CRITICAL STUDIES OF THE DISPERSION OF NOX GASES EMITTED FROM THERMAL POWER STATIONS USING VARIOUS DISPERSION MODELS

[1]S. H. Ganatra ,[2]B. B. Shende, [2]N. G. Telkapalliwar [3]N. Gupta

[1]Dept. of Chemistry, Institute of Science, R.T. Road, Civil Lines Nagpur
[2] Dept. of Chemistry, Dr. Ambedkar College, Deekshabhoomi, Nagpur
3 Dept. of chemistry, Guru Nanak Institute of Engineering & Management, Nagpur
Corresponding author E-mails : bapushende@gmail.com, sunilganatra@gmail.com

ABSTRACTS

The Dispersion study of oxides of nitrogen (NOx) gases emitting from thermal power stations nearby Nagpur city carried out with the help of Industrial Source Complex 2 model (ISC2 model). It is reported that the dispersion is gives authentic dispersion of NOx gases during the experiment. The maximum concentrations for 3 hours 24 hours and Month averages are reported to be 702.43 microgram/ m^3, 369.914 microgram/ $m^3$and 87.36 microgram/ m^3respectively.

Key Words: Dispersion of oxides of nitrogen, Thermal power stations, dispersion models, ISC2, Nagpur city.

INTRODUCTION

Koradi is situated in Nagpur district of Maharashtra state in India. Various industries are situated around the Nagpur City. Apart from the other industries Koradi Thermal Power Station and Khaperkheda Thermal power stations are the major thermal power stations which produce electricity throughout the year with full capacity and efficiency. To fulfill the increasing demand of electricity; these power plant require coal as a primary source[1]. All the times coal is in the form of pure quality. Sometimes the coal which is usedis of low quality. Due to this the percentage dispersion of the oxides of nitrogen (NOx) increases . These increase NOx combine with humidity and rain water and precipitated around these power plants in forms of acid drops or acid rains and hence the areas around these power plant is more acidic as compared to the other areas . Also the people residing around these power plant, particularly the old persons; those ailing from chronic diseases from respiratory system feels discomfort [2]. Hence it was thought interesting to carry out the dispersion studies of the NOx gases emitted from thermal power stations using regulatory dispersion model.

EXPERIMENTAL

Research work has been carried on Koradi Thermal Power stations, Koradi district Nagpur as a source of NOx gases pollutant. This plant is situated nearly 15 km. away from the Nagpur city. This plant is producing 1160 Mega Watt electricity per day i.e. MW/day installed electricity generation capacity. The average coal consumption capacity of this plant per killo watt per hour (KW/H) is 0.84 kg. There are total seven turbines. Four turbines are generating 120 MW, one turbine generating 200 MW and the remaining two are generating 210 MW each. There are total five stacks for seven turbines[3]. The required data were collected from environmental department of the same plant. Radiosonde data were collected in electronic from Indian Meteorological Department Pune M.S. Radiosonde data is upper air data and show variation of the temperature and pressure with respect toheight. This data were used to calculate mixing height for each hour[4].

The meteorological surface data file contains three hourly weather data of Nagpur city. For dispersion calculation hourly weather data is required [5,6],hence three hourly weather data were converted into hourly weather data using computer programme “change.exe”.

To calculate hourly weather surface data from three hourly data, statistical techniques were employed i.e. data were prepared using time series techniques. Missing data were evaluated using average techniques[7]. Previous three hour data and post three hour data were average to calculate the missing data with 5% significance level.

ISCST2 model system procured from E.P.A., U.S.A. used to evaluate the dispersion. This model system require the weather data in following format.

Year(two digits) Months (two digits) Days (two digits) Hours (two digits) Wind direction(xxx.xxx total seven digits , four after decimal points) Wind velocity(xxx.xxx total seven digits , four after decimal points) Temperature in Kelvin (xxx.x four digit , one after decimal points) Stability category (x one digit; valid range is from one to six)[8,9].

The model system also require the mixing height data for the respective day and time. The mixing height may be defined as that height above the earth surface to which released pollutants will extend, primarily through the action of the atmospheric turbulence. Generally temperature lapse methods were used in the study to calculate the mixing height [10]. Mixing height for any hour is known and radiosonde lapse rate values generally obtained for early morning or evening.

To determine the mixing height for noon the noon surface temperature is plotted on the temperature height graphs, a line representing the dry adiabatic lapse rate of $10^0C/Km$.is drawn through this noontime temperature[11, 12]. The intersection point of this line with temperature height graphs of early morning radiosonde is the mixing height.

For Nagpur city, hourly mixing height data were not available. Hence it is calculated using "mixheight.exe" computer program which was designed in our laboratory[13].

The designed data files inputted to ISCST2 model to evaluate the concentration for 35 kilometers surrounding selected thermal power stations. The model system uses Gaussian equations and provides the dispersion in various formats.[14,15, 16,17,18]

ISCST2 provides the output file, it provides the results of dispersion in various format including the results for plotting countours.[19,20]

The selected threshold values are as follows:

3 - hour average	500
24 - hour average	200

RESULT AND DISCUSSION

Dispersion of NOx surrounding the Koradi Thermal Power Stations.

The result file after running ISCST2 model system provides the following details of the dispersion of NOx gas.

- The first, second and 24 -hours highest average concentration values for source group.
- Maximum 50 values for 3 – hours and 24 -hours average concentration for source group.
- The summary of the highest three hours and twenty- four hours result.
- The monthly average concentration values for source group.

Obtained outputs from the ISCST2 model system for 3 – hours average, 24 - hours average and monthly averagesare as follows:

The table 1depicts the result for the first, second and third highest concentration of NOx for 3 - hours, 24 - hours, month average and also for one year period along with the dates. The concentrations are express in micrograms/m^3.

Rank	Average Time	Month	Day	Hour	Conc.	Receptor X Y
First	03	11	21	24	441.316400	.00, 5000.00
Second	03	12	03	24	441.31620	.00, 5000.00
Third	03	11	30	18	419.92290	.00, 5000.00
First	24	04	07	24	321.58870	4924.04, -868.24
Second	24	04	14	24	316.08830	4330.13, 2500.00
Third	24	08	20	24	315.23400	4924.04, -868.24
First	Month	01	31	24	181.85640	.00, 5000.00
Second	Month	11	30	24	152.16040	.00, 5000.00
Third	Month	09	30	24	114.54520	.00, 5000.00
First	Period	-	-	-	83.82755	.00, 5000.00
Second	Period	-	-	-	41.06327	.00, 10000.00
Third	Period	-	-	-	35.39517	2500.00 4330.13

Table No. 1 : First three highest values of NOx for different average time
(Concentration is in micrograms/ m^3 and distances i.e. on X and Y axis are in meters)

Table 1shows the details information regarding to the first three highest dispersion concentrations of NOx and the date on which these dispersion occurred. It also represents the areas in which this dispersion occurred. It also shows the summary of the highest three values of the dispersion of NOx day-wise, month- wise and period –wise.

The highest 3 - hours dispersion of NOx was found to be 441.31 µg/ m^3 within the range of 5 km. around the Koradi Thermal Power Station, Koradi, District Nagpur .The highest 24 –hours dispersion reported was 321.58 µg/ m^3 and distance of 5 km. around the source. The highest month wise concentration of NOx was found to be 181.85 µg/ m^3. Table 2 shows the detail summary of the results.

The obtained dispersions for 3-hours, 24-hours and month averages are also reported graphically in contour format. Contour 1, contour 2 and contour 3 represents the dispersion of 3-hours average, 24-hours average and month averages.

The Summary Of The Result Of NOx For Three Year

It is reported that for all the three years; these concentration remain nearly same. This value is crossing the threshold limit of 300 μg /m^3.

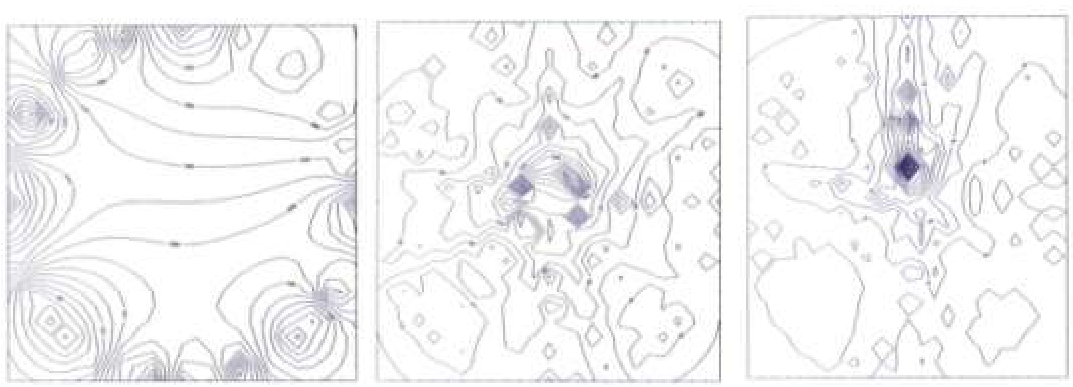
Time	Three Year Average
3 hour average	702.43 microgram/ m^3
24 hour average	369.914 microgram/ m^3
Month average	87.36 microgram/ m^3

Table 2 showing Three year average values for each sample time.

Average values for the three- year month average is 87.36 μg/ m^3 that are again higher than the threshold value of 50 μg/ m^3.

It is known that NOx is easily soluble in water and it forms weakly basic ammonium hydroxide. In clean air, this oxidizes slowly to nitrogen trioxide. It oxidized more readily by atmospheric oxygen in aqueous aerosols. Heavy metal ions in solution catalyses the reaction, that stops when aerosols become basic. Atmospheric ammonia neutralizes the acid to form ammonium sulphate.

Therefore, high concentration of ammonium nitrate expected around this power plant. These high concentrations of ammonium nitrate may pose health threat to the living being residing the adjoining areas around Koradi Thermal Power Plant.



Contour No. 1: 3 – Hours **Contour No.2: 24 – Hours**

Contour No. 3: - Monthly Average

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