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Assessment of SPM and Ozone in Amravati City

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Abstract - *Air pollution has become an environmental problem of public concern worldwide. The Amravati city is fast developing city, rural population around city migrated towards the city. Because of various facilities such as education, market, business, health, and entertainment are available in the city; increasing urbanization increases the vehicular traffic day by day. In addition to this five star MIDC at Nandgaon Peth which is a distance of 20 km from the core Amraati city is growing tremendously. It is observed that the air quality of Amravati city is degrading day to day which affect human health in the city and adjoining area. The Sofia thermal power station contributes a large quantity of SPM, RSPM, SOx, and NOx etc. In our study, the concentration of suspended particulate matter (SPM)is monitored over periods of 24 hours and OZONE is monitored over period of 8 hrs. at Amravati city. Pollutants concentrations were used to determine the AQI. The five locations have to select for the assessment of SPM and OZONE on the basis of traffic volume, locality and availability of electricity. The High Volume Sampler (HVS) is use to find out the concentration of SPM and O_3. The air is blown at the rate of 1.5 m^3/min. for SPM and 1.0 LPM for O_3. Spectrophotometer is also used for evaluation for O_3 concentration. SPM is collected on filter paper and O_3 is collected in a 1% KI in 0.1 m Phosphate Buffer. This study identifies the potential sources of pollutants and degree of air pollution. Further, management strategies to minimize the effect of air pollutants have also been suggested.*

Keywords — *SPM, AQI, HVS, Spectrophotometer, LPM, MIDC*

I INTRODUCTION

"Air pollution means the presence in the outdoor atmosphere of one or more contaminants, such as dust, fumes, gas, mist, odour, smoke, or vapors, in quantities, with characteristics, and of duration such as to be injurious to human, plant, or animal life or to property, or which unreasonably interfere with the comfortable enjoyment of life and property." (Engineers Joint Council - USA). Air is one of the five vital basic natural ingredients of life system. The immediate environment of human-being comprises of air on which depends all forms of life. The major anthropogenic sources of air pollutants are industrial emissions, domestic fuel burning, emissions from power plants and transportation activities etc. The advent of technological and scientific innovations in various fields and diverse activities of human race for its sophistication have put extra load on the atmosphere by way of releasing air pollutants like suspended particulate matter (SPM), respirable suspended particulate matter (RSPM), sulphur dioxide (SO2), oxides of nitrogen (NOx), carbon monoxide (CO), unburned hydrocarbon (HC), hydrogen fluoride (HF) and other organic as well as inorganic pollutants including trace metals responsible for causing health consequences.

Suspended particulate matters are finely divided solids or liquids that may be dispersed through the air from combustion processes, industrial activities or natural resources. This complex mixture includes both organic and inorganic particles, such as dust, pollen, soot, smoke and liquid droplets. These particles vary greatly in size, composition and origin. Particles in air are either directly emitted for instance when fuel is burnt and when dust is carried by wind or indirectly formed when gaseous pollutants previously emitted to air turn in to particulate matter. Ozone (O_3) is a gas that can form and react under the action of light and that is present in two layers of the atmosphere. High up in the atmosphere, ozone forms a layer that shields the Earth from ultraviolet rays. However, at ground level, ozone is considered a major air pollutant. Ground-level ozone– the focus of this study – is formed from other pollutants and can react with other substances, in both cases under the action of light. Concentrations are often low in busy urban centres and higher in suburban and adjacent rural areas, particularly on sunny days in summer. However, ozone can be transported through air over long distances and across borders. Ozone is known to cause adverse health effects, but more research is needed. In the present paper, an attempt is made to represent the overall ambient air quality in various locations in Amravati city, a fast growing industrial area in the Maharashtra state

1.1Effects of SPM

1. Effects on human health

Particulate matter has recently become an issue of increasing importance in pollution studies due to its noticeable effects on human health. Various studies on air pollution effects on health have indicated a strong relationship between air pollutant concentrations and observed health effects. There is also strong evidence that fine particles play an important role in the observed health effects. Coarse particles are effectively removed in the upper part of respiratory track while fine particles are deposited on the bronchi walls in the bronchi tree Particles smaller than 0.1μm experiences Brownian motion as a result of which they get collected in the bronchi. However, particles lying between 0.1 -1 m are too large for Brownian Motion and too small to be trapped in the upper part of the trachea. Hence, they get deposited in the lungs, thus increasing airway resistance 1 shows the respiratory system of a human being showing the extent of the penetration size – fractionated total suspended particulates coarse particles and fine particles. Particle behaviour in the lung is dependent upon the aerodynamic characteristics of particles in flow streams. The aerodynamic properties of particles are related to their size, shape and density. The Deposition of particles in different regimes of the respiratory system depends on their sizes. The nasal openings permit very large dust particles to enter the nasal region, along with much finer airborne particulates.

2. Vegetation and animals

Vegetation reacts with air pollutants over a wide range of pollutant concentrations and Environmental conditions .Air pollutants enter the plant systems through direct and indirect pathways. The outer surfaces of a leaf are covered by a layer of epidermal cells which help in moisture retention. Between the epidermal layers are the mesophyll cells which comprise the spongy and palisade parenchyma. The leaf has a vascular bundle which carries water, minerals and carbohydrate throughout the plant. The stomata's of leaves are controlled by guard cells which can open and close and hence change air spaces in the interior of leaves. Particulate matter enters into leaves through stomata by diffusing into and out of leaves. The indirect pathway occurs through the root system. The deposition of air pollutants on soils and surface water can cause alteration of the nutrient content of the soil in the vicinity of the plant. This changes the soil conditions Extensive tissue collapse or necrosis results from injury to the spongy or palisade. Cells in the interior of the leaves. Urban vegetation can directly or indirectly affect the local and regional air quality by altering the urban atmospheric environment. Trees affect local air temperature by transpiring water through their leaves, by blocking solar radiation (tree shade) and therefore reducing radiation absorption and eat storage by various anthropogenic surfaces which include buildings and roads. During dry seasons, trees predominantly reduce local air temperatures by increasing within and below - canopy air temperature due to reduced turbulent exchange with above canopy air .Reduced air temperature due to trees can improve air quality because the emission of many pollutants and/or their precursors is temperature dependent. Decreased air temperature can also reduce ozone formation in the atmosphere Physical mass, water transpiration and thermal/ radioactive properties of trees can also affect wind speed, relative humidity, turbulence and surface albino. The emission of volatile organic compounds (VOCS) from trees can contribute to the formation of ozone and carbon monoxide, Since VOC emissions are temperature dependent and trees generally lower air temperatures, increased tree coverage can lower VOC emissions and consequently ozone levels in urban areas Heavy metals on vegetation and in bodies of water have been found to be toxic to animals and fish Gaseous and particulate fluorides have caused injury and damage to a wide range of animals (domestic, wild and fish). Abnormal intake of arsenic results in severe colic (salivation, thirst, vomiting), diarrhea, bloody feces, a garlic-like odor on the breath, cirrhosis of the liver and spleen. Cattle feeding on herbage containing 25-50 mg/kg lead resulted in the excitable jerking of muscles, frothing of the mouth, the grinding of teeth and paralysis of the larynx muscles. Molybdenum poisoning in cattle often lead to emaciation, diarrhea, anemia, stiffness and fading of hair color. Vegetation containing 280 mg/kg of Molybdenum affects cattle. Mercury in fish has been found in the water of developed countries. Mercury in the water is converted into methyl mercury by aquatic vegetation. Small fish consume such vegetation, which in turn are eaten by large fish and eventually by human beings. Food with more than 0.5 ppm of Hg (0.5 mg/kg) cannot be sold in the United States for human consumptions.

3. Visibility reduction

Visibility degradation is one of the most readily perceived impacts of fine particulate matter. Fine particles absorb and scatter light and therefore reduce visibility For example, in many parts of the United States, the visual range has been reduced to 70 % from natural conditions. In the eastern part of the US, the current range is 14-24 miles versus a natural visibility of 70 miles. In the western US, the current range is 33-90 miles versus a natural visibility of 140 miles. Fine particles with a diameter between 0.3-1.0 μm make the major contribution to visibility reduction The most immediate and obvious impact of urban air pollution is its impairment of visibility. Most cities in the world like Lagos are experiencing high levels of visibility degradation due to high emission intensity and adverse meteorology high emission intensity is as a result of fine particles that interact more strongly with visible radiation due to their diameter being similar to that of light wavelengths.

4. Soiling and damage to materials

An important part of particulate matter pollution is the soiling of man-made surfaces. Hence, the processes of cleaning, painting and repairing exposed surfaces become an economic burden. Acid particles can severely deteriorate artwork and historic monuments and result in the reduction of their aesthetic appearance and life span. Chemical degradation of materials due to deposition of atmospheric acid particles is an important aspect of material damage. Airborne particulate matter

Are generally of two classes, the fine particulates and coarse particulates .They differ not only in size but also in source, chemical composition, physical properties and their formation process. These particulate matters tend to soil cities due to surfaces that become dusty so that streets, sidewalks and floors have to be swept or dusted more frequently, and clothing must also be washed more frequently. In addition, the dust which is alkaline, damages painted surfaces such as walls, doors and automobiles. The soiling of exterior building materials was investigated by Be loin and Hayne to be dependent on type of paints. For white paints, the soiling was found to be directly proportional to the square root of the particle dose of the particulate matter. Also, Michelson and Touring related the frequency of repainting houses to atmospheric particulate concentrations. A linear relationship between repainting frequency and atmospheric particulates was obtained. The cost of repainting associated with loss of cleanliness was found to be proportional to the atmospheric particulate level raised to an exponent. The degree of soiling damage is influenced by the optical and chemical compositions of airborne particulate matter. Walling observed that a diesel particulate is about 3.5 times blacker than the average urban particulate. Hence, diesel smoke tends to stick to surfaces more than average particulates. He compared the reflectance of diesel soot with known reflectance of average urban particulates. He concluded that only 1/3 to 1/4 of the mass of diesel soot compared with urban particulates was required to achieve a stain of equivalent darkness. Hence, diesel soot is expected to have a greater affinity to surfaces than generated atmospheric particulates. The liquid components of diesel particulates allow it to adhere to a surface more readily than dry average particulates. Diesel soot has a greater propensity to smear and is more difficult to remove than dry particulates due to its liquid components. The soluble organic fraction of diesel soot from light duty engines was reported by Kageyama and Kinehara to vary from 10 to 80 percent by mass, depending on engine operating conditions. Soiling is an optical effect which is essentially the darkening of reflectance those results from the deposition of airborne particulate matter to external building surfaces. Summarized the factors that affect the degree of soiling as: the blackness per unit mass of smoke, the particle size distribution, the chemical nature of the particles, substrate- particle interfacial binding, surface orientation and the micro-meteorological conditions. Similarly, different types of particulate emission have different soiling characteristics. And Mansfield reported that diesel emissions have a much higher degree of soiling relative to petrol or domestic coal emissions. This is due to higher particulate elemental carbon (PEC) content as reported by QUARG. PECs have a high optical absorption coefficient. Hence, a PEC particle landing on a surface is more likely to adhere than other particulate matter.

1.2 Effects of OZONE on Environment

Short-term exposure to ozone peaks can temporarily affect the lungs, the respiratory tract, and the eyes. It can also increase the susceptibility to inhaled allergens. Long-term exposure to relatively low concentrations of ozone can reduce lung function. Research shows adults and children who spend more time outdoors participating in vigorous physical activities are at greater risk from the harmful health effects of ozone exposure. While there are relatively few studies of ozone's effects on children, the available studies show that children are no more or less likely to suffer harmful effects than adults. However, there are a number of reasons why children may be more susceptible to ozone and other pollutants. Children and teens spend nearly twice as much time outdoors and engaged in vigorous activities as adults. Children breathe more rapidly than adults and inhale more pollution per pound of their body weight than adults. Also, children are less likely than adults to notice their own symptoms and avoid harmful exposures. Further research may be able to better distinguish between health effects in children and adults. Children, adolescents and adults who exercise or work outdoors, where ozone concentrations are the highest, are at the greatest risk of harm from this pollutant.

Ozone’s effect on plant life Ozone exposure reduces the overall productivity of plants, damaging cells and causing destruction of leaf tissue. As a result, ozone exposure reduces the plants’ ability to photosynthesize and produce their own food. Plants respond by growing more leaves thereby reducing the amounts of stored carbohydrates in roots and stems. This weakens plants, making them susceptible to disease, pests, cold and drought.

• Ozone reduces crop and timber yields, resulting in millions of dollars in economic losses.
• Ozone disturbs the stability of ecosystems, leading to sensitive species dying out.
• Ozone exposure reduces the production of roots, seeds, fruit and other plant constituents,
reducing the amount of food available for wildlife.

Ozone can cause substantial damage to a variety of materials such as rubber, plastics, fabrics, paint and metals. Exposure to ozone progressively damages both the functional and aesthetic qualities of materials and products, and shortens their life spans. Damage from ozone exposure can result in significant economic losses as a result of the increased costs of maintenance, upkeep and replacement of these materials.

Effects of exposure to ground-level ozone are Cough, chest tightness, pain upon taking a deep breath,Worsening of wheezing and other asthma symptoms, Reduced lung function & Increased hospitalizations for respiratory causes.Will ozone harm your health? It depends... How long were you exposed?, How much ozone did you inhale? & how fast were you breathing?

Ozone reacts with surfaces as it penetrates the indoor environment, usually resulting in lower levels indoors than outdoors. However, levels of ozone indoors can approach outdoor levels when windows or doors are open. Moreover, equipment such as photocopiers, laser printers and certain air purifiers can emit ozone indoors as well. Air purifiers that purposely emit ozone, called ozone generators, should not be used in occupied spaces as they can emit unsafe levels of ozone. Once inside, ozone can cause harmful health effects and damage materials, depending on its concentration.

II MATERIALS AND METHODS

2.1 Study area

Amravati city is located near a major industrial area i.e. sofia power plant. The abundance availability of man power and adequate infrastructure facility have encouraged establishment of several industries including power plant in Nandgaon Peth area. Operation of industries in such a large scale will have definite load on physical, chemical and biological characteristics of the natural environment. Consequently, there will be considerable air pollution in pace with industrial advancement. The concentration of SPM and O_3 assessment is carried out at important areas of Amravati city. These areas are selected on the basis of traffic volume and availability of electric supply. The selected areas are shown in table1.

Table 1: Sampling stations

Station No.	Locations	Types of Area
Station 1	P.R.M.I.T and R, Badnera	Institutional Area
Station 2	Sai Nagar	Residential Area
Station 3	Rajapeth	Commercial Area
Station 4	Rukhmini Nagar	Hospital Area
Station 5	Renuka Industries, M.I.D.C.	Industrial Area

2.2 Methodology

Analysis of SPM was carried out using High Volume Sampler (PEM-HVS-8) at an average flow rate of 1.0-1.5 m3/min at five sampling stations (details given in Table 1) on monthly basis during the study period. Condition a filter paper in oven. Prepare a sampling assembly by uncorking screws of the bracket. Take the tare (initial) weight of filter paper. Place the filter in the sampling system securely and tighten the screws of the bracket. Set the timer for the period of sampling. Start the sampler and adjust flow rate to about 1.5 lit/min for 24 hours sampling. Note the flow rate at the end of the desired sampling period Transit the sampling train to environmental laboratory carefully with scientific precautions. Condition the filter paper again for the same period as was done prior to sampling. Take the final weight of filter paper. The concentration of the particulate matter is estimated on the net mass collected divided by the volume of air sampled. For the collection of gaseous pollutant like O_3 the sampler having thermoelectrically cooled gaseous attachment containing impingers (bubbler trains) in series with 1% KI in 0.1 m Phosphate Buffer as absorbing solution for O_3 was used. The collected samples were put in ice boxes immediately after sampling and kept in a refrigerator prior to analysis. The samples were analyzed spectrophotometrically (Systronic UV-Visible Spectrophotometer 118) .

2.3. *Air Quality Index (AQI)*

The Air Quality Index (AQI) is an environmental index which describes the overall ambient air status and trend of a particular place based on specific standard. It is a tool that transforms the (weighted) values of individual air pollutants (parameters) into a single number or set of numbers (Rao, 1993). The overall ambient air quality of a specified area can be assessed in a better way and quantified in terms of AQI since it represents the cumulative effect of all the pollutants. AQI can also enable one to formulate the alternative policies for prevention of air pollution or to design control equipment which, for instance, will reduce the level of certain pollutants while increasing the levels of others. There are several methods and equations used for determining the AQI. The higher the AQI value, greater is the level of air pollution and greater is the health risk. The AQI scale is divided into five categories as depicted in Table 2. It describes the range of air quality and its associated potential health effect.

Table No. 2 Air Quality Index [World Health Organization]

Air Quality	**Air Quality Index**	**Health Advisory**
Good	0-50	None
Moderate	51-100	Unusually sensitive people should Reducing heavy exertion.
Unhealthy for sensitive group	101-150	People with heart or lung disease & old, adults & Children should reduced Heavy exertion.
Unhealthy	151-200	Everyone else should reduce heavy and prolonged Exertion.
Very Unhealthy	201-300	People with heart or lung disease & old, adults & Children should avoid all physical activities outdoor everywhere else should reduced prolong or heavy exertion

III RESULTS AND DISCUSSION

SPM: Throughout the study period it has been observed that station 1(Institutional area), 3 (Commercial area) and 5 (Industrial area) SPM was found above the permissible limits i.e. (406.64 $\mu g/m^3$, 291.46 $\mu g/m^3$and 584.92 $\mu g/m^3$) respectively. The average SPM values at stations 1, 3, 5 exceeded the permissible limit of National Ambient Air Quality Standard (NAAQS) while at remaining two locations i.e. at station 2 and 4 (Residential and Hospital area) SPM level was good within standard limits set by CPCB. Actually for knowledge point of view SPM level is relatively high during winter i.e. November- February in comparison to monsoon i.e. July-October and summer i.e. March-June. This trend was due to the fact that in winter, anti-cyclonic condition prevailed which was characterized by calm or very slow wind. There was little dispersion or dilution of pollutants which was caused higher level of SPM. This high particulate emission at station 1 is due to the fact that location was near the MIDC area. Also the whole assembly was put at parking area which is very near to NH6. Station 3 i.e. at Rajapeth is very core commercial area of city as traffic volume is considerably high and hence emission of particulate matter is high. Station 5 i.e. Rukhmini Nagar is very near to Bus Depot and highly affected by vehicular traffic and hence emission of particulate matter is very high.

Station No.	Type of Area	Location	SPM	O_3	AQI
1	Institutional Area	P.R.M.I.T & R, Badnera	406.64	8.07	105.69
2	Residential area	Sai Nagar,Samarthwadi	178.43	5.70	47.46
3	Commercial Area	Rajapeth	291.46	9.51	77.62
4	Hospital Area	Rukmani Nagar	93.187	7.12	58.46
5	Industrial Area	Renuka Industries, M.I.D.C	584.92	10.93	63.96

Table No. 3 Locations of different areas with concentrations of SPM, O_3 &AQI

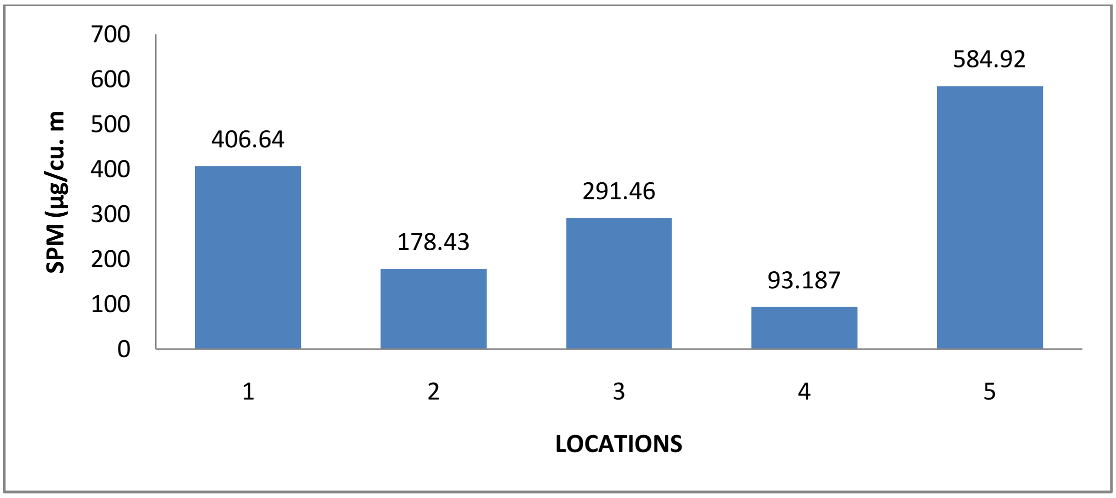

Fig. No.1 Graphical representation of concentration of SPM

O_3: The detected concentration of O_3 was far below the prescribed limits set by the NAAQS at all the locations. The highest average concentration of O_3 of only 11.406 µg/m^{3}was found at station 5 (MIDC area). The lowest value of O_3 was observed 5.43 µg/m^3 at station 4 i.e. Hospital area. As per knowledge point of view O_3 level is bit high in winter in comparison to summer and monsoon. This is due to the prevalence of high speed wind and no precipitations.

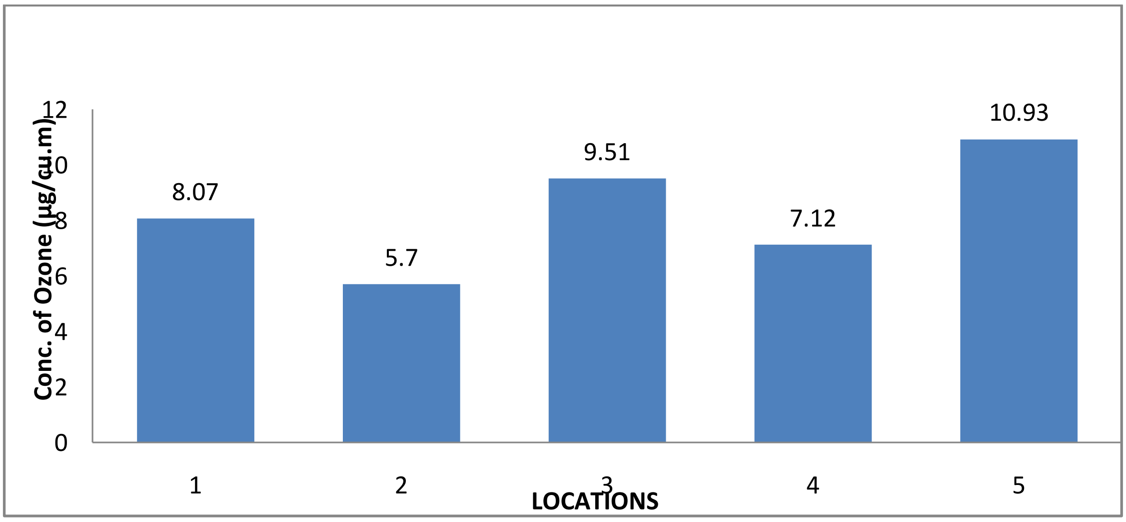

Fig. No. 2 Graphical representation of concentration of O_3

AQI: The average AQI for different stations are depicted in table 2 .The highest (105.83) and lowest (12.7087) AQI were observed at location 1(Institutional Area) and Location 4 (Hospital Area) respectively. It is seen that the AQI values at Location 1 is more than 100 indicating sever pollution of the ambient air. Heavy air pollution is found at Location 1 and Location 5 and light air pollution is noticed at Locations 2 and 4. High values of AQI are due to mainly SPM emission.

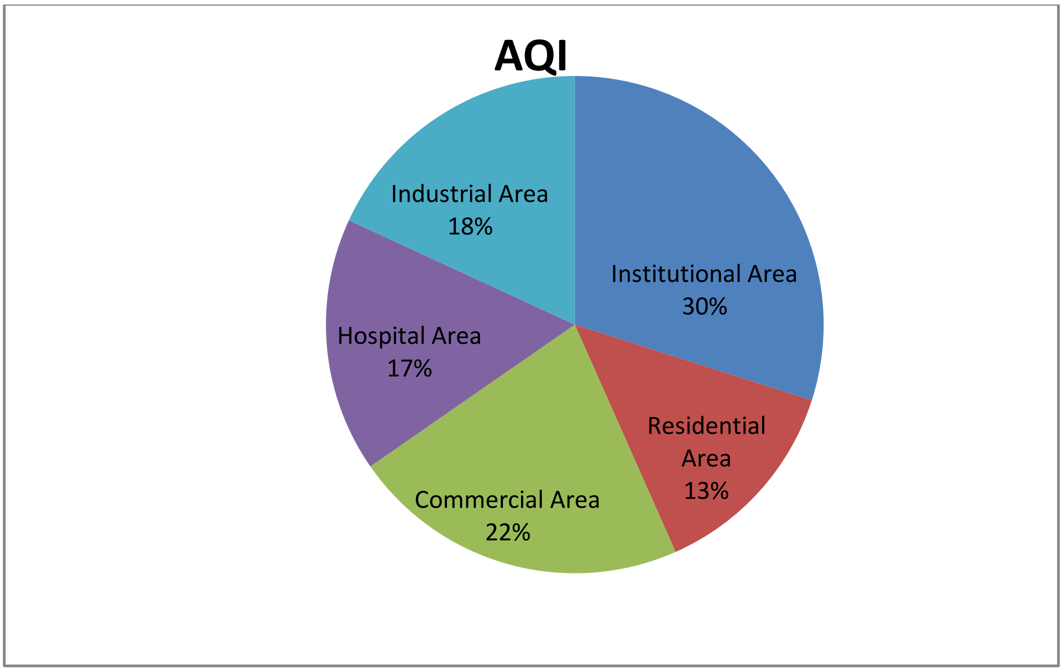

Fig. No.3 Graphical representation of AQI at different stations

IV CONCLUSIONS

Computed and analysed data prevailed that suspended particulate matter (SPM) were having the major air pollutant is at three locations. However gases pollutants (O_3) within the permissible limits at all stations. The following points concluded that,

1. The value of SPM at station 1, 3, 5 is more than prescribed by NAAQS and at station 2, 4 is within permissible limit.
2. The value of O_3 at all the station is within the permissible limit.
3. It can be suggested that ambient air at Institutional, Commercial and Industrial area is not safe for people who are suffering from heart and lung diseases. Similarly old people and children should reduce heavy exertion at these locations. The prolonged or heavy exertion at these intersections may create adverse physiology effect on the people.
4. For maintaining the SPM concentration within an acceptable level, it is suggested that massive green plantation must be taken up in the entire area. Trees having high dust trapping efficiency so that it can be grown along side of the roads and water is to be sprinkled continuously at the sources of generation of particulate matter immediately.
5. Measures like limiting vehicle speed at vulnerable locations, conducting public awareness, campaigns about the harmful effects of air pollution and educating drivers to be more eco-friendly must be taken.
6. Moreover regulatory authorities must ensure that industries should discharge their moral and social responsibilities to protect the environment.
7. Severe pollution is found at Industrial Area, Heavy air pollution is found at Institutional and commercial area, Light air pollution is found at Residential and hospital Area.
8. Air quality index is unhealthy (for sensitive zone) at institutional area & moderate at remaining for station.

REFERENCES

[1]. A.M.O. Abdul Raheem, F.A. Adekola and I.B. Obioh (2009), Monitoring of sulfur dioxide in the guinea savanna zone of nigeria: implications of the atmospheric photochemistry, Chemical Society of Ethiopia.

[2]. A.M.O. Abdul Raheem, F.A. Adekola and I.B. Obioh, (2013) Selected Trace Metals Analysis of Total Suspended particulate Matter in Rural Areas in Edo state, Nigeria,Greener Journal of Environmental Management and Public Safety**, (**Vol. 2 (2),**) (**pp. 091-098**).**

[3]. Analitis A.,Katsouyanni K.,Dimakopoulou K., Samoli E., Nikoloulopoulos A.K.,and Petasakis Y., (2006), Short-term effects of ambient particles on cardiovascular and respiratory mortality, Epidemiology, 17(2), pp 230 – 233.

[4]. Barman S.C., Kumar N., and Singh R., (2010), Assessment of urban air pollution and its probable health impact, Journal of Environmental Biology, 31(6), pp 913-920.

[5]. C.N. Tripathi, Jahanvi Kulshreshtha and Istuti Gupta,(2013),Determination of SOx [6]. Concentration in Ambient Air and its Dependency on Meteorological Parameters: A Case Study,C.N. Tripathi, Jahanvi Kulshreshtha, Istuti Gupta / International Journal of Engineering Research and Applications (IJERA) (Vol. 3) (pp.287-291)

[7]. Dibofori-Orji A. N.; Edori O. S (2013), Suspended Particulate Matter (SPM) and Trace Metals Emission from the Combustion of Tyres in A Nigeria Abattoir, Chemistry and Materials Research (Vol.3).

[8].Joshi P.C.,and Semwal M.,2011, Distribution of air pollutants in ambient air of district Haridwar (Uttarakhad), India: A case study after establishment of State Industrial Development Corporation, International Journal of Environmental Sciences, 2(1), pp 237-243.

[9]. Muhammad Ali Awan, Syed Hassan Ahmed, Muhammad Rizwan Aslam and Ishtiaq Ahmed Qazi,(2011),Determination of Total Suspended Particulate Matter and Heavy Metals in Ambient Air of Four Cities of Pakistan, Iranica Journal of Energy and Environment.

[10]. Panda B.K,Panda C.R.(2012),Estimation of ambient air quality status in Kalinga Nagar Industrial complex in the district of jaipur of Odisa Environmental science. Volume 3,No 2.

[11]. Zlauddin A., and Siddique N.A., (2006), air quality index (AQI)-A tool to determine ambient air quality, Pollution research, 25, pp 885-887.