International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072

ANALYSIS OF COARSE(PM_{10}) AND FINE($PM_{2.5}$) PARTICULATE MATTER CONCENTRATION OF KALABURAGI

Dr. Shashikant R. Mise[1], Ataur Rahman[2]

[1]Professor, Department of Civil Engineering, PDA College of Engineering Kalaburagi, Karnataka, India
[2]PG student, Department of Civil Engineering, PDA College of Engineering Kalaburagi, Karnataka, India

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Abstract -*This study assesses the ambient air quality status in sensitive and residential areas of Kalaburagi city. Two sampling stations viz; Government Hospital and Lal Bahadur Shastri Nagar were selected to determine the concentration of suspended particulate matter (PM10), Respirable suspended particulate matter (PM2.5). The ambient air quality was analysed by taking the Monthly Average concentration of the particulate matter at both the sampling stations. The study and analysis of the data revealed that Suspended particulate matter PM10 and Respirable particulate matter PM2.5 were the major air pollutants at both the sampling stations with concentrations levels exceeding the NAAQS limits specified for sensitive and residential area by Central Pollution Control Board (CPCB), Delhi.*

Key Words: PM10, PM2.5, NAAQS, CPCB

1. INTRODUCTION

In addition to land and water, air is the prime resource for sustenance of life. For better human health and wellbeing of the humanity, clean air is one of the main basic requirements. Clean air is deteriorating day by day, and being polluted by variety of sources e.g. household combustion devices, motor vehicles, industrial facilities, and forest fires (the common sources of air pollution) that change the composition of atmosphere, affecting the biotic environment adversely. Air Pollution is a complex mixture of gases, particles, aerosols, water vapour which has originated due to human development and other natural/anthropogenic activities. Air Pollution is a complex mixture of gases, particles, aerosols, water vapour which has originated due to human development and other natural/anthropogenic activities. Its close relation to human development, complex structure containing infinite proportions of Particles and more challenging towards its management.

Pollutants which are present in the atmosphere emerging from two important sources are natural and human sources. Human anthropogenic activities such as burning of motor vehicles, burning of fossil fuels and Industrial process like smoke came from the chimney are the major creator of the air pollutants. Natural sources are volcanic eruption, forest fires, wind erosion, pollen dispersal etc. These are all directly affects the air quality as well as human health, animal and plant life.

The difference between PM10 and PM2.5 is simply a matter of size. While PM2.5 is fine, PM10 is larger and coarser.

1.1 Objectives

- To measure the concentration of Suspended particulate matter (PM10).
- To determine the concentration level of Respirable suspended particulate matter (PM2.5).
- To compare the measured values with the standard values of National Ambient Air Quality Standards (NAAQS).
- To analyse air quality of Kalaburagi city using the obtained values of PM10 and PM2.5 in ambient air.

1.2 Sources and effects of particulate matter

Suspended Particulate Matter (PM10)

PM10 is suspended particulate matter in the air with a diameter of 10 micrometers or less (including smoke, soot, salts, acids and metals).Particulate matter includes microscopic particles and tiny droplets of liquid.

Because of their small size, these particles are not stopped in the nose and upper lungs by the body's natural defenses but go deep into the lungs, where they may become trapped and cause irritation. Exposure to particulate matter can cause wheezing and similar symptoms in people with asthma or sensitive airways.

Sources of suspended particulate matter PM10:

- Dust from construction sites, landfill, agriculture
- Dust blown from open lands
- Smoke from wildfires and waste burning
- Motor vehicles

Effects of particulate matter PM10:
Short term effects

- Difficulty in breathing
- Chest pain
- General respiratory discomfort
- Sore throat
- Nasal congestion

Long term effects

- Lung tissue damage

- Cancer
- Asthma
- Premature death

Respirable Suspended Particulate Matter (PM2.5)

Respirable Suspended particulate matter (PM2.5) refers to particles that have diameter less than 2.5micrometers and remain suspended for longer.
PM2.5 particles are floating particulate matter in the air which is so small and it can be absorbed into the blood stream upon inhalation. For this reason it is typically typically the pollutant posing the greatest health threat.

Sources of Particulate Matter PM2.5:

- These particles are formed as a result of burning fuel and chemical reactions that take place in the atmosphere.
- Natural processes such as forest fires also contribute to PM2.5 in the air
- Combustion resulting from power plants
- Smoke and soot from Wildfire and waste burning
- Vehicular emissions and combustion from motors.

Effects of Particulate Matter PM2.5:
Short term effects

- Irritation to the eyes, throat, and nose
- Irregular heartbeats
- Asthma attacks
- Coughing, chest tightness, shortness of breath

Long term effects

- Respiratory illness such as Bronchitis, asthma, emphysema
- Lung tissue damage
- Cancer
- Heart attack
- Stroke
- Premature death

2. STUDY AREA

KALABURAGI – SUN CITY : Kalaburagi was known as 'KALBURGI' in former days which means stony land in Kannada. Kalaburagi district is situated in the northern part of Karnataka State. In the earlier days, Kalaburagi was a district of Hyderabad Karnataka area and became a part of Karnataka State after re-organization of states. Kalaburagi is situated in Deccan Plateau located at 17.33°N 76.83°E and the general elevation ranges from 300 to 750 meters above mean sea level.

Selection of Sampling Stations :

1. Government Hospital (Sensitive)

2. Lal Bahadur Shastri Nagar (Residential)

Fig.1. shows the Sampling stations in Kalaburagi city.

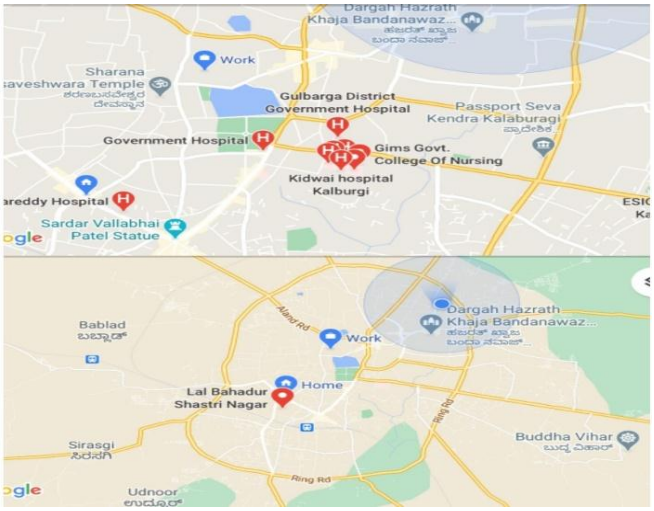

Fig.1: Study area

3. MATERIALS AND METHODOLOGY

3.1. Suspended Particulate Matter (PM10) in ambient air (Gravimetric Method)

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4cm (8 X 10 in) filter at a flow rate, which is typically 1132L/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. The Field Sampling is carried carried out using High Volume Sampler.

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of Particulate Matter PM10 in ambient air:

- Analytical balance
- Sampler : High Volume Sampler with size selective inlet for PM10 and automatic volumetric flow control
- Calibrated flow-measuring device to control the airflow at 1132L/min. · Top loading orifice kit.

Reagents / Chemicals

Filter Media – A Glass fibre filter of 20.3 X 25.4cm (8 X 10 inches) in size.

Sampling

The Field Sampling was carried out using High Volume Sampler. 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 24hours. 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.

Analysis

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 (Wi) 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 (Wf).

Calculation

The equation given below can be used to determine PM10 mass Concentration:

C PM10 µg/m3 = (Wf – Wi) x 106 / V

Where,
C PM10 = Concentration of Nitrogen dioxide, µg/m3
Wf = Initial weight of filter in g
Wi = Initial weight of filter in g
10^6 = Conversion of g to µg
V = Volume of air sampled, m^3

3.2. Respirable suspended Particulate Matter (PM2.5) in ambient air (Gravimetric Method)

Principle of the method

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 PM2.5 size ranges is separated for collection on a 47 mm polytetrafluoroethylene (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.

Sampling and analysis

Sampling equipment designated as FRM (Federal Reference Method) or FEM (Federal Equivalent Method) was used. The mass concentration in the ambient air is computed as the total mass of collected particles in the PM2.5 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 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

The equation given below can be used to determine PM2.5 mass concentration:

$$PM2.5 = M2.5 / V$$

$$PM2.5 = (Mf – Mi) \times 103 / Qavg \times t \times 10^{-3}$$

Where,

M2.5 = total mass of fine particulate collected during sampling period (µg)

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

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

Qavg = average flow rate over the entire duration of the sampling Period (L/min)

t = duration of sampling period (min)

PM2.5 = mass concentration of PM2.5 particulates (µg/m3).

4. RESULTS AND DISCUSSION

4.1. Results of Sampling station 1: Government Hospital

The sampling station 1 is Ecologically sensitive area.

The result of the measurements during the year 2018(Data collected) Fig .2 & Fig.3 shows that;

The suspended particulate matter (PM10) concentration was minimum of 20µg/m3 in August and maximum of 131µg/m3 in March which is greater than that of the NAAQS limit i-e; 100µg/m3 Specified by CPCB, Delhi.

The Monthly Average concentration of Respirable Particulate Matter (PM2.5) was minimum of 15µg/m3 and maximum of 65µg/m3 which is slightly more than of NAAQS limit i-e; 60 µg/m3 .

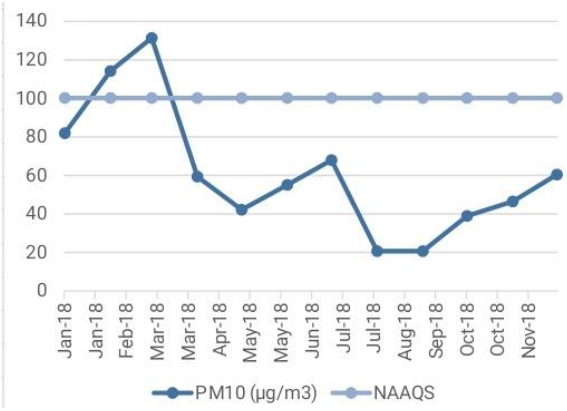

Fig.2: Monthly Average concentration of PM10 at Government Hospital

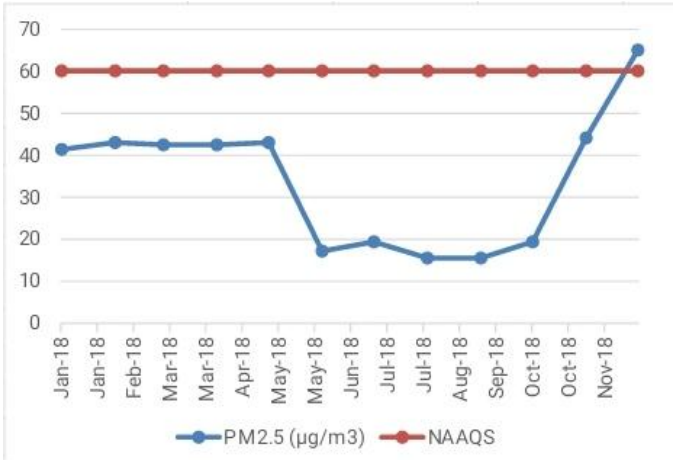

Fig.3: Monthly Average concentration of PM2.5 at Government Hospital

The result of the analysis carried out during the year 2019 Fig..4 & Fig.5 shows that;

The suspended particulate matter (PM10) concentration was minimum of 51µg/m3and maximum of 148µg/m3 which is greater than that of NAAQS limit i-e; 100µg/m3.

The Monthly Average concentration of Respirable Particulate Matter (PM2.5) was minimum of 29 µg/m3 and maximum of 67 µg/m3 which is slightly more than of NAAQS i-e; 60 µg/m3.

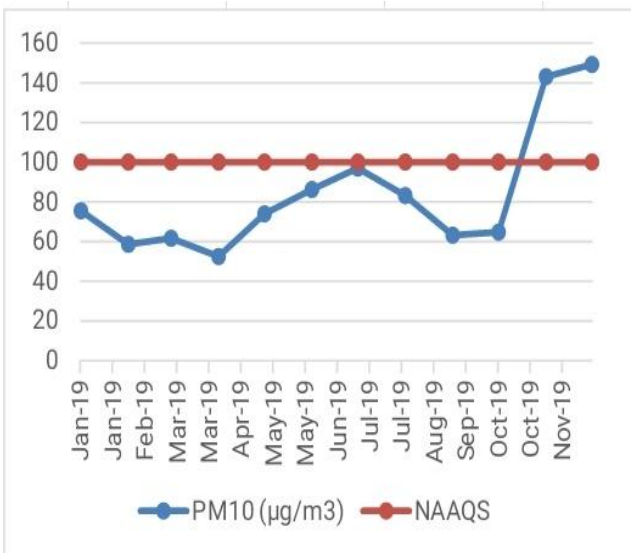

Fig.4: Monthly Average concentration of PM10 at Government Hospital

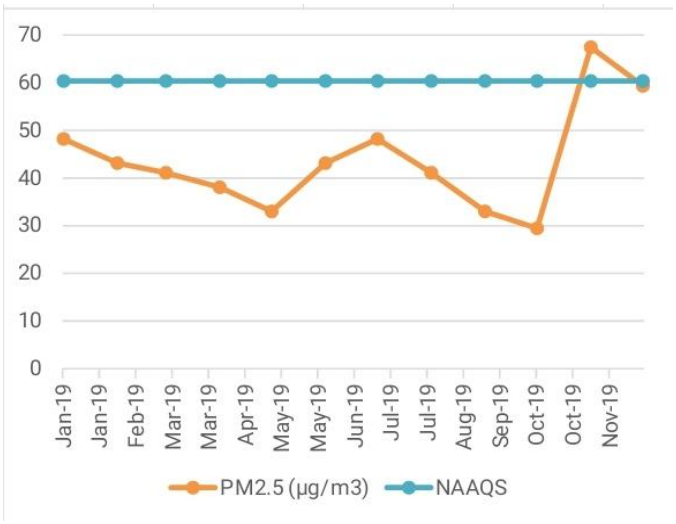

Fig.5: Monthly Average concentration of PM2.5 at Government Hospital

4.2. Results of Sampling Station 2: Lal Bahadur Shastri Nagar

The sampling station 2 is Residential area. The result of the measurements during the year 2018(data collected) Fig. 6 and Fig. 7 shows that;

The suspended particulate matter (PM10) concentration was minimum of 45µg/m3 and maximum of 95µg/m3 in which isis within the NAAQS i-e; 100µg/m3.

The Monthly Average concentration of Particulate Matter (PM2.5) was minimum of 33µg/m3 and maximum of

64µg/m3 which is slightly more than of NAAQS i-e; 60µg/m3 .

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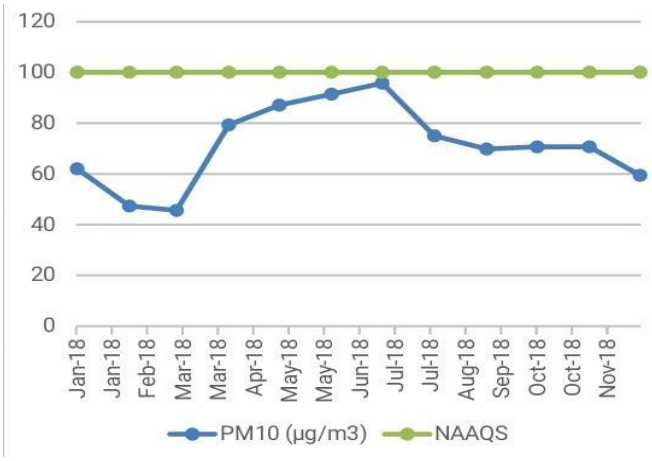

Fig.6: Monthly Average concentration of PM10 at Lal Bahadur Shastri Nagar

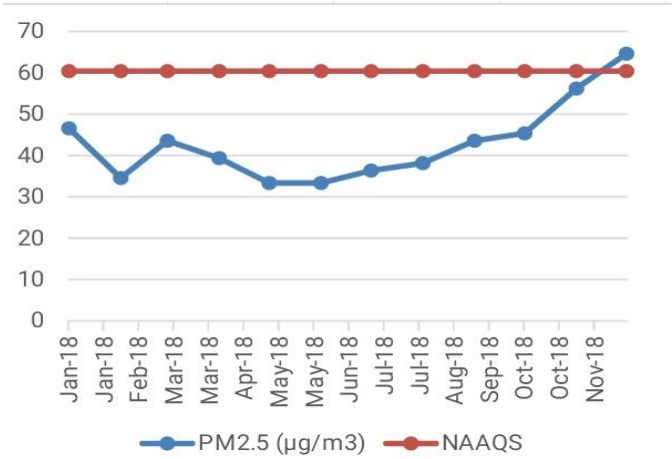

Fig.7: Monthly Average concentration of PM2.5 at Lal Bahadur Shastri Nagar

The result of the measurements during the year 2019(data collected) Fig. 8 and Fig. 9 shows that ;

The Monthly Average concentration of suspended particulate matter (PM10) was minimum of 50µg/m3 and maximum of 83µg/m3 in which is within the NAAQS i-e; 100µg/m3.

The Monthly Average concentration of Particulate Matter (PM2.5) was minimum of 37µg/m3 and maximum of 57µg/m3 which is slightly more than of NAAQS i-e; 60µg/m3 .

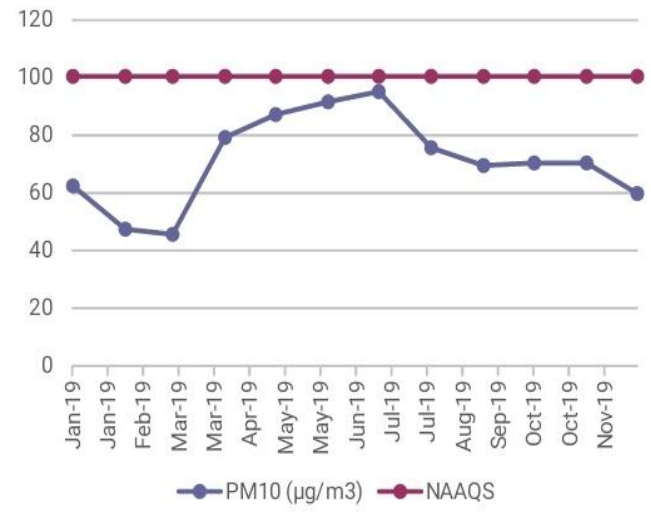

Fig.8: Monthly Average concentration of PM10 at Lal Bahadur Shastri Nagar

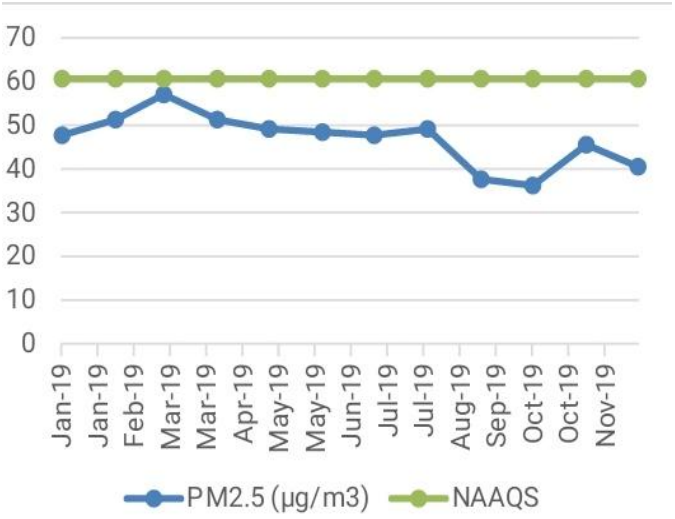

Fig.9 : Monthly Average concentration of PM2.5 at Lal Bahadur Shastri Nagar

5. CONCLUSIONS

The study and analysis of the data revealed that Suspended particulate matter (PM10) and Respirable suspended particulate (PM2.5) were the major air pollutants at both the sampling stations with concentrations levels exceeding the NAAQS limits Specified for sensitive and residential area by CPCB, Delhi.

The suspended particulate matter (PM10) concentration was minimum of 20µg/m3 in August and maximum of 131µg/m3 in March which is greater than that of the NAAQS limit i-e; 100µg/m3 Specified by CPCB, Delhi.

The Monthly Average concentration of Respirable Particulate Matter (PM2.5) was minimum of 29 µg/m3 and maximum of 67 µg/m3 which is slightly more than of NAAQS i-e; 60 µg/m3.

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BIOGRAPHIES

Description: Professor, Department of Civil Engineering, PDA College of Engineering Kalaburagi, Karnataka, India.

Description: PG student, Department of Civil Engineering, PDA College of Engineering Kalaburagi, Karnataka, India.