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Ambient Air Pollutant Levels In The Vicinity Of NTTPS Thermal Power Plant

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Abstract: *Coal-fired thermal power plants are responsible for a considerable amount of air pollution in the environment. This paper analyzed the ambient air quality, in the vicinity of Narla Tata Rao Thermal Power Station(NTTPS) located in the Ibrahimpatnam village of Andhra Pradesh by measuring the concentration of SOx, NOx and particulate matter using standard methods. For analysis five sampling sites were selected around the thermal power plant under study covering industrial and residential areas. The results showed that the concentration of the air pollutants both in industrial and residential areas are within the standard values recommended by NAAQ(National Ambient Air quality quality) standards but particulate matter PM10 is in the threshold levels in all the sampling sites. This will lead to adverse effects on long term exposure specially on vegetation and human health.*

Keywords: *Air pollution, thermal power plant, SOx, NOx, PM_{10}, $PM_{2.5}$, NAAQ, sampling sites.*

I. Introduction

Industrialization is an essential feature of economic growth in the developing countries but industrial practices are producing adverse environmental health consequences through the release of air pollutants, water pollutants and the disposal of hazardous wastes into the environment .To ensure power on demand, India has envisioned an additional generating capacity of 250,000 MW by the year 2013 [1]. It is estimated that electricity demand outstrips supply by 8-15%. With India's population of more than a billion that is growing at an annual rate of about 2% the gap between demand and supply of the electricity may rise further. Large difference between electric power generation and consumption are due to transmission and distribution losses. To meet its large and growing power needs, there are many shortcomings [2]. Main emissions from coal-fired thermal power plants are CO_2, NOx, SOx, and air-borne inorganic particles such as fly ash, carbonaceous material (soot), suspended particulate matter (SPM), and other trace gas species. Thermal power plants, using about 70% of total coal in India [3] are among the large point sources having significant contribution (47% each for CO_2 and SO_x) in the total point sources of emissions in India. SO_x emissions from coal combustion mainly depend on the sulphur content in the coal unlike the emissions of CO_2 and NOx which depends on the operating conditions and the design of the plant. Chakraborty et al. (2008) [4] measured SO_x emissions in the range of 7.445-8.763 g/kWh for thermal plants of the 250 MW capacities. CO_2 and SO_x emissions are influenced by the chemical composition (particularly carbon and sulphur content) of coal and the coal usage per unit of electricity.NOx emissions are estimated based on equilibrium reaction calculated at an average gas temperature of 1200 K. Chakraborty et al. measured NOx emissions in the range of 1.81-2.37 g/kWh for plants of the 250 MW capacities. NOx emissions are influenced by the excess air used during combustion and the coal usage.

Due to continuous & long lasting emission of SOx & NOx, which are the principal pollutants of coal based power plants, surrounding structures, buildings, monuments of historic importance & metallic structures are affected very badly. It is pertinent to note that the values of the pollutants reported are even after all the mitigative, modern and state of the art preventive control equipments installed and working in all the Power Stations [5].Manohar et al. in1989 have carried out the study on effects of thermal power plant and found that the emissions from industrial stacks causes environmental and health problems[6]. Significant quantities of the air pollutants may cause impact on CO_2 capture which is an essential feature in coal fired thermal power plants [7]. The multivariate analysis done by Grazia M Marcazzan et.al on elements, gaseous pollutants and mass concentration data-sets lead to the identification of four main sources contributing to PM_{10} and $PM_{2.5}$ composition vehicles exhaust emissions, resuspended crystal dust, secondary sulphates and industrial emissions[8].

From the literature survey of the coal based power plants which are using bituminous coal , it was found that the ambient sulphur dioxide concentration was in the range of 20-25 ug /m^3 in and around

Ramagundam where NTPC (National thermal power corporation) is located . In case of Chandrapur Super thermal power Station the concentration of SO_x varied from 3.61-18.9 ug/m^3 ,NO_x varied from 8.89-26.55 ug/m^3 and SPM from 52.6-193.2 ug/m^3. The concentration of SO_x, NO_x and SPM (suspended particulate matter) varied from 3-37, 5-34, 65-482 ug/m^3 respectively in and around Gandhinagar thermal power Plant (GTPP) .Ambient NO_x concentration in case of natural gas based power plant was found to be in the range of 5-7 ug/m^3 [9] which is lower when compared to coal based thermal power plant.The present study concentrates on the analysis of ambient air quality, in the vicinity of *NTTPS* thermal power plant located in the Ibrahimpatnam village of Andhra Pradesh state in India.

II. Materials And Methods

The pollutants emitted from coal fired thermal power plants depend largely upon the characteristics of the fuel burnt, temperature of the furnace, actual air used, and other additional devices to control the emissions. Combustion of coal releases gases and particles into the air and results in air pollution. Analysis of SOx, NOx and particulate matter $PM_{2.5}$ and PM_{10} are estimated in the ambient air surrounding NTTPS by using standard methods. Negative effects of sulphur oxides (SOx) and nitrogen oxides (NOx) include the formation of acid rain which effect the agricultural and in turn human health [10].

The present study area is located in the Ibrahimpatnam village of Krishna district in Andhra Pradesh. The NTTPS has a generation capacity of 1760 MW with its six units of 6 X 210 MW each and one unit with 500 MW which requires 35000 metric tons of coal for the generation of steam. To control air pollution from the plant electrostatic precipitators with high efficiency have been installed in these units. Inspite of implementing measures to mitigate the impact of air pollution from this plant emission of air pollutants is inevitable. Hence the present study is done to analyze the air pollutant levels in the ambient air in the vicinity of NTTPS. Five sampling sites namely Kondapalli,Ibrahimpatnam,Jupidi,Ferry village and Guntupalli villages were selected covering industrial and residential areas.They are located at different distances in the vicinity of the power plant . Sampling for the air pollutants in these areas was done during the months of April- June 2013.

Ibrahimpatnam village is the area in which NTTPS power plant is situated along with some residential colonies ..Kondapalli village is a heritage place with the famous Kondapalli fort which is situated at 2Km to the NTTPS. These two areas are considered as industrial areas To study the levels of air pollutants in the ambient air of the residential areas surrounding NTTPS ,villages at various distances from the power plant are selected. Jupidi village located at a distance of 3 Km in the east direction to the power plant, Ferry village located at 2 Km south to the power plant and Guntupalli village located at 5Km distance west to the power plant are selected as the residential areas for the analysis.

2.1 Estimation of SOx levels in the Ambient air

From the selected sampling sites in the vicinity of the power plant SOx gases are absorbed from the ambient air into the absorbing solution sodium or potassium tetra chloro mercurate taken into the Impingers shown in the Fig-1. A stable di-chloro sulphite mercurate complex is formed which is then treated with bleached pararosaniline solution and HCl to form intensely colored (red purple) rosaniline methanol sulphonic acid.The concentration of the color is then determined spectrophotometrically.

Fig-1: Showing Impingers during sampling.

2.2 Estimation of NOx levels in the ambient air

Oxides of Nitrogen gases are collected by bubbling ambient air through a sodium hydroxide–sodium arsenate solution to form a stable solution of sodium nitrite. The nitrite ion produced during sampling is determined colorimetrically.The absorbing reagent is mixed with phosphoric acid and sulphanilamide (Diazotizing reagent) and N-1 (Napthyl) – ethylenediamine dihydrochloride (NEEDA) (Coupling reagent) an azo- dye is formed.The intensity of the dye colour is estimated colorimetrically.

2.3 Estimation of particulate matter PM_{10} and $PM_{2.5}$

Ambient air is drawn through a size-selective inlet of the fine dust sampler equipment shown in the Fig-2. This consists of 20.3 X 25.4 cm (8 X 10in) filter with a flow rate of 0.2 to 11/min. Usually glass fibre filter for PM_{10} and PTFE filter paper for $PM_{2.5}$ are used. Particles with aerodynamic diameter less than the cut-point of the inlet are only collected by these filters. The mass of the collected particles is determined by the difference in the filter paper weights prior to and after sampling as shown in Fig-3.The concentrations of the particles in the designated size range are calculated by dividing the weight gain of the filter by the volume of air sampled. The system is designed to operate at an air flow of 1 m^3/hr and the sampling period is set to 24hrs.

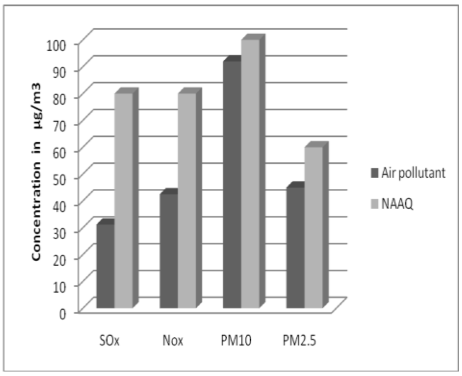
Fig -2: Fine dust sampler **Fig- 3 : Filter papers before and after sampling**

III. Results And Discussion

The results of the analysis conducted are summarized in Table:1 and the values are correlated Fig:4,Fig:5,Fig:6,Fig:7and Fig:8 as shown below,

Table:1 Concentrations of SOx ,NOx ,PM_{10} and PM $_{2.5}$ in μg/m^3 **in the selected sampling sites**

Name of the sampling site	**SO_x**	**NOx**	**PM_{10}**	**$PM_{2.5}$**
Ibrahimpatnam	31.2	42.5	92	45
Kondapalli	18	32	88	42
Jupidi	18	21	62	38
Ferry village	17	22	81	40
Guntupalli	21	33	89	46
NAAQ standard value	**80**	**80**	**100**	**60**



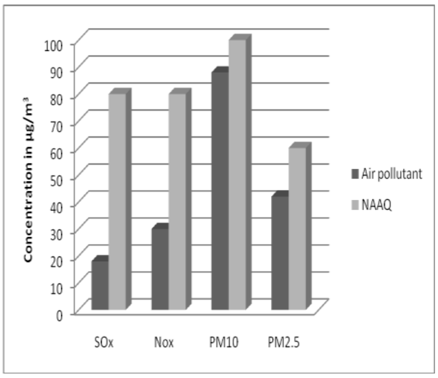


Fig -4 :Air pollutant levels at Ibrahimpatnam **Fig-5:Air pollutant levels at Kondapalli**

The concentration of air pollutants in the industrial areas ,Ibrahimpatnam and Kondapalli are shown in Fig-4 and Fig-5 respectively. From the above data it it is found that all the air pollutants (SOx,NOx,PM_{10} and $PM_{2.5)}$ are more concentrated in the Ibrahimpatnam area than in the Kondapalli village . SOx and NOx levels are far below the NAAQ standards while PM_{10} and PM $_{2.5}$ levels are almost near to the NAAQ standards indicating that particulate matter pollution is high.Further it is found that PM_{10} levels are very high in contrast to $PM_{2.5}$.

As NTTPS is located in the Ibrahimpatnam village all these air pollutants are found to be more concentrated in that area than in Kondapalli village. Presence of these air pollutants in the ambient air of Ibrahimpatnam area will interfere the recovery processes of flugases at the power house of the power plant.Kondapalli is located in south direction to power plant surrounded by hills so the polluted air from the power plant is confined more in that area. The bituminous coal used for the combustion contains more amount of trace elements like Zn, Cd, Pb and Mn .Particulate matter PM_{10} in particular is emitted more than $PM_{2.5,}$SOx, NOx gases.The trace element content present in the agricultural soil was low compared to the airborne particulate matter that was highly enriched with Zn, Cd, Pb and Mn.

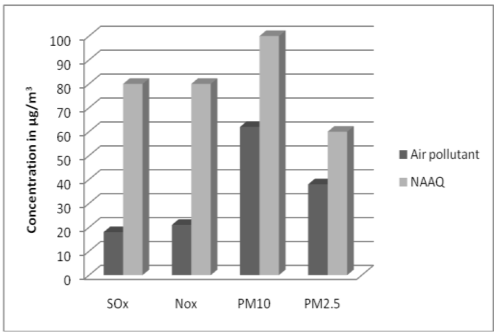


Fig 6: Air pollutant levels at Jupidi

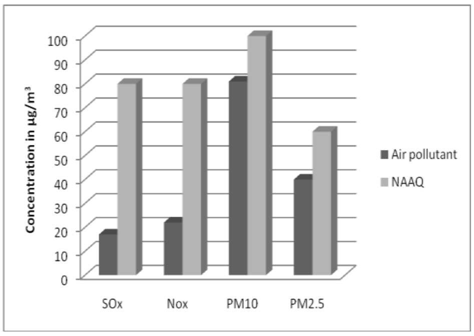


Fig 7: Air pollutant levels at Ferri village

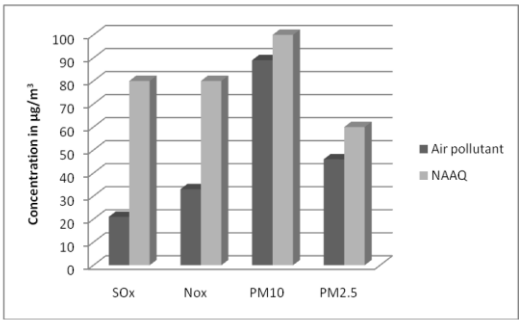


Fig 8: Air pollutant levels at Guntupalli village.

From the above data in Fig -6 ,Fig-7 and Fig-8 collected from the residential areas, it is found that concentration levels of SOx and NOx are very low compared to NAAQ standards. It is observed that particulate matter in the ambient air is more than SOx and NOx levels.Particulate matter particularly PM_{10} levels are in the threshold levels in Ferri and Guntupalli villages compared to Jupidi village . Jupidi is located in east direction ,Ferri village is located in south while Guntupalli is located in west direction to the power plant.The wind direction for this power plant is mostly in the south and west directions hence emissions are more concentared in these areas.

Presence of these air pollutants in the ambient air effects the capturing process of CO_2 gas from the flue gases [11]. Particulate matter deposited directly in the soil can influence nutrient cycles, especially that of nitrogen [12]. From the multivariate statistical analysis conducted by D.Vousta indicated that the composition of the air pollutant levels in vegetables, the soil and the atmospheric particulates were largely different from one another [13]. As found by Farmer there exists a direct relationship between the concentration of particulate matter in the air and amount of dust deposited on the leaf surfaces [14].

IV. Conclusion

From the above analysis it is found that except Jupidi village site which is situated east to the power plant, all the other four sites are exposed to more particulate matter because of which people residing in these areas are found to be suffering from respiratory problems.The SO_x, NO_x ,PM_{10} and $PM_{2.5}$ concentrations were quite high in the industrial areas like Kondapalli and Ibrahimpatnam villages which are located in the immediate vicinity of the power plant compared to the residential areas like Jupidi,Ferri and Guntupalli villages. SOx,NOx gases are rapidly converted to acidic species H_2SO_4, HNO_3 which will lead to acid rains and effect the agricultural crops.Suspended particulate matter in air results in respiratory problems like asthma,lung and throat infections among the people residing in the industrial areas mostly. This study concludes that inspite of taking stringent measures like, usage of 98% efficient electrostatic precipitator, modern equipment to determine the day wise emission levels of air pollutants, particulate matter emissions are still in the threshold levels. Hence continuous monitoring and upgraded mitigation measures are to be implemented to reduce air pollutant levels in the vicinity of the power plant.

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