



Air Quality Assessment in Coimbatore City

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Abstract: As per Bureau of Indian Standards Air Pollution is one of the biggest issues facing by Human race. Air pollution is defined by “Presence of Unwanted substances in the Ambient Atmosphere”. Major Pollutants causing Air Pollution is Particulate matter (PM10, PM2.5), Oxides of Nitrogen (NO₂), Oxides of Sulphur (SO₂), Carbon monoxide (CO) and Lead. Ambient Aerosols present in the atmosphere is also reason for increase in Air pollution. Air Quality Index is a risk tool communication which tells us about threats to the Environment. Meteorological parameters are also responsible for change in the concentrations of pollutants present. National Ambient Air Quality Standards gives the rational value which indicates problems. As Per NAAQS there are six categories Good, Moderate, Satisfactory, Poor, Very poor, Severe and with respective Color, and Nomenclatures. Though current AQI data is not available for Coimbatore city it is monitored using Air Samplers and Dispersion Models. The data interpreted is compared with Indian Standards.

I. INTRODUCTION

Air quality evaluation is important for assessing the nature of population exposure to air pollution. Assessment of population exposure is necessary for health impact assessment, which in turn is crucial for developing plans for air quality management and protecting the public health. Air quality also depends upon type of pollutant, the magnitude, the duration and sources. Monitoring of air is often used to determine the air pollution levels in urban and rural environments. A monitoring network produces concentration measurements that can be compared with the national and international guideline values. The risk factors includes traffic volumes, population and activities in the environment. The pollutants include gases, particulate matters, radioactive materials and many others. Most of these substances are naturally present in the atmosphere in low concentrations and are usually considered to be harmless. Our papers involve outdoor air monitoring in four different locations such as Annur, Peelamedu, Sivanantha Colony and Town Hall situated at Coimbatore. Air sampling methods are being adopted for air sampling and tested in laboratory for respective pollutants causing undesirable changes.

II. EQUIPMENT'S AND METHODOLOGY

In this paper we selected some areas in Coimbatore city which includes,

- Annur
- Peelamedu
- Sivanantha Colony
- Town Hall

Annur (11.23° N 77.10° E) is a town panchayat and taluk headquarter of Coimbatore city. It is a suburb of Coimbatore city located north-east from the center of city. According to census government of India, Annur has a population of 20079 people are lived.

Peelamedu (11.0332°N 77.0277°E) is a neighborhood in the eastern part of Coimbatore city. It is a major commercial center and one of the oldest residential part of city. The growth of peelamedu during the last decade can be cited due to the growth of IT sectors. Area stretches from Nava India to Sitra, encompassing major educational institutions, hospitals and industries. Pollution around this zone varies due to population, activities and traffic.

Coimbatore Town Hall (10.9941° N, 76.9557° E) is a neoclassical municipal building in Coimbatore, India. The building has been used for Municipal Corporation meetings, public meetings and protests and civic receptions.

Sivanantha Colony (11.0225° N, 76.9565° E) is a neighborhood and suburb in Coimbatore, India. Sivanantha Colony shares its border with Tatabad, R.S.Puram, Rathinapuri and Kavundampalayam. Locality map of Sivanantha Colony showing roads, local train routes, hotels, hospitals, schools, religious places.



SAMPLING AND ANALYSIS OF PM₁₀ (GRAVIMETRIC METHOD)

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM₁₀ in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Field Sampling - Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. For automatically flow-controlled units, record the designated flow rate on the data sheet. Record the reading of the elapsed time meter. The specified length of sampling is commonly 8 hours or 24 hours. During this period, several reading (hourly) of flow rate should be taken. After the required time of sampling, record the flow meter reading, take out the filter media from the sampler, and put in a container or envelope.

Filter inspection: Inspect the filter for pin holes using a light table. Loose particles should be removed with a soft brush. Apply the filter identification number or a code to the filter if it is not a numbered. Condition the filter in conditioning room maintained within 20-30°C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Take initial weight of the filter paper (W_i) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30°C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Take final weight of the filter paper (W_f)

Calibration

Periodical calibration of the sampler is being done by Orifice Transfer Standard - The PM₁₀ sampler calibration orifice consists of a 3.175 cm (1.25 in) diameter hole in the end cap of 7.62 cm (3 in) diameter by 20.3 cm (8 in) long hollow metal cylinder. This orifice is mounted tightly to the filter support in place of the inlet during calibration. A small tap on the side of the cylinder is provided to measure the pressure drop across the orifice. A flow rate of 1132 L/min through the orifice typically results in a pressure difference of several inches of water. The relationship between pressure difference and flow rate is established via a calibration curve derived from measurements against a primary standard such as a Roots meter at standard temperature and pressure. Flow resistances that simulate filter resistances are introduced at the end of the calibrator opposite the orifice by a set of perforated circular disks.

Calculation

$$C_{PM_{10}}(\mu\text{g}/\text{m}^3) = (W_f - W_i) \times 10^6 / V$$

Where, $C_{PM_{10}}$ = Concentration of PM₁₀, $\mu\text{g}/\text{m}^3$ W_f = Initial weight of filter in g
 W_i = Initial weight of filter in g 10^6 = Conversion of g to μg
 V = Volume of air sampled, m^3

Particulate matter 10: (PM₁₀)

$$\text{Volume of air sample in } \text{m}^3 \quad V = Qt; \quad V = 0.82 + 0.80/2 \times 357\text{min} \quad = 289.17 \text{ m}^3$$

$$PM_{10} = W_2 - W_1 \times 10^6 / V$$

$$= 0.0116 \times 10^6 / 289.17 \quad = 40.12 \mu\text{g}/\text{m}^3$$

$$\text{Volume of air sample in } \text{m}^3 \quad V = Qt$$

$$V = 0.99 + 0.98/2 \times 370\text{min} \quad = 365.435 \text{ m}^3$$

$$PM_{10} = W_2 - W_1 \times 10^3 / V \quad = 0.0227 \times 10^6 / 365.435 \quad = 62.25 \mu\text{g}/\text{m}^3$$

Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

SAMPLING AND ANALYSIS OF PM_{2.5} (GRAVIMETRIC METHOD)

Principle



An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a mass flow / volumetric flow controller coupled to a microprocessor into specially designed inertial particle-size separator (i.e. cyclones or impactors) where the suspended particulate matter in the PM_{2.5} size ranges is separated for collection on a 47 mm poly tetra fluoro ethylene (PTFE) filter over a specified sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the PM_{2.5} size ranges divided by the actual volume of air sampled, and is expressed in µg/m³. The microprocessor reads averages and stores five-minute averages of ambient temperature, ambient pressure, filter temperature and volumetric flow rate. In addition, the microprocessor calculates the average temperatures and pressure, total volumetric flow for the entire sample run time and the coefficient of variation of the flow rate.

Calculation and Reporting of Mass Concentration

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$$M_{2.5} = (M_f - M_i) \text{ mg} \times 10^{-3} \mu\text{g}$$

$M_{2.5}$ = total mass of fine particulate collected during sampling period (µg)

M_f = final mass of the conditioned filter after sample collection (mg)

M_i = initial mass of the conditioned filter before sample collection (mg)

10^3 = unit conversion factor for milligrams (mg) to micrograms (µg)

Field records of PM_{2.5} samplers are required to provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler.

$$V = Q_{\text{avg}} \times t \times 10^{-3} \text{ m}^3$$

Where,

V = total sample value (m³)

Q_{avg} = average flow rate over the entire duration of the sampling period (L/min)

t = duration of sampling period (min)

10^3 = unit conversion factor for liters (L) into cubic meters (m³)

The equation given below can be used to determine PM_{2.5} mass concentration:

$$PM_{2.5} = M_{2.5} / V$$

Particulate matter 2.5 micron: (PM_{2.5})

$$\text{Volume of air sample in m}^3 V = Q_{\text{avg}} \times t \times 10^{-3} \text{ m}^3 = 16.67 \times 480 \times 0.001 = 8.0016 \text{ m}^3$$

$$m_{2.5} = (m_f - m_i) \times 10^3 \mu\text{g} = 0.132 \text{ mg} \times 1000 = 132 \mu\text{g}$$

$$PM_{2.5} = m_{2.5} / V = 132 / 8.0016 = 16.50 \mu\text{g/m}^3$$

$$\text{Volume of air sample in m}^3 V = Q_{\text{avg}} \times t \times 10^{-3} \text{ m}^3 = 16.67 \times 495 \times 0.01 = 8.25165 \text{ m}^3$$

$$m_{2.5} = 0.203 \times 1000 = 203 \mu\text{g}$$

$$PM_{2.5} = m_{2.5} / V = 203 / 8.25165 = 24.6 \mu\text{g/m}^3$$

Data reporting should be done in prescribed Format. The Format shall contain all information including calibration. The data sheet must be accompanied by Sample Tracking sheet.

SAMPLING AND ANALYSIS OF NITROGEN DI OXIDE(NO₂) IN AMBIENT AIR(MODIFIED JACOB AND HOCHHEISER METHOD)

Principle of the method

Modified Jacob & Hochheiser Method (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of nitrogen).

Ambient nitrogen dioxide (NO₂) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO₂) produced during sampling is determined colorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)-ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

Calibration

Preparation of Standards

Pipette 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 15 and 20 ml of working standard solution in to 50 ml volumetric flask. Fill to 20 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Add reagents to



each volumetric flask as in the procedure for analysis. Read the absorbance of each standard and reagent blank against distilled water reference.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C (\text{NO}_2 \mu\text{g}/\text{m}^3) = (A_s - A_b) \times \text{CF} \times V_s / V_a \times V_t \times 0.82$$

Where,

C NO₂ = Concentration of Nitrogen dioxide, μg/m³

A_s = Absorbance of sample

A_b = Absorbance of reagent blank

CF = Calibration factor

V_a = Volume of air sampled, m³

V_s = Volume of sample, ml

V_t = Volume of aliquot taken for analysis

0.82 = Sampling efficiency

Nitrogen-di-oxide: (NO₂)

$$\begin{aligned} \text{Volume of air sample in m}^3 V_a &= (f_i \times f_t) / 2 \times (t_f - t_i) \times 60 \times 10^{-3} \\ &= (2 + 1.5) / 2 \times 357 \times 10^{-3} \\ V_a &= 0.62475 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{NO}_2 &= (\text{NO}_2 \mu\text{g}/50\text{ml} \times D \times V_s) / (V_a \times 0.8 \times V_t) \\ \text{Abs} &= 0.059 \end{aligned}$$

$$= (0.059 + 0.01545) / 0.020686 = 3.59 \mu\text{g}/50\text{ml}$$

$$\text{NO}_2 = (3.59 \times 1 \times 27) / (0.62475 \times 0.82 \times 10) = 18.92 \mu\text{g}/\text{m}^3$$

$$\begin{aligned} \text{Volume of air sample in m}^3 V_a &= (f_i \times f_t) / 2 \times (t_f - t_i) \times 60 \times 10^{-3} = (1 + 0.9) / 2 \times 371 \times 10^{-3} \\ &= 0.35245 \text{ m}^3 \end{aligned}$$

$$\text{Abs} = 0.071 \quad \text{NO}_2 = (\text{Absorption} - \text{Intercept}) / \text{slope value}$$

$$= (0.071 + 0.01545) / 0.020686 = 4.17 \mu\text{g}/50\text{ml}$$

$$\text{NO}_2 = (4.17 \times 1 \times 25) / (0.35245 \times 0.82 \times 10) = 36.07 \mu\text{g}/\text{m}^3$$

Quality Control (QC) is the techniques that are used to fulfil requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

SAMPLING AND ANALYSIS OF SULPHUR DI OXIDE(SO₂) IN AMBIENT AIR (IMPROVED WEST AND GAEKE METHOD) AS PER IS 5182(PART 2) - 2001

Principle of the method

Modified West &Gaeke Method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide). Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro-mercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely coloured pararos aniline methyl sulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer

Calibration

The actual concentration of the sulphite solution is determined by adding excess iodine and back titrating with standard sodium thiosulfate solution. To back-titrate, measure, by pipette, 50 ml of the 0.01 N iodine solution into each of two 500 ml iodine flasks A and B. To flask A (blank) add 25 ml distilled water and into flask B (sample) measure 25 ml



sulphite solution by pipette. Stopper the flasks and allow to react for 5 minutes. Prepare the working sulphite-TCM solution at the same time iodine solution is added to the flasks. By means of a burette containing standardized 0.01 N thiosulfate, titrate each flask in turn to a pale yellow. Then add 5 ml starch solution and continue the titration until the blue colour disappears.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

Concentration of sulphite solution

$$C = ((V1-V2) \times N \times K)/V$$

Where,

C= SO₂ concentration in µg/ml
 V1= Volume of thiosulfate for blank, ml
 V2= Volume of thiosulfate for sample, ml
 N= Normality of thiosulfate
 K = 32000 (Milliequivalent weight SO₂/µg)
 V = Volume of standard sulphite solution, ml
 $C(SO_2 \mu g/m^3) = (A_s - A_b) \times CF \times V_s / V_a \times V_t$

Where,

C(SO₂) = Concentration of Sulphur dioxide, µg/m³
 A_s = Absorbance of Sample
 A_b = Absorbance of Reagent blank
 CF = Calibration Factor
 V_s = Volume of air sampled, m³
 V_a = Volume of sample, ml
 V_t = Volume of Aliquot taken for analysis, ml

Sulphur-di-oxide: (SO₂)

$$\text{Volume of air sample in m}^3 V = (f_i \times f_t) / 2 \times (t_f - t_i) \times 60 = (1 + 0.9) / 2 \times 357 = 339.15 \text{ L}$$

$$V_n = V \times (P / 760) \times (298 / (t + 273)) = 339.15 \times (730 / 760) \times (298 / (32 + 273)) = 339.15 \times 0.96053 \times 0.9771 = 318.3 \text{ L}$$

$$C = (A - A_0 \times 10^3 \times B) / V_n \times D = (0.745 \times 10^3 \times 1) / 318.3 \times 2.50$$

$$SO_2 = 5.85 \mu g/m^3$$

$$\text{Volume of air sample in m}^3 V = (f_i \times f_t) / 2 \times (t_f - t_i) \times 60 = (1 + 0.8) / 2 \times 357 = 321.3 \text{ L}$$

$$V_n = V \times (P / 760) \times (298 / (t + 273)) = 321.3 \times 0.96053 \times 0.9771 = 301.55 \text{ L}$$

$$C = (A - A_0 \times 10^3 \times B) / V_n \times D = (0.876 \times 10^3 \times 1) / 301.55 \times 2.50$$

$$SO_2 = 7.26 \mu g/m^3$$

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

III. RESULTS AND DISCUSSIONS

Location: Sivanantha Colony

Table 4.1 Air Quality Data for Sivanantha colony

Parameters and Date	Indian Standards	07/02/2019(8 hrs) 9.00 am to 5.00 pm	14/02/2019 (8hrs) 9.00 am to 5.00 pm	21/02/2019 (8hrs) 9.00 am to 5.00 pm	28/02/2019 (8hrs) 9.00 am to 5.00 pm
PM ₁₀ (µg/m ³)	100**	38.03	40.12	46.3	42.65
PM _{2.5} (µg/m ³)	60**	15.12	16.50	20.2	19.18



SO ₂ (µg/m ³)	80**	6.01	5.85	4.12	5.50
NO ₂ (µg/m ³)	80**	19.00	18.92	15.00	17.81

Location: Town Hall

Table 4.2 AQI for Town Hall

Parameters and Date	Indian Standards	07/02/2019 (8 hrs) 9.30 am to 5.00 pm	14/02/2019 (8hrs) 9.30 am to 5.00 pm	21/02/2019 (8hrs) 9.30 am to 5.00 pm	28/02/2019 (8hrs) 9.30 am to 5.00 pm
PM ₁₀ (µg/m ³)	100**	60.52	62.25	62.80	59.98
PM _{2.5} (µg/m ³)	60**	25.18	24.65	25.01	24.53
SO ₂ (µg/m ³)	80**	6.98	7.26	7.54	8.06
NO ₂ (µg/m ³)	80**	34.22	36.07	37.06	31.44

Location: Peelamedu

Table 4.3 AQI for Peelamedu

Parameters and Date	Indian Standards	07/02/2019 (8 hrs) 10.30 am to 5.30 pm	14/02/2019 (8hrs) 10.30 am to 5.30 pm	21/02/2019 (8hrs) 10.30 am to 5.30 pm	28/02/2019 (8hrs) 10.30 am to 5.30 pm
PM ₁₀ (µg/m ³)	100**	32.6	22.1	38.28	42.6
PM _{2.5} (µg/m ³)	60**	20.12	15.4	22.01	31.2
SO ₂ (µg/m ³)	80**	2.00	1.34	2.04	1.45
NO ₂ (µg/m ³)	80**	2.50	1.15	2.56	1.56

Location: Annur

Table 4.4 AQI for Annur

Parameters and Date	Indian Standards	07/02/2019 (8 hrs) 12.00 am to 6.00 pm	14/02/2019 (8hrs) 12.00 am to 6.00 pm	21/02/2019 (8hrs) 12.00 am to 6.00 pm	28/02/2019 (8hrs) 12.00 am to 6.00 pm
PM ₁₀ (µg/m ³)	100**	41.5	45.3	73.6	54.6
PM _{2.5} (µg/m ³)	60**	37.7	37.7	52.9	40.9
SO ₂ (µg/m ³)	80**	1.66	1.66	3.73	2.05
NO ₂ (µg/m ³)	80**	1.80	1.80	7.77	3.96

IV. CONCLUSION

Air Pollution is a serious environmental concern all around the globe. Over the last few decades, the intensified process of industrialization and urbanization coupled with rapid population has resulted in severe environmental degradation. In particular, harmful pollutants such as Sulphur dioxide, Nitrogen dioxide, Particulate matter are emitted and these pollutants even exceed air quality guidelines recommended by World Health Organization. So, our paper defines and determines the air quality present in the Coimbatore city. By analyzing the data using sampling methods it is been compared with NAAQ's standards. In order to reduce such rate of pollutants increase, proper measures and guidelines given by Central pollution board should be undertaken.

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