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Ambient Air Quality Monitoring and Possible Health Effects Due to Air Pollution in Hosur Town, Tamilnadu, India

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Abstract:

The study is to focus on ambient quality of air in Hosur, Tamil Nadu, India and its health effect on people. Hosur is a municipal town in Krishnagiri district in the Indian state of Tamil Nadu. The model which was considered to be the concentration of chemicals in the air of the work environment and possible negative health effects to people. The microclimate is under control except during very hot climate in summer. The chemicals are under control in coir producing, automobile and food industries. The chemicals are often over the limit in brick, alloy casting, granite industries and in some of the premises of pharmaceutical industries. According to work results, PM_{10} concentration varies from 45–127 μg/m^3 where $PM_{2.5}$ concentration varies from 24-78 μg/m^3 and these are the highly polluting particles in work environment.

Keywords: Hosur- Industrial hub, ambient air quality, Health disturbances, Air pollutants.

1.0 Introduction:

Hosur is a municipal town in Krishnagiri district in the Indian state of Tamil Nadu (Figure a). It is located about 40 kilometres (25 miles) south east of Bangalore, 48 kilometres (30 miles) north-west of Krishnagiri and 306 kilometres (190 miles) west of Chennai, the state capital. Hosur is known for its manufacturing industries and its pleasant climate. The work mainly concerned for the public health issues. Here, we put our effort to control the air pollution, even though can't succeed 100%. We preferred since it is the hub for many industries & factories. Moreover, automobiles and municipal wastages are also the major cause of the air pollution at Hosur. This made us to take survey on finding the root cause and case study which identify the main reasons that cause pollution in the surroundings of Hosur (Tamil Nadu Urban Infrastructure Financial Services Limited, Final report, December 2008).

1.1 Survey on industries at Hosur:

The State industrial Promotion Corporation of Tamil Nadu (SIPCOT) has developed one of the largest industrial complexes in the country in Hosur, over an area of 1370 acres and to develop Large/Medium/Small industries with SIDCO offering omprehensive services for more than 500 industries.

Industries of various kinds such as electrical, electronic, automobile, chemical, iron and steel are flourishing because of the favorable conditions and infrastructure availability. Information technology has a great scup for investment because of the proximity of Bangalore. Several reputed industrialist have started their units in Hosur. Hosur has been able to attract some of the most prestigious industrial houses in the country including the Tata's, the Birla's, the Hinduja's, TVS group companies, Murugappa group of companies, Lakshmi group and also a number of Multinational Corporations. Hosur Industrial area consists of about 700 industries comprising of large, medium, small and tiny industries. The location of these industries is at SIPCOT phase I & II, SIDCO industrial estates, SIDCO electronic industrial estate and the outside industries are scattered in private lands within 20 kilometers radius of Hosur towards Krishnagiri, Royakottai and Thalli Roads and few major industries in Harita, Bagalur, Belagondapalli, Thorapalli and other areas.

The units located at Hosur manufacture sophisticated products ranging from Trucks, Automobiles, Automobile parts, Motor Cycles, Diesel engines, Power shift Transmission, Castings, Forgings, Cigarettes, Watches, Jewellery, Abrasives, Machineries, Aircrafts, Pharmaceuticals, Biotechnology, Textiles, Chemicals, Electronic, Electrical and General Engineering. The main objective of this work is to determine the health risks due to air pollution in Hosur and to create awareness among the people of this town.

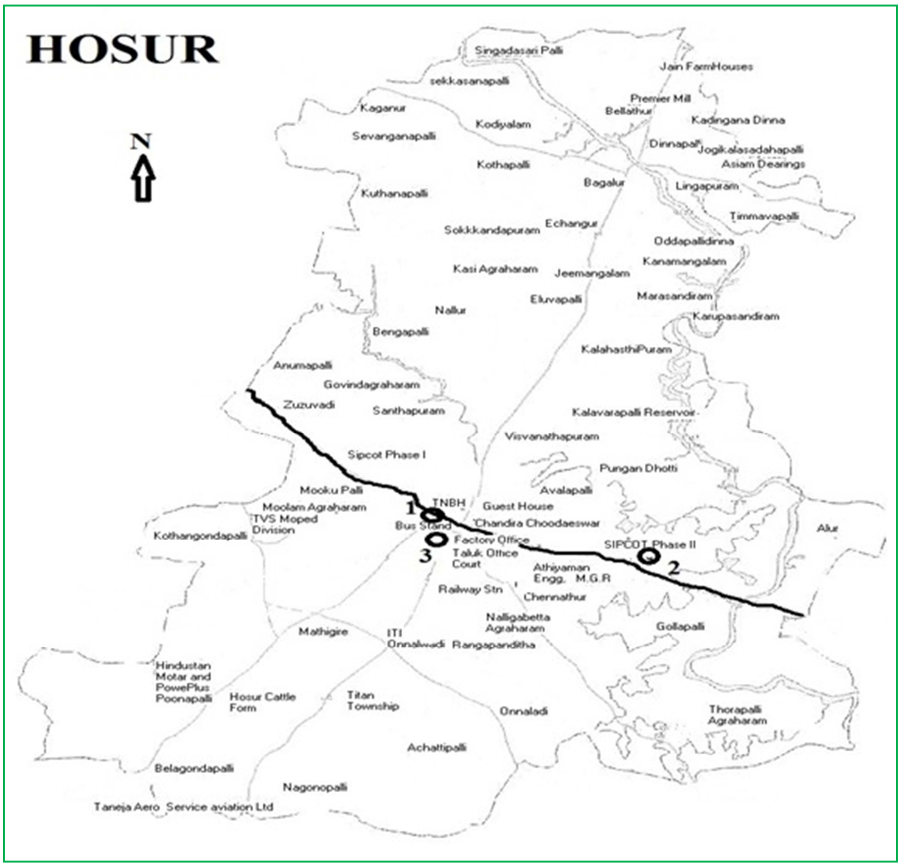

Figure a: Site map of Hosur town

2.0 Materials and Methods:

Guidelines for Sampling and Measurement of notified Ambient Air Quality Parameters (NAAQS 2009):

Under the provisions of the Air (Prevention & Control of Pollution) Act, 1981, the CPCB has notified fourth version of National Ambient Air Quality Standards (NAAQS) in 2009 (Figure b). This revised national standard aims to provide uniform air quality for all, irrespective of land use pattern, across the country. There are 12 identified health based parameters, which are to measure at the national level and with a view to have data comparison, need for uniform guidelines for monitoring, sampling, analyses, sample flow chart, data sheet based on standard method has been felt.

The methods prescribed in the notification for respective parameters are the combination of physical method, wet-chemical method and continuous on-line method. Therefore, to meet the NAAQS requirement, a combination of both manual and continuous method is invariably required at each monitoring location, besides good laboratory set up and infrastructure. In addition to the above, an in-house exercise for applicability of all prescribed / recommended analytical methods was also felt necessary. After review and demonstration in the Central Laboratory, Delhi, guidelines are being prepared and documented, as under:

1. Volume I: Guidelines for manual sampling and analyses (along with sample flow chart and data sheets).

2. Volume II: Guidelines for continuous sampling and real time analyses.

NATIONAL AMBIENT AIR QUALITY STANDARDS (2009)

Pollutants	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogen Dioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob & Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide(CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed by HPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

Figure b: National Ambient Air Quality Standards

In this work, we used Volume –I: Guidelines for manual sampling and analyses of NAAQS 2009 to analyze ambient air quality in Hosur (Central Pollution Control Board, May 2011).

3.0 Results:

The statistical distribution parameters for PM_{10} and $PM_{2.5}$ and trace metals (Pb, As and Ni) in Tables (1, 2 and 3). The PM_{10} concentration varies from 45–127 µg/m^3 where $PM_{2.5}$ concentration varies from 24-78 µg/m^3. PM_{10} concentration was higher at three locations nearby Hosur Bus stand, nearby SIPCOT II and nearby Gandhi statue (Hosur). These locations cover the major part of the Hosur where the busy roads meet, people run from pillar to post and bus terminals though they are receiving higher emissions. These values are higher than the 24 hours PM_{10} (100 µg/m3) and around higher than the 24 hours PM_{10} (60 µg/m3) National Ambient Air Quality Standard (NAAQS, 2009) prescribed by the Central Pollution Control Board (CPCB) of India. Apart from industries, the diesel vehicle exhaust is also responsible for emitting particulate matter (PM_{10}) in large amounts. The test results for air quality monitoring in 3 different places in Hosur is given below (Table 1, 2 and 3).

3.1 Test conditions:

Test was carried out on 24 hours of 6th September 2011. Ambient Temperature during test was 22.7 ^{o}C (Minimum) and 29.0 ^{o}C (Maximum). Relative Humidity was 58.3% (Minimum) and 91.6% (Maximum). Wind Speed was at 2.21 m/sec and sky was observed to be clear and nil rainfall.

Table 1: Location of Sampling - Nearby Hosur Bus Stand

S. No.	PARAMETERS	Unit	Test Results	NAAQ Norms
1.	Sulphur Dioxide as SO_2	$\mu g/m^3$	9.8	80.0
2.	Nitrogen Dioxide as NO_2	$\mu g/m^3$	28.7	80.0
3.	Particulate Matter as PM_{10}	$\mu g/m^3$	127.0	100.0
4.	Particulate Matter as $PM_{2.5}$	$\mu g/m^3$	78.0	60.0
5.	Ozone as O_3	$\mu g/m^3$	16.0	180.0
6.	Lead as Pb	$\mu g/m^3$	0.24	1.0
7.	Carbon Monoxide as CO	$\mu g/m^3$	0.486	2.0
8.	Ammonia as NH_3	$\mu g/m^3$	3.5	400.0
9.	Benzene as C_6H_6	$\mu g/m^3$	0.26	5.0
10.	Benzo(a)Pyrene	$\mu g/m^3$	0.23	1.0
11.	Arsenic as As	$\mu g/m^3$	1.0*	6.0
12.	Nickel as Ni	$\mu g/m^3$	1.8	20.0

Note: *Indicate less than detectable limit

3.2 Test conditions:

Test was carried out on 24 hours of 6th September 2011. Ambient Temperature during test was 22.7 ^{o}C (Minimum) and 29.0 ^{o}C (Maximum). Relative Humidity was 58.3% (Minimum) and 91.6% (Maximum). Wind Speed was at 2.21 m/sec and sky was observed to be clear and nil rainfall.

Table 2: Location of Sampling - Nearby SIPCOT II

S. No.	PARAMETERS	Unit	Test Results	NAAQ Norms
1.	Sulphur Dioxide as SO_2	$\mu g/m^3$	6.67	80.0
2.	Nitrogen Dioxide as NO_2	$\mu g/m^3$	19.8	80.0
3.	Particulate Matter as PM_{10}	$\mu g/m^3$	45.0	100.0
4.	Particulate Matter as $PM_{2.5}$	$\mu g/m^3$	24.0	60.0
5.	Ozone as O_3	$\mu g/m^3$	10.0*	180.0
6.	Lead as Pb	$\mu g/m^3$	0.05*	1.0
7.	Carbon Monoxide as CO	$\mu g/m^3$	0.356	2.0
8.	Ammonia as NH_3	$\mu g/m^3$	2.0	400.0
9.	Benzene as C_6H_6	$\mu g/m^3$	0.14	5.0
10.	Benzo(a)Pyrene	$\mu g/m^3$	0.02*	1.0
11.	Arsenic as As	$\mu g/m^3$	1.0*	6.0
12.	Nickel as Ni	$\mu g/m^3$	1.0*	20.0

Note: *Indicate less than detectable limit

Table 3: Location of Sampling - Nearby Gandhi Road

S. No.	PARAMETERS	Unit	Test Results	NAAQ Norms
1.	Sulphur Dioxide as SO_2	$\mu g/m^3$	8.21	80.0
2.	Nitrogen Dioxide as NO_2	$\mu g/m^3$	25.3	80.0
3.	Particulate Matter as PM_{10}	$\mu g/m^3$	86.0	100.0
4.	Particulate Matter as $PM_{2.5}$	$\mu g/m^3$	50.0	60.0
5.	Ozone as O_3	$\mu g/m^3$	12.0	180.0
6.	Lead as Pb	$\mu g/m^3$	0.13	1.0
7.	Carbon Monoxide as CO	$\mu g/m^3$	0.361	2.0
8.	Ammonia as NH_3	$\mu g/m^3$	2.3	400.0
9.	Benzene as C_6H_6	$\mu g/m^3$	0.20	5.0
10.	Benzo(a)Pyrene	$\mu g/m^3$	0.06	1.0
11.	Arsenic as As	$\mu g/m^3$	1.0*	6.0
12.	Nickel as Ni	$\mu g/m^3$	1.2*	20.0

Note: *Indicate less than detectable limit

3.3 Test conditions:

Test was carried out on 24 hours of 6th September 2011. Ambient Temperature during test was 22.7 ^oC (Minimum) and 29.0 ^oC (Maximum). Relative humidity was 58.3% (Minimum) and 91.6% (Maximum). Wind Speed was at 2.21 m/sec and sky was observed to be clear and nil rainfall.

3.4 Various Air Pollutants and their Health Effects

3.4.1 Carbon monoxide

The binding of carbon monoxide (CO) with haemoglobin to form carboxyhaemoglobin (COHb) reduces the capacity of blood to carry oxygen, and the binding with other haemoglobin proteins is directly related to changes in the functions of affected organs, such as the brain, cardiovascular system, exercising skeletal muscle and the developing fetus. At very high concentrations, well above normal ambient levels, CO causes death. A COHb level of 2.5% should not be exceeded to protect middle-aged and elderly people with documented or latent coronary artery disease from acute ischaemic heart attacks and to protect the fetuses of pregnant women from untoward hypoxic effects.

3.4.2 Ozone

Ozone (O_3) is a secondary photochemical pollutant formed from the precursor's volatile organic compounds, NOx and CO in the presence of short wavelength solar radiation. Acute exposure to high ozone levels can induce changes in lung function, airway inflammation and increased airway responsiveness to bronchoconstrictors. Ozone can enter the body through inhalation and can reach the respiratory system because it is not very soluble in water.

3.4.3 Sulfur dioxide

A range of chronic and acute health impacts may result from human exposure to sulfur dioxide (SO_2) or related species. Particulate aerosol formed by the gas-to-particle formation has been found to be associated with numerous health effects, as mentioned in the section on PM_{10}. In a gaseous form, SO_2 can irritate the respiratory system; in case of short-term high exposure, a reversible effect on lung functioning may occur, according to individual sensitivity. The secondary product H_2SO_4 primarily influences respiratory functioning. Its compound, polynuclear ammonium salts or organo-sulfates, act mechanically in alveoli and, as easily soluble chemicals, they pass across the mucous membranes of the respiratory tract into the organism (Hangartner *et al.,* 1989).

3.4.4 Nitrogen dioxide

Nitrogen dioxide (NO_2) is an air pollutant produced in combustion processes. Whenever nitrogen dioxide is present, nitric oxide (NO) is also found; the sum of NO and NO_2 is collectively referred to as nitrogen oxides (NO_x). Only the health effects of NO_2 are considered here. At very high concentrations, which may only be encountered in serious industrial accidents, NO_2 exposure can result in rapid and severe lung damage. NO_2 primarily acts as an oxidizing agent that may damage cell membranes and proteins (Atkins *et al.,* 1986). To protect the general public at large from such chronic effects, therefore, an annual average guideline value of 40 $\mu g/m^3$ has been set (WHO, 1995).

3.4.5 Particulate Matter (PM_{10} and $PM_{2.5}$)

Airborne particulate matter represents a complex mixture of organic and inorganic substances. Because of the complexity of particulate matter and the importance of particle size in determining exposure and human dose, multiple terms are used to describe particulate matter. (ISO 7708: 1995; EN 481, 1991; EN 12341, 1995).

Most of the quantitative information available on the health effects of particulate matter comes from studies in which particles in air have been measured as PM_{10}. The large body of information on studies relating day-to-day variation in particulate matter concentrations to day-to-day variation in health provides quantitative estimates of the effects of particulate matter that are generally consistent.

3.4.6 Benzene

Benzene has low acute toxicity, but repeated exposure to very high concentrations can cause severe effects on the blood and blood-forming organs in humans. Benzene is known to be a human carcinogen. The most convincing relationship is found between benzene exposure and the development of acute non-lymphocytic leukaemia (Mowrer *et al.,* 1996).

3.4.7 Polycyclic Aromatic Hydrocarbons

Polycyclic (or polynuclear) aromatic hydrocarbons (PAH) are complex mixtures of hundreds of chemicals, including derivatives of PAH, such as PAH with a NO2 group (nitro-PAH) and oxygenated products, and also heterocyclic aromatic compounds (Lindstedt *et al.,* 1982).

The biological properties of most PAH are still unknown. Nevertheless, the available data, mostly from animal studies, indicate that several PAH may induce a number of adverse effects, such as immunotoxicity, genotoxicity, carcinogenicity and reproductive toxicity (affecting both male and female offspring). PAH may also influence the development of atherosclerosis.

3.4.8 Lead

Lead (Pb) toxicity can be explained by interactions with different enzymes, and that is why almost all organs can be considered as target organs for lead. A wide range of biological effects has been evidenced experimentally, including effects on haem biosynthesis, the nervous system, the kidneys, the reproductive organs, the cardiovascular system, the immune system, the liver, the endocrine system and the gastrointestinal tract (Cikrt *et al.,* 1997).

3.4.9 Atmospheric Cadmium

Cadmium (Cd), whether absorbed by inhalation or via contaminated food, may alter kidney functioning in various ways. There is also sufficient evidence that cadmium can produce lung cancer in humans and animals exposed by inhalation, and the International Agency for Research on Cancer has classified cadmium as a class-1 human carcinogen (Pekar *et al.,* 1997).

4.0 Conclusion:

This study concluded with results that ambient air in Hosur is polluted. The major pollutants are Particulate matter (PM_{10} and $PM_{2.5}$). Health effects caused by various air pollutants were informed to create awareness among people in Hosur. The study area covers a substantial portion of Hosur town. The characterization of trace metal sources in the study area is quite challenging due to a large number of industrial and urban sources. Trace metals (As, Pb and Ni), PM_{10} and $PM_{2.5}$ were characterized at three locations of Hosur Town, Tamilnadu, India to identify and quantify their major sources. The findings of this study may provide a comprehensive database for framing an appropriate strategy for necessary mitigative/preventive measures.

5.0 Acknowledgments:

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