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Study of ambient air pollution in Chandawali District, U.P., India

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Abstract

Ambient air quality refers to the quality of outdoor air in our surrounding environment" It is typically measured near ground level, away from direct sources of pollution. Ambient air pollution problems due to different industries plants automobiles and house hold emission are directly related to the pollution. During combustion, elements of coal are converted into their oxides. The chief pollutants generated during combustion are carbon monoxide, carbon dioxide, sulphur dioxide, nilrogenoxide and flyash. Results indicate that CO values are much higher for site 1, it goes as high as 1186.98 µg/m³ in May For site 2 the highest CO value is 1168.55 µg/m³ again in the month of May. For site 3 and 4 highest measured CO is 1148.40 and 1031.43 µg/m³ respectively in summers. maximum average temperature recorded is 44°C in June 04 and minimum is 16°C in January 24. Maximum average relative humidity is 75% in August 23 and minimum is 10% in May 24. Similarly maximum aver-age wind velocity is found 3.0 m/sec in June 24 and minimum is 1.1 m/sec in Nov. 23. Relationship between average CO values and average temperatures of all four sites. In summer CO concentrations are found higher than in rainy season. In winter, as it is comparatively calm, precipitation of CO in lower atmosphere is more and levels of CO in the ambient air are found higher However, the highest ambient CO are received during summers.

Keywords: Ambient air quality, Air pollution, Suspended particles, Carbon mono oxide

1. Introduction

The ambient air quality is a complex and dynamic environmental phenomenon. It exhibits large temporal and spatial variations due to the changes in the rate of emissions from anthropogenic and natural sources as well as due to changes in meteorological and topographic conditions[1]. Ambient air quality refers to the quality of outdoor air in our surrounding environment. It is typically measured near ground level, away from direct sources of pollution[2]. The monitoring of ambient air quality in an area is imminent to provide data to allow a resolution of the dynamic nature of air quality in terms of temporal and spatial variations. The monitoring data generated may be compared with the prescribed permissible air quality standards and their violations may suggest the bias and gravity of air pollution problems prevailing in an area[3].

The epidemiological evidence for the health impacts of air pollution in India is strong, strengthening it in several aspects as outlined in several studies would aid in more informed policy making. There are challenges however that precludes high quality research on the health effects of air pollution from being conducted in India and many of these have to do with the quality and the availability of air quality and health outcome data. [4,5] Most of these pollutants (viz. gases, particulates, etc.) are naturally present in the atmosphere in low (background) concentrations and are usually considered to he harmless. [6] The air pollutants and their possible sources are well described by different workers. The possible sources for a few pollutants are as follows: [7,8]

- Particulate Matter- agricultural operations, industrial processes, combustion of wood and fossil fuels, construction and demolition activities, and entrainment of road dust into the into air etc.[9]

- Suspended particulate matter- pollen grains, fungus, spores, metal oxides, dust, fly ash, smoke, mists, house vapors, vehicular activity and combustion etc.[10]

- SO_2- Chemical industry, Boiler fuel gases, fossil fuel burning, coal burning etc.

- NO_2-Nitric acid manufacture, High temperature oxidation process using air.

  Motor vehicle exhaust and Nitrate process, etc.[11]

- CO-Incomplete combustion of Gasoline, natural gas, oil, coal, and wood etc.
- NH, Agriculture, Animal husbandry and NH3-based fertilizer, Industrial processes, Vehicular emissions and Volatilization from soils and oceans etc.

Anthropogenic sources are the major contributors of the more hazardous pollutant species and include mobile sources and stationary categories. Mobile categories are mainly vehicular and stationary categories include industrial activities such as alumina reduction, coke production, petroleum refining, and domestic heating by wood, kerosene and coal and refuse burning, coal fired power

plants.12,13

Ambient Air pollution problems due to automobile emission and different industries plants are directly related to the combustion of coal ingredients. [14] During combustion, elements of coal are converted into their oxides. The chief pollutants generated during coal combustion are carbon monoxide, carbon dioxide, sulphur dioxide, nilrogenoxide and flyash. [15,16] The main elements of coal, carbon and hydrogen are converted into CO_2 and HO, respectively during complete combustion but as a result of simultaneous incomplete combustion CO is generated[17].

Shi. Y. et.al. (2020)[18] Increased CO concentration in atmosphere is dangerous not only due to its well known health impacts, its oxida-tion reactions are also responsible for enhancing CO, a green house gas in the atmosphere[19]. In power genetaring plants, CO is lowest or slightly above the stoichiometric Air/Fuel ratio. At lower than stoichiometrie Air/Fuel ratios, high CO concentrations reflect the relatively low oxygen concentration and the possibility of poor reactant mixing from low turbulence. These two factors can increase CO emissions even though flame temperatures and residence time are high. [20] Athigher than stoichiometric Air/Fuel ratios, increased CO emissions result from decreased flame temperatures and shorter residence time[21,22] These factors remain predominant even when oxygen concentrations and turbulence increases in high temperature combustion process, possibility of incomplete combustion is though very little, the presence of CO in the vicinity of power plant is an un-avoidable phenomenon[23].

City Chandauli is the biggest industrial city of Uttar Pradesh. It is well known for its major industrial network in and around the city The city faces extreme climatic conditions. Temperature varies from 10 to 48°C. The average rainfall is about 84°C, humidity annually ranges from 8% to 88% Summers are full of dust storm. Wind velocity varies from 2-20 km/hr. More than twenty large and small scale industries including a paper mill & rice mills. The present investigation has been carried out to evaluate the role of different industries and automobile emissions in enhancing the ambient air CO levels in the city As meteorological parameters are also responsible for dispersion of pollutants, Listiyorini et.al. (2020),[24] dependence of ambient CO levels on metrological conditions such as average temperature, wind speed, direction and relative humidity has been looked into.

MATERIAL AND METHODS

The concentration of ambient CO near Chandauli is directly measured using MSA CO aspirator tubes. CO-detector tubes are widely applied in industrial hygiene and are suitable for analysis of highly polluted atmospheric air[25]. The measurement is based on the reaction: $5CO+I_2O_2 \rightarrow I_2+5CO$, The iodine colored layer in the tube corresponds in length to the CO concentration in the sample. [26,27] For monitoring of CO emission levels from near Chandauli City, four sites are selected for sampling work. Three sites are situated within the premises of Chandauli City, while fourth one is in the residential colony situated at an Arial distance of about 1.5 Km from the main city area. Sampling stations along with their directions have been listed below.

1. Sampling Station 1 Highway crossing (East - South direction)
2. Sampling Station 2 Main city (West-North direction)
3. Sampling Station 3 Circumference of city (East - North direction)
4. Sampling Station 4 Industrial area (South - East direction)

Meteorological parameters are monitored using automatic whether station mounted on main administrative building of Chandauli City.

DESCRIPTION OF THE STUDY AREA

Geographically, Chandauli is 351 km south of the Himalayas, at an elevation of 814 m above mean sea level. It has a semi-arid climate with extremely hot summers, heavy rainfall in the monsoon season and very cold winters. The annual mean temperature is 25.3^0 C and the annual mean rainfall is 653mm[28]. Northwesterly winds normally prevail while in June and July, south-easterly winds predominate. Wind speeds are typically higher in summer and monsoon; in winters, calms are frequent. Pre-monsoon dust storms are westerly from the Great Indian Desert, carrying large concentrations of TSP into the ambient air of Chandauli. Inversion conditions mostly prevail in winters, increasing the pollution concentration (Green piea, 2000)[29]. Chandauli, with an area of $1*219km^2$ is inhabited by about 8.3lacs people (population density 6*294 per km^2) , of which 4.3lacs million are in urban areas. Besides, various other urban pressures, such as industrial activity, transport infrastructure, construction activities and migration also confer a continued growth trend to Chandauli. It has three site based HC-Highway crossing and the industrial area (IA), and two natural gas (SV) based the site toward Varanasi and the site towards Bihar (Tables S1 and S2 in the Supporting Material, SM). There are about 360 industrial units in Chandauli. Chandauli accounts for about 8% of the total registered vehicles in India (NASA, 2020)[30].

SOURCE EMISSION INVENTORY

TSP, SO_2 and NO_2 emissions from point, area, and line sources in the study area were computed and compiled for each month during the study period[31]. Selection of SO_2 NO_2 and TSP as criteria pollutants is based on the rationale that: (a) these are the significant pollutants emitted from TPPs, (b) they are the only air pollutants which are subject to current Indian standards and WBEG, (c) they are measurable/continuously monitored by regulatory authorities, (d) changes in parameters can be predicted by the modeling process.

RESULTS

CO is monitored continuously from July 23 to June 24 at all four sites. Number of observed values, minimum and maximum concentrations, monthly averages with standard deviations are given in Tables 1 to 4. Results indicate that CO values are much higher for site 1, it goes as high as 1186.98 µg/m³ in May For site 2 the highest CO value is 1168.55 µg/m³ again in the month of May. For site 3 and 4 highest measured CO is 1148.40 and 1031.43 µg/m³ respectively in summers.

On investigating the impact of meteorological parameters on ambient air CO levels, temperature, relative humidity, wind velocity and wind direction are continuously monitored for entire period of study on half hourly basis[32].

Table 1 Results of CO Monitoring at Site-1

Months	No. of Observations	CO Min. conc.	CO Max. □g / m^3	CO Monthly □g / m^3	Std Deviation □SD Avg./ m^3
July 23	48	575	975	756.56-	138.32
August 23	42	075	850	73.1.57	19,64
September 23	45	550	1000	771.67	113.39
October 23	15	625	1000	803.23	124.24
November 23	45	625	975	853.11	S1.70
December 23	48	550	1075	7811レ	136.01
January 24	45	500	1200	786.67	204.61
February 24	42	600	925	748.21	64.96
March 24	48	650	950	750.60	60.10
April 24	45	500	1350	876.43	249.98
May 24	45	915	1535	1186.98	163.20
June 24	45	630	1410	1073.60	173.61

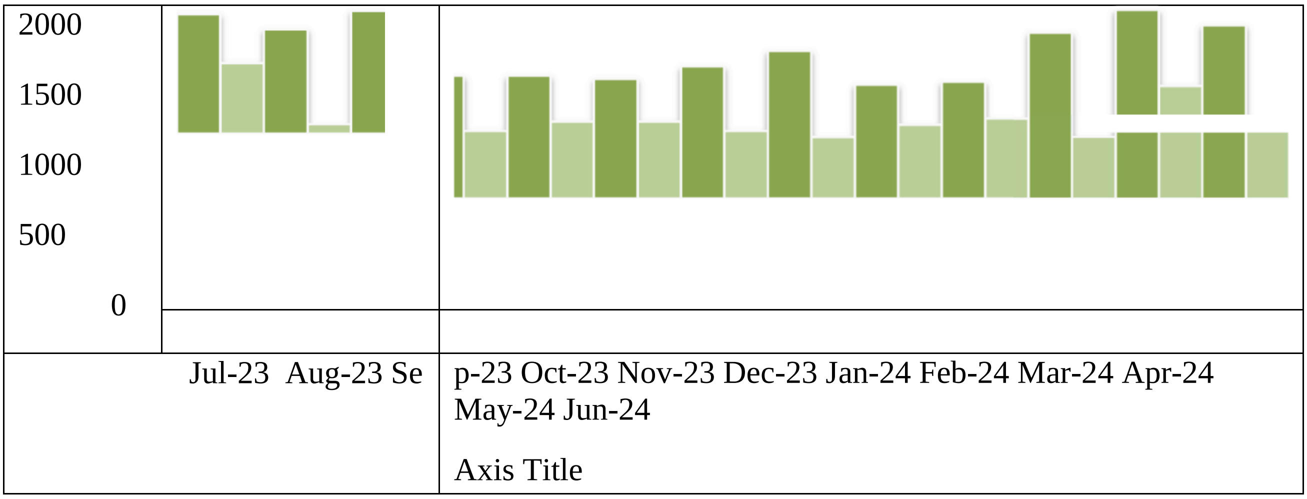

Fig-1 Results of CO Monitoring at Site-1

able-2 Results of CO Monitoring at Site - 2

Months	No. of Observations	CO Min. conc.	CO Max. □g / m^3	CO Monthly □g / m^3	Std Deviation □SD Avg./ m^3
July 23	48	525	950	757 29	121 27
August 23	36	700	925	830.56	47.48
September 23	45	575	1175	916.67	153.46
October 23	15	750	1175	938.33	108.51
November 23	45	525	950	661.07	101.06
December 23	48	600	1035	852.56/	88.50
January 24	45	650	1500	707.78	208.68
February 24	42	700	950	840.48	69.17
March 24	48	675	75	05.36	9.52
April 24	45	500	1500	1014.29	253.34
May 24	45	721	1390	1168.55	163.75
June 24	45	743	1455	1165.43	172.04

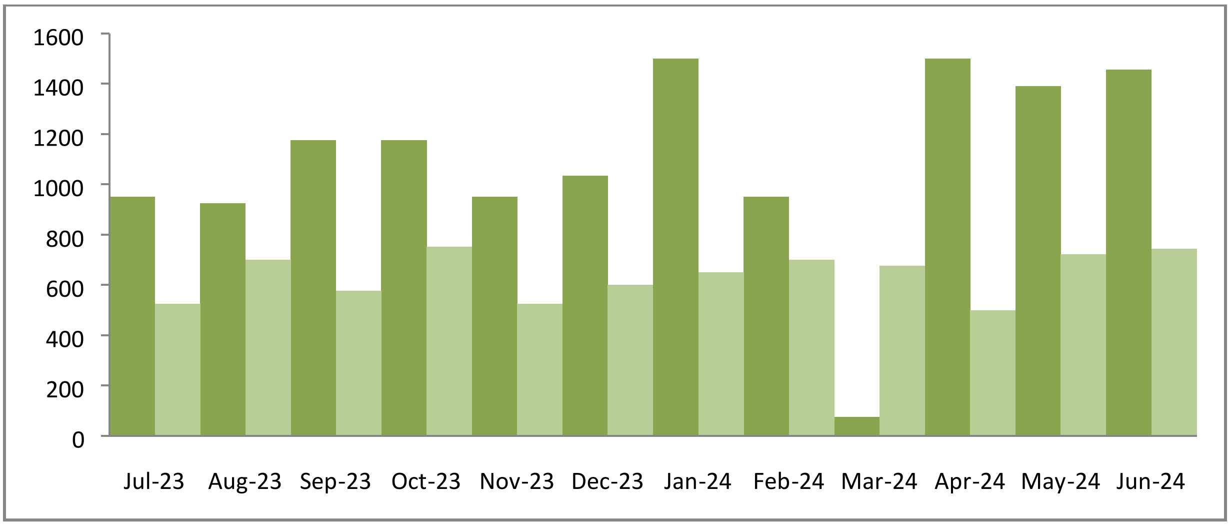

Fig-2 Results of CO Monitoring at Site-2

Table 3 Results of CO Monitoring at Site-3

Months	No. of Observations	CO Min. conc.	CO Max. □g / m^3	CO Monthly □g / m^3	Std Deviation
July 23	48	575	950	747.40	119.20
August 23	42	600	750	692.86	39.15
September 23	45	555	1060	787.89	142.05
October 23	15	595	1060	848.33	129.82
November 23	45	600	950	832.22	93.48
December 23	48	555	1060	745.07	115.46
January 24	45	425	1050	664.44	162.24
February 24	42	252	900	488.79	120.30
March 24	48	400	850	652.98	139.05
April 24	45	425	1050	684.52	168.65
May 24	45	870	1400	1148.40	147.71
June 24	45	875	1770	1135.60	184.63

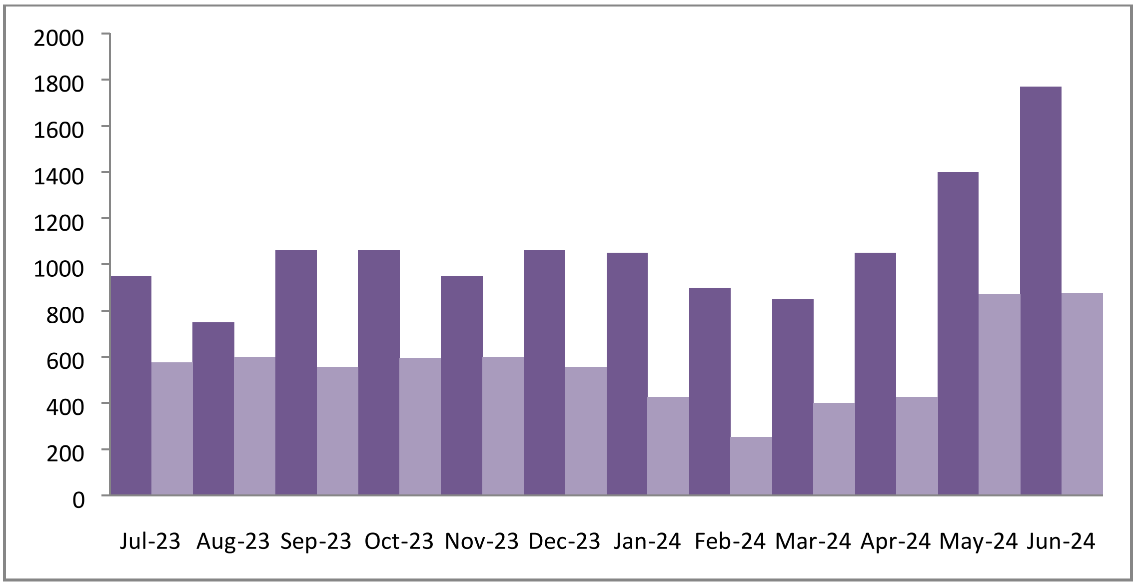

Fig-3 Results of CO Monitoring at Site-3

Table 4 Results of CO Monitoring at Site-4

Months	No. of Observations	CO Min. conc.	CO Max. □g / m^3	CO Monthly □g / m^3	Std Deviation
July 23	48	575	950	733.85	128.25
August 23	42	550	675	613.69	29.84
September 23	45	545	975	714.67	101.88
October 23	15	580	935	734.67	92.66
November 23	45	575	875	654.60	68.13
December 23	48	545	1045	770.00	138.49
January 24	45	450	1025	675.89	150.25
February 24	42	355	650	512.02	59.46
March 24	48	450	775	625.60	91.15
April 24	45	450	1025	812.86	95.57
May 24	45	478	1355	909.69	220.22
June 24	45	870	1395	1031.43	151.71

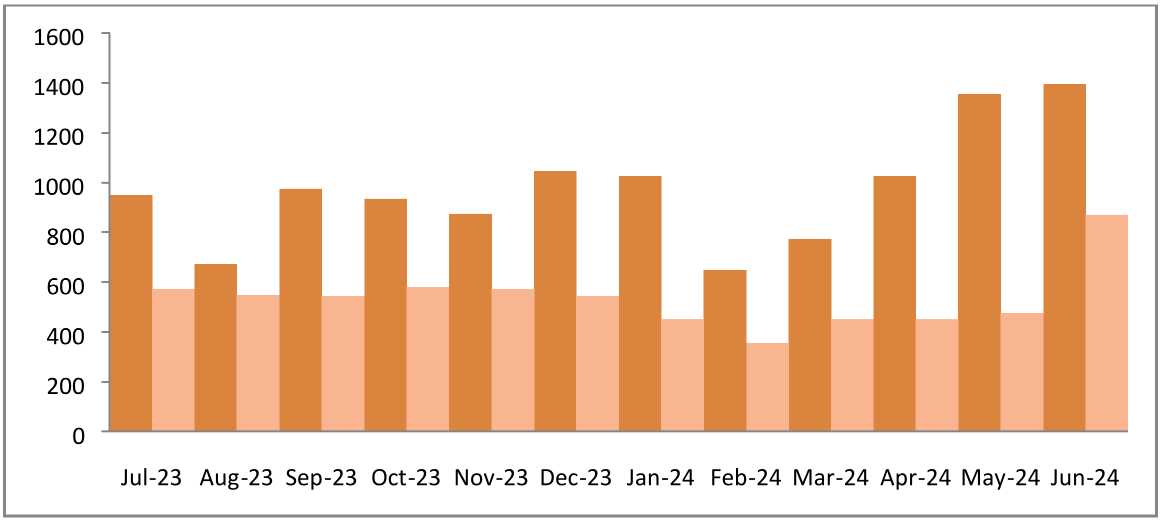

Fig-4 Results of CO Monitoring at Site-4

Table 5 Monthly average values of temperature, relative humidity and wind velocity during study period

Months	Average Temperature (°C)	Humidity (%) Average relative	Average wind velocity (m /sec.)
July 23	35	72	2.3
August 23	33	75	2.1
September 23	36	62	1.9
October 23	32	35	1.6
November 23	28	45	1.1
December 23	20	48	1.3
January 24	16	37	1.2
February 24	23	45	2.4
March 24	25	38	1.8
April 24	32	16	20
May 24	38	10	2.5
June 24	44	13	3.0

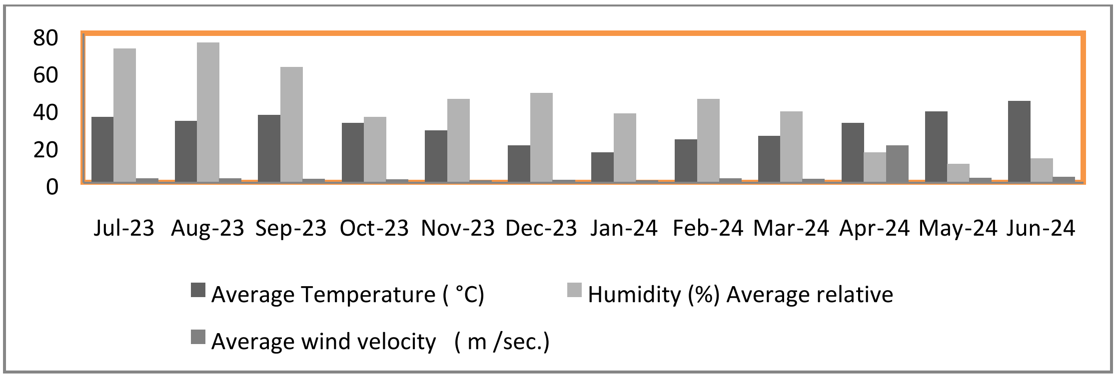

Fig-5 Monthly average values of temperature, relative humidity and wind velocity during study period

The maximum value of wind velocity is found 20 km per hour in June 2024 during day time. Maximum average temperature recorded is 44°C in June 04 and minimum is 16°C in January 24. Maximum average relative humidity is 75% in August 23 and minimum is 10% in May 24[33]. Similarly maximum aver-age wind velocity is found 3.0 m/sec in June 24 and minimum is 1.1 m/sec in Nov. 23. Relationship between average CO values and average temperatures of all four sites are given in Fig. 1. To study the effect of relative humidity on CO concentration the monthly average values of CO at all 4 sites are plotted against monthly averages of relative humid in Fig.2. Plot of monthly average values of CO and wind velocities for all sites may be seen in Fig. 3. Table 6 gives the monthly total maximum and minimum percentage air blow in all 4 directions.

Table 6 Percentage of air blow in a four directions

		North-East	East-South	South-west	West-North
July, 2023	Total of blow	22.2	5.5	34.8	34.8
	Maximum	85	21	14.8	104
	Minimum	3.0	0.3	3.1	73
Aug., 2023	Total of blow	15.0	7.5	50.8	28.5
	Maximum %	6.1	55	24.0	13:0
	Minimum%	22	11	54	55

Sept., 2023	Total % of blow	13.1	40	48.0	38.2
	Maximum %	4.1	22	20.6	13.0
	Minimum %	2.0	0.2	30	5.5
Oct., 2023	Total% of blow	30.4	12.0	38.4	38.2
	Maximum %	12.0	4.4	12.5	126
	Minimum %	5.1	0.7	5.0	7.4
Nov, 2023	Total% of blow	41.1	10.0	25.0	20.9
	Maximum%	13.4	5.0	8.7	6.1
	Minimum%	5.1	2.0	22	3.4
Dec., 2023	Total of blow	12.0	23.0	7.0	8.6
	Maximum %	4.8	8.8	24	40
	Minimum%	1.5	2.5	1.5	0.5
Jan., 2024	Total of blow	14.1	13.5	65	75
	Maximum %	8.6	10.5	25	3.1
	Minimum %	3.4	0.7	0.8	0.8
Feb., 2024	Total % of blow	18.2	9.4	8.2	75
	Maximum	14.2	1.5	3.4	3.1

	Minimum	2.4	1.6	0.7	0.8
March, 2024	Total% of blow	38.4	14.0	17.1	8.8
	Maximum %	15.0	4.2	8.6	3.4
	Minimum %	6.3	2.5	1.7	0.7
April, 2024	Total% of blow	30.0	8.0	10.7	15.0
	Maximum %	8.0	4.1	8.2	21 1
	Minimum %	4.0	0.5	25	6.0
May, 2024	Total% of blow	10.9	2.5	20.0	48.0
	Maximum %	7.5	1.5	13.0	13.9
	Minimum %	4.5	0.3	2.1	95
June, 2024	Total% of blow	2.7	12.8	35.6	35.0
	Maximum %	8.0	4.5	22.1	12.1
	Minimum %	35	1.0	1.5	5.1

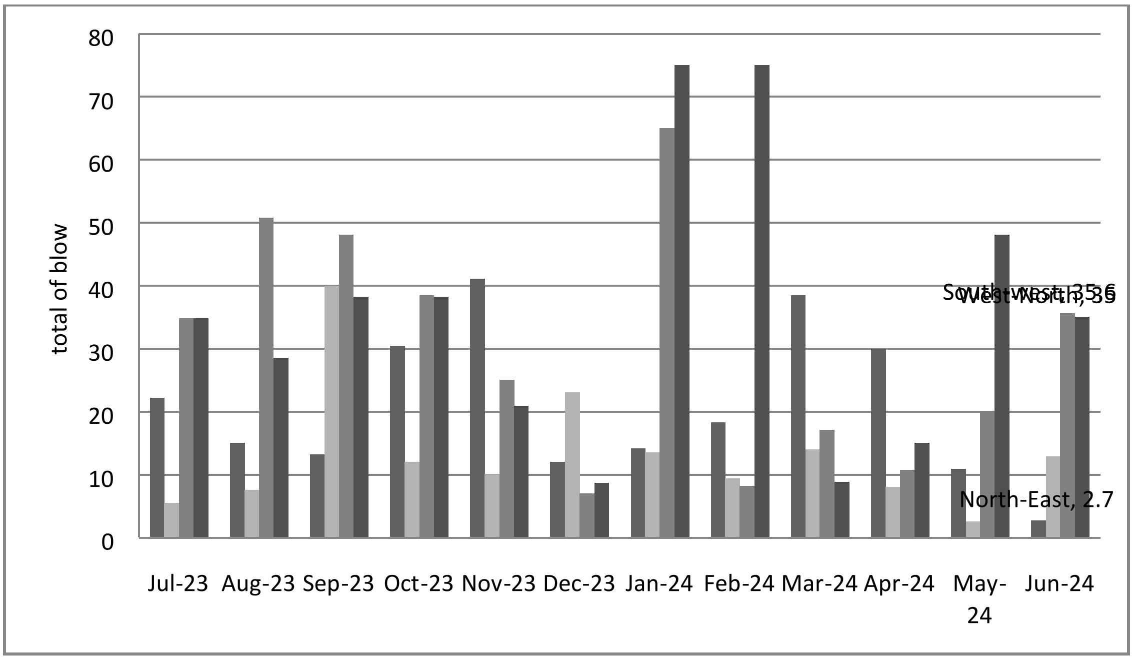

Fig-5 Percentage of air blow in a four directions

DISCUSSION :

All available findings and facts depict that Chandauli is utilizing its coal with full efficiency most of the times but during summers, the CO levels in the vicinity of the power plant is higher than the ambient air quality standard [Industrial area-5000μg/m³, Residential area - 2000 μg/m³ and Sensitive area -

1000 μg/m³][34,35] All the 4 sites are situated within 2 km radius of the main processed plant. Three sampling station are situated within the premises of Chandauli. while fourth one is in a residential colony about 1.5 Km away Results indicate that concen-tration of CO not only velocity depends on distance from the main processed plant but also on meteorological factors.[36]

In summer, as wind speed is very high and % air blow is more in the southwest and west-north direction sampling station. 2 is having higher % of CO than rest of the three. [37,38] In summer CO concentrations are found higher than in rainy season. In winter, as it is comparatively calm, precipitation of CO in lower atmosphere is more and levels of CO in the ambient air are found higher However, the highest ambient CO are received during summers. Due to high humidity, gaseous CO is found less in rainy season. [39,40] Conclusion:

The study reports that gaseous CO near power plants gets affected by relative humidity of the atmosphere. Thus, it is desired that in an impact assessment study and to develop mathematical dispersion models, relative humidity factors should also be taken into consideration in dispersion calculations besides other meteorological factors. It is recommended that to minimize CO emissions from power generating plants, utilizing coal as fuel, combustion units should be designed to have high turbulence, sufficient residence time, high temperature and near stoichio-metric Air/Fuel ratios. The CO generation in automobiles is controlled by combustor design while its dispersion by meteorological conditions.

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