# A COMPARATIVE STUDY OF AMBIENT AIR QUALITY OF AN INDUSTRIAL AND A COMMERCIAL AREA OF JAIPUR USING AIR QUALITY INDEX

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*Abstract* : This study presents analysis of variation in Annual average concentration of three pollutants NO<sub>2</sub>, SO<sub>2</sub>, PM<sub>10</sub> at two selected monitoring sites namely Vishwakarma Industrial Area (VKIA) and Chandpole (Commercial Area) in Jaipur City, Rajasthan, India from year 2011-2020 and to assess the ambient air quality on the basis of comparison with National Ambient Air Quality Standards and the Overall Air Quality Index (AQI). The analysis of the data shows that concentration of SO<sub>2</sub> was always below the permissible limits as specified by CPCB ( $50 \mu g/m^3$ ) at both study areas while PM<sub>10</sub> has crossed the permissible limits at both the monitoring sites over the whole study period with a higher value observed for Vishwakarma Industrial Area. It was also found that the trend variation in Concentration of NO<sub>2</sub> was within the prescribed National Ambient Air Quality Standards more than 50% of the time. The study also shows that PM<sub>10</sub> has highest concentration than both NO<sub>2</sub> and SO<sub>2</sub>, making it a prominent pollutant. It was observed that AQI values ranges from Moderate to Very Poor at Viswakarma Industrial Area while for Chandpole, overall AQI values fall under Moderate category except for year 2016. Thus it shows that Vishwakarma Industrial Area is more polluted as compared to Chandpole, Jaipur.

## *Index Terms* - Ambient Air Quality, Air Quality Index, National Ambient Air Quality Standards NO<sub>2</sub>, PM<sub>10</sub>, SO<sub>2</sub>.

#### I. INTRODUCTION

Air is a mixture of gases that fills the atmosphere giving life to human, plants and animals and thus making earth a living planet.

Urbanization is an unavoidable process in developing nations like India. Since last decade a rapid growth in population, construction activities, industrial pollutants, vehicular emissions etc. have been observed in Jaipur city. With this development in pace, air quality is being deteriorated day by day leading to an increase in level of pollutants like SO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, CO, Oxides of Nitrogen, toxic metals like Pb etc.

All these pollutants pose harmful effect on human health <sup>[1-2]</sup>, as exposure to these cause cardiovascular and respiratory diseases, neurological impairments and even mortality. According to report by WHO, air pollution in 2012 caused the deaths of around 7 million people worldwide <sup>[3]</sup>.

Thus an attempt was made in this investigation to study the effect of three pollutants  $PM_{10}$ ,  $NO_2$  and  $SO_2$  at 2 specified locations in Jaipur City namely Vishwakarma Industrial Area (VKIA) and Chandpole by comparing their annual average concentration with National Ambient Air Quality Standards as specified by CPCB as mentioned in Table 1 over a period of 10 years (2011-2020) and to assess and compare overall air quality status in terms of AQI (Air Quality Index) at these two areas. Many investigators have studied the ambient air quality in these two areas <sup>[4-6]</sup>.

AQI helps in effective communication of Air Quality status to people in terms which are easy to understand. It transforms complex air quality data of various pollutants into a single number (index value), along with a nomenclature and colour. A large no. of studies utilised AQI to assess the ambient air quality in various cities <sup>[7-11]</sup>. Based on ambient concentration values of air pollutants and their likely health impact, AQI has been divided into 6 broad categories as shown in Table 2.

Sr. No.	Name of Pollutant	Time Weighted Average	Concentration in Ambient Air			
			Industrial, Residential, Rural & Other Area	Ecologically Sensitive Area (notified by Central Government		
1	SO <sub>2</sub> (µg/m <sup>3</sup> )	Annual	50	20		
		24 hours	80	80		
2	$NO_2(\mu g/m^3)$	Annual	40	30		
		24 hours	80	80		
3	$PM_{10} (\mu g/m^3)$	Annual	60	60		
		24 hours	100	100		
4	PM <sub>2.5</sub> (µg/m <sup>3</sup> )	Annual	40	40		
		24 hours	60	60		
		100 Maria				

### Table 1- National Ambient Air Quality Standards (2009)

#### Table 2- National Air Quality Index and its possible health impacts

AQI value	Nomenclature	Health Impacts
0-50	GOOD	Minimal Impact
51-100	Satisfactory	Minor breathing discomfort to sensitive people
101-200	Moderate	Breathing discomfort to the people with Lung, Heart disease, children and Older adults
201-300	Poor	Breathing discomfort to everyone on prolonged exposure
301-400	Very Poor	Respiratory illness to everyone on prolonged exposure
>400	Severe	Respiratory effects even on healthy people

#### **II. MATERIALS AND METHODS**

#### 1.1. Study Area

Jaipur "the Pink city" and the capital of Rajasthan is known for its fascinating monuments and colourful markets.

It is the largest city of Rajasthan and lies on geographical coordinates of 26.9°N and 75.8° E at a distance of about 268 km from the National capital New Delhi. According to 2011 census, the city had a population of 3.1 million, making it the tenth most populous city of country.

#### 2.2. Site Description

Two sites, namely Vishwakarma Industrial Area, Jaipur and Chandpole, Jaipur were selected as the monitoring sites. Out of these, Vishwakarma Industrial Area has mainly automobile, paper, Chemical, Marble, Rubber, Steel, textile, Agro industries etc. While Chandpole, Jaipur belongs to a commercial area where bazaar vendors trade in marble, textiles, cotton quilts, footwears, handicrafts, stone sculptures, colourful carpets etc. leading to heavy traffic due to two, three and four wheelers and buses.

#### 2.3. Data set

Data used in this study is secondary data and was collected from Rajasthan State Pollution Control Board (RSPCB) website for Jaipur city from 2011 -2020 for two monitoring stations Vishwakarma Industrial Area and Chandpole, Jaipur.

#### **III. RESULTS AND DISCUSSION**

According to the data obtained from RSPCB Website, annual average concentration of namely 3 pollutants NO<sub>2</sub>, SO<sub>2</sub> and PM<sub>10</sub> and overall computed AQI for the two monitoring sites are summarized in Table 3. The corresponding graphs of concentration of each pollutant with time are plotted for both sites (Figure 1 to 3). A comparative graph for the obtained AOI for 2 sites is also represented in figure 4.

Year	Vishwakarma Industrial Area				Chandpole			
	Annual Average Concentration				Annual Average Concentration			
	<b>NO</b> 2 (µg/m3)	<b>PM</b> <sub>10</sub> (μg/m <sup>3</sup> )	$\frac{SO_2}{(\mu g/m^3)}$	AQI	$\mathbf{NO}_2 (\mu g/m^3)$	<b>PM</b> <sub>10</sub> (μg/m <sup>3</sup> )	$\frac{SO_2}{(\mu g/m^3)}$	AQI
2011	38.98	216	6.39	177.33	39.41	164	6.37	142.67
2012	53.53	238	9.59	192	52.32	209	9.14	172.67
2013	40.28	258	8.08	208	40.62	143	7.23	128.67
2014	43.34	236	7.8	190.67	41.77	148	7.09	132
2015	39.02	249	7.92	199.33	44.09	179	6.97	152.67
2016	36.41	281	9.15	231	35.22	256	8.62	206
2017	33.29	272	8.9	222	32.64	213	8.48	175.33
2018	36.86	284	10.4	234	35.63	172	7.81	148
2019	31.48	195	9.99	163.33	34.21	151	7.46	134
2020	26.28	165	9.28	143.33	24.5	136	7.11	124

#### Table 3 Annual Average Concentration at both the Study sites



#### Figure 1- Change in concentration of NO<sub>2</sub> over the study period at both monitoring sites



Figure 2- Change in concentration of PM<sub>10</sub> over the study period at both monitoring sites



Figure 3- Change in concentration of SO<sub>2</sub> over the study period at both monitoring sites



Figure 4- AQI values for both study sites from year 2011-2020

#### $NO_2 -$

From Figure 1 and table 3, it is found that maximum average concentration of NO<sub>2</sub> for VKIA, Jaipur has been observed in year 2012 i.e. 53.53  $\mu$ g/m<sup>3</sup> and a minimum was observed in 2020 (26.28  $\mu$ g/m<sup>3</sup>) while for Chandpole, a commercial area the maximum (52.32  $\mu$ g/m<sup>3</sup>) and the minimum (24.5  $\mu$ g/m<sup>3</sup>) average concentrations were observed in year 2012 and 2020.

It also shows that the concentration of NO<sub>2</sub> has crossed the National Ambient Air Quality Standards as specified by CPCB  $(40 \ \mu g/m^3)$  in year 2010, 2012, 2013 and 2014 at VKIA and in 2010, 2012, 2013, 2014 and 2015 at Chandpole, Jaipur.

#### **PM**<sub>10</sub>

Table 3 and Figure 2 shows that the annual average concentration for  $PM_{10}$  crosses the National Ambient Air Quality Standards of 60 µg/m<sup>3</sup> (Specified by CPCB) at both the locations in whole study period. Similar results were obtained during a study in Firozabad from year 2005- 2011<sup>[12]</sup>.

The maximum and the minimum concentration observed for  $PM_{10}$  at chandpole was in year 2016 (256 µg/m<sup>3</sup>) and in year 2020 (136 µg/m<sup>3</sup>) and for VKIA, maximum average concentration was observed in year 2018(284 µg/m<sup>3</sup>) and minimum average concentration in 2020 (165 µg/m<sup>3</sup>).

It also shows that the VKIA, Jaipur experiences a higher  $PM_{10}$  Concentration than Chandpole over the whole study period. This is may be because of heavy traffic in industrial area due of loading of finished products and unloading of raw materials. This is in accordance with the study that took place in Jodhpur from July to November 2017 which shows  $PM_{10}$  values are highest for industrial site <sup>[13]</sup>.

Both NO<sub>2</sub> and PM<sub>10</sub> showed a minimum annual average concentration in year 2020 which may be attributed to the imposed COVID - 19 lockdown where all the activities came to a stop reducing vehicular as well as industrial emissions thereby reducing the air pollution. The global Coronavirus pandemic although is fatal and harmful for human beings but proved to be a boon for environmental air quality and also give an idea that if proper measures are adopted, the nation can have better quality of air to breathe.

#### SO<sub>2</sub>-

Table 3 and figure 3 shows that the annual average concentration of  $SO_2$  has never crossed the prescribed limit as specified by CPCB over the whole study period at both the monitoring sites. These results are in correspondence with the study that took place at Bengaluru from year 2006-2015<sup>[14]</sup>.

In VKIA, Jaipur the maximum concentration was observed in year 2018(10.4  $\mu$ g/m<sup>3</sup>) and a minimum was observed in 2011 (6.39  $\mu$ g/m<sup>3</sup>), while for Chandpole, Jaipur the maximum concentration observed was 9.14  $\mu$ g/m<sup>3</sup> in year 2012 and minimum concentration was observed in year 2011 (6.37  $\mu$ g/m<sup>3</sup>).

The variation in Air Quality Index (AQI) over the study period as shown in figure 4 indicates that the Air quality status at VKIA, Jaipur varies from Moderate in year 2011, 2012, 2014, 2015,2019 and 2020 to Very Poor in 2010, 2013, 2016, 2017 and 2018. While for Chandpole, Jaipur AQI falls under Moderate Category for the whole study period except 2016. Both the sites showed a minimum value of AQI in year 2020

AQI values for both the Areas show that VKIA is more polluted in comparision to Chandpole. This may be attributed to heavy traffic and various pollutants emitted due to large no. of industries present in this area.

It is concluded from Table 1 that alone passive or active systems are not appropriate and sustainable due to increasing energy demand trend in space heating/cooling. It forces us to adopt suitable hybrid systems according to tailor made situations.

#### **IV. CONCLUSION**

- 1. PM<sub>10</sub> is most prominent pollutant polluting both the study sites during the Whole study period.
- 2. The higher AQI value for VKIA proves that it is more polluted as compared to Chandpole.

#### V. ACKNOWLEDGMENT

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