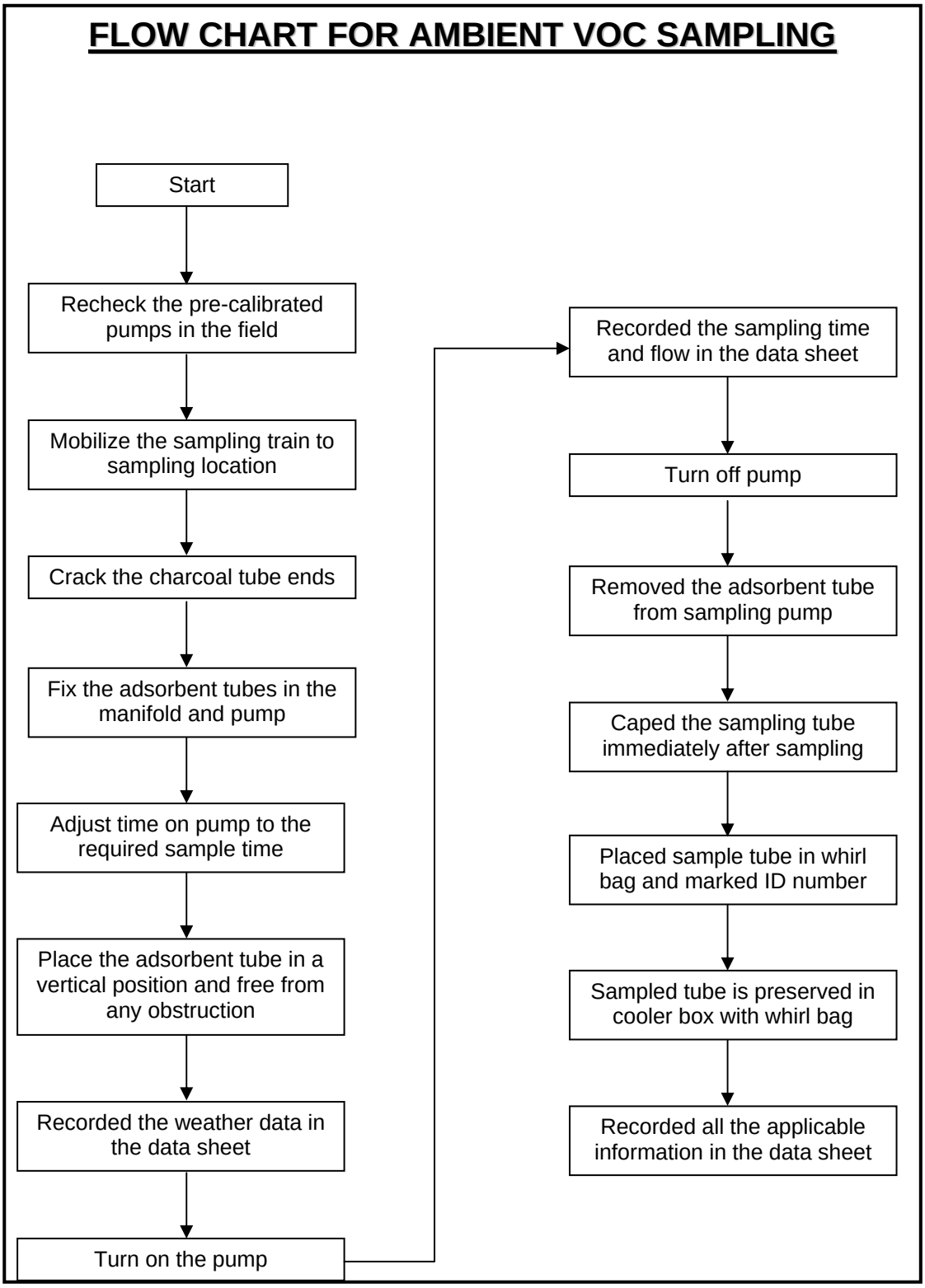
| | | | | |
|---|---|---|---|---|
| | **Formula: CH2BrCl**<br>**MW: 128** | | | |
| **13** | **Chloroform**<br>**Name: Trichloromethane**<br>**Formula: CHCl3**<br>**MW: 118** | 118 | 1 ml / 200 ml water | 61-62 |
| **14** | **Name: Propane, 2,2-dichloro-**<br>**Formula: C3H6Cl2**<br>**MW: 112** | 112 | Slightly sol. In water | 95-96 |
| **15** | **Name: Ethane, 1,2-dichloro-**<br>**Formula: C2H4Cl2**<br>**MW: 98** | 98 | sol. In 120 parts water | 83-84 |
| **16** | **Name: Ethane, 1,1,1-trichloro-**<br>**Formula: C2H3Cl3**<br>**MW: 132** | 132 | insol. In water | 74.1 |
| **17** | **Name: 1-Propene, 1,1-dichloro-**<br>**Formula: C3H4Cl2**<br>**MW: 110** | 110 | -- | 108 |
| **18** | **Carbon Tetrachloride**<br>**Name: Carbon Tetrachloride**<br>**Formula: CCl4**<br>**MW: 152** | 152 | 1 ml / 2000 ml water | 76.7 |
| **19** | **Name: Benzene**<br>**Formula: C6H6**<br>**MW: 78** | 78 | 0.188% | 80.1 |
| **20** | **Name: Methane, dibromo-**<br>**Formula: CH2Br2**<br>**MW: 172** | 172 | 11.93 g / 1000g water | 97 |
| **21** | **1,2 dichloropropane**<br>**Name: Propane, 1,2-dichloro-**<br>**Formula: C3H6Cl2**<br>**MW: 112** | 112 | Slightly soluble in water. | 95 – 96 |
| **22** | **Trichloroethylene**<br>**Name: Trichloroethylene**<br>**Formula: C2HCl3**<br>**MW: 130** | 130 | 0.11 g / 100 g. | 86.9 |
| **23** | **Bromodichloromethane**<br>**Name: Methane, bromodichloro-**<br>**Formula: CHBrCl2**<br>**MW: 162** | 162 | -- | 91-92 |
| **24** | **1,3 dichloropropene**<br>**Name: 1-Propene, 1,3-dichloro-**<br>**Formula: C3H4Cl2**<br>**MW: 110** | 110 | -- | 108 |
| **25** | **Trans 1,3 dichloropropene**<br>**Name: 1-Propene, 1,3-dichloro-, (E)-**<br>**Formula: C3H4Cl2**<br>**MW: 110** | 110 | -- | 112 |

| | | | | |
|---|---|---|---|---|
| **26** | **1,1,2-Trichloroethane**<br>**Name: Ethane, 1,1,2-trichloro-**<br>**Formula: C2H3Cl3**<br>**MW: 132** | 132 | in soluble in water | 113-114 |
| **27** | **Name: Toluene**<br>**Formula: C7H8**<br>**MW: 92** | 92 | 0.067%<br>very slightly sol. in water. | 110.6 |
| **28** | **Name: Propane, 1,3-dichloro-**<br>**Formula: C3H6Cl2**<br>**MW: 112** | 112 | | |
| **29** | **Dibromochloromethane**<br>**Name: Methane, dibromochloro-**<br>**Formula: CHBr2Cl**<br>**MW: 206** | 206 | -- | 121.3-121.8 |
| **30** | **1,2 Dibromomethane**<br>**Name: Ethane, 1,2-dibromo-**<br>**Formula: C2H4Br2**<br>**MW: 186** | 186 | 11.93 g / 1000 g water | 97 |
| **31** | **Tetrachloroethylene**<br>**Name: Tetrachloroethylene**<br>**Formula: C2Cl4**<br>**MW: 164** | 164 | 10000 vol<br>water | 121 |
| **32** | **1,1,1,2-Tetrachloroethane**<br>**Name: Ethane, 1,1,1,2-tetrachloro-**<br>**Formula: C2H2Cl4**<br>**MW: 166** | 166 | 1 g in 350 ml water<br>(sparingly sol. In water) | 146.5 |
| **33** | **Chlorobenzene**<br>**Name: Benzene, chloro-**<br>**Formula: C6H5Cl**<br>**MW: 112** | 112 | Insol. In water. | 131-132 |
| **34** | **Ethyl Benzene**<br>**Name: Ethylbenzene**<br>**Formula: C8H10**<br>**MW: 106** | 106 | Practically insoluble in water. | 136.25 |
| **35** | **Bromoform**<br>**Name: Methane, tribromo-**<br>**Formula: CHBr3**<br>**MW: 250** | 250 | sol. In about 800 parts water. | 149-150 |
| **36** | **p-Xylene**<br>**Name: p-Xylene**<br>**Formula: C8H10**<br>**MW: 106** | 106 | insol. In water. | 137-138 |
| **37** | **M-Xylene**<br>**Name: Benzene, 1,3-dimethyl-**<br>**Formula: C8H10**<br>**MW: 106** | 106 | insol. In water. | 139.3 |
| **38** | **Styrene**<br>**Name: Styrene** | 104 | | |

| | | | | |
|---|---|---|---|---|
| | **Formula: C8H8**<br>**MW: 104** | | | |
| **39** | **Name: Ethane, 1,1,2,2-tetrachloro-**<br>**Formula: C2H2Cl4**<br>**MW: 166** | 166 | 1 g / 350 ml water.<br>(sparingly soluble) | 146.5 |
| **40** | **O – Xylene**<br>**Name: o-Xylene**<br>**Formula: C8H10**<br>**MW: 106** | 106 | insol. In water. | 144 |
| **41** | **1,2,3-Trichloropropane**<br>**Name: Propane, 1,2,3-trichloro-**<br>**Formula: C3H5Cl3**<br>**MW: 146** | 146 | | |
| **42** | **Isopropylbenzene**<br>**Name: Benzene, (1-methylethyl)-**<br>**Formula: C9H12**<br>**MW: 120** | 120 | Insol. In water. | 152-153 |
| **43** | **Bromobenzene**<br>**Name: Benzene, bromo-**<br>**Formula: C6H5Br**<br>**MW: 156** | 156 | 0.045 g / 100 g water<br>Practically insoluble<br>in water. | 156.2 |
| **44** | **n-Propylbenzene**<br>**Name: Benzene, propyl-**<br>**Formula: C9H12**<br>**MW: 120** | 120 | 0.06 g / L water<br>Very slightly sol.<br>in water. | 159.2 |
| **45** | **2-chlorotoluene**<br>**Name: Benzene, 1-chloro-2-methyl-**<br>**Formula: C7H7Cl**<br>**MW: 126** | 126 | Slighly sol. In water | 158.97 |
| **46** | **4-chlorotoluene**<br>**Name: Benzene, 1-chloro-4-methyl-**<br>**Formula: C7H7Cl**<br>**MW: 126** | 126 | Slightly sol.In water | 161.75 |
| **47** | **1,3,5-Trimethylbenzene**<br>**Name: Benzene, 1,3,5-trimethyl-**<br>**Formula: C9H12**<br>**MW: 120** | 120 | 0.002 g / 100g water<br>Practically<br>insoluble in water. | 164.7 |
| **48** | **Tert-butyl benzene**<br>**Name: Benzene, tert-butyl-**<br>**Formula: C10H14**<br>**MW: 134** | 134 | insoluble in water. | 168.5 |
| **49** | **1,2,4 – Trimethylbenzene**<br>**Name: Benzene, 1,2,4-trimethyl-**<br>**Formula: C9H12**<br>**MW: 120** | 120 | Practically<br>insoluble in water. | 169-171 |
| **50** | **Sec-Butylbenzene**<br>**Name: Benzene, (1-methylpropyl)-**<br>**Formula: C10H14** | 134 | Insolu. In water. | 173.5 |

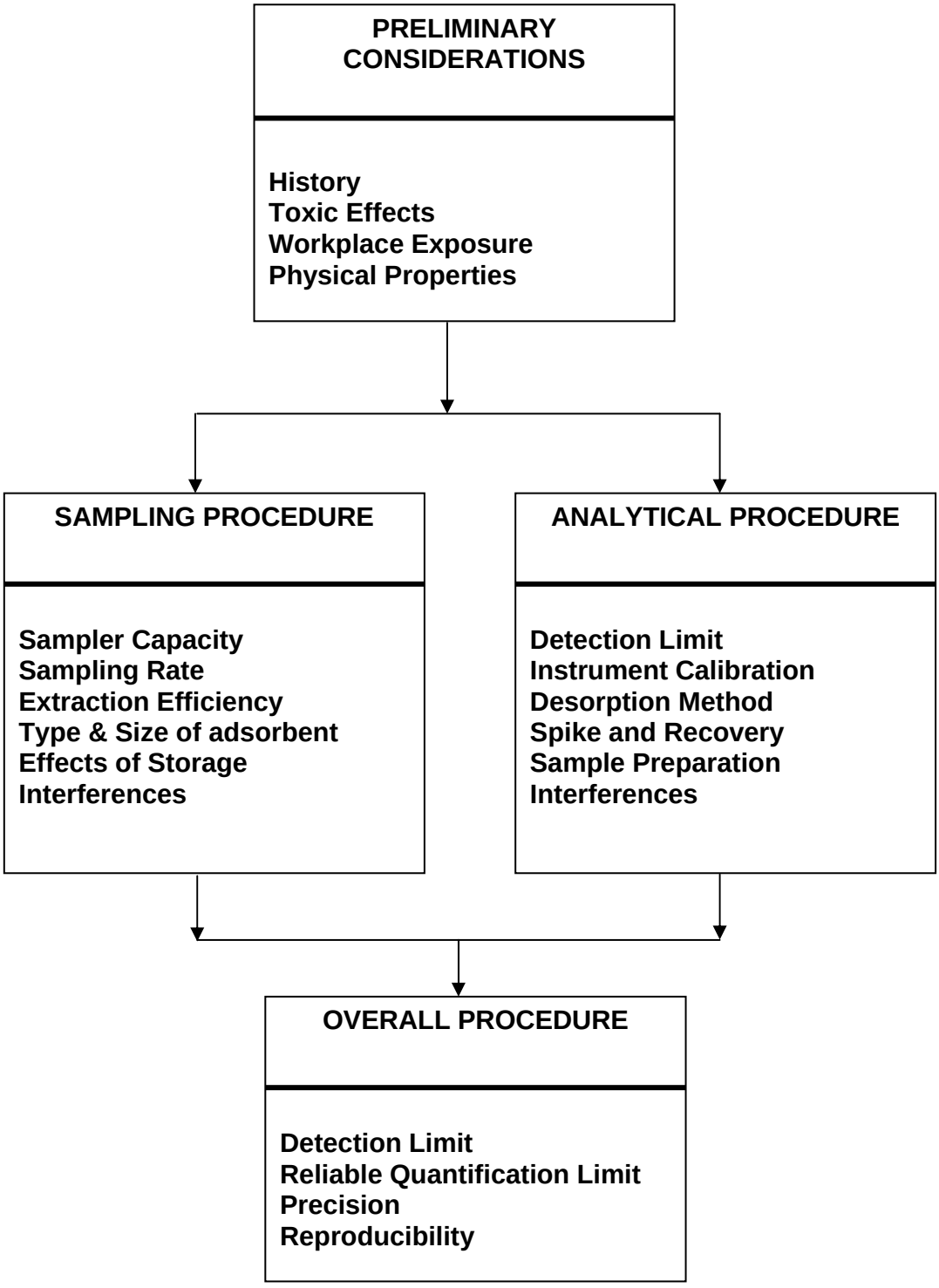
| | | | | |
|---|---|---|---|---|
| | **MW: 134** | | | |
| **51** | **1,3-Dichlorobenzene**<br>**Name: Benzene, 1,3-dichloro-**<br>**Formula: C6H4Cl2**<br>**MW: 146** | 146 | Practically insoluble in water. | 173 |
| **52** | **1,4-Dichlorobenzene**<br>**Name: Benzene, 1,4-dichloro-**<br>**Formula: C6H4Cl2**<br>**MW: 146** | 146 | Practically insoluble in water. | 174.12 |
| **53** | **4-Isopropyltoluene**<br>**Name: Benzene, 1-methyl-4-(1-methylethyl)-**<br>**Formula: C10H14**<br>**MW: 134** | 134 | Practically insoluble in water. | 175.14 |
| **54** | **1,2-Dichlorobenzene**<br>**Name: Benzene, 1,2-dichloro-**<br>**Formula: C6H4Cl2**<br>**MW: 146** | 146 | Practically insoluble in water. | 180.5 |
| **55** | **Name: Benzene, butyl-**<br>**Formula: C10H14**<br>**MW: 134** | 134 | Insol. In water. | 183.1 |
| **56** | **1,2-dibromo 3, chloropropane**<br>**Name: Propane, 1,2-dibromo-3-chloro-**<br>**Formula: C3H5Br2Cl**<br>**MW: 234** | 234 | slightly sol. In water. | 196 |
| **57** | **1,2,4-trichlorobenzene**<br>**Name: Benzene, 1,2,4-trichloro-**<br>**Formula: C6H3Cl3**<br>**MW: 180** | 180 | insol. In water. | 213 |
| **58** | **Naphthalene**<br>**Name: Naphthalene**<br>**Formula: C10H8**<br>**MW: 128** | 128 | Insol. In water | 217.9 |
| **59** | **Hexachlorobutadiene**<br>**Name: 1,3-Butadiene, 1,1,2,3,4,4-hexachloro-**<br>**Formula: C4Cl6**<br>**MW: 258** | 258 | | |
| **60** | **1,2,3-trichlorobenzene**<br>**Name: Benzene, 1,2,3-trichloro-**<br>**Formula: C6H3Cl3; MW: 180** | 180 | Insol. In water. | 221 |

## Annexure – III A



## Annexure – III B

## EVALUATION SCHEME FOR VOC MONITORING AND ANALYSIS

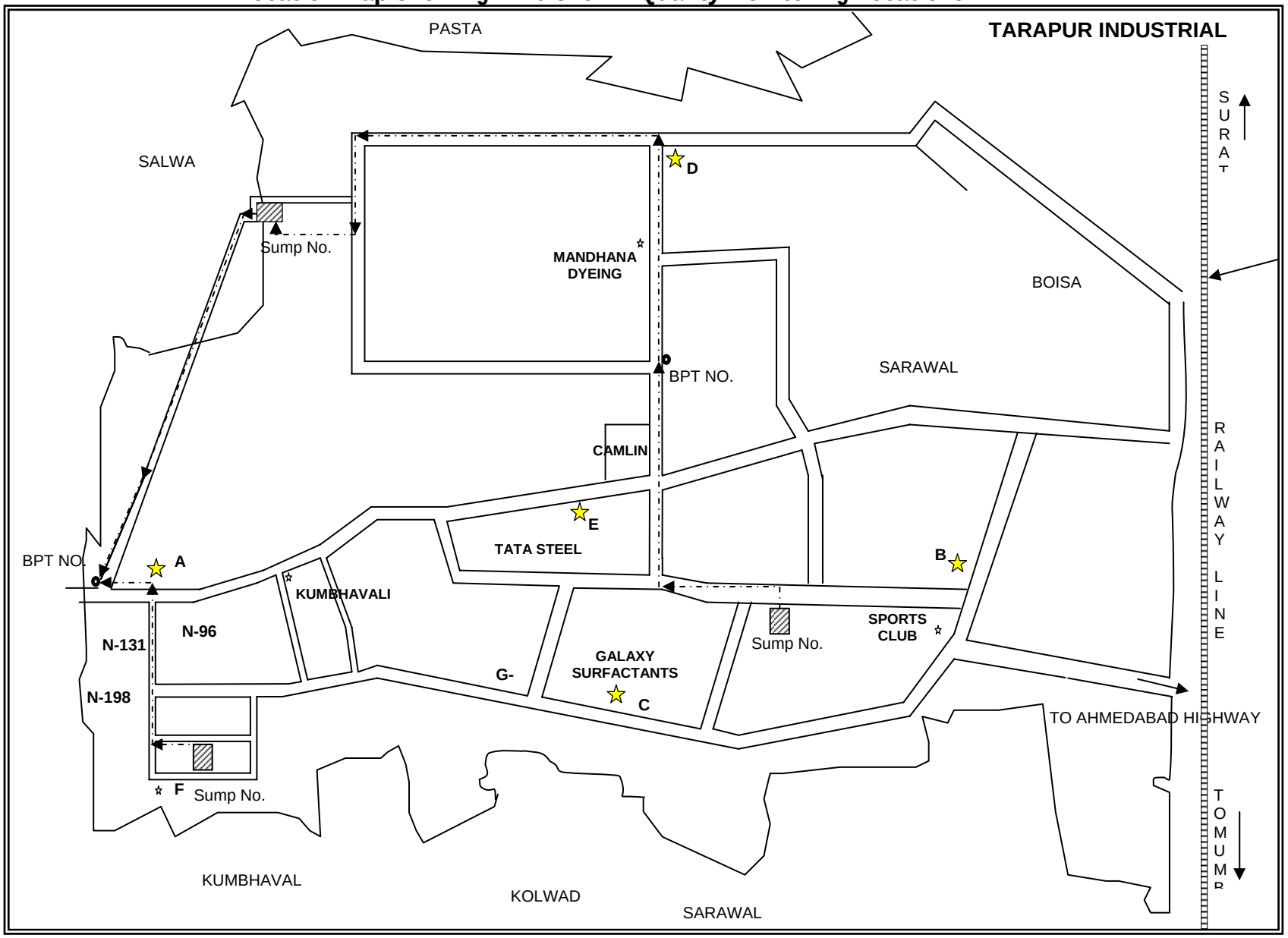


# Annexure-IV

| METROLOGY DATA (January 07, 2009) | | | | | | | |
|---|---|---|---|---|---|---|---|
| S.NO | HOURS | Temp °C | DEW °C | RH % | WIND DIRECTION | WIND SPEED m/sec | RAIN IN |
| 1 | 09.30 am | 21 | 8 | 44 | NE | 1.6 | 0 |
| 2 | 10.30 am | 23 | 8 | 38 | NE | 2.0 | 0 |
| 3 | 11.30 am | 25 | 8 | 35 | NE | 2.2 | 0 |
| 4 | 12.30 pm | 26 | 8 | 32 | NE | 2.0 | 0 |
| 5 | 13.30 pm | 26 | 8 | 34 | NE | 2.0 | 0 |
| 6 | 14.30 am | 26 | 8 | 35 | NE | 2.0 | 0 |
| 7 | 15.30 am | 26 | 10 | 36 | NE | 1.6 | 0 |
| 8 | 16.30 pm | 25 | 10 | 39 | NE | 1.6 | 0 |
| 9 | 17.30 pm | 24 | 10 | 41 | NE | 1.6 | 0 |
| 10 | 18.30 pm | 23 | 10 | 44 | ENE | 1.4 | 0 |
| 11 | 19.30 pm | 22 | 10 | 47 | ENE | 1.4 | 0 |
| 12 | 20.30 pm | 21 | 10 | 49 | ENE | 1.4 | 0 |
| 13 | 21.30 pm | 19 | 10 | 54 | ENE | 1.1 | 0 |
| 14 | 22.30 pm | 18 | 9 | 56 | ENE | 1.1 | 0 |
| 15 | 23.30 pm | 17 | 9 | 60 | ENE | 0.8 | 0 |
| 16 | 0.30 am | 16 | 9 | 65 | E | 0.8 | 0 |
| 17 | 1.30 am | 15 | 9 | 67 | E | 0.8 | 0 |
| 18 | 2.30 am | 15 | 10 | 72 | E | 0.8 | 0 |
| 19 | 3.30 am | 14 | 10 | 75 | E | 0.8 | 0 |
| 20 | 4.30 am | 15 | 10 | 75 | E | 0.8 | 0 |
| 21 | 5.30 am | 15 | 10 | 72 | NE | 0.8 | 0 |
| 22 | 6:30 am | 16 | 10 | 67 | NE | 1.1 | 0 |
| 23 | 7.30 am | 18 | 10 | 60 | ENE | 1.4 | 0 |
| 24 | 8.30 am | 20 | 9 | 54 | ENE | 1.4 | 0 |

**ANNEXURE - V**

## Location Map Showing Ambient Air Quality Monitoring Locations



# Annexure-VI A

| VOC Sampling Details – Tarapur | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **Date of Sampling** | **Time of Sampling** | **Sampling Location** | **Flow rate** | **Sampling Duration** | **Volume of air Sampled** |
| **Ambient Air Quality Monitoring - 1 Round** | | | | | | |
| 1 | 6/1/2009 | 03.00 - 09.00 pm | M/s.Kumbawali Naka Police Chocki | 500ml/min | 6 hours | 180Litres |
| 2 | 6/1/2009 | 03.20 - 09.20 pm | M/s.Tata Steel Wire Division, | 500ml/min | 6 hours | 180Litres |
| 3 | 6/1/2009 | 03.45 - 09.45 pm | M/s.Galaxy Surfactants Ltd., | 500ml/min | 6 hours | 180Litres |
| 4 | 6/1/2009 | 04.00 - 10.00 pm | M/s.Palgar - Dahanu Talaka Sports Association | 500ml/min | 6 hours | 180Litres |
| 5 | 6/1/2009 | 04.30 - 10.30 pm | M/s.Mandhana Dyeing | 500ml/min | 6 hours | 180Litres |
| **Ambient Air Quality Monitoring – 2 Round** | | | | | | |
| 1 | 06 & 07/01/2009 | 10.15 pm - 04.15 am | M/s.Kumbawali Naka Police Chocki | 500ml/min | 6 hours | 180Litres |
| 2 | 06 & 07/01/2009 | 10.20 pm - 04.20 am | M/s.Tata Steel Wire Division, | 500ml/min | 6 hours | 180Litres |
| 3 | 06 & 07/01/2009 | 10.45 pm - 04.45 am | M/s.Galaxy Surfactants Ltd., | 500ml/min | 6 hours | 180Litres |
| 4 | 06 & 07/01/2009 | 11.00 pm - 05.00 am | M/s.Palgar - Dahanu Talaka Sports Association | 500ml/min | 6 hours | 180Litres |
| 5 | 06 & 07/01/2009 | 11.30 pm - 05.30 am | M/s.Mandhana Dyeing | 500ml/min | 6 hours | 180Litres |
| **Ambient Air Quality Monitoring – 3 Round** | | | | | | |
| 1 | 07/01/2009 | 06.15 am - 12.15 pm | M/s.Kumbawali Naka Police Chocki | 500ml/min | 6 hours | 180Litres |
| 2 | 07/01/2009 | 06.30 am - 12.30 pm | M/s.Tata Steel Wire Division, | 500ml/min | 6 hours | 180Litres |
| 3 | 07/01/2009 | 06.45 am - 12.45 pm | M/s.Galaxy Surfactants Ltd., | 500ml/min | 6 hours | 180Litres |
| 4 | 07/01/2009 | 07.00 am - 01.00 pm | M/s.Palgar - Dahanu Talaka Sports Association | 500ml/min | 6 hours | 180Litres |
| 5 | 07/01/2009 | 07.15 am - 01.15 pm | M/s.Mandhana Dyeing | 500ml/min | 6 hours | 180Litres |

# Annexure-VI B

| VOC Sampling Details – Tarapur | | | | | | |
|---|---|---|---|---|---|---|
| **S.No** | **Date of Sampling** | **Time of Sampling** | **Sampling Location** | **Flow rate** | **Sampling Duration** | **Volume of air Sampled** |
| **Ambient Air Quality Monitoring - 1 Round** | | | | | | |
| 1 | 08/01/2009 | 05.00 - 11.00 pm | M/s.Kumbawali Naka Police Chocki | 500ml/min | 6 hours | 180Litres |
| 2 | 08/01/2009 | 05.15 - 11.15 pm | M/s.Tata Steel Wire Division, | 500ml/min | 6 hours | 180Litres |
| 3 | 08/01/2009 | 05.30 - 11.30 pm | M/s.Galaxy Surfactants Ltd., | 500ml/min | 6 hours | 180Litres |
| 4 | 08/01/2009 | 05.40 - 11.40 pm | M/s.Palgar - Dahanu Talaka Sports Association | 500ml/min | 6 hours | 180Litres |
| 5 | 08/01/2009 | 05.50 - 11.50 pm | M/s.Mandhana Dyeing | 500ml/min | 6 hours | 180Litres |
| **Ambient Air Quality Monitoring – 2 Round** | | | | | | |
| 1 | 09/01/2009 | 12.15 - 06.15 am | M/s.Kumbawali Naka Police Chocki | 500ml/min | 6 hours | 180Litres |
| 2 | 09/01/2009 | 12.30 - 06.30 am | M/s.Tata Steel Wire Division, | 500ml/min | 6 hours | 180Litres |
| 3 | 09/01/2009 | 12.45 - 06.45 am | M/s.Galaxy Surfactants Ltd., | 500ml/min | 6 hours | 180Litres |
| 4 | 09/01/2009 | 01.00 - 07.00 am | M/s.Palgar - Dahanu Talaka Sports Association | 500ml/min | 6 hours | 180Litres |
| 5 | 09/01/2009 | 01.15 - 07.15 am | M/s.Mandhana Dyeing | 500ml/min | 6 hours | 180Litres |
| **Ambient Air Quality Monitoring – 3 Round** | | | | | | |
| 1 | 09/01/2009 | 08.30 am - 02.30 pm | M/s.Kumbawali Naka Police Chocki | 500ml/min | 6 hours | 180Litres |
| 2 | 09/01/2009 | 08.45 am - 02.45 pm | M/s.Tata Steel Wire Division, | 500ml/min | 6 hours | 180Litres |
| 3 | 09/01/2009 | 09.00 am - 03.00 pm | M/s.Galaxy Surfactants Ltd., | 500ml/min | 6 hours | 180Litres |
| 4 | 09/01/2009 | 09.15 am - 03.15 pm | M/s.Palgar - Dahanu Talaka Sports Association | 500ml/min | 6 hours | 180Litres |
| 5 | 09/01/2009 | 09.30 am - 03.30 pm | M/s.Mandhana Dyeing | 500ml/min | 6 hours | 180Litres |

**Annexure-VII**

# METHOD OF ANALYSIS
# Ambient Air Quality & Fugitive Emission Samples
# Method – ASTM - 3687

## 1. Scope

.1 The known concentrations of NIST mixed standard are spiked in the adsorbent tube prior to the desorption.

.2 This trial is applicable for analysis of samples taken from ambient or Stack provided that the contaminant adsorbs on to charcoal / Tenax and that it can be analysed.

.3 The above samples were analysed with the help of GC-MS (Purge & Trap, Make Teledyne Tekmar – Velocity XPT Purge & Trap, Sample collector) method.

## 2. Methodology

2.1 This method is complementary to Practice NIOSH Manual of Analytical Methods (NMAM), fourth edition and ASTM D 3687-01 method.

2.2 A known volume of air is drawn through a Charcoal / Tenax adsorption tube to trap the organic solvent vapors present.

2.3 The Charcoal / Tenax is transferred to a small stopper tube and the organic compounds are desorbed with Methanol.

2.4 A aliquot of the desorbed sample is injected into a gas chromatography (Purge & Trap)

2.5 Peaks are identified using techniques such as GC / MS (Purge & Trap) Method.

## 3. Materials and Reagents (for In-house)

a. Conical Flask – Capacity 250ml / 100 ml.
Activated Charcoal tube – Spike has been done earlier in Lab, Keep it in Freezer @ - 10° C.

b. Methanol:- Merck GR grade or equivalent.

c. Water – Millipore, with reference to the specification of Water for Laboratory ISO3696:1987 Electrical conductivity and TOC are within the specifications)

## 4. Spike and Recovery Study

*Precautions to be undertaken for Adsorbents:*

- For Spike and recovery study, activate the charcoal tube at 300°C (Tube desorption temperature) around 1 to 1½ hr. in muffle furnace then cool it in desiccator and kept it in freezer.

- Inject a known amount (2 to 20 micro litre / 100 mg charcoal) one or more VOC NIST standard below the surface off and or directly onto the activated charcoal / Tenax, and cap the tube immediately. It is useful to chill the sampling tube and contents immediately prior to its being charged with solvent, since the heat of adsorption may be sufficient to volatilize some of the material and to cause loss. After spike immediately cap both end. The amount injected should approximate realistically that quantity which would be found in 10 L of air containing the exposure limit designated.

- Tubes should be prepared for each of the following amounts 0.5, 1.0 and 2.0 times the amount determined.

- Let the tubes stand at room temperature for a minimum of 8 hr after spiking

- Remove the plastic caps from the sampling / spike tube, score and break the tubes just above the plug.

- Remove the plug of glass wool in the adsorbent tube and transfer the adsorbent to the appropriate vial and close the vial.

- There are two ways of desorption process through the adsorbent tube. 1. Desorption through the direction of the adsorption with the solvent ($CH_3OH$).

  2. Desorption through the opposite direction of the adsorption.

3. Another way of desorption: transfer the adsorbent along with urethane layer immersed in gas tight vials having known amount of $CH_3OH$, immediately close with cap after transfer the contents. Then dilute this into desirable quantity.

- From time to time agitate the samples. Let the elution process continue for at least 30 min. A longer period of time is desirable.

- For Special application analyte was extracted from sorbent charcoal / Tenax tube using Methanol with unltrasonication. The HPLC grade methanol was used for the isolation of sample for avoiding extreme human toxic effect, lower flash point and lower ignition point of $CS_2$ as compare to Methanol.

- The percentage of chemical recovered from the charcoal / Tenax (calculated by dividing the quantity recovered by the quantity applied, times 100) is the desorption efficiency. The data obtained for the analyte of concern should be corrected by using the decimal fraction of the determined desorption (elution) efficiency.

- When efficiency of a chemical / method desorption is less than 75% then that method error has been taken into consideration for further improvement to next trial.

**5.0 Preparation of Spiked samples**:-

**5.1 Liquid standards:** Internal standards are directly added in the sample extraction. The blank was prepared using a charcoal / Tenax tube from the same batch.

Normal spike levels :- 1 ppm, 5 ppm, 10 ppm, 20 ppm and 25 ppm.

**Advantageous of Using Methanol instead of Carbon disulfide.:-**

1. Analyte recovery was found to be more in case of Methanol
2. Solid – Liquid separation is found good in the case of methanol.
3. Compared to Carbon disulfide, methanol hazardous percentage is found to be less.
4. Solvents are chosen based on solubility for the analytes of interest and ability to be separated from the analytes of interest and ability to be separated from the analytes when chromatographed.
5. Highly volatile compounds should be dissolved in a less volatile solvent.
6. The HPLC grade methanol was used for the isolation of sample for avoiding extreme human toxic effect, lower flash point and lower ignition point of $CS_2$ as compare to Methanol.

## 6. Instrumentation

### 6.1 Purge & Trap Conditions:-

Velocity XPT (with AQUA Tek 70) method

| Variable | Value | Variable | Value |
|---|---|---|---|
| Valve Oven Temp. | 150ºC | Dry Purge Temp. | 40ºC |
| Transfer Line Temp. | 150ºC | Dry Purge Flow | 200 mL / min. |
| Sample Mount Temp. | 90ºC | GC Start | Start of Desorb |
| Purge Ready Temp. | 45ºC | Desorb Preheat Temp. | 245ºC |
| Dry Flow Standby Temp. | 175ºC | Desorb Drain | On |
| Standby Flow | 10 mL / min. | Desorb Time | 1.00 min. |
| Pressurize Time | 0.25 min. | Desorb Temp. | 250ºC |
| Fill I.S. Time | 0.00 min. | Desorb Flow | 200 mL / min. |
| Sample Transfer Time | 0.25 min. | Bake Rinse | On |
| Pre-purge Time | 0.00 min. | Number of Bake Rinses | 3 |
| Pre-Purge Flow | 40 mL / min. | Bake Drain Time | 0.50 min. |
| Sample Heater | Off | Bake Drain Flow | 400 mL / min. |
| Sample Preheat Time | 1.00 min. | Bake Time | 3.00 min. |
| Preheat Temp. | 40ºC | Bake Temp. | 270ºC |
| Purge Time. | 11.00 min. | Dry Flow Bake Temp. | 175ºC |
| Purge Temp. | 0ºC | Bake Flow | 400 mL / min. |
| Purge Flow | 40 mL/min. | Focus Temp. | -150ºC |
| Purge Rinse Time | 0.25 min. | Inject Time | 1 min. |
| Purge Line Time | 0.25 min. | Inject Temp. | 180ºC |
| Dry Purge Time | 0.00 min. | Standby Temp. | 100ºC |

## 6.2 GC conditions:-

Model Used:- 6890 GC (Make:- Agilent Technologies Ltd.)

**Oven**

Initial Temperature : 40 ºC (On) Maximum Temp : 300 ºC

Intial Time : 3.00 Min. Equilibrium Time : 0.50 min.

Ramps:

| # | Rate | Final Temp. | Final Time |
|---|---|---|---|
| 1 | 8.00 | 90 | 2.00 |
| 2 | 6.00 | 240 | 3.00 |
| 3 | 0.0 (off) | | |

Post Temp : 0 ºC

Post Time : 0.00 min.

Run Time : 39.25 min.

**Front Inlet (Split / Splitless)**

Mode : Split

Initial Temp : 250 °C (On)

Pressure : 23.20 psi (On)

Split : 30:1

Split flow : 90.9 mL / min.

Total flow : 96.5 mL / min.

Gas saver : Off

Gas Type : Helium

**Column 1**

Capillary Column

DB-624, 60 m x 0.25 mm x 0.25 µm

Max. Temp. : 260ºC

Mode : Constant Flow

Initial flow : 1.5 mL /min.

Inlet : Front Inlet

Outlet : MSD
Outlet Pressure : Vacuum

**Thermal Aux 2 (Transfer line)**

Use : MSD Transfer Line Heater
Description :
Initial temp : 260 ºC
Initial time : 0.00 min.

| # | Rate | Final Temp. | Final Time | Post Time : 0.00 min. |
|---|---|---|---|---|
| 1 | 0.00 | (Off) | | |

**MS Acquisition Parameters**

General Information

Tune File : atune.u
Acquisition Mode : Scan

MS Information
Solvent Delay : 0.00 min
EM Absolute : True

Resulting EM Voltage : 2035.3

[Scan Parameters]

Low Mass : 40.0
High Mass : 260.0
Threshold : 0
Sample # : 3 A / D samples 8.

[MS zones]

MS Quad : 150 ºC Maximum 200 ºC
MS Source : 230 ºC Maximum 250 ºC

## 7. Results & Discussion :-

- The vapours are desorbed either thermally or by extraction with a solvent and are determined by Gas Chromatography. Worldwide, the mostly used technique for the determination of volatile organic hydrocarbons in ambient is adsorption on activated charcoal / Tenax followed by solvent desorption.
- The desorption efficiency of a particular compound can vary from one laboratory to another, from one batch of activated charcoal / Tenax to another, and can also vary with the amount of compounds adsorbed on the charcoal / Tenax. Thus, it is necessary to determine at least once the percentage of each specific compound that is removed in the desorption process each time a different batch of charcoal / Tenax is used. The Physical and Chemical analysis Branch of NIOSH has found that the average desorption efficiencies for the compounds are between 81% to 100% and vary with each batch of charcoal / Tenax.
- Atleast 2 tubes are prepared in this manner and allowed to stand for at least overnight to assure complete adsorption of the specific compound on to the charcoal / Tenax. These tubes are referred to as the samples. A parallel blank tube should be treated in the same manner except that no sample is added to it. The sample and blank tubes are desorbed with $CH_3OH$ and analyzed in exactly the same manner as the sampling tube.
- Two or three standards are prepared by injecting the same volume of compound in appropriate volume of $CH_3OH$ with the same syringe used in preparation of the sample. These are analysed with the samples.
- The desorption efficiency equals the difference the average peak area of the samples and the peak area of the blank divided by the average peak area of the standards.

Desorption efficiency = ((Area Sample – Area blank) / Area Standard)* 100

## 8. Conclusion:-

Methanol shows good potential for the recovery of VOC's from activated Charcoal / Tenax in studies of Pollutants at workplaces. The most important findings in this study is Ultrasonication and room temperature effects improves analyte recovery.

## Annexure - VIII

# METHOD OF ANALYSIS

# Ambient Air Quality & Fugitive Emission Samples

# Method – EPA TO – 17 &

# Method Validation Document

**CONTENTS**

**Description** .

## SIGNATURE PAGE

**AUTHENTIFICATION**: We the undersigned declare that we have reviewed this report from the
Supporting data and reviewed for completeness, accuracy and compliance with methods and
Procedures as per the relevant Standard Operating Procedures. To the best of our knowledge this
Report accurately reflects the raw data.

Sign:

**APPROVAL**: I, the undersigned declare that I have reviewed this report for any anomalies and
Compliance, procedures and evaluated the scientific validity of the statements and conclusions made in this report. To the best of my knowledge and judgment this report is scientifically valid.

Sign

## 1.0 OBJECTIVE

To validate the method for the determination of "VOCs collected in charcoal and tennax tube, also in solid waste and effluent using GC-MSD with Purge and Trap and Thermal Desorption as per method EPA TO - 17.

## 2.0 SCOPE & APPLICATION

The following performance parameters were assessed during the validation.

1. Accuracy
2. Linearity
3. Limit of Detection
4. Limit of Quantification
5. Recovery

### 2.1 Application

This procedure is applicable for the determination of VOCs collected in charcoal tube using GC-MSD with purge and trap

## 3.0 PROCEDURE

**3.1** Requirements

**3.2** Equipment and Glassware

**3.2.1** Conical Flask – Capacity 250ml,100 ml. and 10ml capacity

**3.3** Chemicals

**3.3.1** Methanol: Merck GR grade or equivalent.

.**3.3.2** Water – Millipore, with reference to the specification of Water for Laboratory ISO3696:1987 Electrical conductivity and TOC are within the specifications)

### 3.3.10 Activated Charcoal tube Specification:-

| Parameters | Big | Small |
|---|---|---|
| Outer Diameter mm | 8.1367 | 6.0167 |
| Inner Diameter mm | 6.16 | 4.2100 |
| Length – mm | 116.76 | 47.1533 |
| Total Wt. of Charcoal Tube g. | 7.8890 | 1.8467 |
| Weight of Charcoal g. | 2.0871 | 0.1835 |
| Weight of Urethane g. | 0.0134 | '- |
| Weight of Glass wool g. | 0.0547 | 0.0562 |
| | | |

### 3.3.11 Activated Charcoal tube (SGS In-house Specification):-

| Parameters | Big |
|---|---|
| Outer Diameter mm | 10.05 |
| Inner Diameter mm | 6.48 |
| Length –Big tube– mm | 75.52 |
| Length – short tube - mm | 26.34 |
| Total Wt. of Charcoal Tube g. | 23.2323 |
| Spring wt. g. | 3.6563 |
| Weight of Charcoal g. | 1.5000 |
| Weight of Urethane g. | 0.0125 |
| Weight of Glass wool g. | 0.0780 |
| | |

Cap specification:-

| Parameters | Big | Small |
|---|---|---|
| Outer Diameter mm | 8.67 | 7.27 |
| Inner Diameter mm | 7.51 | 5.49 |
| Length – mm | 0.3961 | 0.3055 |
| | | |

3.3.12 Rubber Cork with correct diameter, which will fit into the Conical flask.
3.3.13 Connecting glass tubes with polymer hose.
3.3.14 Teflon tape rolls - 1½ inch.
3.3.15 Measuring Jar – For measuring the volume of the solvent.

### 3.3.12 Tenax : Tenax tube specification:-

| Parameters | Short |
|---|---|
| Outer Diameter mm | 5.80 |
| Inner Diameter mm | 3.62 |
| Length – mm | 86.83 |
| Total Wt. of Tenax Tube g. | 3.5492 g |
| Weight of Tenax : Tenax g. (in Front :Back portion) | 0.050 g : 0.100 g |
| Weight of Urethane g. | 0.010 |
| Weight of Glass wool g. | 0.031 |

3.4 **Sample Preparation** :

3.5.1 **Air Samples**: Before preparing the sample allow the charcoal tube to get room temperature, then break the charcoal tube just above the glass wool plug. Carefully transfer the charcoal into a vial, add 5ml of chromatographic pure methanol, cap the container or vial tightly such that no volatilization occur, sonicate it for 30sec settle for 20-30min.

Then take 43µL of supernatant methanol into a VOC vial containing 43ml of Milli-Q water, swirl 2-3 times and place the vial in auto sampler of purge and trap system. Same manner do the blank without charcoal.

3.5.2 **Solid Waste and Soil Samples**: Take 5gm of samples add 10mL of MeOH sonicate,(prior to the sonication add preservative Sodium bisulphate this will prevents the biodegradation of the volatile target analytes ) then make up the volume to 100ml with organic free water. Filter the sample with no time span and load it into the purge and trap system.

3.5.3 **Effluent and water samples**: load the effluent sample directly, in case it is turbid or oily dilute the sample with organic free water. Water samples can be loaded directly in to the purge and trap system.

### 3.5 Preparation of Standards for calibration curve:

Standards for calibration curve were prepared from stock of 2000µg/mL (AccuStandard)

**Prepration of Stock Solutions**

| Conc. Of Stock Solution (mg/L) | Volume of Stock (mL) | Volume of Diluent* (mL) | Made up Volume (mL) | Final Conc. (mg/L) |
|---|---|---|---|---|
| 2000 | 1 | 9 | 10 | 200 |
| 200 | 2.5 | 7.5 | 10 | 50 |
| 200 | 1.25 | 8.75 | 10 | 25 |
| 50 | 4 | 6 | 10 | 20 |
| 20 | 5 | 5 | 10 | 10 |
| 10 | 5 | 5 | 10 | 5 |
| 10 | 1 | 9 | 1 | 1 |

**Preperation of Calibratin Curve Standards**

| Conc. Of Stock Solution (µg/ml | Volume of Stock (µL) | Made up Volume (mL) | Final Conc(µg/L | Lable |
|---|---|---|---|---|
| 25 | 43 | 43 | 20 | CC5 |
| 20 | 43 | 43 | 10 | CC4 |
| 10 | 43 | 43 | 8 | CC3 |
| 5 | 43 | 43 | 5 | CC2 |
| 1 | 43 | 43 | 1 | CC1 |

**Details of GC/MS Method :**

**Instrument Details:** Model Used:- 6890 GC-MSD (Make:- Agilent Technologies Ltd.)

**6.2 GC conditions:-**

**Oven**

Initial Temperature : 40 ºC (On)
Maximum Temp : 260ºC
Initial Time : 3.00 Min.
Equilibrium Time : 0.50 min.
Ramps:

| # | Rate | Final Temp. | Final Time |
|---|---|---|---|
| 1 | 10 | 100 | 0.00 |
| 2 | 25 | 225 | 3.00 |
| 3 | 0.0 (off) | | |

Post Temp : 0 ºC
Post Time : 0.00 min.
Run Time : 17.00 min.

**Front Inlet (Split / Split less)**

Mode : Split
Inlet Temp : 250 °C (On)
Pressure : 23.20 psi (On)
Split : 50:1
Split flow : 49.6 mL / min.
Total flow : 53.1 mL / min.
Gas saver : ON
Gas Type : Helium

**Column 1**

Capillary Column
Model Number: J&W US5270225H
DB-VRX,20m x 0.18mm x 1µm
Intial flow : 1.0mL/min
Inlet : Front Inlet
Outlet : MSD
Outlet pressure : vacuum

**Column 2**

Capillary Column
Model No.: J&W US5215021H
DB-624,60m x 0.25mm x 1.4µm
Intial flow : 1.5mL/min
Inlet : Back
Outlet : MSD
Outlet pressure : Vaccum

**Thermal Aux 2 (Transfer line)**

Use : MSD Transfer Line Heater
Initial temp : 260 ºC
Initial time : 0.00 min.

## MS Acquisition Parameters

General Information

Tune File : atune.u
Acquisition Mode : Scan

| Name | Quantification ion |
|---|---|
| Dichlorodifluoromethane | 85 |
| Chloromethane | 50 |
| Vinyl chloride | 62 |
| Bromomethane | 94 |
| Ethylchloride | 64 |
| Trichloromonofluoromethane | 101 |
| 1,1-dichloroethene | 96 |
| Methylene chloride | 84 |
| Trans-1,2-Dichloroethene | 96 |
| 1,1-dichloroethane | 63 |
| Cis-1,2-Dichloroethene | 96 |
| Bromochloromethane | 128 |
| Chloroform | 83 |
| 2,2-dichloropropane | 77 |
| 1,2-dichloroethane | 62 |
| 1,1,1-Trichloroethane | 97 |
| 1,1-dichloropropene | 75 |
| Carbon Tetrachloride | 117 |
| Benzene | 78 |
| Dibromomethane | 93 |
| 1,2-dichloropropane | 63 |
| Trichloroethylene | 95 |
| Bromodichloromethane | 83 |
| 1,3-dichloropropene | 75 |
| Trans-1,3-dichloropropene | 75 |
| 1,1,2-Trichloroethane | 83 |
| Toluene | 91 |
| 1,3-Dichloropropane | 76 |
| Dibromochloromethane | 129 |
| 1,2-Dibromoethane | 107 |
| Tetrachloroethylene | 166 |
| 1,1,1,2-Tetrachloroethane | 131 |
| Chlorobenzene | 112 |
| Ethylbenzene | 91 |
| Bromoform | 173 |
| m & p - Xylene | 106 |
| Styrene | 104 |
| 1,1,2,2-Tetrachloroethane | 83 |
| O-Xylene | 106 |

| | |
|---|---|
| 1,2,3-Trichloropropane | 75 |
| Isopropyl benzene | 105 |
| Bromobenzene | 156 |
| n-Propylbenzene | 91 |
| 2-Chlorotoluene | 91 |
| 4-Chlorotoluene | 91 |
| 1,3,5-trimethylbenzene | 105 |
| Tert-Butylbenzene | 119 |
| 1,2,4-trimethylbenzene | 105 |
| Sec-Butylbenzene | 105 |
| 1,3-dichlorobenzene | 146 |
| 1,4-dichlorobenzene | 146 |
| 4-isopropyltoluene | 119 |
| 1,2-dichlorobenzene | 146 |
| Butylbenzene | 91 |
| 1,2-dibromo-3,-chloropropane | 75 |
| 1,2,4-trichlorobenzene | 118 |
| Naphthalene | 128 |
| Hexachlorobutadiene | 225 |
| 1,2,3-trichlorobenzene | 180 |

**6.1 Purge & Trap Conditions:-** Velocity XPT (with AQUATEK 70) method

| Variable | Value | Variable | Value |
|---|---|---|---|
| Valve Oven Temp. | 150ºC | Dry Purge Temp. | 40ºC |
| Transfer Line Temp. | 150ºC | Dry Purge Flow | 200 mL / min. |
| Sample Mount Temp. | 90ºC | GC Start | Start of Desorb |
| Purge Ready Temp. | 45ºC | Desorb Preheat Temp. | 245ºC |
| Dry Flow Standby Temp. | 175ºC | Desorb Drain | On |
| Standby Flow | 10 mL / min. | Desorb Time | 1.00 min. |
| Pressurize Time | 0.25 min. | Desorb Temp. | 250ºC |
| Fill I.S. Time | 0.00 min. | Desorb Flow | 200 mL / min. |
| Sample Transfer Time | 0.25 min. | Bake Rinse | On |
| Pre-purge Time | 0.00 min. | Number of Bake Rinses | 3 |
| Pre-Purge Flow | 40 mL / min. | Bake Drain Time | 0.50 min. |
| Sample Heater | Off | Bake Drain Flow | 400 mL / min. |
| Sample Preheat Time | 1.00 min. | Bake Time | 3.00 min. |
| Preheat Temp. | 40ºC | Bake Temp. | 270ºC |
| Purge Time. | 11.00 min. | Dry Flow Bake Temp. | 175ºC |
| Purge Temp. | 0ºC | Bake Flow | 400 mL / min. |
| Purge Flow | 40 mL/min. | Focus Temp. | -150ºC |
| Purge Rinse Time | 0.25 min. | Inject Time | 1 min. |
| Purge Line Time | 0.25 min. | Inject Temp. | 180ºC |
| Dry Purge Time | 0.00 min. | Standby Temp. | 100ºC |

**6.2 Thermal Desorption Conditions : Unity Thermal Desorber method**

Thermal desorption is a simple extension of the technique of gas chromatography (GC) and is most commonly used in combination with a GC analyzer.In the process of thermal desorption, heat and a flow of inert gas are used to extract volatile and semi-volatile organics retained in a sample matrix or on a sorbent bed. The analytes desorb into the gas stream and are transferred into an analytical system in a small, concentrated volume of vapour.

Unity Thermal desorber Conditions :

| | |
|---|---|
| Desorption temp : | 275°C |
| Desorption time : | 5 min |
| Cold trap packing : | Tennax TA |
| Cold trap focusing temp : | -10°C |
| Cold trap (secondary ) desorption temp : | 300°C |
| Secondary desorption time | 3 min |
| Flow path temp : | 120°C |
| Desorb flow : | 4ml/min |
| Inlet split : | 52ml/min |
| Outlet split : | 50ml/min |

**Validation Parameters:**

**Accuracy**: The accuracy of an analytical method is the extent to which test results generated by the method and the true value agree.The true value for accuracy assessment can be obtained by comparing the measured value with the true value.

**Linearity**: The linearity of an analytical method is its ability to elicit test results that are directly, or by means of well defined mathematical transformations, proportional to the concentrations of anlytes in samples within a given range.Linearity is determined by a series of injections of standards at about five different concentrations that span 50-150% of the expected working range assay. The response should be linearly related to the

concentrations of standards. A linear regression equation applied to the results should have an intercept not significantly different from zero.

**Limit of Detection** : The limit of detection is the point at which a measured value is larger than the uncertainty associated with it. It is the lowest concentration of analyte in a sample that can be detected, but not necessarily quantified.

**Limit of Quantification**: The limit of quantification is the injected amount, which results in a reproducible measurement of peak heights are typically required to be about 10-20 times higher than the base line noise.

**Recovery:** A known concentration of standard was spiked into the sample and injected into the instrument. And recovery was calculated as follows

Calculation:

Recovery % = Obtained conc (µg/L)./spiked conc.(µg/L) X 100

**Results:**

**Linearity :** Linearity is plotted using five point calibration curve and it is found to be satisfactory having a linear regression of 0.99. Data are enclosed

**Limit of Quantification** : The limit of quantification with this method is 1µg/L

**Limit of Detection :** The limit of detection with is method is 0.5µg/L

**Recovery :** The recovery with this method is 65-115%

The data are enclosed

**Conclusion** : It is concluded that the method is applicable to determine the volatile organic compounds collected on charcoal tube using GC-MSD with purge and trap technique.The method is rugged,stable and reproducible

**ANNEXURE - IX**

# METHOD OF ANALYSIS
# Soil and Waste samples
# Method – EPA 5035A /8260B

## 1. Scope

1.1 This Method describes a closed –System purge-and-trap process for the analysis of Volatile Organic Compounds (VOC's) in solid materials (eg., Soils, Sediments, and soild waste).

1.2 While the method is designed for use on samples containing low levels of VOC's, procedures are also provided for collecting an preparing solid samples containing high concentrations of VOC's and oily wastes.

1.3 The above samples are analysed with the help of GC-MS (Purge & Trap, Make Teledyne Tekmar – Velocity XPT Purge & Trap, Sample collector) method.

## 2. Methodology

2.1 This method EPA 5035A for most volatile organic compounds that have boiling points below 200°C and that are insoluble or slightly soluble in water. Volatile, water-soluble compounds can be included in this analytical technique. However, quantitation limits are significantly higher because of poor purging efficiency. The purging efficiency can be improved for water soluble analytes eg., ketones and alcohols, when purging at an elevated temperature of 80°C as compared to 20° or 40°C.

## 3. Materials and Reagents (for In-house)

3.1 Conical Flask – Capacity 250ml / 100 ml.
Activated Charcoal tube – Spike has been done earlier in Lab, Keep it in Freezer @ - 10° C.

3.2 Methanol:- Merck GR grade or equivalent.

3.3 Water – Millipore, with reference to the specification of Water for Laboratory ISO3696:1987 Electrical conductivity and TOC are within the specifications)

3.4 A1 Filter paper. – for filtration.

## 4. Experiments (In-house)

a. Low concentration soil method – generally applicable to soils and other soilid samples with VOC concentrations in the range of 0.5 to 200 µg / kg.

b. Volatile organic compounds (VOCs) are determined by collecting samples and shipping to the laboratory or appropriate analysis site by the various methods outlined in Appendix A of 5035A. To ensure minimal loss of volatile constituents prior to analysis the entire sample vial is placed, uncapped with septum, into the instrument, auto sampler device. Before analysis, organic – free reagent water, surrogates and internal standards (if applicable) are automatically added without opening the sample vial. The vial containing the sample is heated to 40°C and the volatiles purged into an appropriate trap using an inert gas (He) and the sample is agitated. Purged components travel via a transfer line to a trap. When purging is complete, the trap is heated and back flushed with Helium to desorb the trapped sample components into a gas chromatograph for analysis by an appropriate determinative method.

c. High Concentration method – generally applicable to soils and other solid samples with VOC concentrations greater than 200 µg / kg. The sample introduction technique, particularly those containing high concentrations (generally greater than 200 µg / Kg) of VOCs which may overload either the volatile trapping material or exceed the working range of the determinative instrument system (e., GC/MS, GC/FID, GC/ELCD etc.,).

In such instances this method describes two sample collection options and the corresponding sample purging procedures.

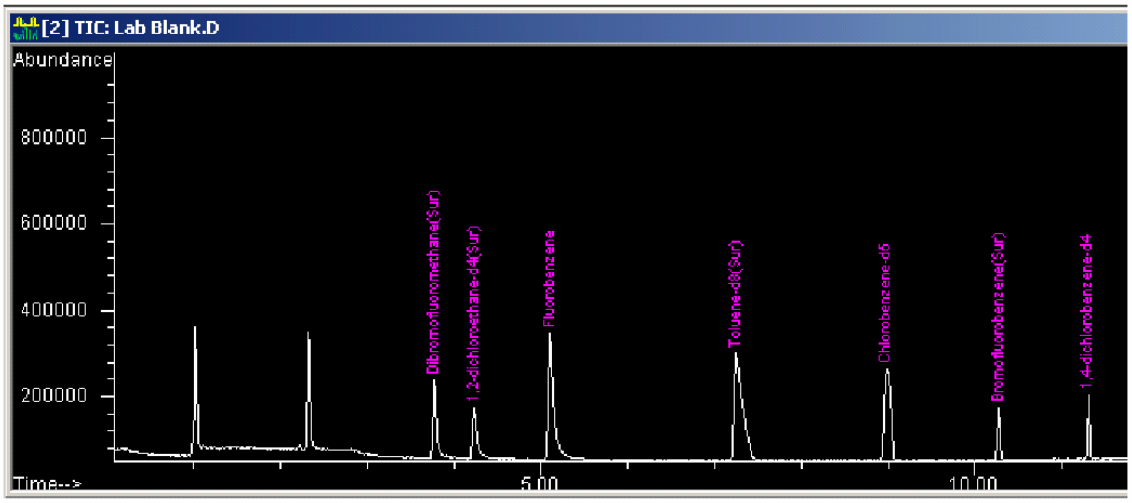
d. The first option is to collect an appropriate sample volume in a pre-weighed vial with a septum-sealed screw-cap that contains a water miscible organic solvent (methanol – 5 ml). At the time of analysis, an aliquot of the solvent is removed from the vial and diluted into water(organic free water) along with the internal standards and surrogates, then purged and analysed by an appropriate determinative method. If required do sonication and filter and the sample with short span of time and immediately give it for analysis.

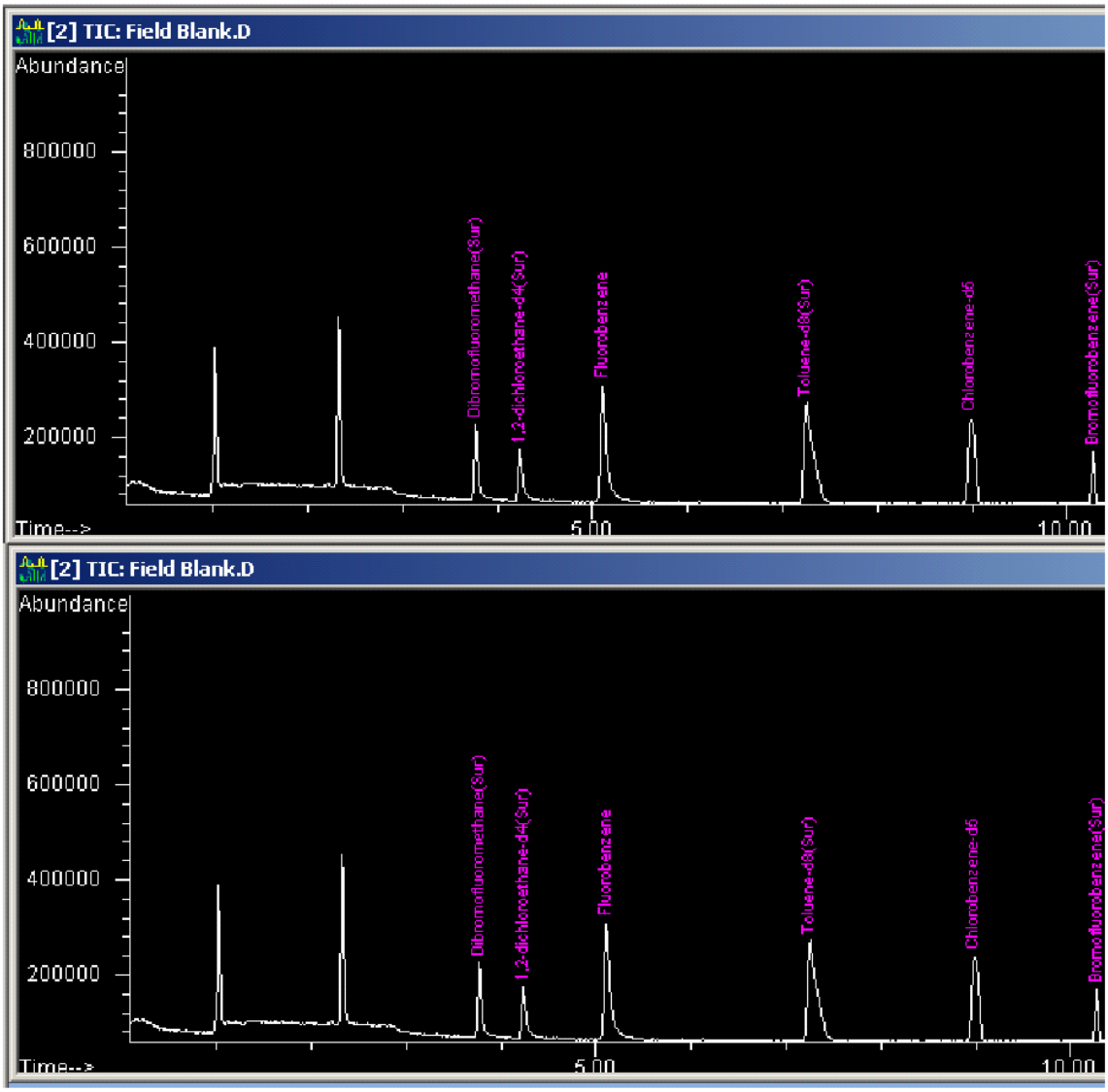
**5. Instrumentation & conditions:-**

Similar conditions has been maintained for Solid waste and Effluent also.

**ANNEXURE - X**

# CHROMATORGRAMS

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Abundance
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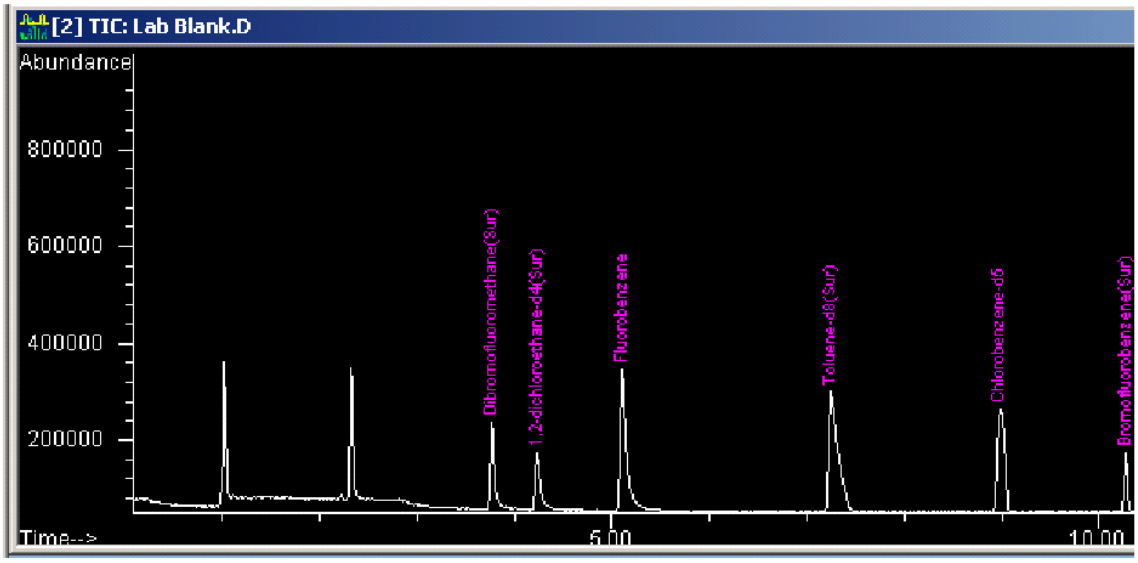
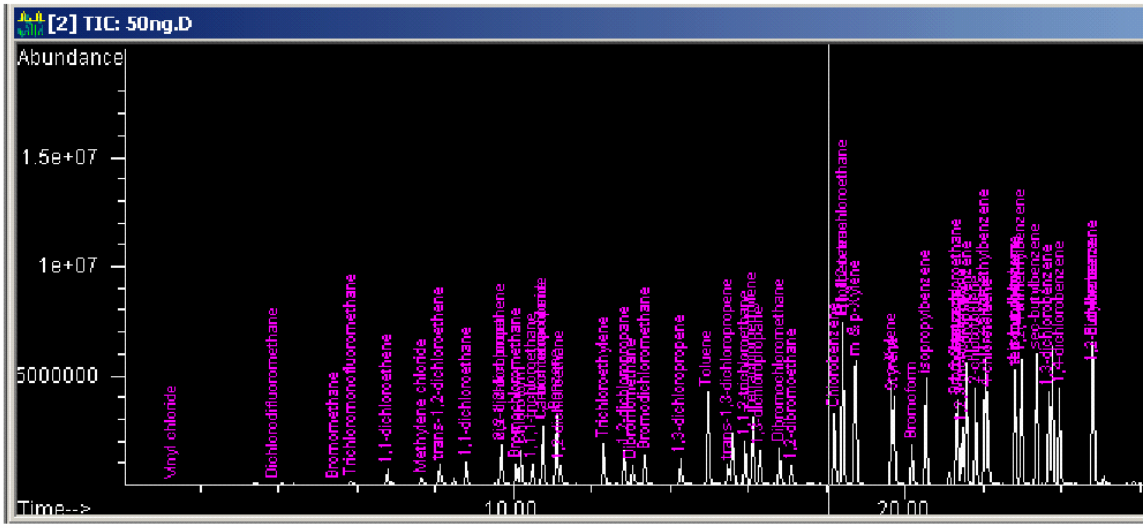
600000
400000
200000
Time-->
5.00
10.00
Dibromofluoromethane(Sur)
1,2-dichloroethane-d4(Sur)
Fluorobenzene
Toluene-d8(Sur)
Chlorobenzene-d5
Bromofluorobenzene(Sur)
[2] TIC: Field Blank.D
Abundance
800000
600000
400000
200000
Time-->
5.00
10.00
Dibromofluoromethane(Sur)
1,2-dichloroethane-d4(Sur)
Fluorobenzene
Toluene-d8(Sur)
Chlorobenzene-d5
Bromofluorobenzene(Sur)

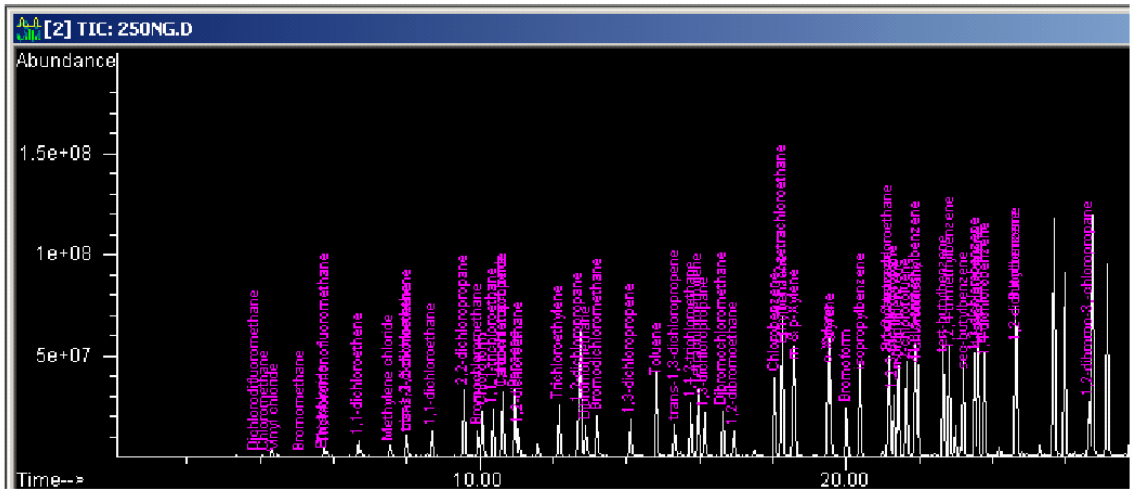

[2] TIC: Lab Blank.D
Abundance
800000
600000
400000
200000
Time-->
5.00
10.00
Dibromofluoromethane(Sur)
1,2-dichloroethane-d4(Sur)
Fluorobenzene
Toluene-d8(Sur)
Chlorobenzene-d5
Bromofluorobenzene(Sur)



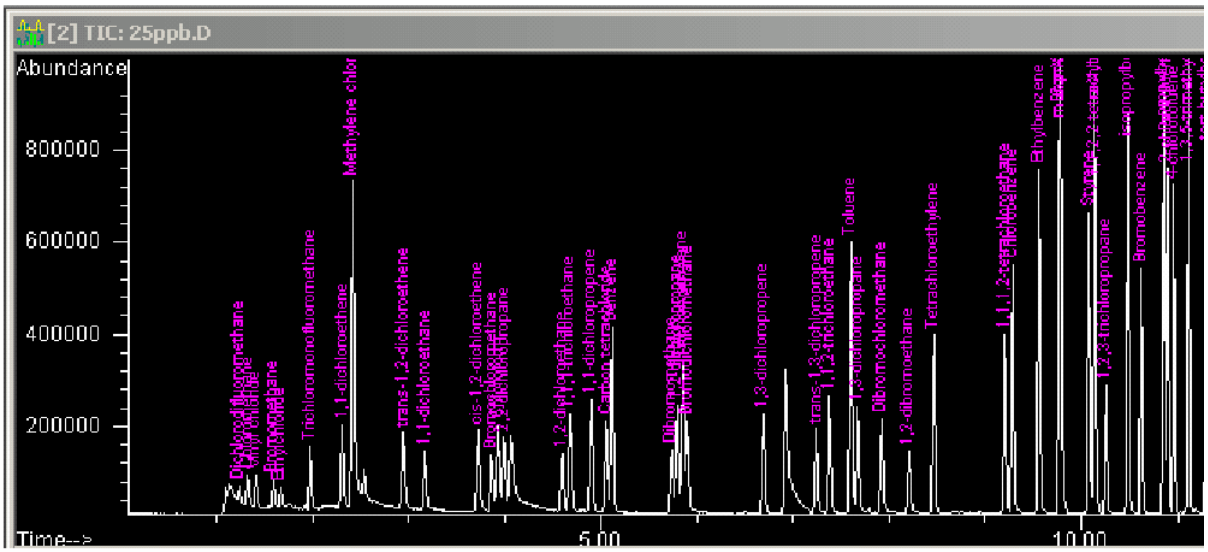

```
Data File : 50ng.D
Operator  :
Sample    : Spike_50ng
Misc      :
ALS Vial  : 1   Sample Multiplier: 1
Quant Method : C:\MSDCHEM\1\METHODS\VOC 60_VF.M
Quant Title  : VOCs using
Response via : Initial Calibration
```

| Internal Standards | R.T. | QIon | Response | Conc Units | | Dev(Min) |
|---|---|---|---|---|---|---|
| **Target Compounds** | | | | | | Qvalue |
| 7) 1,1-dichloroethene | 6.79 | 61 | 5949860 | 31.74 ng | | 98 |
| 8) Methylene chloride | 7.66 | 84 | 1712456 | 26.56 ng | # | 62 |
| 9) trans-1,2-dichloroethene | 8.11 | 61 | 5833606 | 38.39 ng | | 92 |
| 10) 1,1-dichloroethane | 8.80 | 63 | 12850550 | 36.65 ng | | 98 |
| 11) cis-1,2-dichloroethene | 9.69 | 61 | 8795658 | 42.39 ng | | 95 |
| 12) Bromochloromethane | 10.08 | 130 | 4321137 | 46.90 ng | # | 78 |
| 13) Chloroform | 10.20 | 83 | 14391961 | 43.35 ng | | 98 |
| 14) 2,2-dichloropropane | 9.69 | 77 | 4045900 | 1.79 ng | | 95 |
| 15) 1,2-dichloroethane | 11.19 | 62 | 8268715 | 48.71 ng | # | 95 |
| 16) 1,1,1-trichloroethane | 10.48 | 97 | 8631478 | 8.45 ng | | 98 |
| 17) 1,1-dichloropropene | 10.74 | 75 | 10945893 | 43.30 ng | | 97 |
| 18) Carbon tetrachloride | 10.75 | 117 | 8943613 | 13.47 ng | | 99 |
| 19) Benzene | 11.09 | 78 | 37581724 | 38.15 ng | | 99 |
| 20) Dibromomethane | 13.05 | 174 | 3543532 | 55.67 ng | # | 82 |
| 21) 1,2-dichloropropane | 12.84 | 63 | 8697441 | 43.53 ng | # | 90 |
| 22) Trichloroethylene | 12.31 | 130 | 9844597 | 47.96 ng | | 100 |
| 23) Bromodichloromethane | 13.35 | 83 | 12503210 | 48.36 ng | | 98 |
| 24) 1,3-dichloropropene | 14.26 | 75 | 9327502 | 48.03 ng | | 92 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 25) trans-1,3-dichloropropene | 15.48 | 75 | 7349537 | 55.41 ng | # | 93 |
| 26) 1,1,2-trichloroethane | 15.92 | 97 | 9717275 | 48.26 ng | | 97 |
| 27) Toluene | 14.98 | 91 | 48639048 | 37.65 ng | | 99 |
| 28) 1,3-dichloropropane | 16.29 | 76 | 12533676 | 46.87 ng | # | 85 |
| 29) Dibromochloromethane | 16.79 | 129 | 14142249 | 49.24 ng | | 100 |
| 30) 1,2-dibromoethane | 17.09 | 107 | 8959810 | 48.96 ng | | 100 |
| 31) Tetrachloroethylene | 16.11 | 166 | 16040440 | 48.38 ng | | 100 |
| 32) 1,1,1,2-tetrachloroethane | 18.40 | 131 | 6810835 | 80.28 ng | # | 79 |
| 33) Chlorobenzene | 18.20 | 112 | 30334684 | 45.41 ng | | 99 |
| 34) Ethylbenzene | 18.41 | 91 | 56118963 | 32.87 ng | | 99 |
| 35) Bromoform | 20.17 | 173 | 14319746 | 48.93 ng | | 98 |
| 36) m & p-Xylene | 18.73 | 91 | 85998810 | 30.18 ng | | 96 |
| 37) Styrene | 19.71 | 104 | 31202414 | 41.68 ng | | 99 |
| 38) 1,1,2,2-tetrachloroethane | 21.31 | 83 | 19890105 | 43.02 ng | # | 60 |
| 39) o-Xylene | 19.65 | 91 | 46602297 | 38.58 ng | # | 96 |
| 40) 1,2,3-trichloropropane | 21.46 | 75 | 17579510 | 46.66 ng | | 90 |
| 41) isopropylbenzene | 20.54 | 105 | 57248541 | 32.99 ng | | 99 |
| 42) Bromobenzene | 21.34 | 77 | 18642781 | 43.40 ng | | 96 |
| 43) n-propylbenzene | 21.57 | 91 | 72723735 | 27.42 ng | | 99 |
| 44) 2-chlorotoluene | 21.80 | 91 | 41880739 | 40.24 ng | | 99 |
| 45) 4-chlorotoluene | 22.11 | 91 | 33859513 | 43.88 ng | # | 87 |
| 46) 1,3,5-trimethylbenzene | 22.03 | 105 | 53666335 | 33.76 ng | | 95 |
| 47) tert-butylbenzene | 22.80 | 119 | 47134924 | 37.51 ng | | 99 |
| 48) 1,2,4-trimethylbenzene | 22.96 | 105 | 55217963 | 33.94 ng | | 96 |
| 49) sec-butylbenzene | 23.36 | 105 | 73015274 | 29.04 ng | | 98 |
| 50) 1,3-dichlorobenzene | 23.67 | 146 | 33146961 | 42.65 ng | | 99 |
| 51) 1,4-dichlorobenzene | 23.94 | 146 | 34266172 | 41.99 ng | | 99 |
| 52) 4-isopropyltoluene | 22.80 | 119 | 47062010 | 37.95 ng | # | 59 |
| 53) 1,2-dichlorobenzene | 24.82 | 146 | 34009240 | 41.65 ng | | 100 |
| 54) Butylbenzene | 24.78 | 91 | 56126349 | 32.93 ng | | 98 |
| 55) 1,2-dibromo-3,-chloropropa | 26.80 | 157 | 13181730 | 46.59 ng | | 97 |
| 56) 1,2,4-trichlorobenzene | 28.85 | 180 | 32371735 | 43.92 ng | | 100 |
| 57) Naphthalene | 29.51 | 128 | 85189117 | 17.99 ng | | 99 |
| 58) Hexachlorobutadiene | 29.20 | 225 | 22559567 | 47.36 ng | | 99 |
| 59) 1,2,3-trichlorobenzene | 30.05 | 180 | 32758876 | 44.02 ng | | 99 |

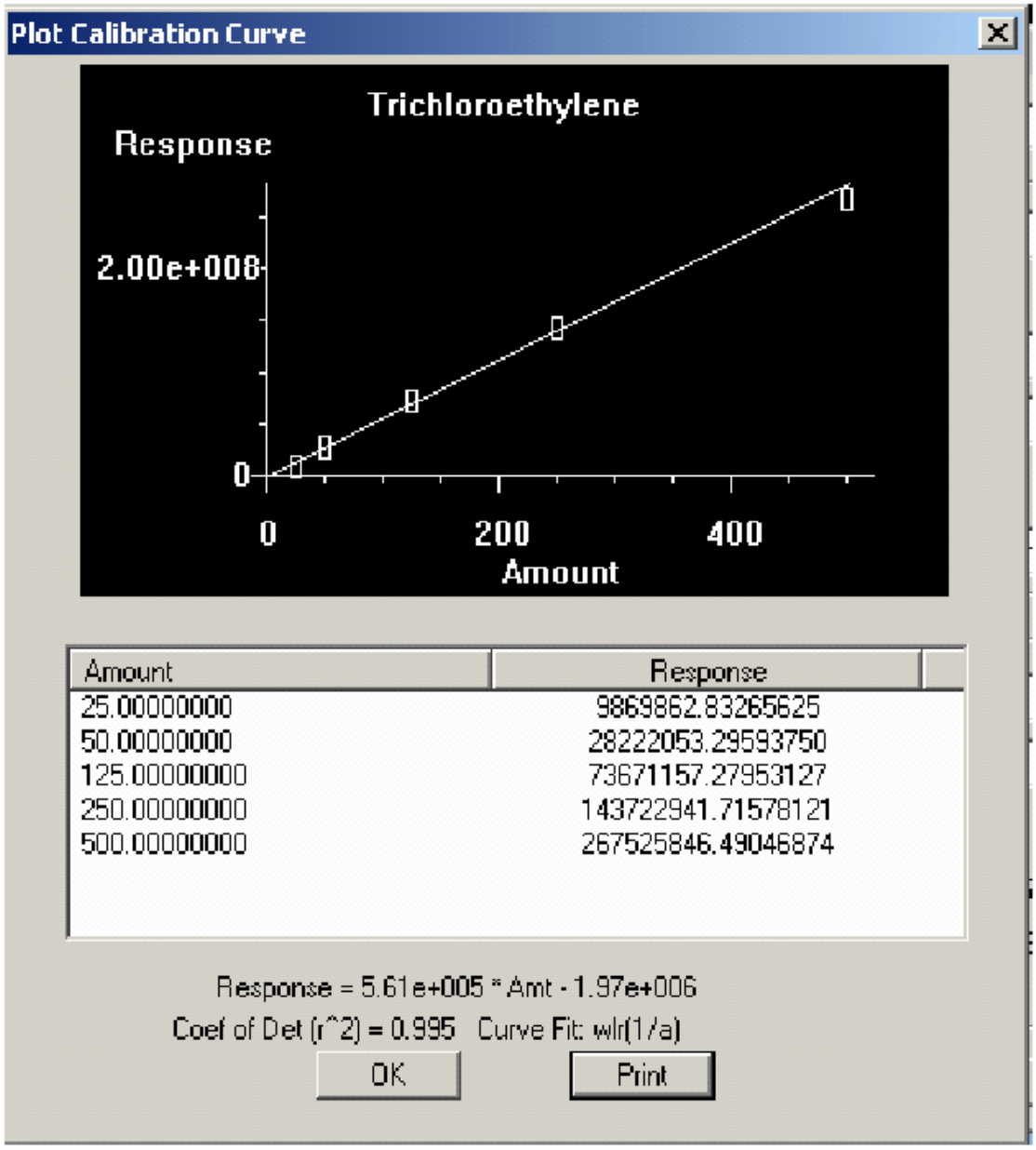


# Purge & Trap
# Standards Chromatorgram




| Target Compounds | | | | | | Qvalue |
|---|---|---|---|---|---|---|
| 1) Dichlorodifluoromethane | 1.24 | 85 | 232437 | 25.00 ppb | # | 90 |
| 2) Chloromethane | 1.33 | 50 | 623604 | 25.00 ppb | | 98 |
| 3) Vinyl chloride | 1.41 | 62 | 648982 | 25.00 ppb | | 98 |
| 4) Bromomethane | 1.60 | 94 | 335606 | 25.00 ppb | | 98 |
| 5) Ethylchloride | 1.67 | 64 | 380961 | 25.00 ppb | | 96 |
| 6) Trichloromonofluoromethane | 1.98 | 101 | 1020462 | 25.00 ppb | | 99 |
| 7) 1,1-dichloroethene | 2.31 | 61 | 933441 | 25.00 ppb | | 93 |
| 8) Methylene chloride | 2.42 | 84 | 3590396 | 25.00 ppb | | 87 |
| 9) trans-1,2-dichloroethene | 2.95 | 61 | 920569 | 25.00 ppb | | 96 |
| 10) 1,1-dichloroethane | 3.17 | 63 | 1213830 | 25.00 ppb | | 99 |
| 11) cis-1,2-dichloroethene | 3.72 | 61 | 943271 | 25.00 ppb | | 98 |
| 12) Bromochloromethane | 3.87 | 130 | 572656 | 25.00 ppb | | 95 |
| 13) Chloroform | 3.94 | 83 | 1454437 | 25.00 ppb | | 99 |
| 14) 2,2-dichloropropane | 4.00 | 77 | 1137315 | 25.00 ppb | | 100 |
| 15) 1,2-dichloroethane | 4.60 | 62 | 978747 | 25.00 ppb | # | 97 |
| 16) 1,1,1-trichloroethane | 4.68 | 97 | 1488332 | 25.00 ppb | | 99 |
| 17) 1,1-dichloropropene | 4.90 | 75 | 1157281 | 25.00 ppb | | 98 |
| 18) Carbon tetrachloride | 5.06 | 117 | 1312235 | 25.00 ppb | | 100 |
| 19) Benzene | 5.12 | 78 | 3634300 | 25.00 ppb | | 98 |
| 20) Dibromomethane | 5.74 | 174 | 694924 | 25.00 ppb | | 98 |
| 21) 1,2-dichloropropane | 5.80 | 63 | 882160 | 25.00 ppb | # | 83 |
| 22) Trichloroethylene | 5.85 | 130 | 1228441 | 25.00 ppb | | 96 |
| 23) Bromodichloromethane | 5.90 | 83 | 1285890 | 25.00 ppb | | 97 |
| 24) 1,3-dichloropropene | 6.70 | 75 | 1321419 | 25.00 ppb | | 100 |
| 25) trans-1,3-dichloropropene | 7.24 | 75 | 1060345 | 25.00 ppb | | 99 |
| 26) 1,1,2-trichloroethane | 7.38 | 97 | 942313 | 25.00 ppb | | 98 |
| 27) Toluene | 7.61 | 91 | 4711599 | 25.00 ppb | | 98 |
| 28) 1,3-dichloropropane | 7.68 | 76 | 1439678 | 25.00 ppb | | 98 |
| 29) Dibromochloromethane | 7.93 | 129 | 1149877 | 25.00 ppb | | 95 |
| 30) 1,2-dibromoethane | 8.21 | 107 | 971232 | 25.00 ppb | | 98 |
| 31) Tetrachloroethylene | 8.47 | 166 | 1416086 | 25.00 ppb | | 98 |
| 32) 1,1,1,2-tetrachloroethane | 9.21 | 131 | 1244471 | 25.00 ppb | | 97 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 32) | 1,1,1,2-tetrachloroethane | 9.21 | 131 | 1244471 | 25.00 ppb | | 97 |
| 33) | Chlorobenzene | 9.28 | 112 | 3234335 | 25.00 ppb | | 96 |
| 34) | Ethylbenzene | 9.56 | 91 | 4999416 | 25.00 ppb | | 96 |
| 35) | Bromoform | 9.77 | 173 | 985282 | 25.00 ppb | | 99 |
| 36) | m & p-Xylene | 9.78 | 91 | 7798300 | 25.00 ppb | | 96 |
| 37) | Styrene | 10.08 | 104 | 3107516 | 25.00 ppb | | 92 |
| 38) | 1,1,2,2-tetrachloroethane | 10.13 | 83 | 1204739 | 25.00 ppb | # | 1 |
| 39) | o-Xylene | 10.14 | 91 | 4011127 | 25.00 ppb | | 96 |
| 40) | 1,2,3-trichloropropane | 10.26 | 75 | 978833 | 25.00 ppb | | 93 |
| 41) | isopropylbenzene | 10.48 | 105 | 4780510 | 25.00 ppb | | 97 |
| 42) | Bromobenzene | 10.62 | 77 | 1682413 | 25.00 ppb | | 95 |
| 43) | n-propylbenzene | 10.86 | 91 | 5348606 | 25.00 ppb | | 97 |
| 44) | 2-chlorotoluene | 10.89 | 91 | 3345521 | 25.00 ppb | | 99 |
| 45) | 4-chlorotoluene | 10.96 | 91 | 4159907 | 25.00 ppb | | 88 |
| 46) | 1,3,5-trimethylbenzene | 11.12 | 105 | 4081684 | 25.00 ppb | | 91 |
| 47) | tert-butylbenzene | 11.30 | 119 | 4045879 | 25.00 ppb | | 95 |
| 48) | 1,2,4-trimethylbenzene | 11.40 | 105 | 4125834 | 25.00 ppb | | 93 |
| 49) | sec-butylbenzene | 11.47 | 105 | 5247423 | 25.00 ppb | | 99 |
| 50) | 1,3-dichlorobenzene | 11.48 | 146 | 2519084 | 25.00 ppb | | 98 |
| 51) | 1,4-dichlorobenzene | 11.53 | 146 | 2533620 | 25.00 ppb | | 98 |
| 52) | 4-isopropyltoluene | 11.62 | 119 | 4440105 | 25.00 ppb | | 97 |
| 53) | 1,2-dichlorobenzene | 11.78 | 146 | 2562461 | 25.00 ppb | | 99 |
| 54) | Butylbenzene | 11.91 | 91 | 3268215 | 25.00 ppb | | 99 |
| 55) | 1,2-dibromo-3,-chloropropa | 12.10 | 157 | 319144 | 25.00 ppb | | 92 |
| 56) | 1,2,4-trichlorobenzene | 13.00 | 180 | 1660739 | 25.00 ppb | | 98 |
| 57) | Naphthalene | 13.15 | 128 | 3632620 | 25.00 ppb | | 98 |
| 58) | Hexachlorobutadiene | 13.21 | 225 | 910080 | 25.00 ppb | | 99 |
| 59) | 1,2,3-trichlorobenzene | 13.27 | 180 | 1603228 | 25.00 ppb | | 99 |




| Amount | Response |
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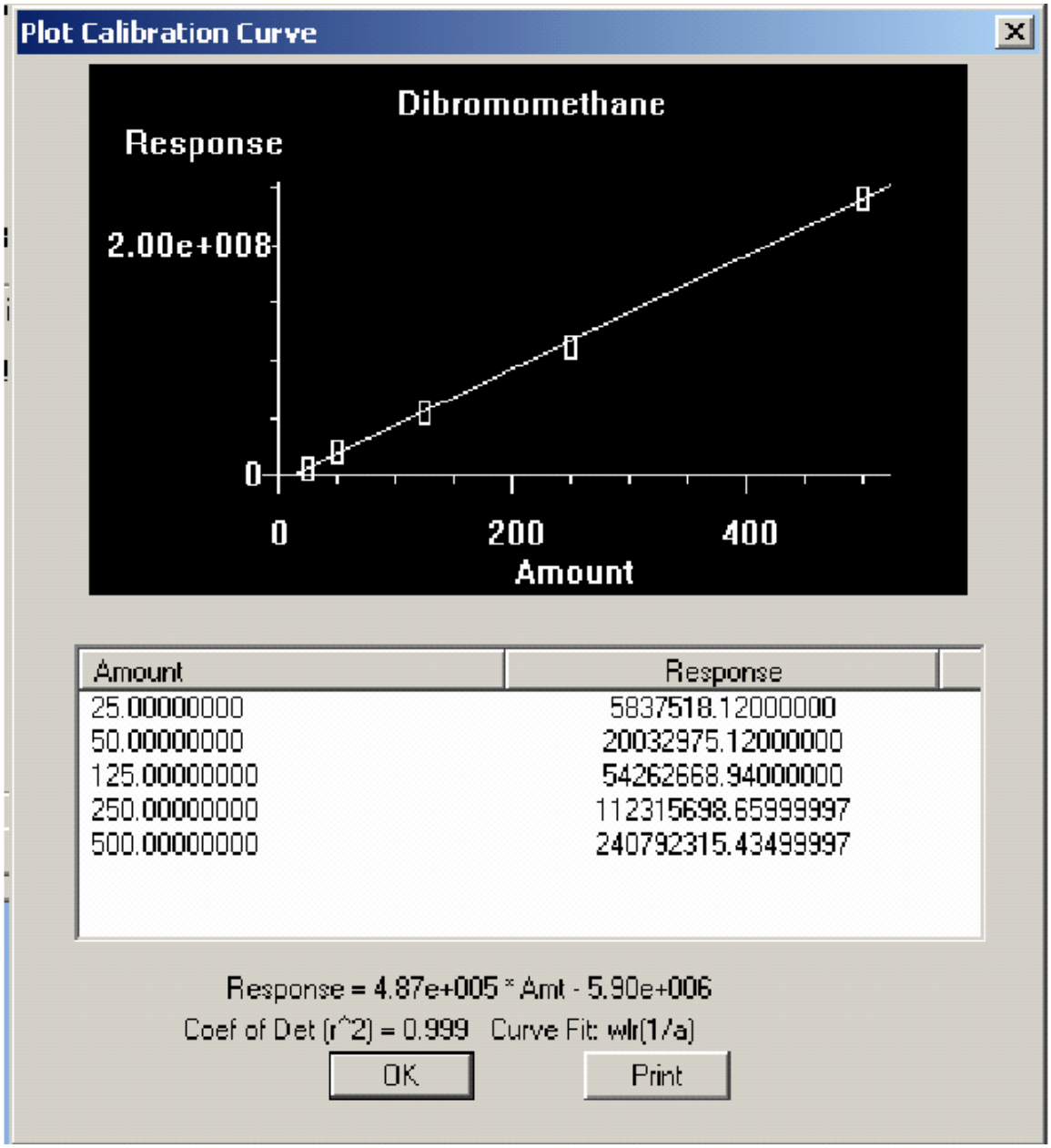
| 125.00000000 | 73671157.27953127 |
| 250.00000000 | 143722941.71578121 |
| 500.00000000 | 267525846.49046874 |

Response = 5.61e+005 * Amt - 1.97e+006

Coef of Det (r^2) = 0.995 Curve Fit: wlr(1/a)

OK Print




| Amount | Response |
|---|---|
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| 50.00000000 | 20032975.12000000 |
| 125.00000000 | 54262668.94000000 |
| 250.00000000 | 112315698.65999997 |
| 500.00000000 | 240792315.43499997 |

Response = 4.87e+005 * Amt - 5.90e+006

Coef of Det (r^2) = 0.999 Curve Fit: wlr(1/a)

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**Annexure-XI**

# PROFILE OF THE CHEMICALS

Source: National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, February 2004

| Sr. No. | Name of Chemical | Odour | Symptoms | Target organs | Carcinogen |
|---|---|---|---|---|---|
| 01 | Hydrogen sulphide | Rotten eggs | Irritation of eyes, respiratory system, coma, convulsion, conjunctivitis, eye pain, tears to eyes, dizziness, headache, weakness and exhaustion, insomnia, gastrointestinal disturbance | Eyes, respiratory system, Central Nervous System | No |
| 02 | Disagreeable odour like garlic or rotten cabbage | Irritation eyes, skin respiratory system | Irritation eyes, skin, respiratory system; convulsion | Eyes, skin, respiratory system, central Nervous System, blood | No |
| 03 | Dimethyl Sulphide | NA | Irritation, eyes, skin, respiratory system | Eyes, skin, respiratory system, central nervous system | No |
| 04 | Ethanol | Characteristic suffocating odour | Irritation eyes, skin, nose, headache, drowsiness, weakness, exhaustion, cough, liver damage, anemia, reproductive effects. | Eyes, skin, respiratory system, central nervous system, liver, blood, reproductive system | No |
| 05 | Methylene Chloride | Faint sweet odour | Irritation eyes, skin, weakness, exhaustion, drowsiness, dizziness, numbness, tingle limbs, nausea [potential occupational carcinogen] | Eyes, respiratory system, cancer site: [in animals: lung, liver, salivary& mammary gland tumours] | Yes |
| 06 | Trichloroethane | Chloroform like odour | Irritation eyes, skin, nose, headache, drowsiness, weakness, exhaustion, cough, liver damage, anemia, reproductive effects. | Eyes, skin respiratory system, heart, liver, kidneys cancer site: [in animals: liver and kidney cancer] | Yes |
| 07 | Toluene | Sweet pungent benzene like odour | Irritation eyes, nose, weakness, and exhaustion, confusion, dizziness, headache, dilated pupils, tears to eyes, anxiety, muscle fatigue, insomnia dermatitis, liver injury, kidney damage | Eyes, skin, respiratory system, central nervous system liver and kidney | No |
| 08 | Dimethyl Disulphide | NA | Irritation eyes, skin, respiratory system | Eyes, skin, respiratory system, central nervous system blood | No |
| 09 | Acetone | Fragrant mint like odour | Irritation eyes, nose, throat, headache, dizziness, central nervous system depression, dermatitis | Eyes, skin, respiratory system, central nervous system | No |
| 10 | Isopropyl Alchohol | Odour of rubbing | Irritation eyes, nose, throat, drowsiness, dizziness, headache, dry cracking skin, alcohol | Eyes, skin, respiratory system | No |
| 11 | n-Hexane | Gasoline like odour | Irritation of eyes, nose, nausea, headache, peripheral neuropathy, numbness, extremities muscle weakness, dermatitis, dizziness, chemical pneumonia | Eyes, skin, respiratory system, central nervous system | No |

| Sr. No. | Name of Chemical | Odour | Symptoms | Target organs | Carcinogen |
|---|---|---|---|---|---|
| 12 | Chloroform | Pleasant odour | Irritation of eyes, skin, dizziness, mental dullness, nausea, confusion; headache, weakness, exhaustion, enlarged liver [potential carcinogen] | Liver, kidneys, heart, eyes, skin, central nervous system cancer site: [in animals; liver and kidney cancer] | Yes |
| 13 | Carbon Tetrachloride | Characteristic either like odour | Irritation of eyes, skin, CNS depression, nausea, vomiting, liver, kidney injury, drowsiness, dizziness | Eyes. Respiratory system, lungs, liver kinder, skin cancer site: [in animals: liver cancer] | Yes |
| 14 | Benzene | An aromatic odour | Irritation eyes, skin, skin, nose, dizziness, headache, nauseam exhaustion, bone marrow depression [potential occupational carcinogen] | Eyes, skin, respiratory system, blood, central nervous system bone marrow Cancer Site [leukaemia] | Yes |
| 15 | 2-Butanone (Methyk Ethyl Ketone) | A moderately sharp, fragrant, mint- or acetone like odour | Irritation eyes, skin, nose, headache, dizziness, vomiting, dermatitis | Eyes, skin respiratory system blood, central nervous system | No |
| 16 | Carbon Disulphide | A sweet ether like odour | Dizziness, headache, poor sleep, weakness, exhaustion, anxiety, weight loss, gastritis, kidneys, liver injury, eyes burns, dermatitis, reproductive effects | Central nervous system, peripheral nervous system, cardiovascular system, eyes kidneys, liver, skin, reproductive system | No |
| 17 | Ethylbenzene | An aromatic odour | Irritation eyes, skin, mucous membrane, headache, coma. | Eyes, skin respiratory system, central nervous system | No |
| 18 | m,p Xylenes | An aromatic odour | Irritation eyes, skin, nose, throat, dizziness, excitement, drowsiness, incoordination, staggering, gait, nausea, vomiting, abdominal pain, dermatitis | Eyes, skin, respiratory system, central nervous system gastrointestinal tract, blood, liver, kidneys | No |
| 19 | Acetonitrile | An aromatic odour | Irritation nose, throat, nausea, vomiting, chest pain, weakness, exhaustion, convulsion, in animal: liver, kidneys damage | Respiratory system, cardiovascular system, central nervous system, liver, kindneys | No |
| 20 | Acrylomitrile | An unpleasant odour | Irritation eyes, skin, headache, sneezing, nausea, vomiting, weakness, exhaustion, dizziness, skin [potential occupational carcinogen] | Eyes, skin, cardiovascular system, liver, kidneys, central nervous system Cancer Site [brain tumours lung & bowel cancer] | Yes |
| 21 | 1,2-Dichloroethane | Chloroform-like odour | Irritation eyes, central nervous system depression; nausea, vomiting, dermatitis; liver, kidneys, cardiovascular system damage [potential occupational carcinogen] | Eyes, skin, kidneys, liver, central nervous system, cardiovascular system Cancer Site [in animals: forestomach, mammary gland and circulatory system cancer] | Yes |
| 22 | Vinyl chloride | Pleasant odour at high concentration | Weakness, exhaustion, abdominal pain, gastrointestinal bleeding, enlarged liver [potential occupational carcinogen] | Liver, Central Nervous System, blood, respiratory system, lymphatic system | Yes |
| 23 | I,I Dichlorochane | Chloroform like | Irritation skin, central nervous system depression, | Skin, liver, kidneys, lungs, central | No |

| | | | | | |
|---|---|---|---|---|---|
| | | odour | liver, kidneys, lung damage | nervous system | |
| 24 | 1,1,2-Trichlorothane | Sweet, chloroform like odour | Irritation eyes, nose, central nervous system depression, liver, kidney damage [potential occupational carcinogen] | Eyes, respiratory system, central nervous system liver, kidneys Cancer Site: [in animal liver cancer] | Yes |
| 25 | Clorobenzene | Almond like odour | Irritation eyes, skin, nose, drowsiness, incordination, central nervous system depression; in animals: liver, lung, kidney injury | Eyes, skin, respiratory system, central nervous system, blood. | No |
| 26 | o-Xylene | Aromatic odour | Irritation eyes, skin, nose, throat, dizziness, excitement, drowsiness, incordination, anorexia, nausea, vomiting, abdominal pain, dermatitis | Eyes, skin, respiratory system, central nervous system, gastrointestinal tract, blood, liver, kidneys | No |
| 27 | 1,2,4-Trimethylbenzene | | Irritation eyes, skin, nose, throat, respiratory system, bronchitis, headache, drowsiness, fatigue, dizziness, nausea, incordination, vomiting, confusion, chemical pneumonitis | Eyes, skin respiratory system, central nervous system, blood | No |
| 28 | Alpha-pinene | A characteristic odour | Irritation eyes, skin, nose, throat, headache, dizziness, convulsion, blood in the urine, kidney damage, abdominal pain, nausea | Eyes, skin respiratory system, central nervous system, kidneys | No |
| 29 | d-Limonene | Characteristic citrus odour | Irritation of eyes, nose, lungs, lightness of head, difficulty in breathing, skin irritation, liver injury, kidney damage | Eyes, skin, respiratory system, liver and kidney | No |
| 30 | 1,3 Butadiene | Mild aromatic and gasoline like odour | Irritation eyes, nose, throat, drosiness, dizziness, reproductive damages, [potential occupational carcinogen] | Eyes, respiratory system, central nervous system, reproductive system Cancer Site [blood cancer] | Yes |
| 31 | Acrolin | A piercing disagreeable odour | Irritation eyes, skin, mucous membrane, chronic respiratory disease | Eyes, skin, respiratory system, heart | No |
| 32 | Methyl tert-Butyl Ether | NA | NA | NA | NA |
| 33 | Styrene | A sweet, floral odour | Irritation eyes, nose, respiratory system, headache, weakness, exhaustion, dissiness, confusion, drowsiness, unsteady gait, possible liver injury, reproductive effects | Eyes, skin, respiratory system, central nervous system, liver, reproductive system | No |
| 34 | Nonane | A gasoline like odour | Irritation eyes, skin, nose, throat, headache, drowsiness, dizziness, confusion, nausea, tremor | Eyes. Skin, respiratory system, central nervous | No system |
| 35 | Chloromethane | A faint sweet odour | Dizziness, nausea, vomiting, visual, disturbance, stagger, slurred speech, convulsion, coma, liver, kidney damage reproductive [potential occupational carcinogen] | Central nervous system, liver, kidneys, reproductive system Cancer Site [ in animals; lungs, kidney & forestomach tumours] | No |
| 36 | N-Butyl Acetate | A mild turpentine like odour | Irritation eyes, skin, upper respiratory system, headache, drowsiness | Eyes, skin, respiratory system, central nervous system | No |

| | | | | | |
|---|---|---|---|---|---|
| 37 | Hexachlorobutadiene | A mild, turpentine like odour | In animals, irritation eyes, skin, respiratory system; kidney damage; [potential occupational carcinogen] | Eyes, skin, respiratory system, kidneys Cancer Site [in animals: kidney tumours] | Yes |
| 38 | Carbony Sulphide | NA | NA | NA | NA |
| 39 | Chloroethane | A pungent ether-like odour | Incordination abdominal cramps, cardiac arrest; liver, kidney damage | Liver, kidneys, respiratory system, cardiovascular system, central nervous system | No |
| 40 | Trichlorofluoromethane | Odourless liquid | Incordination, tremor, dermatitis, cardiac arrest | Skin, respiratory system, cardiovascular system | No |
| 41 | 4-Methyl-2-Pentanone | A mild odour | Irritation eyes, skin, headache, drowsiness, dermatitis | Eyes, skin central nervous system | No |
| 42 | Cumene | A sharp, penentrating aromatic odour | Irritation eyes, skin, mucous membrane; dermatitis, headache, coma | Eyes, skin, respiratory system, central nervous system | No |
| 43 | 1,3,5-Trimethyl benzene | A distinctive aromatic odour | Irritation eyes, skin, nose, throat, respiratory system, bronchitis, headache, drosiness, fatigue, dizziness, nausea, incordination, vomiting, confusion, chemical pneumonits | Eyes, skin, respiratory system, central nervous system, blood | No |
| 44 | Bromomethane | A chloroform like odour at high temperature | Irritation eyes, skin, respiratory system, central Nervous System depression; liver, kidney disease cardiac arrest [potential occupational carcinogen] | Eyes, skin, respiratory system, central nervous system, blood | No |
| 45 | Vinyl Acetate | A pleasant fruit odour | Irritation eyes, skin, nose, throat, hoarseness cough, loss of smell; eye burns, skin blisters | Eyes, skin respiratory system | No |

## Annexure - XII

## INTERNATIONAL STANDARDS OF SOME VOC COMPOUNDS.

| Name of the chemicals | EPA Region levels (µg/m3) | Texas Effects screening levels short term (µg/m3) | Texas Effects screening levels long term (µg/m3) | North Carolina Annual Standards (µg/m3) | North Carolina 24-Hr Standards (µg/m3) | North Carolina l-hr standards (irritants (µg/m3) | California EPA Rfc* µg/m3 (health numbers)# |
|---|---|---|---|---|---|---|---|
| Hydrogen Sulphide | 1.00 | 1.00 | - | - | - | 330 | - |
| Methyl mercaptan | 2.10 | 2.00 | 0.200 | - | - | 50 | - |
| Dimethyl sulphide | - | - | 3.00 | - | - | - | - |
| Ethanol | - | 18800 | 1880 | - | - | - | - |
| Methylene chloride | 4.09 | 260 | 26.0 | 24.0 | - | - | 3000 |
| Trichloroethane | 1.10 | 1350 | 135 | 59 | - | - | 600 |
| Toluene | 400 | 1880 | 188 | - | - | 4700 | 400 |
| Dimethyl Disulphide | - | - | - | - | - | - | - |
| Acetone | 370 | 5900 | 590 | - | - | - | - |
| Isopropyl Alcohol | - | 7850 | 785 | - | - | - | - |
| n-Hexane | 210 | 1760 | 172 | - | 1100 | - | - |
| Chloroform | 0.0840 | 98.0 | 9.80 | 4.30 | - | - | 300 |
| Carbon tetrachloride | 0.130 | 126 | 13.0 | 6.70 | - | - | 40 |
| Benzene | 0.250 | 12.0 | 3.00 | 0.120 | - | - | 60 |
| 2- Butanone (methyl ethyl ketone) | | 1000 | 3900 | 390 | | 3700 | 1000 |
| Carbon disulphide | 730 | 30.0 | 3.00 | - | 186 | - | - |
| Ethyl benzene | 1100 | 2000 | 200 | - | - | - | 1000 |
| m,p xylene | - | 2070 | 208 | - | - | - | 60 |
| Acetonitrile | 62.0 | 340 | 34.0 | - | - | - | 2 |
| Acrylonitrile | 0.0280 | 43.0 | 4.30 | 0.15 | - | - | 2 |
| 1,2-Dichloroethane | 0.0740 | 16.0 | 4.00 | 3.80 | - | - | 400 |
| Vinyl chloride | 0.220 | 130 | 13.0 | 0.380 | | | 10 |
| 1,1 Dichloroethane | 520 | 4000 | 400 | | | | 500 |
| 1,1,2-trichloroethane | | | | | | | |
| Chlorobenzene | 0.120 | 550 | 55 | | | | 400 |
| o-xylene | 730 | - | - | | | | - |
| 1,2,4- trimethyl benzene | 6.20 | 1250 | 125 | | | | - |

## ANNEXURE - XIII

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