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Studies on noise and air quality monitoring at Shirdi(Maharashtra), India

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ABSTRACT

This study analyzed the spatial characteristics of urban environmental noise and air produced at 05 and 01 noise and air monitoring stations respectively in Shirdi, Ta-Rahata. Dist-Ahmadnagar, Maharahtra, India. Noise and air data were collected at varying intervals: morning, afternoon, and evening in both summer and winter. Urban population is exposed to high level of noise and air pollutants due to motor vehicle pollution. It is world wide phenomena and problem is more acute especially in developing countries because of fast growth rate, slow adaptability of upgrade technology and other socio economical factors. The potential health effects of noise pollution are numerous, pervasive, persistent, and medically and socially insignificant. Noise produces direct and cumulative adverse effects that impair health and that degrade residential, social, working, and learning environments with corresponding real (economic) and intangible (well-being) losses.There are several reports regarding the vehicular emission is responsible for higher level of air pollutants like SPM, SO_2, NOx and other organic and inorganic pollutants including trace metals and their adverse effects on human and environmental health.

Key Words- Noise, Air quality monitoring, Environment, Shirdi.

INTRODUCTION

In recent years there has been great interest in environment and many new words have been a part of our vocabulary words such as ecology, environment, acid rain, ozone layer depletion, photo chemicals, smog, global warming, and green house effect. Simultaneously we have been made aware of environmental problems which include effects of air pollutants on human beings, plants and animals. Air pollution causes increased respiratory illness to the old and young, decreasing visibility, damage to plants and animals and has possibly catastrophic effects on the global scale. Problems due to air pollution crop up especially in urban areas and areas of high industrial activities which includes the rural areas were industrial development is encouraged. Another major cause of air pollution is the automobiles or vehicle pollution. [1, 7, 15]

MATERIALS AND METHODS

Part: I- Noise Measurement

The discrimination and differentiation between sound and noise also depends upon the habit and interest of the person/species receiving it, the ambient conditions and impact of sounds of frequencies less than 20 H_Z are called infrasonics and greater than 20,0000 H_Z are called ultrasonics. Environmental pollution and its consequent influence over the life quality of human beings may be considered as a "hot topic" in scientific research. [18,20,24]. I have selected Shirdi, Ta-Rahata, Dist-Ahmadnagar, Maharashtra,India, as my monitoring station which is very famous for Sai Baba Temple. The popularity of this temple is increasing day by day. The trust has also opened various other facilities for the devotees as well as the common people which stay in the nearby region. The popularity is increase in such an extent that devotees for other states as well as from other countries use to visit the temple. The Sai Baba Sansthan trust has developed following things.1) Sai Baba English medium School.2) Sai Baba Kannya Vidyalaya Mandir. 3) Sai Baba Junior College.4) Sai Baba ITI College. 5) The Shirdi Sai Baba Sansthan hospital.

A. Location of Shirdi

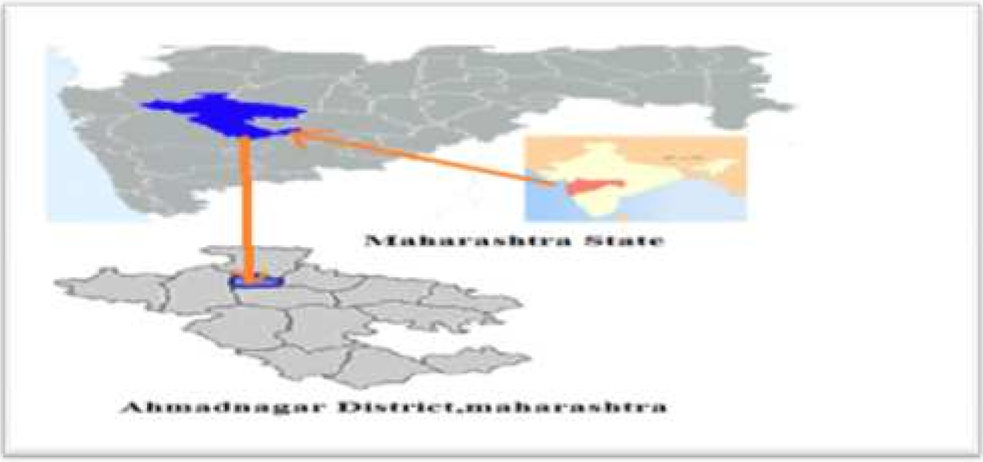

Fig.1. Location map of study area Shirdi, Ahmadnagar, Maharashtra

Shirdi is a town and falls under the jurisdiction of municipal council located in Rahata Tahasil in Ahmednagar District in the Indian state of Maharashtra. It is located at 19°46′N 74°29′E/ 19.77°N 74.48°E. Shirdi is accessible via the Ahmednagar - Manmad State Highway No.10, approximately 83 km from Ahmednagar and 15 km from Kopargaon. It is located 185 km East of the Western Seashore line. Shirdi is best known as the late 19th century home of the popular Guru Sai Baba. It has an average elevation of 504 meters (1653 feet). As of the 2001 India census, the population of Shirdi stood at 26,169. Males constitute 53% of the population and females 47%. Shirdi has an average literacy rate of 70%, higher than the national average of 59.5%, male literacy is 76%, and female literacy is 62%. In Shirdi, 15% of the population is under 6 years of age.

B. Measurement of Noise

The first step of the study was to select the main streets and crowed roads in the Shirdi city. In order to determine the measurement points, primary and secondary streets of the city are surveyed before the study. Thus, noise pollution is determined in three main streets and vehicle numbers were counted on the pre-determined roads and streets and by this way, primary and secondary streets where noise problem was thought to take place were determined. [10, 19]

Street bearing the heaviest traffic load was the State Highway No.10 Street. On this street, 2,246 vehicles on the average passed in an hour. Among the various vehicles passing on the street in an hour, 1,522 were automobiles, followed by minibus and bus 528 with highest value. From this, by determining the reasons for noise in the area where it was high, measures to be taken against noise were proposed. Overall noise chart is prepared on the basis of the measurements conducted in the city.

C. Noise parameters

i) L Equivalent, Leq: Noise level generated by transport facility show good amount of variability to respect to time. It is, therefore, necessary to establish meaningful statistical noise measures that describe the magnitude of the problem while capturing the variability.

$$L_{eq} = C + K \log Nx \qquad (1)$$

ii) Noise pollution Level, Lnp

$$Lnp = L_{50} + \frac{(L_{10} - L_{90})^2}{60} + (L_{10} - L_{90}) \qquad (2)$$

Where L_{10}, L_{50} and L_{90} indicate the level exceeded for 10%, 50% and 90% of time respectively in a set of record of noise level in a given interval of time. Lnp is expressed in the units of dB (A).

iii) Traffic Noise Index, TNI:

$$TNI = 4 (L_{10} - L_{90}) + L_{90} - 30 \text{ dB (A)} \qquad (3)$$

iv) Noise climate, NC:

$$NC \text{ in dB (A)} = (L_{10} - L_{90}) \qquad (4)$$

D. Study design

Noise levels have been measured at five locations in Shirdi City. During 7:00 A.M to 11:00 PM on working days .The study incorporates most of the major locations around the temple, which includes Sai Baba Prasadalaya,(01-PRA), Sai Baba Sansthan gate 01(02-GATE1), Sai Baba Sansthan gate02(03-GAT2), Sai Baba Temple Corner (04-TCO), & Near ST Stand (05-STS). Noise levels have been measured at the roadside as well as at distances away from roadside.

Table 1. Noise Monitoring Stations at Shirdi

Sr. No.	Location Code	Direction	Distance (m)	Sampling distance from centre of road (m)
1.	01-PRA	W	60	40
2.	02-GAT1	NW	35	3.5
3.	03-GAT2	SW	25	3.5
4.	04-TCO	E	15	20.5
5.	05-STS	SE	30	7

E. Noise level at Different Locations

LOCATION 01:- Sai Baba prasadalaya**,** 01-PRA:

Table 2. Avg. Noise Level Recorded at Location 01-PRA

Time	Distance from Road side (m)			
Interval	0 m	15 m	30 m	45 m
7 am-11am	72.5 dB	70.4 dB	69.3 dB	67.9 dB
11am-3pm	72.0 dB	70.4 dB	68.9 dB	67.1 dB
3pm-7pm	73.3 dB	71.8 dB	69.6 dB	68.4 dB
7pm-11pm	72.6 dB	71.2 dB	70.5 dB	69.6 dB

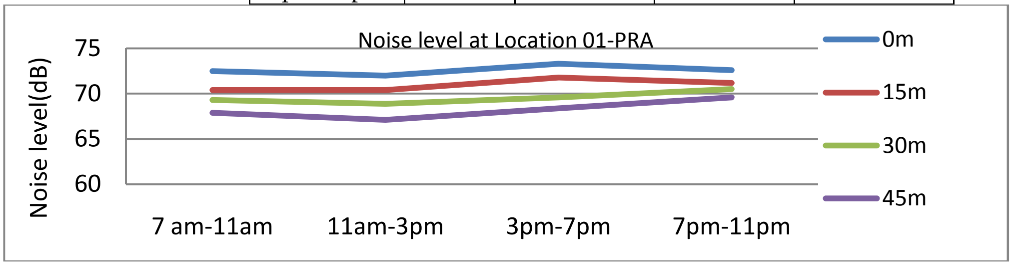

Fig.2. Variations in Noise Level with Distance at 01-PRA

LOCATION 02:- Sai Baba Sansthan Gate 01, 02-Gat1:

Table 3. Avg. Noise Level Recorded At Location 02-GAT1

Time	Distance from Road side (m)			
Interval	0 m	15 m	30 m	45 m
7 am-11am	73.5 dB	72.0 dB	67.5 dB	69.8 dB
11am-3pm	71.2 dB	71.1 dB	69.4 dB	66.9 dB
3pm-7pm	72.7 dB	72.4 dB	68.2 dB	67.2 dB
7pm-11pm	73.2 dB	72.0 dB	70.0 dB	69.0 dB

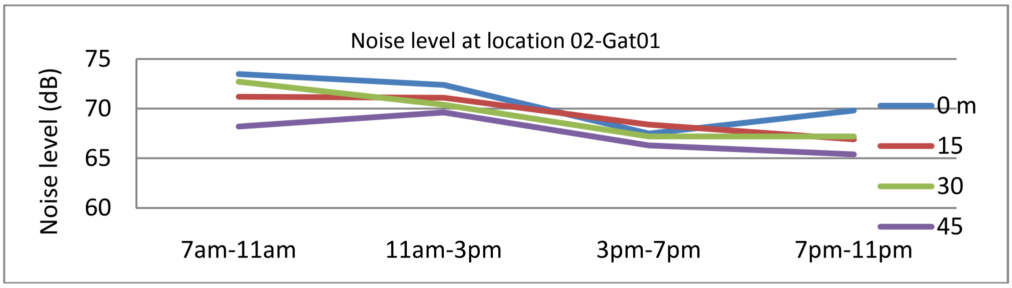

Fig 3. Variations in Noise Level with Distance at 02-GAT1

LOCATION 03:- Sai Baba Sansthan gate 02, 03-GAT2:

Table 4. Avg. Noise Level Recorded at Location 03-GAT2

Time	Distance from Road side (m)			
Interval	0 m	15 m	30 m	45 m
7 am-11am	72.2	72.3	68.8	69.9
11am-3pm	72.5	70.5	67.2	68.5
3pm-7pm	71.8	71.7	66.9	66.4
7pm-11pm	67.8	67.3	65.5	64.4

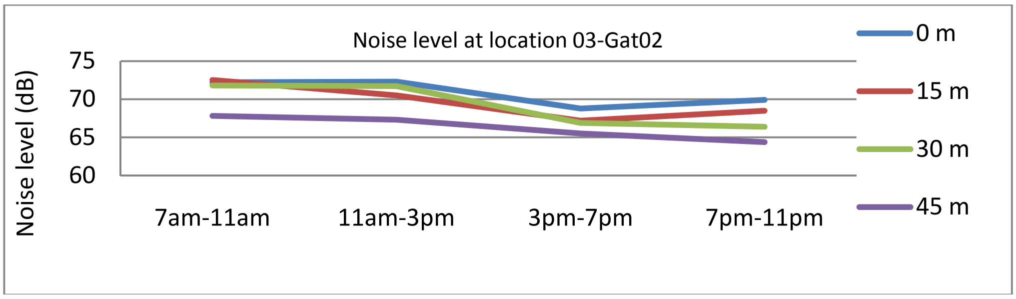

Fig. 4.Variations in Noise Level with Distance at 03-GAT2

LOCATION 04:- Sai Baba Mandir Corner, 04-TCO:

Table 5. Avg. Noise Level Recorded at Location 04-TCO

Time	Distance from Road side (m)			
Interval	0 m	15 m	30 m	45 m
7 am-11am	73.6	71.7	69.4	69.9
11am-3pm	72	69.6	65.6	65.1
3pm-7pm	70.7	68.9	67.5	66.4
7pm-11pm	64.9	69.0	65.1	64.9

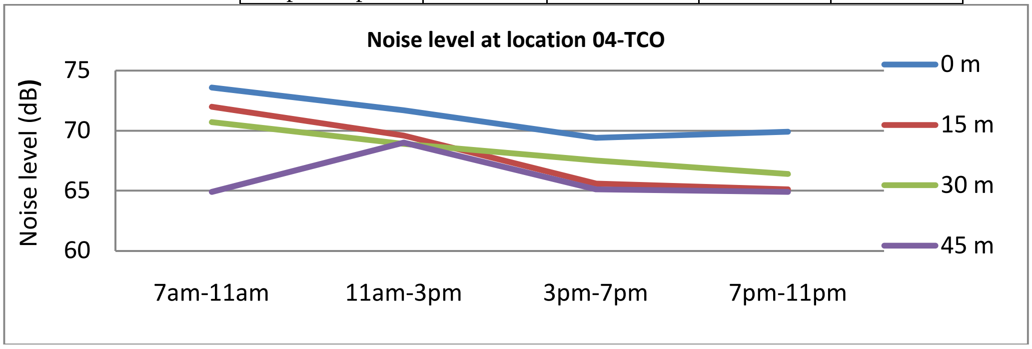

Fig. 5. Variations in Noise Level with Distance at 04-TCO

LOCATION 05:- Near ST Stand, 05-STS:

Table. 6. Avg. Noise Level Recorded at Location 05-STS

Time	Distance from Road side (m)			
Interval	0 m	15 m	30 m	45 m
7 am-11am	74.9	72.1	69.8	65.4
11am-3pm	70	69.0	62.3	64.0
3pm-7pm	71.5	69.9	64.5	64.4
7pm-11pm	67.0	68.0	65.3	66.9

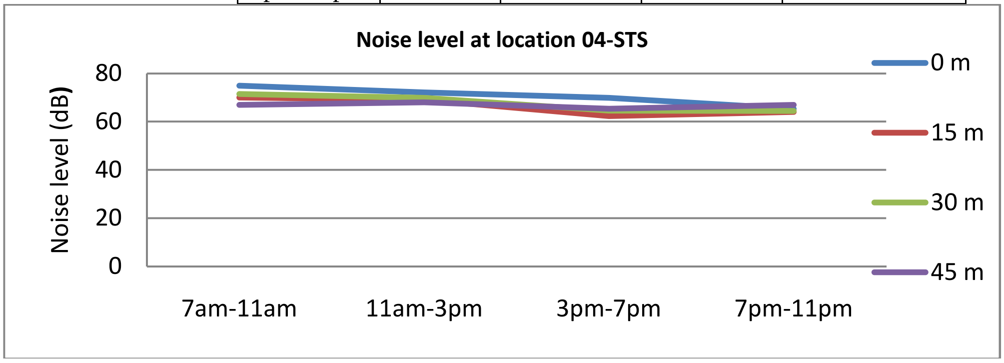

Fig.6. Variations in Noise Level with Distance at 05-STS

F. Noise Parameters at Different Locations

Table. 7. Noise Level Parameters

Area	Location	Noise Level Parameters						
		L_{10}	L_{50}	L_{90}	Leq	LNP	TNI	NC
Residential Area	01-PRA	81.2	77.6	72.5	82.51	87.56	79.7	8.7
	02-GAT1	81.8	78.9	73.6	83.90	88.22	73.6	8.2
	03-GAT2	82.1	75.5	71.7	84.00	88.50	83.3	11
	04-TCO	80.2	75.6	73.1	81.09	83.54	71.5	7.1
	05-STS	83.3	79.2	76.4	84.12	87.09	74	6.9

Table 8. Noise Level Recorded at Location 01-PRA

Sr. No.	Noise level range in dB(A)	Average Noise level range in dB(A)	No. of time Noise level exceeded	% of time Noise level exceeded	Cumulative percentage
1.	48-52	50	0	0	100
2.	52-56	54	0	0	100
3.	56-60	58	0	0	100
4.	60-64	62	1	2.5	97.5
5.	64-68	66	2	5	92.5
6.	68-72	70	2	5	87.5
7.	72-76	74	5	12.5	75
8.	76-80	78	18	45	30
9.	80-84	82	8	20	10
10.	84-88	86	2	5	5
11.	88-92	90	1	2.5	2.5
12.	92-96	94	1	2.5	0
13.	96-100	98	0	0	0
14.	100-104	102	0	0	0

Table 2 to Table 6; present the variation of noise level near the road at some of location where it has been measured. Also it is observed that the noise level remain almost constant during the sixteen hours of measurement. During this time, traffic composition also remains similar and Fig.1 to Fig 5 depicts the relationship between time interval and noise level.

From Table 7, Table 8, it is observed that even in residential areas, the level of noise pollution is very severs for household near the roadside. Most of schools and Hospitals, which are particularly vulnerable, are located near the roads.

Part: II - Air Quality Measurement

A. High Volume Sampler

It is used to monitor an ambient air quality for suspended particulate matter (SPM). It also has a provision to collect samples of gaseous pollutants such as SO_2, NO_2, CO etc. from ambient air by absorbing them in appropriate reagents kept in impinger tube followed by a further analysis in the laboratory. It can be used to collect air quality samples in industrial areas, urban areas and other sensitive areas. Air is drawn into a covered housing and through a filter by a high flow rate blower at 1.1 to 1.5 m^3/min that allows suspended particulate matter to collect on the filter surface. Particles with diameter of 0.1 to 100 micrometer are collected on glass fiber filters. SPM is calculated by measuring the mass collected on filter and volume of air sample.[14]Sampling at an average flow rate of 1.1 m^3/min for 24 hrs gives an adequate sample even in an

atmosphere having concentration particulates as low as 1 µgm/m³, if particulate levels are unusual high the satisfactory sample may be obtained in 6 to 8 hrs or less.

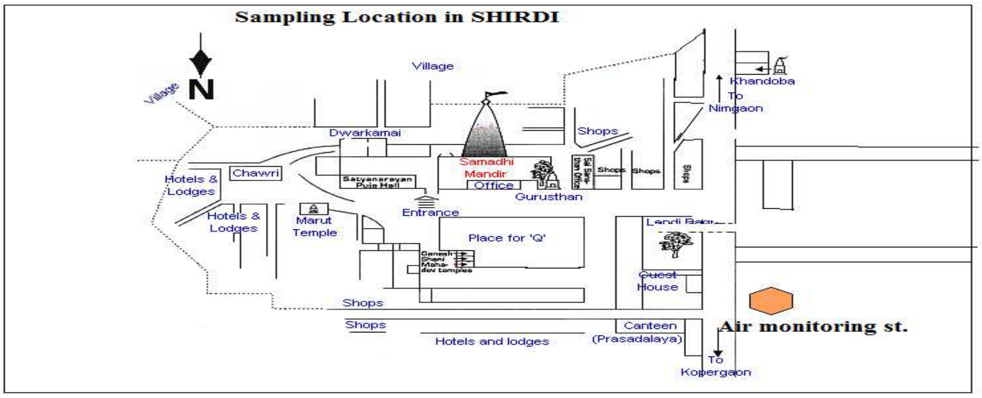

Fig.7. Air sampling station at Shirdi

B. Measurement of Suspended Particulate Matter
By Jacob and Hochheiser Method

The mass concentration of suspended particulates in air is calculated by measuring the mass of collected particles and the volume of air sampled .In HVS, the flow rate of air passing through the filter is monitored by measuring the pressure drops across the orifice plate between the filter holder and the blower. The manometer scale used to measure the pressure drop is calibrated in air flow in cubic meter/minute. A time totaliser records the time in minutes for which instrument has sample the air. The mass of particulates is measured gravimetrically using a balance capable of reliable measurement to the nearest milligram. [9]
The concentration of SPM is calculated as follows:

a] Weight of suspended particulates, W =

$$W = W_f - W_i \quad \text{(gms)} \tag{5}$$

Where,

W_f = Wt. of filter paper after sampling
W_i = Initial Wt of filter paper

b] Volume of air sampled,V=

$$V = Q \times T \quad (m^3) \tag{6}$$

Where,

Q = Average sampling rate (m^3/min)
T= Sampling time in minutes.

$$\text{and} \quad Q = \frac{Q_1 + Q_2}{2}$$

Where,

Q_1 = Initial flow rate at the beginning of sampling.
Q_2 = Final flow rate just before the end of sampling.

$$\text{c] Concentration of SPM} = \frac{W_f - W_i \times 10^6}{Q \times T} \quad (\text{gms}/m^3) \tag{7}$$

C. Measurement of Gaseous Pollutants
Laboratory Method to Measure Suspended Particulate Matter, SO_2, NO_2 [9]
Aim**:** To find suspended particulate matter (SPM), SO_2, NO_X, concentration in ambient air.

Apparatus**:** High volume sampler (HVS) with accessories, glass, timer, and filter paper.
Reagents: 1) 0.1 N NaOH solution (Absorption liquid for NO_X). 2) 0.1 N Iodine solution (Absorption liquid for SO_2).3) 0.1 N H_2SO_4. 4) 0.1 N solution of sodium thiosulphate. 5) Starch indicator. 6) Phenolthalein indicator.

Procedure: -

a] To find SPM concentration in ambient air
1.Condition the filter paper at 20^0C for 5 hrs.2.Take initial weight of filter paper.3.Keep the filter paper in position in faceplate and tight the gasket and close the roof shutter.4.Set the time for prescribed time.5.Note down the initial flow rate at starting and final flow rate at the end of prescribed time.6.Take final weight of filter paper after completion of sampling time.7.Find volume of air sample at normal temperature and pressure condition by measuring temperature and pressure from meter.8.Find the concentration of SPM.

b] To find SO_2 concentration in ambient air.
1.Fill the impinger tube with same of 0.1 N Iodine solutions.2.Pass the adjusted flow through impinger tube.3.After sampling period, titrate 10 ml iodine solution from impinger tube with 0.1 N Sodium thiosulphate solution using starch indicator & titrate blank with same reagent.

c] To find NO_2 concentration in ambient air.
1.Fill the impinger with 30 ml of 0.1 N NaOH.2.Connect the outlet of first impinger tube to NaOH solution.3.After sampling period titrate 10 ml NaOH solution from impinger tube with 0.1 N Sodium thiosulphate solution using starch as indicator. Also make blank correction.

d] Calculations:
To find the volume of air sample at NTP condition:

$$\text{Volume of air sampled, } Vm = \frac{(Q_1 + Q_2) \times t}{2}$$

Were,
Q_1 = Initial rate of flow in (lit/min)
Q_2 = Final flow of rate in (lit/min)
t = sampling time in (min)

$$Vs = Vm\,(Pb - Pm) \times \frac{298}{760\,(T + 273)}$$

Were,
Vm = Volume of air sampled
Vs = Volume of air sampled at NTP conditions.
Pb = Barometric atmospheric pressure at location sampling = 760 mm of Hg
Pm = Pressure while suction (from manometer) = (14.4-13.2) cm of water = 0.882 mm of Hg
T = Temperature while sampling (37ºC)

1) To find SPM

$$\text{SPM in } \mu g/m^3 = \frac{(\text{Final weight of filter paper in gm} - \text{Initial weight of filter paper in gm}) \times 10^6}{1.2 \times t}$$

Were**,** t = sampling time in (min)

2) To find SO_2

$$SO_2 \text{ in } \mu g/m^3 = \frac{(A - B) \times 122.35}{Vs}$$

Where,

A = ml of thiosulphate required for absorption solution.
B = ml of thiosulphate for blank solution.

3) To find NO_X

$$NO_2 \text{ in } \mu g/m^3 = \frac{(A-B) \times 22.4}{Vs}$$

D. Results for Monitoring and Analysis of SPM:

Calculations for SPM

$$\text{SPM in } \mu g/m^3 = \frac{(\text{Final weight of filter paper in gm} - \text{Initial weight of filter paper in gm}) \times 10^6}{1.2 \times t}$$

Where, t = Sampling time in (min) =8 hrs = 480 min.

$$\text{SPM in } \mu g/m^3 = \frac{(2.7542-2.7135) \times 10^6}{1.2 \times 480}$$

$$= 70.65\ \mu g/m^3$$

E. Calculations for SO_2 and NO_2

To find the volume of air sample at NTP condition

$$\text{Volume of air sampled, } Vm = \frac{(Q_1 + Q_2) \times t}{2}$$

Where,

Q_1 = Initial rate of flow in (lit/min)
Q_2 = Final flow of rate in (lit/min)
t = Sampling time in (min) =8 hrs = 480 min

We have, Q_1 = 130 lit/min=0.13 m^3/min
Q_2 = 110 lit/min=0.11 m^3/min

$$Vm = \frac{(0.13 + 0.11) \times 480}{2}$$

$$Vm = 57.6\ m^3$$

$$Vs = Vm\ (Pb-Pm) \times \frac{298}{760\ (T + 273)}$$

Where,

Vm =Volume of air sampled
Vs = Volume of air sampled at NTP conditions.

Pb = Barometric atmospheric pressure at location sampling =760 mm of Hg
Pm = Pressure while suction (from manometer) = (14.4-13.2) cm of water = 0.882 mm of Hg
T = Temperature while sampling (37ºC)

$$Vs = 5.76\,(760 - 0.882) \times \frac{298}{760\,(37 + 273)}$$

$Vs = 55.29\ m^3$

To find SO_2

$$SO_2 \text{ in } \mu g/m^3 = \frac{(A - B) \times 122.35}{Vs}$$

Where,
A = ml of thiosulphate required for absorption solution.
B = ml of thiosulphate for blank solution.

$$SO_2 = \frac{(26.00 - 13.2) \times 122.35}{55.30}$$

$SO_2 = 28.31\ \mu g/m^3$

Calculations for NO_2

1) To find the volume of air sample at NTP condition

$$\text{Volume of air sampled, } Vm = \frac{(Q_1 + Q_2) \times t}{2}$$

Were,
Q_1 = Initial rate of flow in (lit/min)
Q_2 = Final flow of rate in (lit/min)
t = Sampling time in (min) =8 hrs = 480 min

We have, Q_1 = 130 lit/min=0.13 m^3/min
Q_2 = 110 lit/min=0.11 m^3/min

$$Vm = \frac{(0.13 + 0.11) \times 480}{2}$$

$Vm = 57.6\ m^3$

$$Vs = Vm\,(Pb - Pm) \times \frac{298}{760\,(T + 273)}$$

Where,
Vm =Volume of air sampled
Vs = Volume of air sampled at NTP conditions.
Pb = Barometric atmospheric pressure at location sampling =760 mm of Hg
Pm = Pressure while suction (from manometer) = (14.4-13.2) cm of water = 0.882 mm of Hg
T = Temperature while sampling (37ºC)

$$Vs = 57.6\,(760 - 0.882) \times \frac{298}{760\,(37 + 273)}$$

$Vs = 55.30\ m^3$

To find NO_2

(A - B) x 22.4

$$NO_2 \text{ in } \mu g/m^3 = \frac{\qquad}{Vs}$$

$$NO_2 = \frac{(27.10 - 5.3) \times 22.4}{55.30}$$

$$NO_2 = 8.83\ \mu g/m^3$$

RESULTS AND DISCUSSION

From the study is observed that the average noise level near the road side in Shirdi city is about 71.49 dB (A) which far exceeds the acceptable limits of 60 dB (A) set by the Department of Environment India. It is observed that the noise level remain almost constant during the sixteen hours of measurement. During this time traffic compositions also remain similar. The noise level exceeding 10% of the measurement time (L) 10 were 81.2, 81.8, 82.1, 80.2, 83.3 dB at Location01-PRA, 02-GAT1, GAT2, 04-TCO, 05-STS, respectively. The noise levels exceeding 90% of the measurement time (L) 90 were 72.5, 73.6, 71.7, 13.1, 76.4 dB at the same locations. The monitoring has been carried out using High Volume sampler machine, 8 hrs sampling of pollutants was carried out for nearly 09 months. It can be seen that the concentration of SPM ranges from 39.93 $\mu g/m^3$ to 147.56 $\mu g/m^3$. It can also be seen that the concentration of SO_2 ranges from 19.25 $\mu g/m^3$ to 38.16 $\mu g/m^3$ and the concentration of NO_2 ranges from 6.68 $\mu g/m^3$ to 9.84 $\mu g/m^3$. It was observed that high SO_2 concentrations were generally associated with the wind blowing from WNW-NW directions, and the high SPM concentrations were usually related to the wind blowing from W-NW directions. The sampling was carried out for nearly nine months and SPM, SO_2, NO_2 were analyzed for 8 hrs. The average concentration for SPM, SO_2, and NO_2 was found to be 91.61 $\mu g/m^3$, 27.18 $\mu g/m^3$, 8.14 $\mu g/m^3$ respectively. Accordng to CPCB recommendation the pollutants concentration should be within 200 $\mu g/m^3$ for SPM, 80 $\mu g/m^3$ for SO_2 and NO_2.

CONCLUSION

The result of this study show that the levels of noise pollution in Shirdi city far exceed the acceptable limit during peak days (Saturday, Sunday, Thursday and National Holidays) and Festival Days (Ramanavmi and Gudhipadwa etc.) as per set by department of Environment, India. Even the residential area and vulnerable institutions like school and hospitals faces noise which has much higher noise level than acceptable limit. Air Quality Monitoring was carried out to know about the concentration three major pollutants namely SPM, SOx, and NOx at the site selected for the study. For overcoming this problem in Shirdi city Maharashtra,India government should take following action plan because there is chance of IT sector and for agricultural based industries.1.Check the traffic signals properly.2.Proper management of traffic.3.Divert all the traffic for another subway.4.Shirdi city declare as “No Horn city.” 5.Particulate emission could be effectively controlled if dust control measures are adopted.6 Detailed studies over a longer period are required to assess spatial and temporal variations in concentrations of particulate matter around the city due to the new construction activities.

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