Chapter II

Description of samples and experimental Methods
As a part of the programme, some of the odorous pollutants such as sulphur dioxide, nitrogen dioxide, oxidants (represented as ozone), were studied to determine their levels and their influence on metal at different industrial locations and busy roads intersections at some selected places of Ahmedabad city.

Ahmedabad is mainly divided in two parts, one on eastern bank of Sabarmati and the other on western bank. The eastern side can further be divided into two zones, one far-east zone which is purely industrial and the other a commercial and residential area with very high density of population, On the western side of Sabarmati river lies a purely residential area.

For the purpose of the study, interest was mainly in industrial, and commercial and residential areas. However, for reference purely residential areas were also considered. The description of the sampling sites and sampling conditions is as under.

1 For the sampling of sulphur dioxide, nitrogen dioxide, oxidants (ozone) the sites selected are as shown in map 2.1. Map 2.1 also indicates places were corrosion study was carried out. In all, 12 sites were selected
MAP SHOWING SAMPLING SITES IN AHMEDABAD CITY

- Naranpura Zone
- University Zone
- Ramrat

MAP-2:1
out of which 4 were in industrial area, 6 in residential-commercial area and 2 in purely residential area.

Site 1 - Naroda C-colony:

Industrial complexes, number of textile mills, chemical plants and a railway line are in this zone. Samples were taken at 30'. Wind direction during August-December is SW-SE.

Site 2 - Rakhipal (Shanker Chemicals):

The metals were exposed just outside the factory 'Shanker Chemicals' producing sodium meta-bisulphite using sulphur. This one is an old factory. There are, therefore, some leakages and SO₂ gas gets liberated not only from the chimney but also from the leakages. SO₂ gas can be smelled even at a distance and if one remains for more time, coughing starts. Exposed metals were kept at a distance of 100 meters from the chimney at the height of 30', wind direction was usually from chimney to sampling point for most of the days, for most part of the year.

Site 3 - (Gandhi Road) Bala Hanuman:

This also is a busy and well travelled road similar to Gheekanta Road. It is also congested by tall buildings of the average height of 40'. The road is 30' wide. Heavy traffic, with the average of 3000 vehicles per hour, during the peak hours is observed. The atmosphere is smoky during
the evening hours. Tall buildings inhibit wind circulation and traffic conditions are poor. Samples were taken at the noise height near the road side during the peak hours.

Site 4 - Pankor Naka:

This site is similar to site - 3.

Site 5 - Relief Road:

Relief Road is passing through the business centre with thickly populated area. It is 60' wide at the sampling point, congested by tall buildings of the average height of 50' on both the sides of the road. All other conditions are the same as above sites (i.e. no...). Samples were collected during peak hours at the height of 6' above the road level just near the roadside.

Site 6 - Checkanta Road:

This road of the city is one of the veins of Ahmedabad. It is a narrow road 30' wide. It is surrounded by tall buildings on both the sides. It is a densely populated area and main business centre of the city. Peak hours are from 10.00 a.m. to 11.30 a.m. and during evening 6.00 p.m. to 8.00 p.m. During this period, traffic jams are observed. Traffic density during peak hours is about 2000 vehicle per hour. But the exhaust emissions are high, because of the poor performance of municipal and three wheeler autorikshaws;
In the evening time, smoke settles on the road, thereby reducing the visibility. Samples were taken at a height of 15' from the road level near an intersection of the roads. Because of the tall buildings wind is obstructed considerably. Eye irritation and smoke odor have been found to occur on many days during winter months.

**Site 7 - Kalupur Police Station:**

Description is almost similar to that at site 5 (Relief Road).

Eye irritation is frequent. Smoke settles in the evening. The sampling site is situated in the housing colony. Samples were taken at the height of 15' from the ground level—wind direction during most part of the year is from the area of six chimneys towards the sampling site.

**Site 8 - Kalupur Overbridge:**

It is the part of the city where truck traffic is at its maximum. This part is situated just near the main railway station of Ahmedabad where coal fire engines are in operation. Like other parts, this also is a densely populated area. Samples were taken at the intersection of six roads and about 50 meters from the railway lines. Smoky conditions are observed during evening, especially during winter months. Samples were taken at the height of 15' from ground level.
Site 9 - Saraspur:

This station is also situated in industrial area. Sampling station was situated in the vicinity of a big chemical plant. The wind direction is from plant to a sampling station during September to March.

Site 10 - Rakhial (Lal Mills area):

It is situated in the industrial area where number of textile mills are located. Samples were taken at the centre of the area of six textile mills as shown in map 2.1.

Site 11 - Paldi:

Sampling station was situated in the purely residential area on the bank of Sabarmati river. It is not as densely populated as the eastern part. No tall buildings are there. Smoky atmosphere is not found. Samples were taken at a height of 15' during evening time.

Site 12 - Naranpura:

Same as in Paldi area.

11 To study the effect of water vapour and other gaseous pollutants on the corrosion of metals like mild steel, zinc aluminium five sites were selected.
Site 1 - Cellulose products:

The metals were exposed in the premises of the Cellulose products of India Ltd. It manufactures CMC and chloroacetic acid. It's emission contains Cl⁻, Cl₂ and vapours of acetic acid and chloroacetic acid. The metals were exposed some 100 meters away from the chimney at the height of 70' facing the chimney. The wind direction during July to January is generally from chimney to sampling point.

Site 2 - Raknial (Shanker Chemicals):

The metals were exposed just outside the factory 'Shanker Chemicals' producing sodium meta-bismuthite using sulphur. This one is an old factory. There are, therefore, some leakages and SO₂ gas gets liberated not only from the chimney but also from the leakages. SO₂ gas can be smelled even at a distance and if one remains for more time, coughing starts. Exposed metals were kept at a distance of 100 meters from the chimney at the height of 30', wind direction was usually from chimney to sampling point for most of the days, for most part of the year.

Site 3 - Kankaria (Ambica mills Compound):

The metals were exposed at the premises of the Ambica mills compound, where the prevailing atmosphere of SO₂, soot and other emissions due to textile mill, nearby
chemical plant and adjoining Kankaria loco-shed (Ahmedabad station). The metals were kept in the direction facing the mills, and were put in the open ground.

Site 4: Kavarangpur:

The metals were exposed at 15' height in an open area. This is purely a residential area where atmosphere is unpolluted. The metals were exposed in South-West direction.

Sampling Methods:

For the purpose of taking the samples of pollutants such as SO₂, NO₂ and oxides and N₂O, following sampling technique, was used.

Midget impinger was used to sample the air. Its orifice was of 1 mm internal diameter and the distance between the nozzle and the bottom was kept at 5 mm. The 10 ml. selective absorbent was put in this impinger and the air was drawn through it for an hour. Impinger was followed by the calibrated flow-meter to read the rate of flow of air through impinger. It was further connected to the distributor which was followed by a glass bottle of 500 ml. capacity which in turn was joined to the vacuum pump of the capacity of drawing 10 litres per minute. The empty bottle served the purpose of making the suction uniform. Four
impingers were attached to the four outlets of the distributor through flow meters. The vacuum created by the impinger specifications was 12" of water. The efficiency of the impinger was found to be 93-96%. Samples were taken at the respective places of interest for an hour and then immediately taken to the laboratory and analysed.

Ozone measurements were made by emf method as per Indian Meteorological Department instructions for use and care of surface ozone recorder. A cell was consisting of a platinum wire-gauge and silver electrodes and the medium was KI in neutral buffer of dihydrogen sodium phosphate and disodium hydrogen phosphate. The cell wires were joined to the positive and negative terminals of an amplifier which amplified the cell potential. The counter emf 0.42 v was applied by the battery to counter the cell potential. After amplification it was connected to a recorder which recorded the current changes in milliamperes. The air was drawn through the cell by the motors which drew the air at the rate of 100 ml. per 22 seconds and 23 seconds. Continuous recording at the sampling sites was done. This air flow was checked by the calibrated flow-meter which read 0.1 lpm to 1 lpm. Ozone, chlorine, hydrogen peroxide, organic peroxides and various other oxidants will liberated iodine by this method. A positive response of about 10% of the ppm
\( \text{NO}_2 \) occurs. It is customary to express the results as zone. Serious interferences occur from reducing gases and dust.

For corrosion studies, the specimens of the size 15x10 cm. of the metals were cut. These metals were fixed on the rack which was inclined at 45° angle. Then the rack was placed facing the direction of the wind.

To determine chloride in air, a surgical gauge was wrapped around a glass tube. It was previously boiled with distilled water for two hours to remove all starch. It was then exposed to air with its ends in distilled water to keep it wet. It was put in a shade so as to protect it from sun, birds, etc.

To study the \( \text{SO}_2 \) in the air \( \text{PbO}_2 \) candle method was used. Candle was prepared by applying 5 gms of \( \text{PbO}_2 \), in about 5 ml of gum tragacanth solution prepared by dissolving the gum in ethyl alcohol and diluting with distilled water, and applied to a cotton gauge wrapped around the glass tube having covered area 10x10 cms. The candle was exposed in a cage which was very well ventilated and covered at the top so as to protect it from the sun and birds.

Odorant pollutant samples for absorption study in laboratory were prepared by taking the known amount of inorganic substance or organic substance to liberate a gas or organic vapour in a glass bottle. Air gas (vapour) mixture
was withdrawn every time and for each liquid absorbent. Air-gas (vapour) mixture concentration was determined every time before and after the absorption by chemical methods.

Fruit samples were obtained from the local market. In some cases, unripe fruits were purchased and half the number of fruits were allowed to ripen, while in other cases, ripe and unripe fruits were purchased. Care was taken to see that all the purchased fruits belong to the similar size, colour and appearance, and all belonged to the same garden.

Methods of Analyses:

SO$_2$:

For determining SO$_2$ in ambient air, West and Gaite colorimetric method was used $2, 3, 4, 5$. This method is applicable in the range of 0.005 to 5 ppm. SO$_2$ in air is absorbed in 0.1 N sodium tetrachloro mercury. Non-volatile dichlorosulfite mercury ion is formed in this process. To this, 2.5 ml of acid bleached pararosaniline hydrochloride is added, followed by 2.5 ml of 0.2% formaldehyde solution and diluted to 25 ml. It was allowed to stand for 20 minutes for maximum colour development and then read at 560 m.$\mu$m. Using Ema colorimeter Model AE, 11 calculations were done.
according to formula

\[ SO_2 \text{ ppm} = \frac{\text{microlitres of SO}_2 \text{ in sample}}{\text{volume of air sampled in litres at STP}} \]

**NO\textsubscript{2}**:

This was determined by Saltzman method\(^6,7,3\). This method is sensitive over a range from few ppb to about 5 ppm.

After collection of sample in 0.1 N NaOH, color reagents were added and was allowed to stand for 15 minutes for full colour development. The intensity of colour was measured at 550 m\(\mu\) using Bruna AE-11, concentration of NO\textsubscript{2} (in ppm) was calculated following the formula:

\[ NO_2 \text{ ppm} = \text{Corrected Absorbance} \times \frac{A}{V} \]

where \( V \) = volume of air sample

\( M \) = volume in m\(\mu\) of NaNO\textsubscript{2} interpreted at absorbance 1.

This value multiplied by 4 gives standard factor \( h \) defined as number of microlitres of NO\textsubscript{2} required by 10 m\(\mu\) absorbing reagent to give an absorbance of 1.

**Oxidants**:

Oxidants were determined by Alkaline potassium iodide method(9).
This method was selected because its range is from a few parts per hundred millions to about 20 ppm. Sample was taken in alkaline KI solution to which H₂O₂ have been added to remove interference from SO₂. The solution was boiled and cooled so as to remove excess H₂O₂ and then acidified by sulphuric acid to 3.8 pH and then read at 352 nm by colorimeter Luma Al-11.

Calculations were done as per formula given below:

\[
\text{Oxidant ppm (expressed as O}_3) = \frac{\text{Corrected absorbance}}{V} \times N/V
\]

where \( V \) = volume of air sampled  
\( N \) = standardization factor.

Ozone:

Continuous ozone measurement was done by neutral buffered KI. The iodine liberated was measured by the change in current of a cell consisting of Pt/neutral buffered KI/Ag. The procedure and calculations were done as per IMD booklet.¹⁰

Atmospheric pollution determination:

SO₂ was determined by the method evolved by the Fuel Research Institute U.K.¹¹ and according to Department of Scientific and Industrial Research.¹²,¹³
Chloride content of the air was determined by the wet candle method evolved by Ambler. The candle consisted of a piece of surgical bandage (10x10 cms) wrapped around a glass cylinder and maintained wet by dipping its two ends into a glass container containing distilled water. After exposure of one month, candle was removed, boiled with the bandage and made up to a fixed volume. Chloride content was measured by titrations with standard silver nitrate solution using potassium chromate as indicator.

Preparation of Specimens:

Mild steel plates were made free from mill scale by immersing them in Clerk's solution and finished with number 'c' grade with emery paper, de-greased in sulphur free distilled CCl₄, dried and weighed. After exposure, the same treatment was used and the loss in weight determined emmensing in Clerk's solution for three minutes.

Zinc panels were washed with 5% chromic acid solution, then polished and buffered using Ronak polishing and buffing compositions and finally degreased with sulphur free distilled CCl₄, then weighed corrosion products were removed by immersing in cold 10% chromic acid for 5 minutes at room temperature. Then panel was washed by water to remove chromic acid. Then it was dried and weighed and loss determined.
Aluminium panels were washed in chromic acid solution containing \( \text{Cr}_2\text{O}_3 \) in \( \text{H}_2\text{SO}_4 \) and buffed, finally degreased with \( \text{CCl}_4 \).

The panels were exposed in outdoor conditions on Monel metal frames at an angle of 45° facing south. The panels were exposed in duplicate.

Fruit samples were obtained from local market and the pulp of the fruit was analysed for pH, sugars and titratable acids using standard methods of analyses\(^2\).
REFERENCES

1. Stem, A.C., 'Air Pollution', Vol. 11, p. 73-75 Pub.
2. West, P.W. and Gasek, J.C., Ind. Eng. Chem. 48, 1517
   (1956).
5. Hochhaisev, S., U.S.Public Health Serv. Publ. 999-AP-
   6 (1964).
7. Thomas, R.D., MacLeod, J.A., Robbin, J.C., Goettelman,
   23, 1810 (1950).
10. Indian Meteorological Departments, 'Instructions for use
    'Investigation of Atmospheric Pollution', Vid. Saryal,
    Bond, Singhania, G.K., J. Sc. Ind. Res. (Ind.), 15 B (3)
    455 (1956).
12. Department of Scientific and Industrial Research (DSIR),
    'Investigation of Atmospheric Pollution 1931-1933',