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Chemistry

AMBIENT AIR QUALITY IN AND AROUND CHANDRAPUR CITY

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ABSTRACT Rapid growth in industries and due to the urbanization are responsible for recent environmental situation in various cities in India as well in Asian countries and also has seen a fast growth in their population along with significantly increased levels of air pollution in urban centers. Chandrapur, a town in Maharashtra, due to its coal mining activities, cement industries, and thermal power station has almost doubled its population in last decade.

This paper is a comparative study between the ambient air qualities of Chandrapur district during January 2015 to December 2017 at six different stations. The analysis for NOx, SO2 and RSPM has been done as per the standard methods of CPCB and MPCB.

It has been observed that SO2 level particularly in MIDC Chandrapur area samples were significantly higher than that of other stations. Ballarpur is located about 10 to 12 Kms away from Chandrapur and it has been observed that NOx level in air samples of Ballarpur was higher than normal. In general it was observed that RSPM level in almost all samples were higher. It may be concluded that the pollution level of SO2, NOx and RSPM mass concentration was significantly increased in the area under industrial impact.

KEYWORDS : NOx, SO2, RSPM, Industrial pollution, Residential pollution.

INTRODUCTION:

Unlimited and free natural resource is treated as clean air but today we cannot get such type of clean air easily due to the air pollution. Air pollution may be defined as the presences of air pollutants in the atmosphere to such an extent that they can produce harmful effects on man and his environment. In recent years there has been significant development activity in terms of industrialization, Urbanization, etc. in almost all medium and small towns and cities in India[1,11]. Significant growth is also observed in the automobile sector also. Modernization and enhanced industrial activities have lead to increased use of fossil fuels [2] coupled with sharp increase in vehicular population, has taken its toll on the environment with special reference to atmospheric system. Air pollution is one of the major problems in the cement industries and especially in mining area generally by open cast coal mining and the underground coal mines and as well as their transportation. All major mining activity contributes to the problem of suspended particulate matter directly or indirectly [3,4,and5].

Air pollution concentration varies spatially and temporally causing the air pollution pattern to change with different locations and time due to changes in meteorological and topographical conditions. Yearly periodical observations pertaining to gaseous and particulate air pollutants were carried out at industrial sites.

Combustion is the largest source of air pollutants. It is estimated that 15% of hydrocarbon emissions are the result of anthropogenic sources such as the burning of oil, natural gas, coal, and wood. Automobiles, in most countries, account for only a small percent of the total fuel burned, but they are responsible for a large percent of the carbon monoxide generated because of this incomplete combustion (Wallace 2006).Combustion is also an indirect cause of acid rain, because NO, NO2 and SO_2 are released to the atmosphere. A survey by CPCB (Central Pollution Control Board) has identified 23 critically polluted Indian cities. Amongst them the air pollution of Chandrapur is most alarming. An extensive study in the analysis of the concentration of the critical pollutants [6,7,11] such as Sulphur dioxide (SO_2), Nitrogen oxide (NOx) and RSPM present in the ambient air Chandrapur is made during the sampling period.

When fuel containing sulfur is burned SO_2 is formed. Raw materials such as crude oil, coal, and ore that contain common metals like aluminum, copper, zinc, lead etc were Sulfur is prevalent. From thermal power plants, smelting process of sulfide ores to produce copper, lead and zinc Sulfur oxides are emitted in significant quantities. The specific sources of sulfur dioxide generated during combustion process are diesel driven vehicles. Sulfate particles generated, can be transported over long distances and deposited far from the formation sources. SO_2 can result in respiratory illness, visibility impairment particularly in children and the elderly, and it can also aggravate existing heart and lung diseases.

A NOx is a generic term for a group of highly reactive gases in varying amounts that contain nitrogen and oxygen. Vehicles, industrial processes that burn fuel are Sources of nitrogen oxides. Ground level ozone is form due to the oxides of nitrogen when it reacts with volatile organic compounds and they also react to form nitrates, acid aerosols. Volatile organic compounds and oxides of nitrogen also contribute to nutrient overload that deteriorates water quality. It irritates the nose and throat, and it appears to increase susceptibility to respiratory infections.

Stationary and mobile sources emitted Particulate Pollutants. Particles are formed in the atmosphere by physical and chemical conversion from both natural and anthropogenic gaseous substances. Particulate pollutants are very diverse in character and cover a size range from <0.1µm to >100µm. PM_{10} are the particles with upper size limited by a 50% cut at 10 µm aerodynamic diameter (USEPA, 1996). PM_{10} can be formed by physical processes of grinding, crushing and abrasion of surfaces. Mining, Cement industries and agricultural activities are some of the sources of large size particles. $PM_{2.5}$ is the particles with upper size limited by a 50% cut at 2.5 µm aerodynamic diameter (USEPA, 1996).

Fig.1: Geographical Map Of Chandrapur

Study Area:

MIDC Chandrapur, Ghugus, Gadchandur, Ballarpur, and MIDC Tadali, were located in district Chandrapur Maharashtra state. It is a major store house of medium range of coal, cement industries and one of the biggest Thermal Power station in Asia. Chandrapur district in 'Vidharbha' region is located in the eastern edge of Maharashtra. It is located between 78.46'E longitude and 19.30' N to 20.45'N Latitude. The district is bounded by Nagpur, Bhandara and Wardha on the northern side, Gadchiroli on the eastern side, Adilabad district of the Andhra Pradesh on the southern side and Yavatmal on the western side. The air quality issues at Chandrapur have also been studied under US Asia Environmental Program by a team of experts from US-EPA in September, 2004[11]. They recommended and carried out the institutional analysis a pilot project to implement as an alternate approach to manage the air quality at Chandrapur by the Visible Emission Observations (VEOs) from the stationary sources [11,12]. The existing major industries in Chandrapur district include Paper industry, Coal mines, Cement plants, Lime mining and kilns, Steel and Super Thermal Power Plant of MSEB [11,12].

MATERIAL AND METHODS:

In order to know the status of air quality in Chandrapur district, six sampling stations were selected for air quality monitoring. Monitoring of the air quality was carried out during **January-2015 to December-2017.**

Sampling Methods For Gaseous Pollutants

As per the standard method of CPCB and MPCB samples are collected and analyzed. The SO_2 concentration in the air is sampled by West-Geake method.

The colour is estimated by using spectrophotometer, which is tuned to the wavelength of 560 nm. NOx concentration in the air sample is measured by Jacob and Hochheiser method. High volume sampler is used to collect samples of NOx present in the ambient air. By using a spectrophotometer at 540nm, the intensity of colour is measured and this value is proportional to the nitrogen oxide present in the sampled air. The interference caused by SO_2 is eliminated by treating with hydrogen peroxide [8].

Respirable Particulate Matter

PM_{10} are the particulate matter having aerodynamic diameter less than 10 µm and it is fraction of the particulate matter suspended in air and it represents the fraction that is considered to enter the respiratory system. Measured RSPM gravimetrically with GFA/EPM 2000 filter paper using respirable dust sampler.

Table No. 01: Indian National Ambient Air Quality Standards (INAAQS)

Pollutants	Time-weighted average	Concentration in ambient air		
		Industrial Areas	Residential, Rural & other Areas	Sensitive Areas
Sulfur Dioxide (SO_2) (µg/m^3)	Annual *	80	60	15
	24 hours**	120	80	30
Oxides of Nitrogen as (NO_X) (µg/m^3)	Annual *	80	60	15
	24 hours**	120	80	30
Respirable Particulate Matter (RPM) (< 10 µ) (µg/m^3)	Annual *	120	60	50
	24 hours**	150	100	75

* Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

** 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.

RESULTS AND DISCUSSION:

The air quality prescribed National Ambient Air Quality Standard (NAAQS) values were listed in Table no. 1. The monthly mean, maximum, minimum concentration and standard deviation for various pollutants regarding and different sampling sites are tabulated in the Table No. 2 to 4 and Figure No. 2 to 19.

AO Chandrapur

The monitoring station AO Chandrapur is near the main city bus stand and a large number of vehicles of all types are always engaged in transport. The minimum value of RSPM was 44µg/m^3 during July 2015 and the maximum value was 144µg/m^3 during month of November 2016. The average of Twelve months will be the 80.28µg/m^3 and it is within the prescribed limit of CPCB for residential area. The standard deviation was in between 18.79 to 28 during 2015 to 2018. The SO_2 and NOx values were in the prescribed limit. The SO_2 value ranges from 4µg/m^3 to 6µg/m^3 while the NOx value ranges from 16µg/m^3 to 34µg/m^3 and the standard deviation was 0.29 to 0.67 and 3.42 to 4.23 respectively.

MO MIDC, Chandrapur

The monitoring station is situated in the industrial zone. The minimum value of SO_2 was 2µg/m^3 and the maximum value was 17µg/m^3 during 2015 to 2017. The average value was 5.69µg/m^3 and it is well below prescribed limit. Similarly the value of NOx it is well below prescribed limit. The NOx value ranges from 12µg/m^3 to 49µg/m^3. But the value of RSPM it is above the prescribed limit by CPCB for industrial zone. The minimum value for RSPM is 34µg/m^3 and the maximum value is 113µg/m^3 and the average value was observed to be 73.94µg/m^3. The standard deviation was 20.83 during 2015 to 2017. In the given period the values of RSPM were within the prescribed limit in all the months. So in the MIDC area of Chandrapur there is decrease in the pollution as compared to 2012 to 2014 [13].

GHUGHUS

The monitoring station is situated in residential area which is surrounded by several opencast coal mines and heavy vehicle transportation of these coal mines. The minimum value of RSPM was 86µg/m^3 and the maximum value was 417µg/m^3 and the average value was 216.022µg/m^3 during 2015 to 2017. The standard deviation was 62.74. All the values of RSPM are very high and it is well above the prescribed limit 150 µg/m^3. The minimum value of RSPM is below the prescribed limit and it gradually increased throughout the monitoring period. The value of SO_2 ranges from 2µg/m^3 to 24 µg/m^3 and standard deviation was 2.37. The values of NOx ranges from 11µg/m^3 to 33µg/m^3 and standard deviation were 4.76. The values of SO_2 and NOx are within the prescribed limit. Therefore in this area the pollution level which is quite high, is worsening day by day and has badly affected the daily life of people of Ghughus Township. The future scenario will be more complicated in that area.

GADCHANDUR

The monitoring station is situated in residential area of Gadchandur. The area is surrounded by several number of cement factories. The average value of NOx and SO_2 are 21.76µg/m^3 and 3.99µg/m^3 and it is well below the prescribed limit of CPCB. The standard deviation for SO_2 and NOx were 0.38 and 5.34. The minimum value of RSPM was 64µg/m^3 and the maximum value was 317µg/m^3. The average value for all 3years was 151.17µg/m^3 and it is just above the standard value 150µg/m^3. The standard deviation is 41.11. There is gradual decrease in pollution load as compare to period 2012 to 2014 [13].

BALLARPUR

The monitoring result at Ballarpur Municipal Corporation Building indicates that the maximum and mean values of RSPM are above the CPCB limit for residential area. The minimum value was 75.66µg/m^3 and the maximum value was 190µg/m^3 during month of December 2016. The standard deviation was 122.07 during the prescribed period. The SO_2 value ranges from 2µg/m^3 to 6µg/m^3 and it is well below the prescribed limit. The NOx value ranges from 16µg/m^3 to 74µg/m^3. The standard deviation was 10.15.

MIDC, TADALI

The monitoring station is situated in industrial zone near WCL coal mines. The minimum value of SO_2 was 2µg/m^3 and the maximum value was 7µg/m^3. The average value was 4.17µg/m^3 and it is well below prescribed limit. Similarly the value of NOx is below the prescribed limit. The mean value of NOx is 22.48µg/m^3. The value of RSPM is within the prescribed limit by CPCB for industrial zone. The minimum value for RSPM is 34µg/m^3 and the maximum value is 193µg/m^3 and the average value was observed to be 79.53µg/m^3. The standard deviation was 24.73. In the given period the values of RSPM

is within the prescribed limit. So in the MIDC area of Tadali there is gradual decrease in pollution in the given period as compare to 2012 to 2014 [13].

Table No. 2: Ambient Air Quality Monitoring Results For Sox For Sampling January 2015 - December 2017 For All Stations (Unit in µg/m3)

Period	SOX																	
	AO Chandrapur			MO MIDC Chandrapur			Ghughus			Gadchandur			Ballarpur			MIDC Tadali		
	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017
Jan	5	5	4	16	11	4	5	4	4	4	4	4	NR	4	4	4	5	4
Feb	5	4	4	7	9	2	24	4	2	4	4	2	5	4	2	4	5	2
Mar	6	6	4	5	17	4	6	4	4	5	4	4	5	4	4	4	4	4
Apr	4	5	4	4	5	4	5	6	4	4	4	4	4	6	4	5	NR	4
May	4	4	4	4	4	4	5	4	4	4	4	4	5	4	4	4	4	4
June	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
July	4	4	4	4	5	4	4	4	4	4	4	4	4	5	4	4	4	4
Aug	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Sep	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	4
Oct	4	4	4	4	6	4	4	6	4	4	5	4	4	5	4	4	5	4
Nov	4	4	4	16	4	4	8	4	4	4	4	4	5	4	4	5	4	4
Dec	5	4	4	10	4	4	4	4	4	4	4	4	4	4	4	7	4	4
Mean	4.41	4.41	4.08	6.83	6.42	3.83	6.41	4.33	3.92	4.08	4.08	3.83	4.36	4.33	3.83	4.42	4.27	3.833
Min.	4	4	4	4	4	2	4	4	2	4	4	2	4	4	2	4	4	2
Max.	6	6	5	16	17	4	24	6	5	5	5	4	5	6	4	7	5	4
Std Dev.	0.67	0.67	0.29	4.65	4.03	0.58	5.66	0.78	0.67	0.28	0.28	0.58	0.51	0.65	0.58	0.90	0.47	0.58

Table No. 3- Ambient Air Quality Monitoring Results For NOx For Sampling January 2015-december 2017 For All Stations (Unit in µg/m3)

Period	NOx																	
	AO Chandrapur			MO MIDC Chandrapur			Ghughus			Gadchandur			Ballarpur			MIDC Tadali		
	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017
Jan	26	23	31	32	21	43	13	18	30	15	21	NR	NR	36	34	10	22	30
Feb	18	25	33	28	47	35	14	27	30	9	27	31	52	26	33	13	27	31
Mar	27	26	32	31	25	30	18	25	25	11	25	30	35	74	32	11	25	27
Apr	17	23	31	16	27	23	15	18	22	16	20	24	16	25	24	13	NR	22
May	16	22	33	13	23	31	13	22	28	10	22	34	23	23	34	17	22	29
June	18	33	28	12	49	12	11	29	11	10	33	10	17	50	17	23	27	23
July	25	21	33	32	24	34	14	15	33	14	19	34	26	39	34	20	20	33
Aug	17	34	22	23	38	25	15	27	21	15	23	23	34	31	25	23	25	23
Sep	23	26	26	29	37	28	20	29	26	21	35	28	20	37	28	21	20	26
Oct	18	31	31	21	33	30	15	29	29	14	27	31	22	36	29	16	22	31
Nov	22	26	33	29	21	32	20	18	32	20	18	32	25	23	34	22	19	32
Dec	18	27	32	41	22	31	18	17	26	17	17	27	20	24	29	19	18	25
Mean	20.42	26.42	30.42	25.58	30.58	29.5	15.5	22.833	26.08	13.73	23.92	27.64	26.36	35.33	29.42	17.33	22.45	27.67
Min.	16	21	22	12	21	12	11	17	11	9	17	10	16	23	17	10	18	23
Max.	27	34	33	41	49	43	20	29	33	20	35	34	52	74	34	23	27	33
Std Dev.	3.94	4.23	3.42	8.74	10.06	7.48	2.88	5.39	6.01	3.41	5.73	6.89	10.48	14.69	5.29	4.69	3.14	3.85

Table No. 4- Ambient Air Quality Monitoring Results For RSPM For Sampling January 2015-december 2017 For All Stations (Unit in µg/m3)

Period	RSPM																	
	AO Chandrapur			MO MIDC Chandrapur			Ghughus			Gadchandur			Ballarpur			MIDC Tadali		
	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017	YEAR 2015	YEAR 2016	YEAR 2017
Jan	102	98	107	79	112	86	143	212	292	96	134	NR	NR	160	168	54	59	66
Feb	100	103	101	79	95	86	198	243	302	137	183	317	171	116	119	72	66	103
Mar	80	84	89	80	83	75	236	209	280	120	153	240	138	116	136	45	92	134
Apr	71	80	123	58	66	80	256	254	335	127	130	206	130	99	160	121	NR	129
May	72	58	88	67	64	69	221	307	293	150	101	282	129	86	150	51	71	193
June	55	61	66	55	75	55	193	281	193	112	132	112	93	76	93	71	64	71
July	44	66	59	43	59	91	146	198	163	75	108	158	104	66	121	34	73	163
Aug	49	54	60	38	65	42	103	185	201	105	98	177	74	60	104	35	57	70
Sep	56	48	61	34	69	50	86	160	242	63	114	140	99	80	94	35	78	80
Oct	64	97	110	75	72	55	117	184	119	156	64	129	102	74	99	47	69	124
Nov	87	144	91	113	89	95	185	145	339	133	128	164	168	175	176	74	62	105
Dec	73	NR	108	105	91	112	183	163	417	127	132	229	172	190	171	45	59	123
Mean	71.08	81.18	88.58	68.83	78.33	74.67	172.25	211.75	264.67	116.75	123.08	195.82	125.46	108.17	132.58	57	68.18	113.42
Min.	44	48	59	34	59	42	86	145	119	75	64	112	74	60	93	34	59	70

Max.	102	144	123	113	112	112	256	307	417	156	183	317	172	190	176	121	92	193
Std Dev.	18.79	28.25	22.33	24.81	15.82	20.98	53.65	50.29	84.27	28.23	29.78	65.32	34.14	44.36	31.62	24.75	10.25	39.19

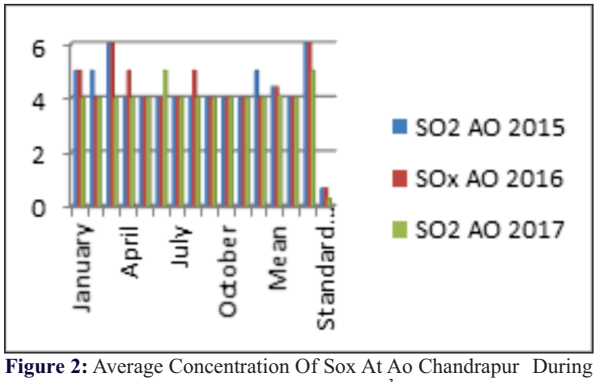

Figure 2: Average Concentration Of Sox At Ao Chandrapur During January-2015-december 2017 (**Unit In Mg/m^3**)

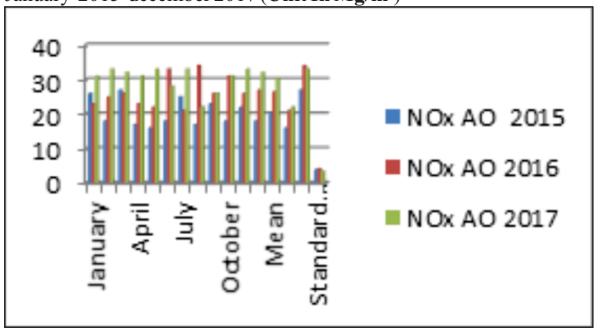

Figure 3: Average Concentration Of NOx At AO Chandrapur During January-2015-december 2017 (**Unit in µg/m^3**)

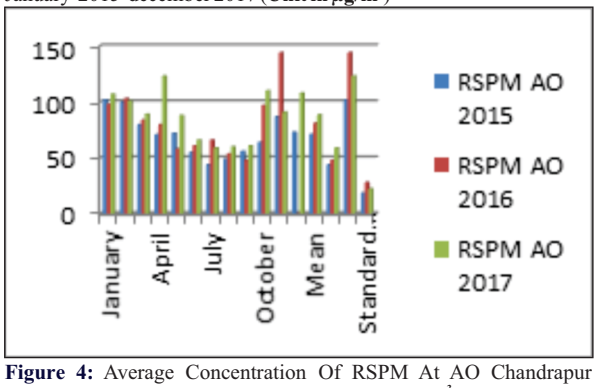

Figure 4: Average Concentration Of RSPM At AO Chandrapur During January-2015-December 2017 (**Unit in µg/m^3**)

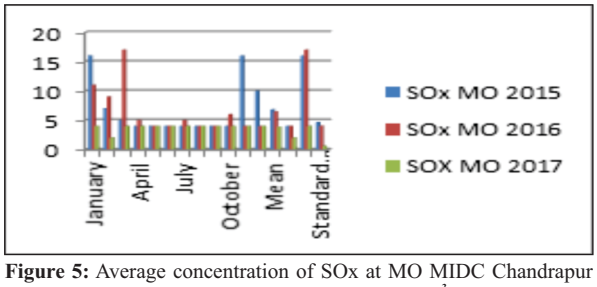

Figure 5: Average concentration of SOx at MO MIDC Chandrapur during January-2015-December 2017 (**Unit in µg/m^3**)

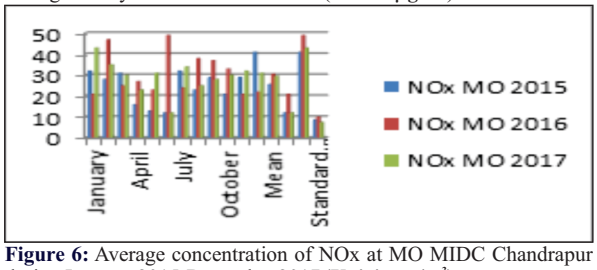

Figure 6: Average concentration of NOx at MO MIDC Chandrapur during January-2015-December 2017 (**Unit in µg/m^3**)

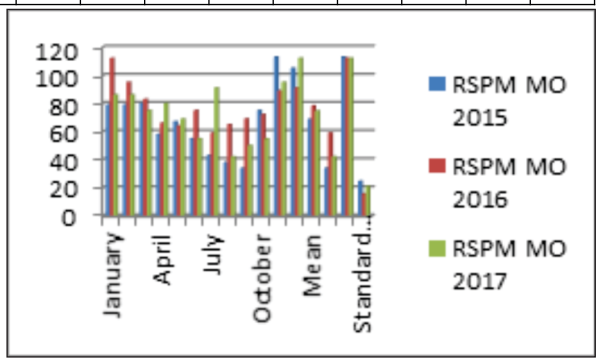

Figure 7: Average Concentration Of RSPM at MO MIDC Chandrapur During January-2015-December 2017 (**Unit in µg/m^3**)

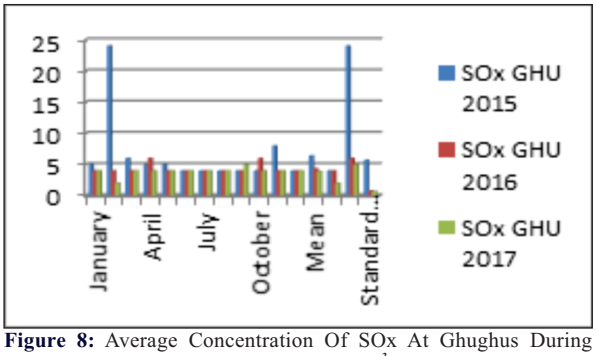

Figure 8: Average Concentration Of SOx At Ghughus During January-2015-December 2017 (**Unit in µg/m^3**)

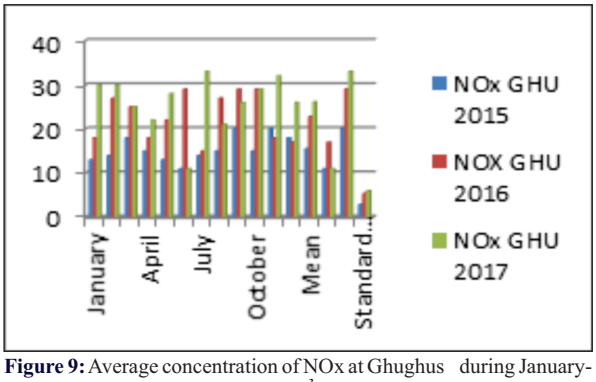

Figure 9: Average concentration of NOx at Ghughus during January-2015-December 2017 (**Unit in µg/m^3**)

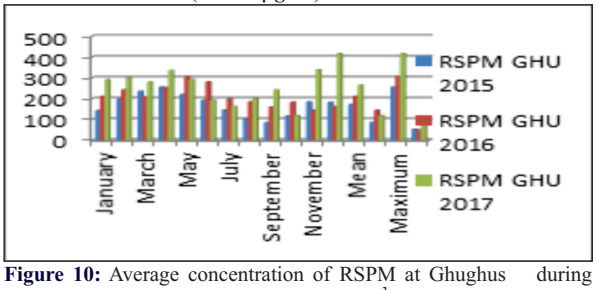

Figure 10: Average concentration of RSPM at Ghughus during January-2015-December 2017 (**Unit in µg/m^3**)

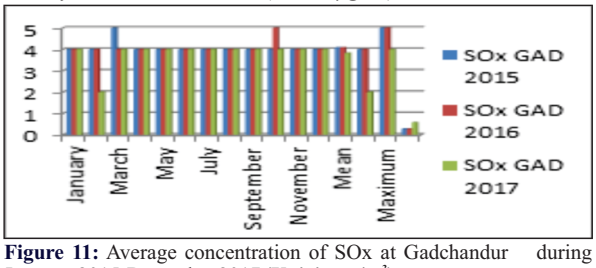

Figure 11: Average concentration of SOx at Gadchandur during January-2015-December 2017 (**Unit in µg/m^3**)

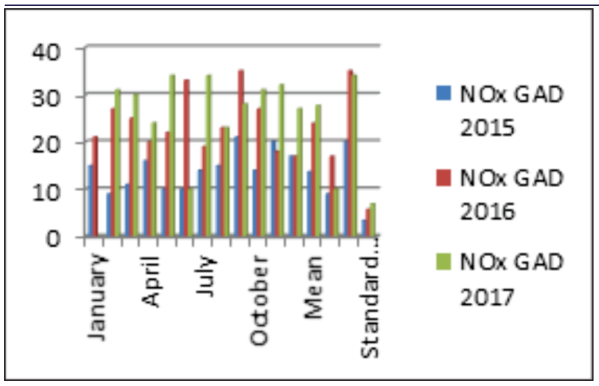

Figure 12: Average concentration of NOx at Gadchandur during January-2015-December 2017 (**Unit in µg/m^3**)

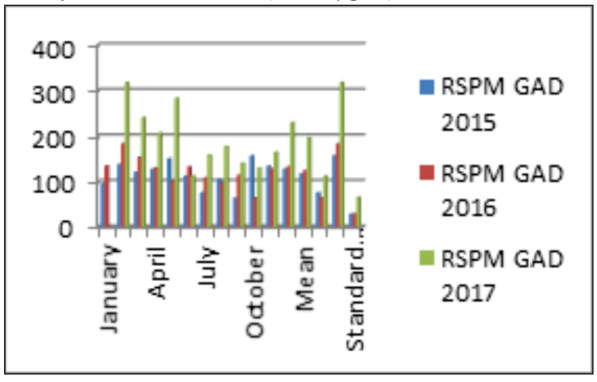

Figure 13: Average Concentration Of RSPM At Gadchandur During January-2015-December 2017 (**Unit in µg/m^3**)

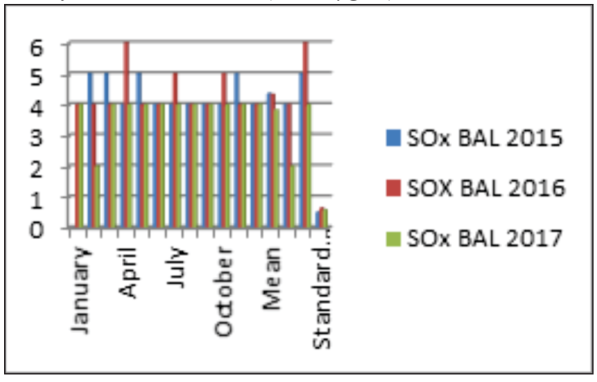

Figure 14: Average concentration of SOx at Ballarpur during January-2015-December 2017 (**Unit in µg/m^3**)

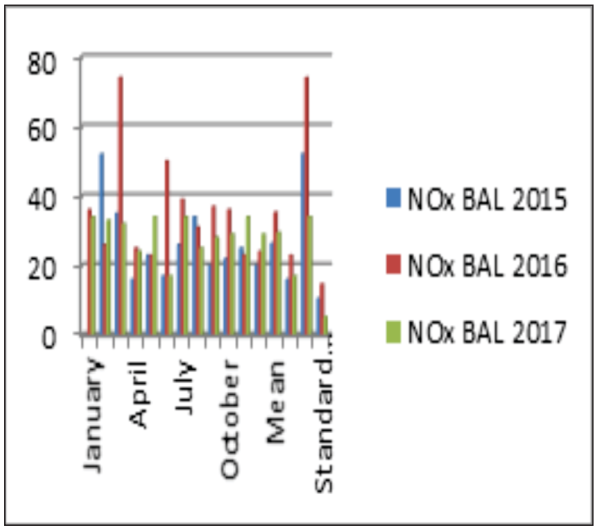

Figure 15: Average concentration of NOx at Ballarpur during January-2015-December 2017 (**Unit in µg/m^3**)

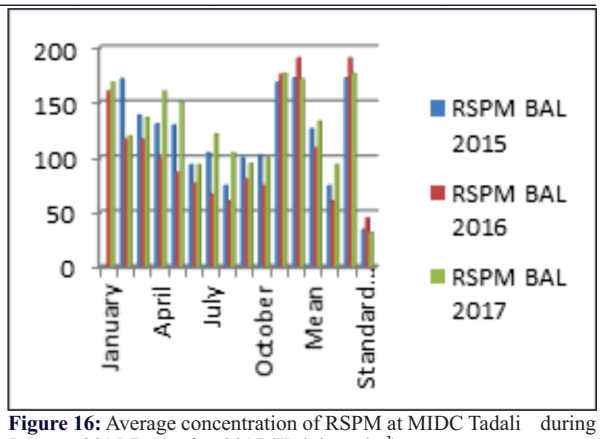

Figure 16: Average concentration of RSPM at MIDC Tadali during January-2015-December 2017 (**Unit in µg/m^3**)

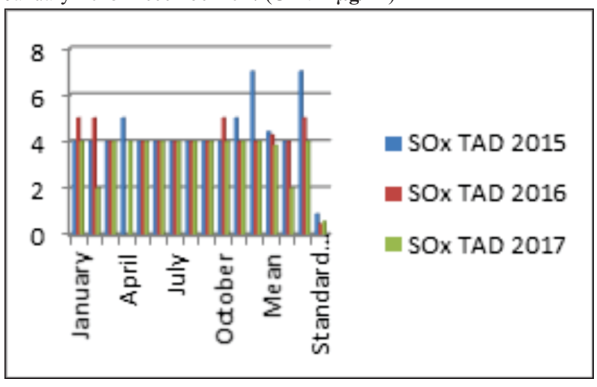

Figure 17: Average concentration of SOx at MIDC Tadali during January-2015-December 2017 (**Unit in µg/m^3**)

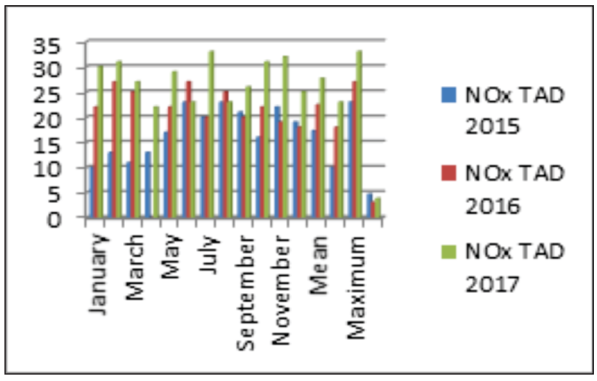

Figure 18: Average concentration of NOx at MIDC Tadali during January-2015-December 2017 (**Unit in µg/m^3**)

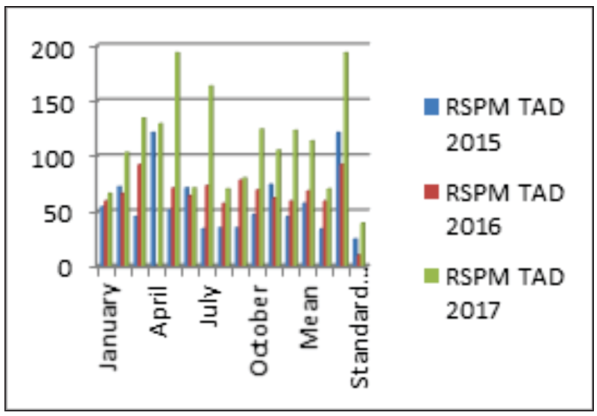

Figure 19: Average concentration of RSPM at MIDC Tadali during January-2015-December 2017 (**Unit in µg/m^3**)

CONCLUSION

From the observed data it was marked that the pollution was not so acute at industrial area but it is reduced as compare to pollution during

2012-2014 at all the six stations. RSPM in mining area like Ghughus and cement industries like Gadchandur were always found to be more than the CPCB limit and it is somewhat moving dangerously towards the pollution. In future scenario will be more complicated in that area. MIDC, Tadali area is also alarming. Also the Quantity of RSPM is maximum in the winter and summer seasons in all the station. It clearly indicates that the pollution level is increasing as the mining activities increases. Concentration of NOx is significant in Ballarpur and Chandrapur only. Both these stations are on the roadside. Station of Chandrapur is located near the main road with high density of heavy vehicles and other private public transport vehicles. Station at Ballarpur is located on the state highway. This road is always crowded with heavy transporting vehicles and other private transport. The overall monitoring results reveal that the study area is slightly polluted with respect to air quality during 2015-2017. Hence appropriate measure should be taken right now to minimize the pollution level to safe limit.

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