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RESEARCH ARTICLE

MONITORING OF AMBIENT AIR QUALITY IN SALEM CITY, TAMIL NADU

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ABSTRACT

Air Pollution is perhaps the commonest form of environmental degradation in the cities of both developed and developing countries. In the environment there are many pollutants which have been observed during different studies regarding air pollution. Among all the pollutants, gaseous and particulate pollutants are more important. In this paper an attempt has been made to study the status and trend of Sulphur dioxide (SO_2), Oxides of Nitrogen (NOx), Respirable Suspended Particulate Matter (PM 10) and Total Suspended Particulate Matter (PM 100) in Salem Sowdeswari College premises where an air quality monitoring station have been established under National Air Quality Monitoring Programme of Central Pollution Control Board, New Delhi. Monitoring of pollutants for carried out for 24 hours (4-hour sampling for gaseous pollutants and 8 hour sampling for particulate matter) thrice a week (Monday, Wednesday and Friday), to have 156 observations in a year.

INTRODUCTION

Human beings are exposed to great number of potentially harmful pollutants in ambient air (1). Pollutants in the atmosphere arise from two major sources: natural and anthropogenic. It may be surprising to learn that globally, the largest source sources of many air pollutants are natural (2). Combustion from motor vehicles and industrial processes by far the major producer of air pollutants (3). Rapid industrialization, urbanization and development of transport have added impetus to economic development at the cost of environment. Although such development is integral to economic growth, the problem lies in their unfettered proliferation in India, leading to severe environmental degradation (4). Unplanned urbanization and rapid industrialization are causing deterioration of the environment and quality of life in developing countries. It is essential to assess the spatial distribution of air quality and its impact on human beings in the urban region (5). Particulate and gaseous emission of pollutants from industries and auto-exhausts is responsible for rising discomfort, increasing air way diseases, decreasing productivity and deterioration of artistic and cultural patrimony in urban centres (6). Urban air pollution is a major focus of public health concern and regulatory activity (7).

Air Quality Monitoring Programmes

With the ever-increasing awareness on air and water pollution since the enactment of Water and Air Pollution Control Acts, people have become more inquisitive about the pollutants' level and their effects. This has resulted in mushroom growth of institutions, consultants and interest groups engaged in monitoring of various pollutants in complex environment. In India, the two institutions National Environmental Engineering Research Institute (NEERI), Nagpur, and Central Pollution Control Board (CPCB), New Delhi monitor the air quality data of the metropolitan cities. NEERI, the institute is operating a nationwide air quality-monitoring network since 1978 but it was discontinued in 1989. The sites were subsequently reopened in 1990. NEERI had begun monitoring at Ahmedabad, Mumbai, Kolkata, Kochin, Delhi, Hydrabad, Jaipur, Kanpur, Chennai and Nagpur. These cities represented a nationwide cross-section of different industrial, geographic and climatic conditions. Monitoring stations were located at three sites in each city which deem to be the representative of industrial, commercial and residential locations.

The CPCB operated its own National Ambient Air Quality Monitoring (NAAQM) Programme in 1985. The main function of the CPCB under the Section 2 of the Air (Prevention and Control of Pollution) Act of India is to improve the quality of air and to prevent, control and abate air pollution throughout India. The NAAQM Programme started with a few stations in Agra and Anpara in the state of Uttar Pradesh expended to 295 monitoring stations covering more than 90 cities/towns in 24 States and Union Territories by 2000-2001. The network has been further expended, and

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presently there are 326 stations operating in 116 cities/towns in 28 States and 4 Union Territories

Objectives of National Air Quality Monitoring Programme

In order to arrest the deterioration in air quality, Government of India enacted Air (Prevention and Control of Pollution) Act in 1981, emphasized further under Environment (Protection) Act, 1986 (8). Under these acts, it is necessary to assess the present and the anticipated air pollution through continuous air quality survey/monitoring programmes. The programme initiated during 1984-85 at the national level under the surveillance of Central Pollution Control Board and called the National Ambient Air Quality Monitoring (NAAQM) Network, has been renamed as National Air Quality Monitoring Programme (NAMP). Ambient air quality monitoring is carried out under this programme so as to generate data that meets the following objectives set for monitoring.

- To determine status and trends of ambient air quality and effects of pollution on air quality in urban environment;
- To estimate the future changes in air quality and to obtain the knowledge and understanding necessary for developing preventive and corrective measures;
- To understand the natural cleansing processes in the environment due to pollution dilution, dispersion, wind based movement, dry deposition, precipitation and chemical transformation of pollutants generated;
- To provide background air quality data as needed for industrial siting and town planning;
- To ascertain whether the prescribed ambient air quality standards are violated;
- To assess the likely health hazard and damage to materials etc;
- To control and regulate pollution from the various sources; and
- To identify non-attainment cities;

Sampling Method

Under NAMP, the air pollutants monitored regularly at all the stations are SO_2, NOx, RSPM (PM 10) and TSPM (PM 100). In addition to critical pollutants, certain parameters of health significance like Lead, H_2S, NH_3 and PAHs are also being monitored in 10 metro-cities of the country since 1990. The monitoring of meteorological parameters such as wind speed and direction, relative humidity and temperature has also been integrated with the monitoring of air quality. The monitoring of pollutants is carried out for 24 hours duration (4 hours sampling for gaseous pollutants and 8 hourly sampling for particulate matter) with a frequency of twice a week, to have 104 observations in a year. NAMP being a nationwide network involves CPCB, various state governments (PCB), Pollution Control Committees, and a few Universities, NEERI etc. CPCB co-ordinates these agencies to ensure the uniformity and consistency of air quality data and provides technical and financial support to them to operate the monitoring stations.

Air Quality Monitoring in Salem City

In order to establish air quality records, and also to take necessary steps to reduce/control the increasing air pollution, the Central Pollution Control Board (CPCB) initiated a programme – National Air Quality Monitoring Programme (NAMP) to monitor air quality in the premises of Salem Sowdeswari College located nearby Kondalampatty Roundane in Salem City which is a fifth largest urban center in Tamil Nadu. This programme was initiated from July 1996 with the coordination of State Pollution Control Board.

Study Area

Salem city, the Head Quarter of Salem district is located at 11.669437º north 78.140865º east. It has an average elevation of 278 metres (912 ft). It is located on-either banks of the river Thirumanimuthar at the tri-junction of Bangalore, Coimbatore and Cuddalore roads at a distance of about 350 Kms from Chennai. The city is surrounded by a natural amphitheatre of hills formed by the Sheveroys and Nagarmalai to the north, the Jeragamalai to the South, the Kanjamalai to the west and the Godumalai to the east. The river Thirumanimuthar runs through the city and divides the city into two parts. The fort is the oldest building in town. The origin of Salem city lies on western part of the city. New extensions and developments are found on north, northwest, east, south and southwestern parts of the city (9). Salem is a city and a corporation in Salem district in the State of Tamil Nadu. Located in the north central part of the southernmost state of India, it is a fifth largest city of Tamil Nadu, after Chennai, Coimbatore, Madurai and Trichy. Almost completely surrounded by hills, it is also a part of the Kongu Nadu (Tirupur and Coimbatare) region. It is a fast developing urban centre and it extends its influence over the entire Salem and Namakkal Districts and parts of South Arcot, Dharmapuri, Erode, Perambalur and Trichirappalli Districts.

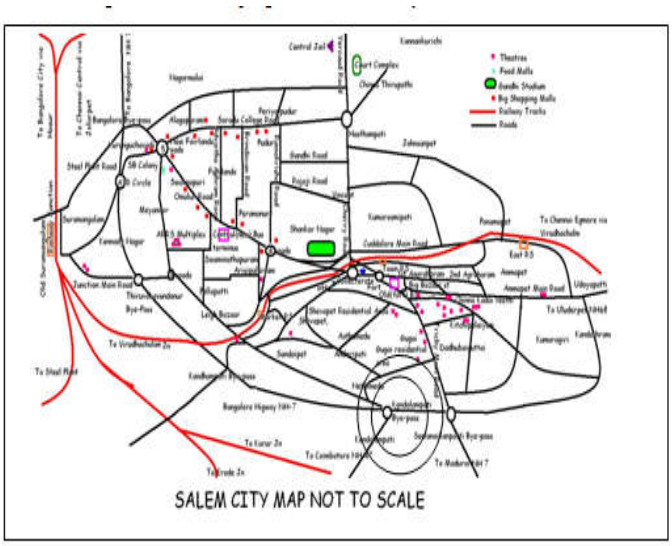

Fig.1 Location of Sampling Station in Salem City

The climate in Salem is pleasant except during summer. During summer season it is hot. The heat declines to some extent on the outbreak of south west monsoon. During winter period, the climate is chill but enjoyable. The city gets its rainfall from northeast monsoon. The average annual rainfall is 920 mm. The maximum and minimum temperatures are 39.8º C and 20.4º C respectively. Highest temperatures are generally recorded during March, April and May. Hot

Table.1 Status of SO_2 and NOx (24 Hours Average) during 2010-2011

Month & Year	TS	SO_2 (µg/m^3)				NO_X (µg/m^3)			
		Min	Max	Mean	SD	Min	Max	Mean	SD
Apr-10	11	6	10	9	1	17.3	34	25	5
May-10	13	4.8	12	9	2	15.2	38	28	6
Jun-10	13	6	11	10	1	18.6	45	28	6
Jul-10	13	7.1	11	8	1	15.1	45	27	7
Aug-10	11	6.9	10.7	8.6	1.1	19.1	36.1	27.1	4.8
Sep-10	10	6.3	10	8	1	12.1	29	21	5
Oct-10	13	6.4	9	8	1	18.2	30	24	4
Nov-10	11	7.6	11	9	1	16.9	59	27	12
Dec-10	13	7.1	8.6	7.5	0.4	16.7	30.6	20.3	3.5
Jan-11	11	6.5	9.6	7.8	0.8	17.4	22.6	20.5	1.8
Feb-11	10	7.6	10	8	1	14.5	24	19	3
Mar-11	13	8	10	9	1	19.6	40	24	6
2010-11	142	4.8	12	8.5	0.72	12.1	59	24.2	3.3

TS: Total Number of 24 Hours Surveys

Table 2. Status of RSPM and TSPM (24 Hours Average) during 2010-2011

Month & Year	TS	RSPM/PM10 (µg/m^3)					TSPM /PM 100 (µg/m^3)				
		Min	Max	Mean	GM	SD	Min	Max	Mean	GM	SD
Apr-10	11	35	157	79	72	36	67	228	126	116	53
May-10	13	44	108	69	67	18	65	162	105	102	28
Jun-10	13	37	129	62	59	23	61	153	94	91	24
Jul-10	13	30	69	54	53	11	52	109	83	82	17
Aug-10	11	32.2	84.1	65.2	62.9	17	63.3	120	94.3	93.1	15
Sep-10	10	38	81	59	57	15	59	126	88	86	21
Oct-10	13	35	97	62	59	18	54	119	85	84	18
Nov-10	11	28	132	86	78	35	58	187	124	116	44
Dec-10	13	48	123	88	84	25	73	180	119	115	30.7
Jan-11	11	67	150	105	102	28	94	222	147.6	143	41
Feb-11	10	57	105	81	80	17	88	168	132	129	30
Mar-11	13	65	114	83	82	14	105	170	128	126	18
2010-11	142	28	157	74.4	73.1	15	52	228	110.5	108.6	21.6

TS: Total Number of 24 Hours Surveys

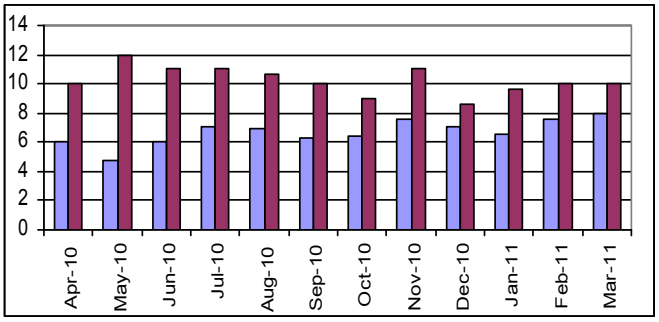

Fig.2 Min and Max of 24 Hours Averages of SO_2

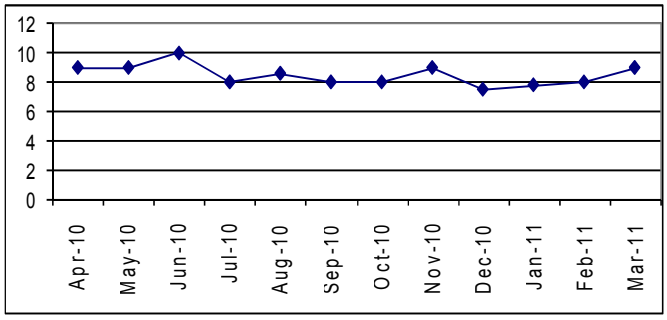

Fig. 3. Trend in Monthly Mean Concentration of SO_2

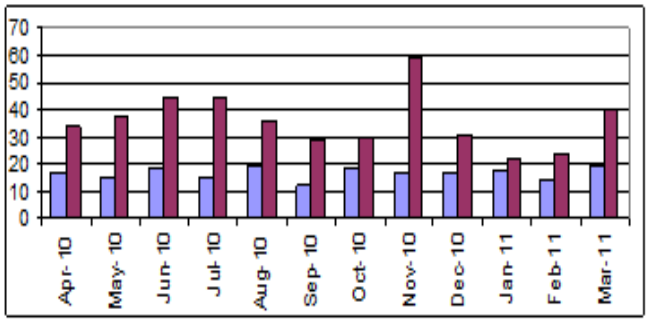

Fig.4 Min and Max of 24 Hours Averages of NOx

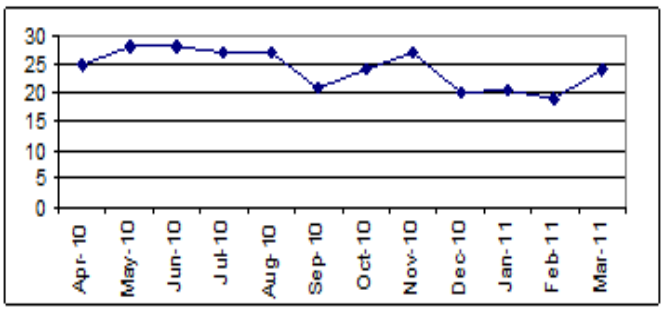

Fig.5. Trend in Monthly Mean Concentration of NOx

temperature prevails during the day from 09.00 to 17.30 hours. After 17.30 hours Salem city is exposed to the pleasant and moderate temperature.

Description of Station

It is located at 11º.38' 01.84" north 78º 07' 48.14" east. It has an average elevation of 278 metres (912 ft). The station comes under the category of mixed zone. The major sources of air pollution near the monitoring site are the emissions let out from the steel alloys and re-rolling mills located within 1 km from the site. Apart from the industrial sources, frequent movement of heavy and light vehicles, two and three wheelers on the nearby National Highways (NH7 and NH 47) emit huge quantities of smoke from their exhaust pipes.

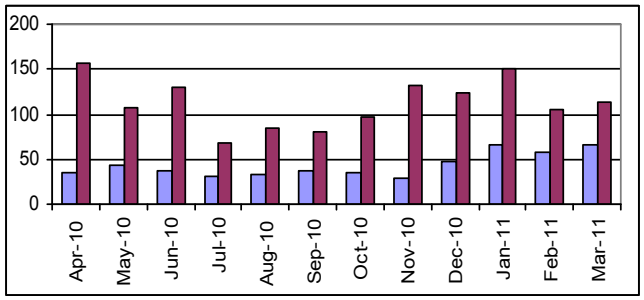

Fig.6 Min and Max of 24 Hours Averages of RSPM (PM 10)

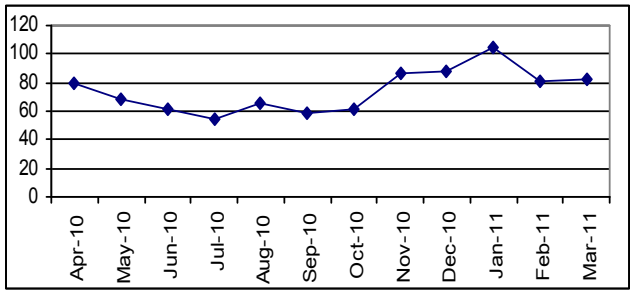

Fig. 7. Trend in Monthly Averages of RSPM (PM 10)

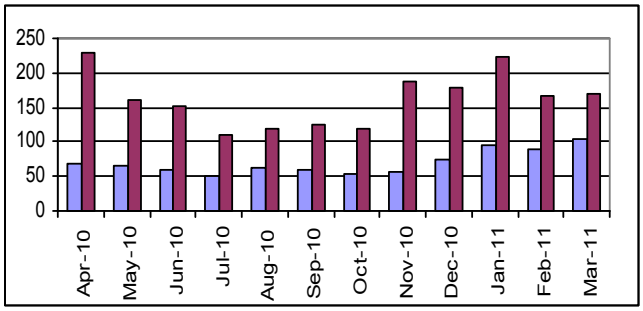

Fig. 8. Min and Max of 24 Hours Averages of TSPM (PM 100)

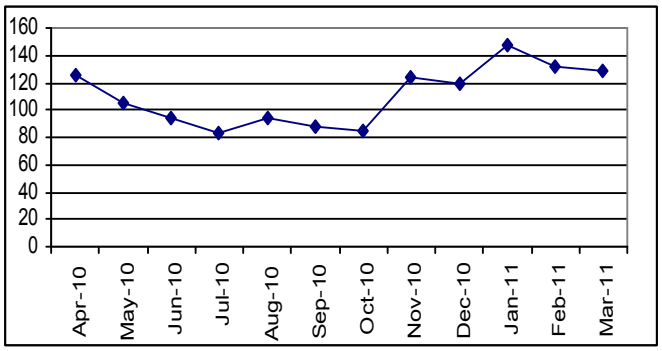

Fig. 9. Trend in Monthly Averages of TSPM (PM 100)

Moreover there are more than 20 auto diesel works being carried out along the road sides of both the National Highways. Commercial activities such as hotels, automobile shops, petrol bunks, tea and coffee bars and medical stores are also found all along the roads around the station. The educational institutions such as Salem Sowdeswari College of Arts and Science, Government Higher Secondary School and Vidyamandir Matriculation Higher Secondary School are located nearby the monitoring station. The station itself is in the premises of Salem Sowdeswari College Campus. Ammanikondalampatti, Nethimedu and Maniyanur are the residential areas located around the station (10).

Measurement Techniques

Respirable dust high volume sampler is an instrument used for monitoring of air quality parameters and provides 8 hours continuous readings. This instrument has provision for incorporation of gaseous sampling unit, for simultaneously monitoring gaseous pollutants like Sulphur dioxide (SO_2) and Oxides of Nitrogen (NOx) present in the air. Pollution concentrations are subsequently estimated by standard methods of analysis in the laboratory. The Sulphr dioxide (SO_2) and Oxides of Nitrogen (NOx) are measured by improved West and Gaeke method and modified Jacob and Hochheiser method respectively. Total Suspended Particulate Matter (PM 100) is measured by gravimetric technique (HVS-Filtration). PM 10 is measured by gravimetric technique under HVS-Filtration method on a pre-weighted glass micro fibre filter paper (GFA/EPM 2000-Whatman). Difference in the weight of filter paper gives the amount of dust collected and thus the concentration is determined.

Air Quality Status and Trend:

Ambient air quality data generated under National Air Quality Monitoring Programme (NAMP) of Central Pollution Control Board, New Delhi at the station- Salem Sowdeswari College, Kondalampatti in Salem City have been analyzed to determine the status and trends in the ambient air quality during the period from April 2010 to March 2011. It has been found that annual average concentrations of sulphur dioxide, oxides of nitrogen and total suspended particulate matter levels were found to be within the national standards (NAAQS) while the annual average of respirable suspended particulate matter is found to be exceeded the national standard. The Central Pollution control Board (CPCB), New Delhi has prescribed a maximum permissible limit for each air pollutant for specific areas. These are known as National Ambient Air Quality Standards, which are the limit of air quality with an adequate margin of safety. The standards are necessary to protect public health, vegetation and property (11). The month wise status of Gaseous and Particulate Pollutants has been given in Table.1 and 2 respectively.

Sulphur dioxide (SO_2)

The annual mean concentration of sulphur dioxide for the year 2010-2011 was 8.5µg/m^3 and found to be well with in the prescribed standard of 50µg/m^3. The annual mean concentration level always remained within the national standard since 1996. Sulphur dioxide, the most harmful and critical air pollutant is not a major air quality concern in Salem city. The monthly mean concentrations (average of 24 hours averages) of sulphur dioxide were ranging between 7.5-10.0 µg/m^3 in the year 2010-2011. The highest monthly mean concentration was observed during June while the lowest mean concentration was recorded during December. The monthly maximum values of 24 hours averages of sulphur dioxide were ranging between 8.6-12.0 µg/m^3 in the year 2010-2011. The maximum value of 12.0µg/m^3 was recorded in May while the lowest value 8.6 µg/m^3 was recorded in the month of December. No occasions the 24 hours averages of sulphur dioxide exceeded the national standard of 80µg/m^3. The monthly minimum values of 24 hours averages of sulphur dioxide were ranging from 4.8 to 8.0µg/m^3 during the year

2010-2011. The value of 4.8µg/m^3 was recorded in May while the value 8.0µg/m^3 was recorded in March in the year 2010-2011.

Oxides of Nitrogen (NOx)

The annual mean concentration of oxides of nitrogen in the year 2010-2011 was recorded as 24.2µg/m^3 and found to be well within the national standard of 40µg/m^3 for annual average. The annual mean concentrations of oxides of nitrogen were ranging from 7.66 to 37.0µg/m^3 during the period 1996-2011. The annual mean concentration levels of oxides of nitrogen also always remained within the national standard since 1996 in Salem city. The monthly mean concentrations (average of 24 hours averages) of oxides of nitrogen were ranging between 19.0-28.0 µg/m^3 in the year 2010-2011. The highest monthly mean concentration was observed during June while the lowest mean concentration was recorded during February. The monthly maximum values of 24 hours averages of oxides of nitrogen were ranging between 22.6-59.0µg/m^3 in the year 2010-2011. The maximum value of 59.0µg/m^3 was recorded in November while the lowest value 22.6 µg/m^3 was recorded in the month of January. No occasions the 24 hours averages of oxides of nitrogen exceeded the national standard of 80µg/m^3. The monthly minimum values of 24 hours averages of oxides of nitrogen were ranging from 12.1 to 19.6µg/m^3 during the year 2010-2011. The value of 19.6µg/m^3 was recorded in March while the value 12.1µg/m^3 was recorded in September.

Respirable Suspended Particulate Matter (RSPM/PM 10)

There is now growing concern all over the world about particulate matter of size 10 micron and 2.5 micron (PM 10 and 2.5) or less. One micron is equal to one-millionth of a meter. The WHO has classified these as thoracic particles because these are respirable and, because of their small size, get lodged deep down in the lower respiratory track. These particles exacerbate cardiac and respiratory problems among the primary pollutants. National level standard for RSPM/PM 10 annual average is 60µg/m^3 and 24 hours average is 100µg/m^3. The annual mean concentrations of respirable suspended particulate matter was recorded as 74.4µg/m^3 in the year 2010-2011 and found to be slightly exceeded the national standard of 60µg/m^3. The annual mean concentrations of this pollutant parameter were ranging from 28.2 to 85.0µg/m^3 during the period 1996-2011. The monthly mean concentrations (average of 24 hours averages) of respirable suspended particulate matter were ranging between 54-105µg/m^3 in the year 2010-2011. The highest monthly mean concentration was observed during January while the lowest mean concentration was recorded during July. The monthly mean concentrations were found to be not exceeded the national standard of 100µg/m^3 except January during 2010-2011. The monthly maximum values of 24 hours averages of respirable suspended particulate matter were ranging between 69.0-157.0 µg/m^3 in the year 2010-2011. The maximum value 177.0µg/m^3 was recorded in January while the lowest value 69.0µg/m^3 was recorded in the month of July. Almost all the maximum values of 24 hours averages of respirable suspended particulate matter exceeded the national standard of 100µg/m^3 while the values were found to be within the standard during July-October. The monthly minimum values of 24 hours averages of respirable suspended particulate were ranging from 28.0 to 67.0µg/m^3 during the year 2010-2011. The lowest value 28.0µg/m^3 was recorded in November while the highest value 67.0µg/m^3 was recorded in January in the year 2010-2011.

Total Suspended Particulate Matter (TSPM/PM 100)

In the year 2010-2011, the annual mean concentration of total suspended particulate matter was recorded as 110.5µg/m^3 and also found to be within the prescribed standard of 140µg/m^3. The monthly mean concentrations (average of 24 hours averages) of total suspended particulate matter were ranging between 83-147.6µg/m^3 in the year 2010-2011. The highest monthly mean concentration was observed during January while the lowest mean concentration was recorded during July. The monthly mean concentrations were found to be not exceeded the national standard of 200µg/m^3 during 2010-2011. The monthly maximum values of 24 hours averages of total suspended particulate matter were ranging between 109-228µg/m^3 in the year 2010-2011. The maximum value 228µg/m^3 was recorded in April while the lowest value 109µg/m^3 was recorded in the month of July. The monthly maximum values of 24 hours averages of total suspended particulate matter exceeded the national standard of 200µg/m^3 during April and January while the remaining values were found to be within the standard. The monthly minimum values of 24 hours averages of total suspended particulate were ranging from 52-105µg/m^3 during the year 2010-2011. The lowest value 52µg/m^3 was recorded in July while the highest minimum value 105µg/m^3 was recorded in March in the year 2010-2011.

Conclusion

Air quality data obtained from April 2010 to March 2011 clearly indicate that Salem Sowdeswari College premises has no serious air pollution problems in respect of sulphur dioxide, oxides of nitrogen and total suspended particulate matter. The annual averages of these pollutants were found to be well with in the national standards. The annual average of another critical pollutant respirable suspended particulate matter (PM 10) was found to be slightly higher than the national standard in the year 2010-2011. In the present study of status and trend in respect of respirable suspended particulate matter, the annual mean concentration was found to be slightly higher than the required level as per national standard. Almost all the monthly maximum of 24 hours averages of respirable suspended particulate matter in the year 2010-2011 were exceeding the national standard of 100µg/m^3 except during July to October. Increasing vehicular traffic, gen-set operations, and emissions let out from the nearby steel alloys, medium scale units, re-suspension of traffic dust are the major reasons for the increasing trend in respirable suspended particulate matter. The vehicular population is increasing exponentially in many Indian cities and Salem is being one among them. Heavy vehicles traffic is extremely high at Kondalampatti Roundane which is nearby the station. Diesel vehicles are the primary source of smoke (black shoot consisting of un-burn carbon) and oxides of nitrogen in addition to sulphur dioxide. Emissions from vehicles, especially automobiles, are known to contribute substantially to air pollution in urban areas.

At least 10,000 heavy vehicles pass through Salem city or its outskirts everyday causing a lot of pollution apart from consuming enormous fuel. These vehicles emit particulates from the exhaust and disturbed the dust on the roads. Innumerable studies point towards diesel being the major sources of fine particles. The analysis of data clearly shows that respirable suspended particulate matter is emerging as the critical pollutant for primary attention. The main health effects statistically associated with exposure to PM 10 include evidence of increased mortality (those with pre-existing cardiopulmonary conditions) and morbidity (increased by increased hospital admissions, respiratory symptom) rates and dedecrement in lung functions. This particle also plays a central role in environmental problems such as climate change and visibility impairment. In this study it has been observed that the values of suspended particulate matter were found to be slightly exceeded the national standard in two occasions during April and January months while it is found to be well within the standard during remaining months. The study concludes that the seriousness of the air pollution in respect of RSPM (PM 10) may aggravate, if not brought under control. In order to minimize the health risk and cost involved due to air pollution in the city, effort should be made to launch more drastic action plans to reduce PM 10 pollution. The urban transportation should aim at moving people not vehicles. The growing automobile fleet particularly diesel vehicles are becoming biggest threats to public health in our country. Vehicular air pollution is the key culprit in Salem City like many other Indian cities.

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