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STUDY ON AMBIENT AIR QUALITY AND EXCEEDANCE FACTOR FOR SOME CITIES OF HARYANA, INDIA

Sadhana Chaurasia
Head, Dept. of Energy & Environment,
MGCGV, Chitrakoot, Satna, M.P. 485334

Swatesh Gupta
PG Student, Dept. of Energy & Environment,
MGCGV, Chitrakoot, Satna, M.P. 485334

Abstract: **This Study presents an analysis of the variation of concentration of air pollutants namely PM_{10}, $PM_{2.5}$, SO_x and NO_2 at some city of Haryana, in summer season. The results reveal that gaseous pollutants such as SO_x and NO_2 were within the permissible limits while particulate matter ware found higher than permissible NAAQS limit. Highest level of PM_{10}(198.78 µg/m^3) was found in month of June at Sonipat. It may pose detrimental effect on human and environmental health. In this study AQI and Exeedence factor was also calculated. The AQI for all the stations were found in moderate range (101-200). Exeedence factor for PM_{10} was found in critical range at all the sampling stations and for $PM_{2.5}$itwas found in high pollution range at all stations except Panipat.**

Keyword: AQI, Exeedence Factor, NAAQS, Air Pollution.

I. INTRODUCTION:

Air pollution is a serious worldwide environmental problem. After decades of industrialisation, air pollution has become a major environmental issue for both developed and developing countries (Chaurasia et. al. 2020). Poor air quality has chronic effect on environment (Bhuyan et al.,2010). Air pollution seriously damages material sources such as building, various sculptures, and also vegetation. It may be due to particulate matter dispersed in it or gaseous pollutants completely miscible with it in all proportions. Gaseous pollutants such as SO_2, NO_x, CO_2, etc., dispersed in air are the major source of air pollution. (Sarasamma and Narayanan, 2014).Every year large quantities of pollutants are discharged into the environment from ever increasing production of goods and from burning of fossil fuels to generate energy needed to sustain industrial and domestic activities. Awareness of air contamination and measures to monitor and control air quality are inadequate considering the rapidity of increase in pollution levels. (Balashanmugam et al.,2012)

Study Area: Haryana is a state in northern India located at 29.05° N, 76.08° E and approximately 210-275 m.a.s.l. The state has an administrative area of 44,000 km². The population is about 25.4 million. The temperature ranges from 45 °C to 47 °C in pre-monsoon and 2 °C to 5 °C in winter. The cityare dominated by various small, medium and large-scale industries. From 1966 to 1997, the total number of industries has increase up to 7 time, whereas a75times increase in total number of vehicles has been registered.Six major cities namely, Manesar, Faridabad, Panipat, Bawal, Hisar and Sonipat were selected for the ambient air quality monitoring (Table: 3-6).Which have observed considerable growth in commercial and industrial sector during last few years.

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Figure1Map of Haryana showing sampling stations

Methodology: Ambient air monitoring was conducted during summer season from March 2022 to June 2022.8-hoursampling was done forPM_{10}, $PM_{2.5}$, SO_x and NO_2.APM-460 respirable dust samplers (RDS) with provision for gaseous sampling APM-415 (Envirotech, New Delhi) was used for measuring the concentrations of PM_{10}, $PM_{2.5}$, NO_2, and SO_x, in the ambient air. The sampling inlet was placed 1-3 meter above the ground level, depending upon the site available for the RDS. Atmospheric air was drawn for ~8 hours through the cyclone and 20 X 25 cm glass fiber filter (GFF) sheet at a flow rate of 1.0 to 1.2 m^3min and finally the average flow rate was calculated.
In the present study, an attempt has been made to assess the prevailing concentration of the PM_{10}, $PM_{2.5}$, SO_x and NO_2,in the fast-growing urban centers of Haryana(CPCB: 2003). AQI is calculated as per steps given in the CPCB report and computed on Microsoft Excel software and Exceedance factor is used to identify the level of pollution (critical, high, moderate, and low). Following is the equation to find the exceedance factor(Kumar et. al. 2021);

$$\textbf{Exceedance Factor} = \frac{\text{The annual average concentration of critical pollutant}}{\text{The annual standard for a particular pollutant}}$$

Table1Showing station code and stationname

Station Code	Station Name
S1	Manesar
S2	Faridabad
S3	Panipat
S4	Bawal
S5	Hisar
S6	Sonipat

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II. RESULTS AND DISCUSSION:

The sampling and analysis of ambient air quality parameters for six selected station was done in summer season from March 2022 to June 2022.8 hours sampling was done for all the parameter.

The maximum concentration of PM 2.5 was 71.39 µg/m^3 at S2 and minimum 53.42µg/m^3at S5 the concentration of PM2.5 was found in the range of 53.42-71.39µg/m^3(Table-3, Figure-2). The average concentration of PM2.5 was found higher than the standard limit (Table-2) except S3.

The maximum concentration of PM_{10} was 189.41µg/m^3 at S6 and minimum 151.33µg/m^3 at S3 the Concentration of PM_{10} was found in the range of 151.33 – 189.41µg/m^3 (table-4, Figure-3). The average concentration of $PM_{10}$was found higher than the standard limit (Table-2) at all the station.

The maximum concentration of SO_x was 46.25µg/m^3 at S3 and minimum 35.72µg/m^3 at S1 the Concentration of SO_x was found in the range of 35.72 – 46.25µg/m^3 (Table-5, Figure4). The average concentration of SO_x was found within the standard limit (Table-2) at all the station.

The maximum concentration of NO_2 was 75.98µg/m^3 at S6 and minimum 70.55µg/m^3 at S5 the Concentration of NO_2 was found in the range of 70.55 – 75.98µg/m^3 (table-6, Figure-5). The average concentration of PM_{10} was found within the standard limit (Table-2) at all the station.

Table2 National Ambient Air Quality Standard (2009)

S.NO.	Name of Pollutant	Time weighted average	Concentration in ambient air	
			Industrial, residential, Rural & other Area	Ecologically sensitive area (notified by central government
1	SOx (µg/m^3)	Annual	50	20
		24 hours	80	80
2	NO_2 (µg/m^3)	Annual	40	30
		24 hours	80	80
3	PM_{10} (µg/m^3)	Annual	60	60
		24 hours	100	100
4	$PM_{2.5}$(µg/m^3)	Annual	40	40
		24 hours	60	60

Source: CPCB, 2009

Table 3 Monthly Average Concentration of $PM_{2.5}$

Month	S1	S2	S3	S4	S5	S6
March	46.59	68.77	44.8	61.96	58.06	66.96
April	54.11	70.82	52.68	69.88	59.08	67.01
May	67.29	72.51	56.89	74.9	60.91	70.34
June	72.86	73.45	59.32	77.62	62.58	71.08
Mean	**60.21**	**71.39**	**53.42**	**71.09**	**60.16**	**68.85**
±SD	12.01	2.06	6.37	6.88	2.00	2.17
Max	72.86	73.45	59.32	77.62	62.58	71.08
Min	46.59	68.77	44.8	61.96	58.06	66.96

Table 4 Monthly Average Concentration of PM_{10}

Month	S1	S2	S3	S4	S5	S6
March	110.41	153.18	123.27	149.65	142.61	174.31
April	149.95	155.93	158.99	153.98	153.98	189.67

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May	188.49	159.87	155.63	163.38	163.38	194.89
June	195.05	164.88	167.43	171.63	169.75	198.78
Mean	**160.98**	**158.47**	**151.33**	**159.66**	**157.43**	**189.41**
±SD	39.14	5.08	19.35	9.82	11.81	10.74
Max	195.05	164.88	167.43	171.63	169.75	198.78
Min	110.41	153.18	123.27	149.65	142.61	174.31

Table 5Monthly Average Concentration of SO_x

Month	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**
March	26.25	39.67	36.98	38.51	31.83	38.9
April	32.78	41.32	48.98	41.94	35.48	33.51
May	40.01	43.44	49.18	44.96	41.13	42.96
June	43.85	44.79	49.86	45.84	43.03	44.74
Mean	**35.72**	**42.31**	**46.25**	**42.81**	**37.87**	**40.03**
±SD	7.81	2.26	6.19	3.32	5.15	4.99
Max	43.85	44.79	49.86	45.84	43.03	44.74
Min	26.25	39.67	36.98	38.51	31.83	38.9

Table 6 Monthly Average Concentration of NO_2

Month	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**
March	67.38	72.66	61.83	70.38	64.01	69.11
April	63.83	73.83	68.28	71.41	68.34	74.88
May	76.93	75.05	75.91	73.62	72.66	77.61
June	79.86	78.66	76.82	75.81	77.18	82.3
Mean	**72.00**	**75.05**	**70.71**	**72.81**	**70.55**	**75.98**
±SD	7.62	2.60	7.05	2.42	5.66	5.51
Max	79.86	78.66	76.82	75.81	77.18	82.3
Min	67.38	72.66	61.83	70.38	64.01	69.11

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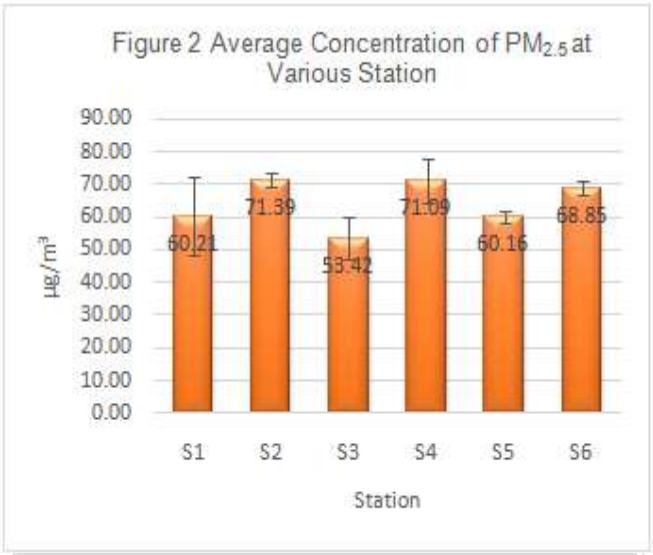

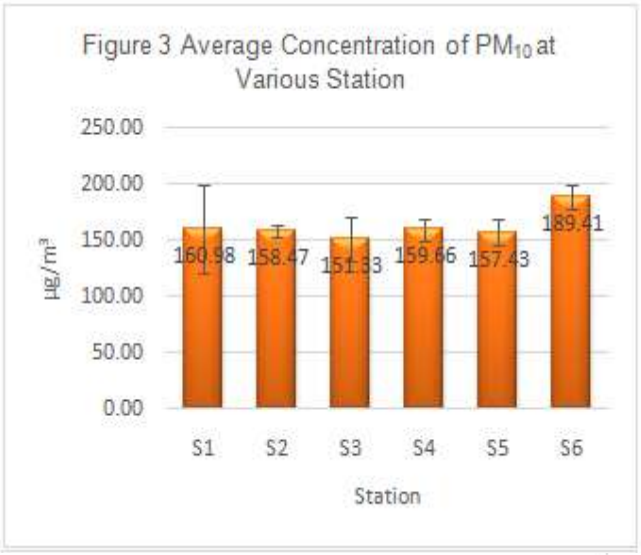

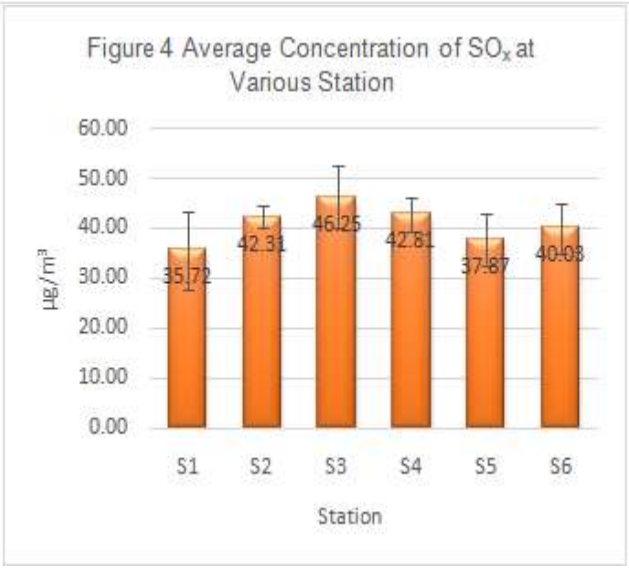

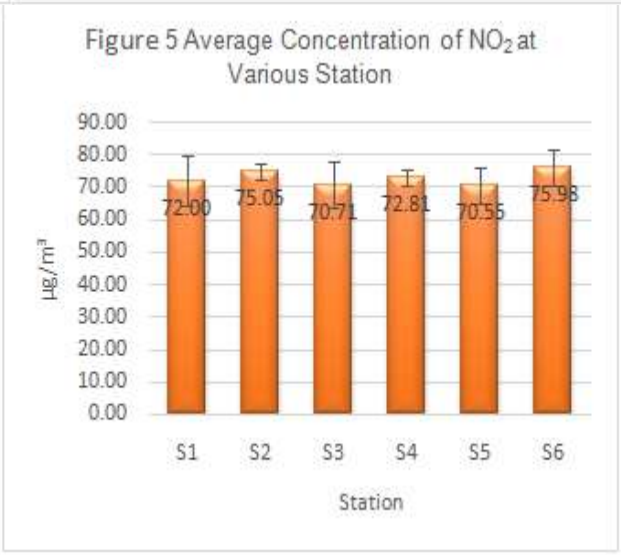

Table 7 Air Quality Index For various stations

Station code	AQI	Remark	Health Effects
S1	140.5	Moderate	Breathing discomfort to the people with lung
S2	139.75	Moderate	Breathing discomfort to the people with lung
S3	134.25	Moderate	Breathing discomfort to the people with lung
S4	144.5	Moderate	Breathing discomfort to the people with lung
S5	138.25	Moderate	Breathing discomfort to the people with lung
S6	159.75	Moderate	Breathing discomfort to the people with lung

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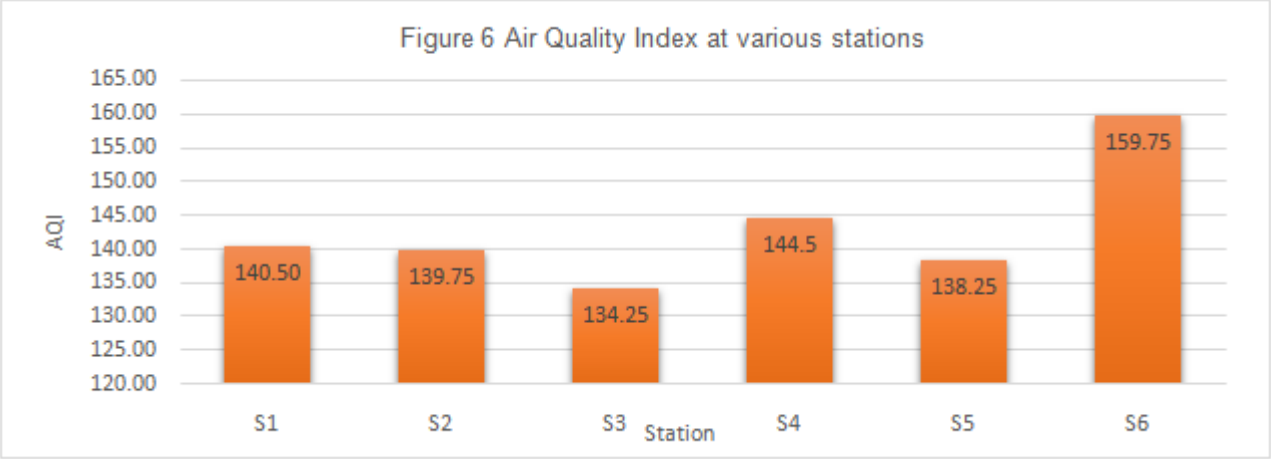

Table 8 Air Quality Index Value Remark and Health Effects

Index Value	Remark	Health Effects
0-50	Good	Minimal Impact
51-100	Satisfactory	Minor breathing discomfort to sensitive people
101-200	Moderate	Breathing discomfort to the people with lung
201-300	Poor	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease
301-400	**Very Poor**	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart disease
>401	Severe	May cause respiratory effects even on healthy people and serious health impact on people with lung/heart diseases. The health impact may be experienced even during light physical activity

AQI: The air quality index is used to express the magnitude of air pollution of an area.AQI for various station is given in table 7,figure 6 the range of AQI was found 134.25 - 159.75.all the station ware found in the moderate air quality range (Table -8)it can affect the people suffering for breathing discomfort and lungs problems. Highest AQI was found for S6 followed by S4

Exceedance factor: The exceedance factor is the average concentration of critical pollutants and their corresponding national air quality standard.
According to their critical pollution level exceedance factor divided into various categories;

Table9 Exceedance factor with their respective range

Level of pollution	Exceedance factor
Low pollution	< 0.5
Moderate pollution	0.5-0.9
High pollution	1.0-1.4
Critical pollution	>1.5

Table 10Exceedance Factor for Various Sampling Stations

Station/ Parameter	S1	S2	S3	S4	S5	S6
PM2.5	1.00	1.19	0.89	1.18	1.00	1.15
PM10	1.61	1.58	1.51	1.60	1.57	1.89
SOx	0.45	0.53	0.58	0.54	0.47	0.50
NO_2	0.9	0.94	0.88	0.91	0.88	0.95

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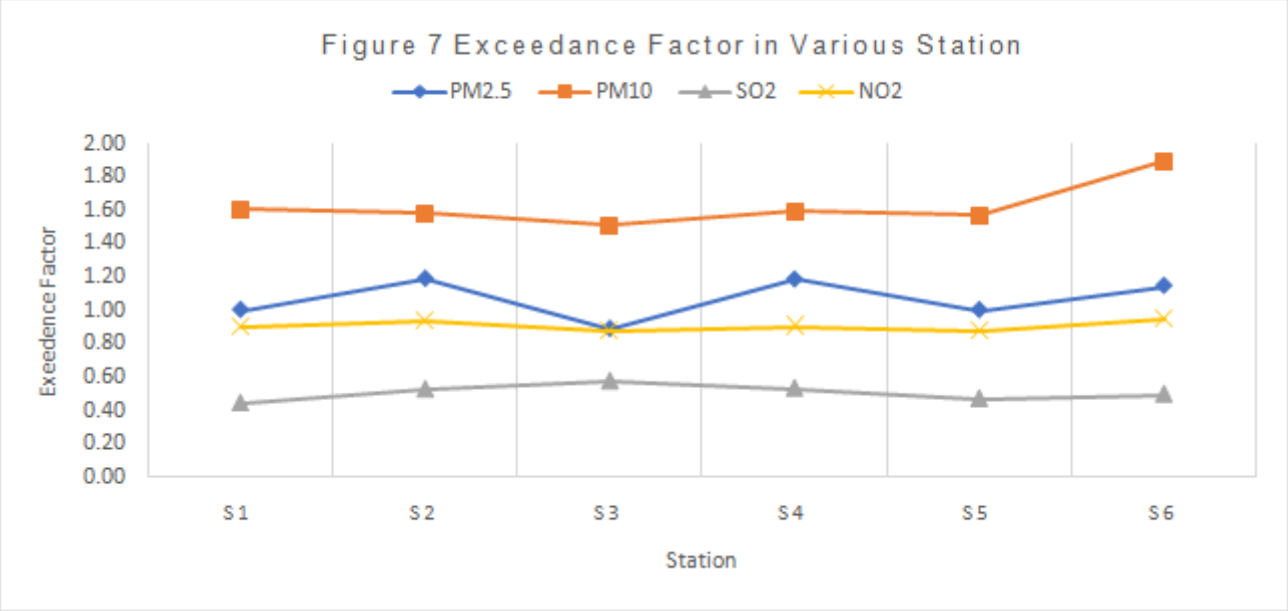

Exceedance factor suggests that $PM_{2.5}$concertation at S3 was found in moderate pollution level and remaining all the station were found in high pollution level. Exceedance factor for $PM_{10}$was found in critical level of pollution at all the station. Exceedance factor of SO_x at S1 and S5 was found in low pollution level and remaining all the station were found in moderate pollution level. Exceedance factor of NO_2 was found in moderate to high pollution level (Table-10).

III. CONCLUSION:

This study reveals that the particulates pollutants, PM_{10} and $PM_{2.5}$ are mostly higher than permissible limits at all the station and SO_x and NO_2 was found within the permissible limit of NAAQS. The mean AQI was found in the range 134.25 – 159.75. AQI shows that all the stations were in moderate quality level. Exceedance factor for $PM_{2.5}$ was found in high pollution level at S1,S2,S4,S5& S6 and at S3 exceedance factor was found in moderate pollution level. Similarly, exceedance factor of PM_{10} shows critical pollution level at all the stations (Srinivas and Sateesh ,2015). Generally, exceedance factor of SOx& NO_2were found I moderate range for all station.

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