

Air quantity impact assessment due to Koradi thermal power plant

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सार – परिवेशी वायु गुणवत्ता का पूर्वानुमान और उत्सर्जन से पड़ने वाले दुष्प्रभाव के लिए वाहनों के विक्षेपण और प्रदूषक प्रजातियों को हटाने की प्रक्रिया का मूल्यांकन करना अनिवार्य है। प्रेक्षित किए गए मौसम वैज्ञानिक आँकड़ों के आधार पर पर्यावरणीय प्रभाव का अनुमान लगाने के लिए गॉशियन विक्षेपण मॉडल (ISCST3) का उपयोग किया गया है। नागपुर के समीप कोराड़ी थर्मल पावर प्लांट के परिवेश में SO₂ सांद्रण के कालिक और स्थानिक वितरण का अध्ययन किया गया है। घंटेवार मिक्सड उँचाई स्थायित्व श्रेणी और संवातन सहसंबंध डाटा का उपयोग SO₂ के प्रतिदिन के अधिकतम सांद्रण का स्थानवार आकलन करने के लिए और SO₂ सांद्रण के कालिक और स्थानिक वितरण का विश्लेषण करने के लिए किया गया।

SO₂ के चरम और अधिकतम सांद्रण की तुलना CPCB'S परिवेशी वायु गुणवत्ता मानकों के साथ की गई और वह क्रिटिकल सीमा में पाई गई। वर्ष में SO₂ सांद्रण के दो अधिकतम और दो न्यूनतम चरम सांद्रण पाए गए। इस अध्ययन से यह पता चला है कि इस प्लांट के परिवेश में वायुमंडल में विक्षेपण क्षमता अधिक पाई गई है।

ABSTRACT. Prediction of ambient air quality and impact of emission requires an assessment of transport, dispersion and removal process of pollutant species. Gaussian dispersal model (ISCST3) used to predict environmental impact based on observed meteorological data. Temporal and spatial distribution of SO₂ concentration in the vicinity of the Koradi Thermal Power Plant near Nagpur has been studied. Calculated hourly mixing height, stability classes and ventilation coefficient data has been used as an input to the model for computing location wise daily highest concentration of SO₂ and analyzed for temporal and spatial distribution of SO₂ concentration.

Extreme and highest SO₂ concentration has been compared with CPCB'S ambient air quality standards and found within the critical limit. Two minima and maxima of extreme concentration of SO₂ were found in a year. Study suggests high dispersal capacity of the atmosphere in the vicinity of the plant.

Key words – Mixing height, Ventilation, Stability, SO₂, CPCB.

1. Introduction

Rapid industrialization and urbanization have introduced severe stresses within the environment which have immediate as well as long term impact. Gaussian dispersion models are frequently used to predict environmental impacts based on observed meteorological data with the help of long term climatology. Such models enable optimal source utilization, development of abatement strategies and assessment of air shed assimilative capacity. Several authors, viz., Padmanabhamurthy & Gupta (1977, 1978, 1979, 1986); Gupta (1980, 1984); Patil & Patil (1990) have attempted to develop diffusion models for Indian region. Local meteorological conditions have a general effect on air quality. Surface concentration increases with temperature (AW and Kleeman, 2003; Dawson *et al.*, 2007b;

Kleeman, 2007) due to faster SO₂ oxidation. In contrast, nitrate and semi volatile component shift from particle phase to gas phase with increasing temperature (Sheehan and Bowman, 2001; Tsigaridis and Kanakidou, 2007).

Thus, an attempt have been made to study month wise accumulation of one hour and 24 hour concentration of Sulphur dioxide (SO₂) within 5 km periphery of Koradi Thermal Power Station by using numerical model called AERMOD model also known as Gaussian Dispersal model.

2. Physiography and power plant characteristics

Koradi Thermal Power Plant has three stacks and details are furnished in Table 1. It is one of the four major power plant began operation in 1974. Plant operates seven

TABLE 1

Stack details of Koradi Thermal Power Plant

Stack No.	Height of stack in meter	Stack Exit Temp. in °C	Stack Exit velocity m/s	Stack Diameter (m)
1	90	142	17.9	3.47 × 3.47
2	90	139	16.8	3.43 × 3.43
3	90	140	17.5	3.15 × 3.15

TABLE 2

Maximum concentration of SO₂ in 24 hour

Month	Maximum 24 Hours mean Concentration (µg/m ³)	Distance in meter & Direction from source
January	10.83	2500, Southeast
February	12.32	2000, Northwest
March	10.03	3000, West-southwest
April	11.03	2500, Southwest
May	12.94	1500, East-southeast
June	10.05	1500, East-southeast
July	7.46	3000, Southeast
August	9.49	3000, East-southeast
September	8.91	3000, East
October	13.50	3000, East-southeast
November	8.82	3500, Southwest
December	7.46	5000, Southwest

units and has a total power generation capacity 1080 MW. Three units have capacity of 660 MW.

The major pollutants from the plant are the particulate matter and Sulphur dioxide (SO₂). These pollutants represent potential future air quality problem in and around Nagpur city, Principle component of particulate matter (PM) like sulfate, nitrate, organic carbon, elemental carbon are mostly present as fine particles less than 2.5 µm diameter (PM 2.5) and these are most concern for human health. Sulfate, nitrate & Organic Carbon are produced within the atmosphere by oxidation in SO₂, NO and Non Methane volatile Organic Compound.

3. Data and method of analysis

No significant variation in surface air temperature between meteorological observatory and power plant. Meteorological data, viz., surface and upper air observations recorded at Nagpur airport has been used in

TABLE 3

Seasonal maximum concentration of SO₂ in 24 hour

Season	Max. 24 Hrly Conc. (µg/m ³) (A)	Distance (m) and direction of occurrence	Observed Air Quality (B)	Total conc. (µg/m ³) (A+B)	AQ std. as Per CPCB
Pre monsoon	12.95	4500, Southeast	13	25.95	80
Post monsoon	13.50	5000, Southwest	14	27.50	80
Winter	12.32	4500, South	21	33.32	80

this study for the period 1st July, 2013 to 30th June, 2014. Daily upper air meteorological data at every 50 hPa level from surface to 700 hPa level of 0000 UTC hours and hourly surface meteorological data like Dry bulb temperature, Wet bulb temperature, wind speed, wind direction, cloud amount have been used for computation of hourly mixing depth and ventilation coefficient and stability classification.

Hourly mixing depth with stability index, wind and ventilation coefficient data have been taken as input to the model. The model has been run for 24 hours daily for 21 × 21 grid point at an interval of 500 meter for predicting the highest concentration of Sulphur Dioxide (SO₂) in one hour and 24 hours respectively. Source of the emission has been considered at the center of the grid. Maximum concentration in a month on hourly and 24 hourly basis has been equated.

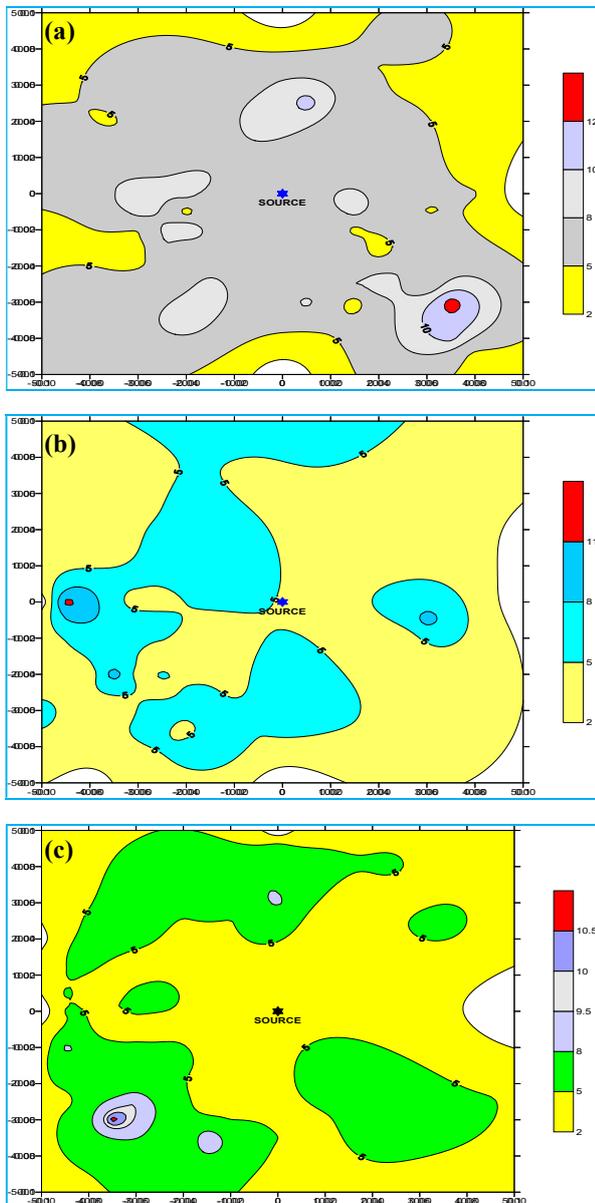
4. Results and discussion

4.1. Highest concentration of SO₂ in one hour

Maharashtra Pollution Control Board Nagpur have recorded 7.0 µg/m³ and 19.0 µg/m³ as minimum and maximum concentration of SO₂ respectively at Government Polytechnic College, Nagpur, the nearest place to Koradi thermal power station and 11 µg/m³ concentration of SO₂ on annual basis.

4.2. Highest concentration of SO₂ in 24 hours

Twenty four hourly highest concentration of SO₂ in a month has been shown in Table 2. The 24 hourly concentration of SO₂ is higher (13.5 µg/m³) in October (Post monsoon season) followed by 12.9 µg/m³ in May (Pre monsoon season). The 24 hourly concentration of SO₂ is lower (7.5 µg/m³) in July (monsoon season) and December (winter season).



Figs. 1(a-c). Seasonal spatial variation of SO₂ concentration around Power plant (a) Pre monsoon (b) Post monsoon (c) Winter

According to CPCB (2012) report, the time weighted average of SO₂ concentration in ambient air in industrial area on annual basis is 80 µg/m³. However, observed maximum 24 hourly SO₂ concentrations near Koradi Thermal power Station is 21 µg/m³ in November (Table 3). The model has also predicted maximum (13.5 µg/m³) 24 hourly concentration of SO₂ in October at 3000 m. east-southeast from source. Thus, 24 hourly concentration of SO₂ does not exceed the National Ambient Air Quality Standard (*i.e.*, 80 µg/m³) of CPCB

for industrial area and remained within the prescribed standard limit throughout the year.

4.3. Seasonal maximum concentration of SO₂ in 24 hour

Predicted maximum 24 hourly and observed concentration of SO₂ by the Maharashtra Pollution Control Board recorded near plant has been shown in Table 3. The model has predicted maximum 24 hourly concentrations of 12.95 µg/m³ at 3500 m in southeast direction during pre-monsoon and 13.50 µg/m³ at 5000 m. in southwest direction during post monsoon season, which are comparable with observed concentration of 12.95 and 13.5 µg/m³ respectively. Model has underestimated maximum 24 hourly concentrations of 12.32 µg/m³ at 4500 m in south direction as compared to observed (21 µg/m³) in winter season.

The total concentration (predicted + observed) in pre, post and winter seasons are much below the Air Quality Standards prescribed by CPCB (2012).

Seasonal spatial distribution of maximum 24 hourly concentration of SO₂ has been depicted in Fig. 1(a-c). In pre monsoon season, the concentration of SO₂ less than 10.0 µg/m³ spreads up to 5000 m in all direction [Fig. 1(a)]. Higher concentration (more than 10.0 µg/m³) observed at 4500 m in southeast of source. The concentration less than 8.0 µg/m³ spreads in all direction up to 5000 m with more concentration (more than 8.0 µg/m³) at 4500 m east of the source in post monsoon season [Fig. 1(b)]. Similarly, concentration less than 8.0 µg/m³ spreads in all direction up to 5000 m with higher concentration (more than 8.0 µg/m³) at 4500 m southwest of source [Fig. 1(c)].

Thus, seasonal spatial variation of 24 hourly concentration of SO₂ remained within the prescribed limit of National Ambient Air Quality Standard (*i.e.*, 80 µg/m³) of CPCB (2012). This study suggests that the location of plant has an ideal location where dispersal capacity of the atmosphere is very strong. Highest dispersal capacity of the atmosphere plays an important role in ventilating the gaseous pollutant quickly from the atmosphere. Therefore, plant is not impacting the Air Quality.

5. Conclusions

Model has predicted less amount of maximum SO₂ concentration in one hour and 24 hour compared to National Air Quality Standard in the vicinity of plant. Model also predicted seasonal SO₂ concentration as compared to actual in pre and post monsoon season and under estimated in winter. Seasonal temporal and spatial

distribution of SO₂ concentration also found below the National Air Quality Standard. Therefore, it is inferred that the plant has an ideal location with high dispersal capacity of the atmosphere.

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