Assessment of Ambient Air Quality in Chinnavedampatti Industrial Cluster, Coimbatore, During 2011 – 2012

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***Abstract* -In this study, the Chinnavedampatti Industrial Cluster, Coimbatore, was assessed for its ambient air quality status. In this cluster, majority of the industries are Engineering Industries. In the present study, two locations within the Industrial cluster have been chosen with respect to the prevailing wind pattern, for monitoring the air quality. The sampling was conducted to determine the concentration of PM_{10}, $PM_{2.5}$, SO_2, NOx and Lead (Pb) present in the air samples using Respirable Dust Sampler (RDS) and Ambient Fine Dust Sampler (AFDS). The results were compared with the National Ambient Air Quality Standards (NAAQS) to check whether the pollutants are within the prescribed limits. The Air Pollution Index (API) was calculated to conclude the air quality status during the current sampling period (November 2011 – April 2012).**

Key words: Wind pattern, PM_{10}, $PM_{2.5}$, SO_2, NOx, NAAQS.

1. INTRODUCTION:

Air pollution is defined as the addition of various hazardous chemicals, particulate matter, toxic substances and biological organisms into the Earth's atmosphere. There are various factors causing air pollution, but what comes from industries and factories is often considered as prime factors in air pollution.

Millions of tons of harmful gases and pollutants are released into the air each year by various industries. Once inhaled, polluted air weakens the lung's natural defense against harmful contaminants. In fact, lung tissue has no reliable defense against air pollution, and therefore, is gradually destroyed by invasive pollutants. There are many health effects of air pollution including irritation of the eyes, nose, mouth, and throat; chest pain; labored breathing; and increased susceptibility to lung infection. At its least severe levels, air pollution is a nuisance to healthy individuals and a burden to those with respiratory diseases.

1.1 Particulate Matter (Pm)

Airborne particulate matter (PM) includes coarse and fine particles such as dust, dirt, soot, smoke, and liquid droplets emitted into the air. They are small enough to get freely suspended in the atmosphere, and can travel over longer distances through air.

1.2 Gaseous Pollutants Gaseous pollutants are the pollutants which are present in the form of gas [e.g., Sulphur dioxide (SO_2), Hydrogen Sulphide (H_2S), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Oxides of nitrogen (NO_X), Hydro Carbon (HC), etc.,

1.3 LEAD (Pb)

Lead is a toxic metal that was used for many years in products found in and around our homes. Lead also can be emitted into the air from industrial sources and leaded aviation gasoline, and lead can enter drinking water from plumbing materials. Lead may cause a range of health effects, from behavioral problems and learning disabilities, to seizures and death. Children six years old and under are most at risk.

1.4 Microscale Meteorology

Particulates emitted from a source are diluted with the environmental air on their path to the site where they can effect damage. The dilution depends on the distance and the prevailing wind and weather conditions.

Microscale meteorology is the study of short-lived atmospheric phenomena smaller than mesoscale, about 1 km or less.

Microscale meteorology controls the most important mixing and dilution processes in the atmosphere. Meteorological parameters decide the fate of particulates once they are released to the atmosphere. The factors that effects the dispersion of particulates in the air are

- Wind Speed and Direction
- Ambient air temperature
- Barometric pressure

1.4.1. *Wind Speed And Direction*

The time taken for the particulate matter to reach the receptors from a source depends on magnitude of the wind. Wind speed is measured in Km/h. Wind rose plots are used to represent the wind speed and direction.

1.4.2. Ambient Air Temperature

Temperature gradient affects the vertical mixing of pollutants in the air. This vertical temperature gradient is termed as the 'lapse rate'. The amount of vertical motion of the atmosphere depends to an important extent on how the temperature varies with altitude. Near the ground, air temperature normally decreases with height. When the rate of decrease is rapid, there is a pronounced tendency toward vertical air mixing. On the other hand, when the air temperature increases with height, vertical air motions are suppressed. This temperature structure is called a “temperature inversion” because it is “inverted” from the normal condition of temperature decreasing with height.

1.4.3 BAROMETRIC PRESSURE:

Barometric pressure or the atmospheric pressure is the pressure exerted on us by the atmosphere. As we go to higher altitudes or elevations, the barometric pressure drops. However, the rate at which it drops is not constant; it drops less per thousand feet at higher altitudes.

2. MATERIALS AND METHODS

2.1. The Study Area – Chinnavedampatti

2.2. Description

Chinnavedampatti is located at 11° 53" N and 76° 58' 52" E, at about 338 metres above mean sea level. Chinnavedampatti is located within Coimbatore corporation limit. Coimbatore is located at the foothills of the Western ghats. Due to unregulated population growth and industrial development, Coimbatore experiences an exponential growth in the vehicular usage and fuel consumption, which results in an increased concentration of particulate matter in the surrounding air. Coimbatore due to its geological arrangement, is stirred by continuous change of atmospheric air and thus also favours dispersion of particulates.

2.3. Sampling Location

Based on wind direction, two sampling locations are selected in Chinnavedampatti.

Location 1: S.B.S INDUSTRIES.
This location was chosen as it falls under the upstream side of the wind direction. The sampling instrument was set at the terrace of the office building at S.B.S INDUSTRIES

Location 2 : DYNAMIC ENGINEERING AND EQUIPMENTS.
This location was chosen as it falls under the downstream side of the wind direction. The sampling instrument was set at the terrace of the office building at DYNAMIC ENGINEERING AND EQUIPMENTS.

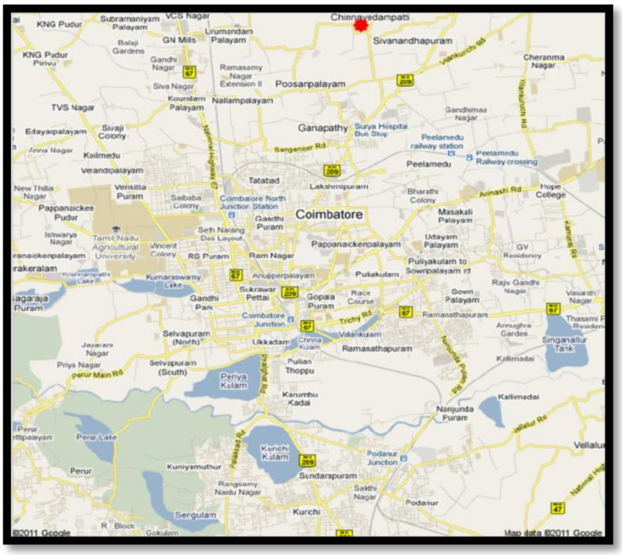

Fig 3.1 : Location map of CHINNAVEDAMPATTI in Coimbatore corporation.

2.4. Pm10 Sampling

The particulates in the ambient air are collected using a Respirable dust sampler. Air is drawn through the sample filter at a controlled flow rate by a pump located downstream of the sample filter. The instruments are continuously operated for 24 hours for a period of two days. The mass concentration is calculated by measuring the weight of collected matter in known volume of air sampled.

Glass fiber filter must be conditioned in an oven at 105°C and weighed prior to sampling. They are fixed in the sampler and covered. Similarly, a pre-weighed cup was attached to the bottom of cyclone separator to collect the coarser particles. Initial and final manometer readings must be noted. After the sampling is done, the filter paper and the cup were removed and labelled. The final weight of the samples are noted.

The mass concentration is calculated using the equation

$$\text{Mass concentration } (\mu g/m^3) = \frac{(W_f - W_i) \times 10^6}{V_s}$$

Where

W_f = Final weight of filter paper (grams)

W_i = Initial weight of filter paper (grams)

V_s = Volume of air sampled (m^3)

2.5. Pm2.5 Sampling

The finer particulates in the ambient air are collected using an Ambient Fine Dust Sampler. Air is drawn through the sample filter at a controlled flow rate by a pump located downstream of the sample filter. The flow of air through the sampler must be at a flow rate to ensure that the size cutoff at 2.5 microns occurs. The instruments are continuously operated for 24 hours for a period of two days.

The coarser particles get trapped in the impactor and the fine particles are collected on the PTFE filter. The mass concentration is calculated by measuring the weight of collected matter in known volume of air sampled. Parameters such as temperature, barometric pressure, and other meteorological parameters are recorded simultaneously.

2.6. Gaseous Sampling

The gas inlet should be kept on the pipe after the cast minimum aluminum hopper but before the blower. There can be three inlets for different gases or one inlet through a manifold. A calibrated rotameter (0 to 3 lpm) shall be provided for checking the flow rate.

2.7. Air Pollution Index:

2.7.1. Definition

An air pollution index is defined as a scheme that transforms the values of individual air pollution related parameters into a single number or set of numbers.

2.7.2. Determination Of Air Pollution Index:

There are several methods and equations available for determining the air pollution index

For these, the following equation was used.

$$API = \frac{1}{3}\left[\frac{SPM}{S_{SPM}} + \frac{so_2}{S_{so2}} + \frac{NO_x}{S_{NOX}}\right] X\ 100$$

Where S_{SPM}, S_{SO2}, S_{NOX} represents the ambient air quality standards for particulars matter, Sulphur dioxide and nitrogen dioxide respectively.

2.7.3. Rating Scale For Indices:

A typical rating scale used is given below:

Table 1: Rating Scales for API

Air pollution index	Air pollution level	Remarks
0-25	Clean air	Good
26-50	Light air pollution	acceptable
51-75	Moderate air pollution	Unsatisfactory
75-100	Heavy air pollution	Unhealthy

3. RESULTS OF ANALYSIS

3.1. Microscale Meteorology

Microscale meteorological parameters are recorded and are presented in Table 2.

Based on the geographical pattern of Coimbatore city, the predominant wind direction is towards North North East (NNE), during the North East monsoon season and towards South South West during the South west monsoon.

The Ambient temperature ranges from 29 °C in the month of November to 38°C in the month of April. The wind speed ranges from 5 Km/h to 10 Km/h.

Table 2: Temperature, Pressure & Windspeed variation

S No.	Location	Date of Sampling	Ambient Air Temperature (°C)		Barometric Pressure (mm of Hg)	Average Wind Speed (Km/h)
			Min	Max		
1	SBS Industries	10.11.2011	17	29	759.0	7
		11.11.2011	18	29	759.8	5
		19.12.2011	18	29	759.8	5
		20.12.2011	20	27	759.8	5
		18.01.2012	15	31	757.5	6
		19.01.2012	16	31	757.5	6
		14.02.2012	19	33	759.8	8
		15.02.2012	20	33	759.8	8
		20.03.2012	23	37	758.3	9
		21.03.2012	23	36	757.5	10
		19.04.2012	25	37	755.3	7
		20.04.2012	25	38	756.8	8
2		10.11.2011	17	29	759.0	7
	Dynamic Engineering and Equipments	11.11.2011	18	29	759.8	5
		19.12.2011	18	29	759.8	5
		20.12.2011	20	27	759.8	5
		18.01.2012	15	31	757.5	6
		19.01.2012	16	31	757.5	6
		14.02.2012	19	33	759.8	8
		15.02.2012	20	33	759.8	8
		20.03.2012	23	37	758.3	9
		21.03.2012	23	36	757.5	10
		19.04.2012	25	37	755.3	7
		20.04.2012	25	38	756.8	8

Table 3: Pollutant Concentration At Location 1

S.No.	Date	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	SO_2 µg/m³	NO_2 µg/m³	Lead µg/m³	API	Remarks
1	10.11.11	43.2	24.3	09.2	13.9	0.02	22.91	CA
2	11.11.11	42.1	22.8	08.1	12.7	0.01	21.42	CA
3	19.12.11	41.4	21.5	08.0	12.1	0.01	20.67	CA
4	20.12.11	40.7	21.4	07.2	11.5	0.01	20.32	CA
5	18.01.12	52.5	33.0	10.2	15.3	0.03	28.47	CA
6	19.01.12	54.1	34.5	11.1	18.2	0.02	30.05	LAP
7	14.02.12	55.4	35.3	10.6	16.5	0.03	30.22	LAP
8	15.02.12	60.1	38.4	11.8	17.1	0.03	32.65	LAP
9	20.03.12	100.1	58.8	16.2	22.1	0.07	50.60	LAP
10	21.03.	100.9	60.5	16.8	23.	0.08	53.16	MAP
11		102.0	61.2	17.3		0.09	53.38	MAP
12		102.7	61.8	17.6		0.08	53.92	MAP
Maximum Concentrati		102.7	61.8	17.6	27.1	0.09		
Minimum Concentrati		40.7	21.4	10.2	11.5	0.01		
Average Concentrati		66.3	39.5	12.1	18.1	0.04		
Threshold Limits		100	60	80	80	1		

LAP- Light Air Pollution, MAP- Moderate Air Pollution, CA- Clean Air

Table 4: Pollutant Concentration at Location 2

S.No.	Date	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	SO_2	NO_2	Lead µg/m³	API	Remarks
1	10.11.11	85.7	48.9	11.1	23.7	0.07	43.54	LAP
2	11.11.11	74.3	47.3	12.4	24.1	0.06	40.95	LAP
3	19.12.11	72.7	46.4	09.6	19.5	0.07	38.68	LAP
4	20.12.11	70.5	45.1	10.3	21.2	0.08	38.61	LAP
5	18.01.12	85.3	49.8	13.7	26.0	0.09	45.18	LAP
6	19.01.12	91.2	50.3	14.5	26.9	0.08	47.16	LAP
7	14.02.12	95.1	53.4	15.3	27.3	0.03	48.07	LAP
8	15.02.12	98.9	54.1	15.8	27.9	0.02	49.14	LAP
9	20.03.12	62.1	39.3	12.4	19.1	0.03	33.99	LAP
10	21.03.12	63.7	43.2	13.2	20.4	0.01	35.74	LAP
11	19.04.12	68.0	47.3	14.1	21.5	0.02	38.67	LAP
12	20.04.12	69.7	50.1	14.5	22.3	0.03	40.44	LAP
Maximum Concentration		98.9	54.1	14.5	23.7	0.09		
Minimum Concentration		62.1	39.3	09.6	19.1	0.01		
Average Concentration		78.1	47.9	13.1	23.3	0.05		
Threshold Limits		100	60	80	80	1		

LAP- Light Air Pollution, MAP- Moderate Air Pollution, CA- Clean Air

3.2. Analysis of Particulate Contaminants

The mass concentrations of particulates were estimated from the difference of the final and initial weight of the filter paper used for air sampling. They are expressed as weight of particulates collected per cubic meter of air sampled (µg/m³). The particulate mass concentration PM_{10} and $PM_{2.5}$ are tabulated in Table 3 and Table 4The value of PM_{10} ranges from 40.7 – 102.7 µg/m³ at Location 1 and 62.1 – 98.9 µg/m³ at location 2.

The value of $PM_{2.5}$ ranges from 21.40 – 61..8 µg/m³ at location 1 and 39.3 – 54.1 µg/m³ at location 2. The obtained values of mass concentration of particulates are compared with the standards prescribed by the National Ambient Air Quality Standards (NAAQS).

The ambient concentrations of PM_{10} and $PM_{2.5}$ was found to exceed the permissible limit at location 1 with PM_{10} at 102.10 µg/m³ and $PM_{2.5}$ at 61.80 µg/m³ with other seasons under the permissible range.

4.2.3 Analysis of Gaseous Contaminants

The concentration of the gaseous contaminants – SO_2 and NO_X present in the ambient air were estimated using spectrophotometric analysis and is presented in Table 3 and Table 4. The ambient level of SO_2 ranges from 7.2 -

17.6 µg/m^3 at location 1 and 9.6 – 15.80 µg/m^3. The level of NO_2 ranges from 11.50 – 27.1 µg/m^3 at location 1 and 19.50 – 27.30 µg/m^3 at location 2. Comparing with the National Ambient Air Quality Standards, it can be confirmed that the ambient level of both SO_2 and NO_2 lies with the prescribed limits.

4.2.4 Elemental Analysis

The concentration of Lead in the particulate matter fraction was estimated using AAS and tabulated in Table 3 and Table 4. The ambient level of lead in the air ranges from 0.01 – 0.09 µg/m^3 at location 1 with an average concentration of 0.04 µg/m^3. At location 2, the level ranges from 0.01 – 0.09 µg/m^3 with an average concentration of 0.05 µg/m^3

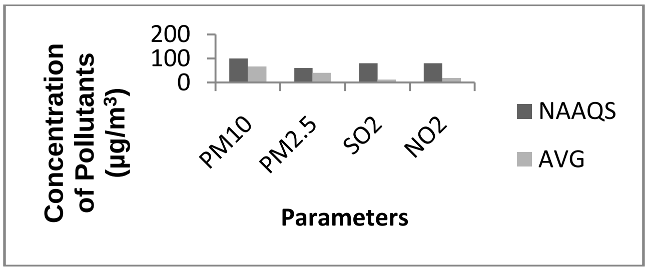

Figure 2: Pollutant Concentration at Location 1

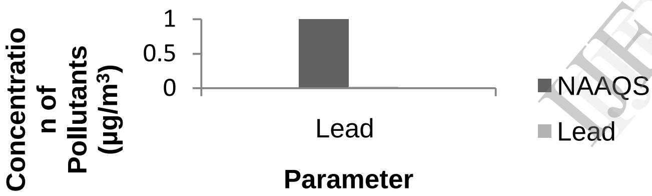

Figure 3: Lead Concentration at Location 1

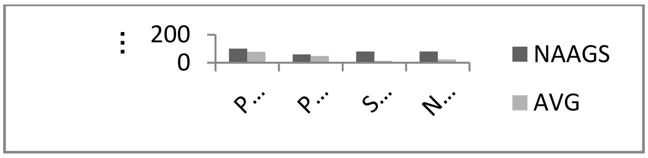

Figure 4: Pollutant Concentration at Location 2

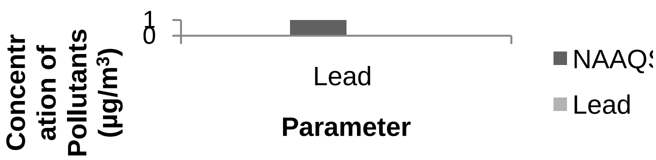

Figure 5: Lead Concentration at Location 2

4. DISCUSSION

From the analysis of particulates and gaseous contaminants sampled in the industrial location, the mass concentration of the PM_{10}, $PM_{2.5}$, SO_2, NO_X and Lead was found to exist within the limits prescribed by the National Ambient Air Quality Standards (NAAQS). It indicates a healthy condition at the sampling location. The level of particulates in the ambient air indicates the industrial expansion in the locality which may lead to increase of concentration of pollutants in future.

The Air Pollution Index (API) was computed for the selected monitoring stations. From the results, it was found that the monitoring station S.B.S Industries recorded the maximum API value of 53.92, indicating moderate air pollution in the month of April, in which the sampling location 1 lies in the downstream part of the Wind direction. And the minimum API value of 20.32 indicating clean air in the month of December, in the sampling location 1 which lies in the upstream part of prevailing wind direction.

The monitoring station Dynamic Engineering and Equipments recorded maximum API value of 49.14, indicating light air pollution in the month of February, in which the sampling location 2 lies in the downstream part of the prevailing wind direction. And a minimum API value of 33.99 recorded during the month of March, in which the sampling location 2 lies in the upstream part of the wind direction.

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