Indian J.Sci.Res. 15 (1): 185-189, 2017
ISSN: 0976-2876 (Print)
ISSN: 2250-0138 (Online)

EFFECT OF METEOROLOGICAL CONDIATION ON NOx POLLUTION OF KOTA CITY, INDIA

NEHA RAJ SAINI[a] AND BHARATIY SHARMA[b1]

[a]Research scholar, Career Point University Kota, Rajasthan, India
[b]Department of Chemistry, M.B.P.G. College, Kota, Rajasthan, India

ABSTRACT

This paper reports the studies of the relationship between ambient NOx concentration and meteorological parameters like temperature, humidity, wind speed and wind direction. Based on this aspect the present study has been conducted with the monitoring of NOx level twice in a weak along with meteorological parameters of highly polluted zone of the city. To correlate meteorological condition with NOx level of selected area pearson correlation coefficient has been determine. It is found that wind speed and temperature are the main parameters which affect the NOx concentration in the ambient air. The wind direction with respect to different seasons is shown in wind rose diagram along with meteorological parameters such as temperature, wind speed. Wind rose diagram predict that pre-monsoon and post-monsoon was predominated by wind westerly where as monsoon period was predominated by west of north west (WNW) wind. Results of Pearson correlation coefficient shows the highest +ve significant correlation between concentration of NOx v/s temperature(r= 0.204) and concentration of NOx v/s wind speed r=0.117 and negative significant correlation was between concentration of NOx v/s relative humidity r=-0.658.

KEYWORDS: Air Pollution, Statistical, Correlation Coefficient, Meteorological Parameters, Wind Rose Diagram.

In recent years, the deterioration of air quality in urban areas has been caused by continuous industrial and commercial development, population growth and an increase in energy consumption (Banerjee et. al., 2011, Turaliolu et. al., 2005). The concentration of air pollutants varies depending on meteorological factors, the source of pollutants and the local topography. However, of these three factors, the one which most strongly influences variations in the ambient concentration of air pollutants with the meteorological factors (Banerjee et. al., 2009). Although the relationships between synoptic meteorology and air pollution shave been investigated for pollutants such as ozone (Krupa et. al., 2003), SO_2 (Kalkstein et. al., 1986), NO_2 (Perez and Trier 2001), and even of visibility by (Sequeria R. and Lai, 1998). This study examines the relationship between meteorological parameters and urban air pollutants specially NOx concentration.

NO_x represent a family of seven compounds. Actually, EPA regulates only nitrogen dioxide (NO_2) as a surrogate for this family of compounds because it is the most prevalent form of NO_x in the atmosphere that is generated by anthropogenic (human) activities. NO_2 is not only an important air pollutant by itself, but also reacts in the atmosphere to form ozone (O_3) and acid rain. The release of oxides of nitrogen (nitrogen oxides and nitrogen dioxides) reacts with volatile organic compounds in the presence of sunlight to produce ground-level ozone, the primary ingredient in smog. Nitrogen oxide also contributes to fine particulate matter, or soot. Both smog and soot are linked to a host of serious health effects. Nitrogen oxide also harms the environment, contributing to acidification of lakes and streams (acid rain).

Meteorological is the science of atmosphere and the study of the characteristics of weather elements. Meteorological parameters are having great importance in transportation, dispersion and natural cleansing of the air pollutants in the atmosphere. By keeping this view in mind our research study is focus on the monitoring and analysis of NOx concentration of highly polluted zone of Kota city and the effect of meteorological parameters on the dispersion of NOx level of the study area of Kota city. Air pollution problems in and around Kota city is a major concern of the study because these Rajasthan first major coals fired thermal power plant is of 1240MW capacity is also located in heart of Kota city.

STUDY AREA

The area selected of the study is the highly polluted area of the Kota city because Rajasthan first coal fired thermal power plant situated with in 3km periphery of the study area, 180 meters high stack continuously release flue gas in to the atmosphere at an

[1]Corresponding author

approximately velocity of 25m/sec. so as to disperse the emitted gases over a wide spread area.

The normal wind direction in Kota city is towards south-southwest, plume from the stacks of KTPS is in the direction of populated location of the city. The cartography coordinates of the study area Latitude 25°11'N75°50'E and Longitude 25.18°N75.83°E

SAMPLING AND ANALYSIS

High Volume Samplers HVS was the basic instruments used to monitor Ambient Air Quality. Envirotech APM 460 is the "DXNL" version of APM 460NL. It is lighter, more compact, can be carried in a car dickey and is ideal for field use. It can be used either by mounting it on roof tops of building or separately outside as the requirement of monitoring necessary. Nitrogen Oxides are collected by bubbling air through a sodium hydroxide solution to from a stable solution of sodium nitrite. The nitrite ion produces during sampling is determined calorimetrically by reacting the exposed absorbing reagent with phosphoric acid, sulphanilamide and N (1- napthyl) ethylendiamine dihydrochloride.

MONITORING PERIOD

NOx monitoring with meteorological parameters was carried out at selected zone throughout the year, twice in the week, Table 1 shows average values of these parameters month wise during the study periods January 2016 – December 2016.

Table 1: Monthly average variation of NOx concentration with Temperature, Humidity, Wind speed and Wind direction (January 2016-December 2016)

Sampling Month	Nitrogen Dioxide (NO_2) µg/m^3	Temperature °C	Wind speed km/hr	Wind direction	Humidity %
Jan-16	36.3	25.77	1.77	11.25	34.22
Feb-16	42.02	27.57	4.71	101.25	30.28
Mar-16	37.00	34.44	3	11.25	19.66
Apr-16	39.29	40	4.33	281.25	16
May-16	39.48	41.87	5	281.25	22.5
Jun-16	33.43	39.11	4.33	281.25	42.66
Jul-16	32.01	29.55	2.66	281.25	79.33
Aug-16	24.34	28	3.88	303.75	83.22
Sep-16	20.38	32.75	3.5	281.25	58.25
Oct-16	25.71	33.5	4.62	303.25	37
Nov-16	32.02	30.88	2.11	101.25	25.55
Dec-16	33.53	26.33	3.11	281.25	37.77

RESULTS AND DISCUSSION

Correlation (r)

In the present study, the Pearson Correlation (r) is used to find a correlation between at least two continuous variables. The Pearson value or Pearson correlations is denoted as r. Other factors, . . . r = (2) such as group size, will determine if the correlation is significant. The general formula of the r is shown in Eq. 1(Dowdy et al 1983).

$$r = \frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sqrt{\left(\sqrt{(\sum X^2 - \frac{(\sum X)^2}{N}}\right)\left(\sqrt{(\sum Y^2 - \frac{(\sum XY)^2}{N}}\right)}} \quad (1)$$

Where N is the sample size, X the value of the independent variable, and Y the value of the dependent variable.

The r value can fall between -1 and +1. A value of r = -1 demonstrates that there is a perfect negative relationship between the two variables. If r = 0, it shows a lack of correlation and a value of r = +1 equates to a perfect positive correlation (Dowdy et al 1983).

The statistical parameters like correlation, mean deviation, standard deviation and coefficient determinant are given in the table 2

Table 2: The correlation, mean deviation, standard deviation, coefficient of determinant of meteorological parameters and NOx concentration between January 2016-December 2016

Statistical Parameters	Concentration of NOx v/s Temperature °C	Concentration of NOx v/s Wind speed km/hr	Concentration of NOx v/s Humidity%
Correlation (r)	0.204482828	0.117517369	-0.65863406
Mean deviation	4.78	14.68708333	10.71173611
Standard Deviation	5.94457151	15.69973968	16.44785356
coefficient of determinant	6.778951725	6.877295409	5.21102118

The relation between NOx and meteorological parameters (ambient temperature, wind speed and relative humidity) was investigated by pearson correlation analysis. The correlation (r) between monthly average NOx concentration and monthly average meteorological parameters are shown in table 2

The relation between NOx and meteorological parameters of KTPS zone are graphed in Figure 1 (a-c). This shows that when the wind speed is high pollutants are diluted by dispersion. Same results has been find out by other researchers (Turalilu et. al., 2005).

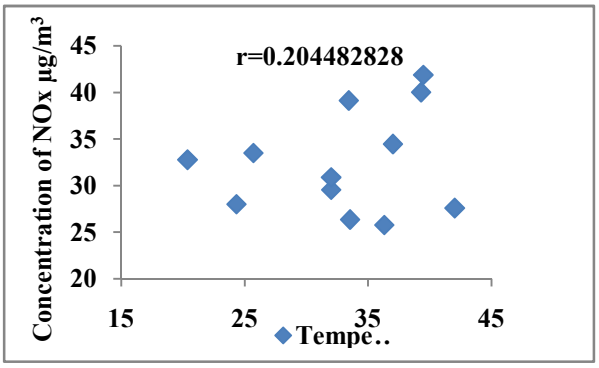

Figure 1a: NOx conc. v/s Temperature

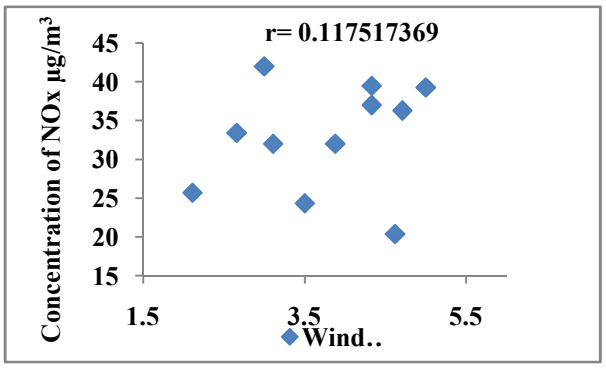

Figure 1b: NOx conc. v/s Wind speed

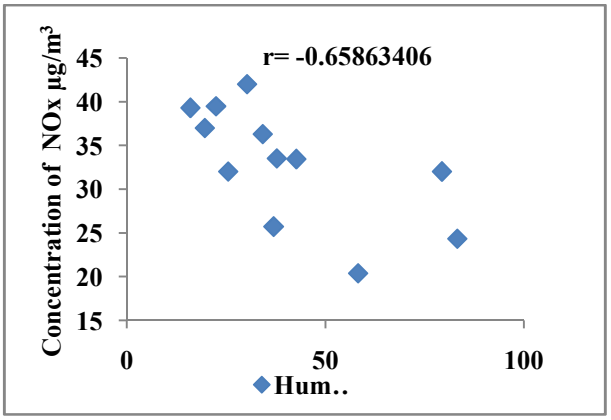

Figure 1C: NOx conc. v/s Humidity

Figure 1: Correlations between NOx concentration and meteorological parameters

WIND ROSE DIAGRAM

One of the most commonly used diagrammatic representation is the wind rose and it gives information on wind speed and wind direction along with their persistence for the fractional period of occurrence at a given location (Donnelly et. al., 2011) states that wind speed has been well- established as being inversely related to NOx concentration, which means that the concentration of NOx tends to be higher in low wind speed areas. Another study undertaken by (Celik et. al., 2007) and states that tall buildings in effect, prevent wind speeds from being sufficiently strong to be able to transport the pollution away.

Moreover, temperature affects pollutant concentration by causing variations in wind circulation and simultaneously dilutes the concentration of air pollutants (Banerjee et al 2011). Figure 2 (2a-d) shows wind rose diagrams in winter, pre-monsoon, monsoon and post-monsoon seasons of Kota city during the year January 2016- December 2016.

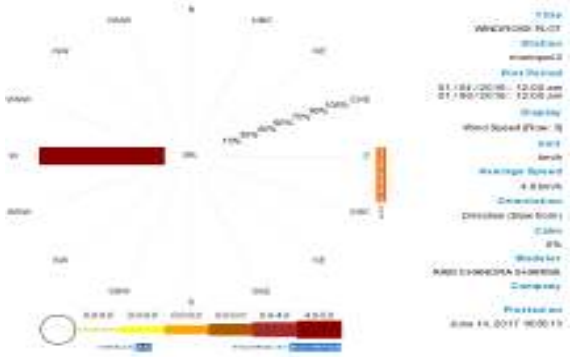

Figure 2a: Jan-Mar(2016)

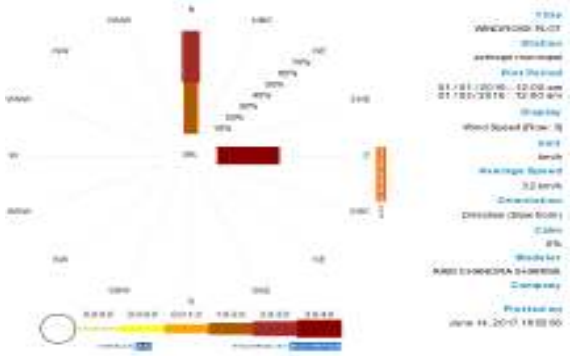

Figure 2b: Apr-Jun(2016)

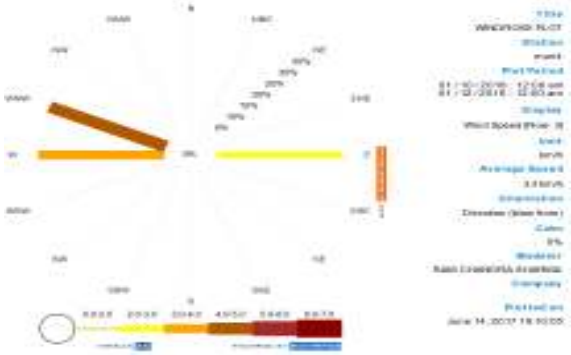

Figure 2c: July-Sep(2016)

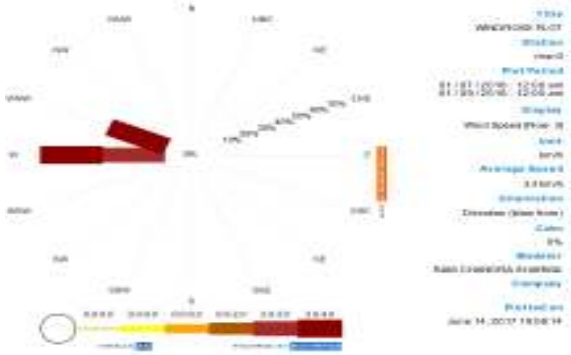

Figure 2d: Oct-Dec(2016)

Figure 2: Prevailing Wind directions in different seasons in Kota city (Jan 2016- Dec 2016)

The Pearson Correlation analysis indicates significant correlations between NOx level and meteorological factors (ambient temperature, relative humidity and wind speed) at the studied location. The analysis shows that wind speed and temperature has a positive correlation to the concentration of NOx. The results also show that temperature has a positive correlation to the concentration of NOx but a negative correlation to relative humidity for studied zone.

The result of the study suggests that the wind direction and speed are good indicator for the distribution of both air pollutants. The temperature usually increases evaporation processes and the high relative humidity will lead to the amount of water vapor and rain that will downwash the amount of pollutants. Studied zone shows the highest +ve significant correlation between concentration of NOx v/s temperature r= 0.204 and concentration of NOx v/s wind speed r=0.117 and negative significant correlation was between relative humidity r=-0.65863406 and concentration of NOx .

ACKNOWLEGDEMENT

The authors are thankful to the Director of chemical testing and research laboratory Kota for providing research facility and the authors are also thankful to the meteorological department of Kota for their support and cooperation.

REFERENCES

Banerjee T. and Srivastava R.K., 2009. Evaluation of ambient air quality at IIE Pantnagar and its surroundings through combined air quality index. International Symposium on Environmental Pollution, Ecology and Human Health, Tirupati, India.

Banerjee T., Singh S.B. and Srivastava R.K., 2011. Development and performance evaluation of statistical models correlating air pollutants and meteorological variables at Pantnagar, India. Atmos. Res., **99**(3-4):505-517.

Celik M.B. and Kadi I., 2007. The relation between meteorological factors and pollutants concentrations in Karabük City. Gazi Univ. J. Sci., **20**(4):87-95.

Donnelly A., Misstear B. and Broderick B., 2011. Application of nonparametric regression

methods to study the relationship between NO_2 concentrations and local wind direction and speed at background sites. Sci. Total Environ**.,** **409**(6):1134-1144.

Dowdy S. and Wearden S., 1983. Statistics for Research. Wiley, New York.

Kalkstein L.S. and Corrigan P., 1986. A Synopticclimatological approach for geographical analysis: assessment of sulfur dioxide concentrations. Annals Assoc. Am. Geograph., **76**:381-395.

Krupa S., Nosal M., Ferdinand J.A., Stevenson R.E. and Skelly J.M., 2003. A multivariate statistical model integrating passive sampler and meteorology data topredict the frequency distributions of hourly ambient ozone (O_3) concentrations. Environ. Pollu., **124**:173–178.

Perez P. and Trier A., 2001. Prediction of NO and NO_2 concentrations near a street with heavy traffic in Santiago, Chile. Atmos. Environ., **35**:1783-1789.

Sequeria R. and Lai K.H., 1998. The effect of meteorological parameters and aerosol constituents invisibility in urban Hong Kong, Atmos. Environ., **32**:2865-2871.

Turaliolu F.S., Nuhoglu A. and Bayraktar H., 2005. Impacts of some meteorological parameters on SO and TSP concentrations in Erzurum, Turkey. 2Chemosphere, **59**(11):1633-1642.