Air Quality Assessment of Jirania Brick Industries Cluster: A Case Study

Amarendra Jamatia, Sumanta Chakraborti

Abstract— The present study is aimed to estimate the quantum of significant air pollution loads that arising out from the brick industries of a small cluster located at Jirania, Tripura, India. For assessing seasonal variations of concentration of particulate matter and other gaseous pollutants, air quality monitoring was carried out using Respirable Dust Sampler at 6 locations in Jirania Brick Industries Cluster before starting brick manufacturing and also during brick production seasons. The concentration of PM_{10}, SO_2 and NO_2 in the ambient air during bricks production was compared with the baseline ambient air quality data that were generated before starting the brick production. The level of deterioration of air quality in terms of low, moderate, high and critical is evaluated by calculating an exceedence factor (EF). Excedence factor (EF) ranges 0.736 implies that the Jirania Brick Industries Cluster is moderately air polluted area. The emission induced particulate matter and other gaseous pollutants increase the ground level concentration and degrading the quality of ambient air around the brick kilns during the brick production season. Human health as well the health of other living entities, manmade heritage and vegetation around the brick kilns are the serious concerned.

Index Terms— Brick, cluster, excedance, kilns, pollutant, Settlement, season.

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1 INTRODUCTION

INCREASING rate of brick production for meeting the large demand of bricks for construction sectors has rise up serious environmental degradation in Jirania area. Production of burnt bricks requires consumption of coal leading to particulate matter and other gaseous pollutants emissions. Many authors investigated the potential impact that arising out from the emissions of brick kilns on ambient air quality and vegetation [1]. Environment and health impact associated due to the brick industries were also investigated in terms of prevalence and respiratory symptoms as health exposures around the brick industries [2, 3, 4]. Air pollution is causing severe health and air quality problems in developing countries due to the use of low quality fuel in vehicles, industrial processes and other energy-derived products [5]. For minimising the air pollution and its prediction, applicability of effective air pollution modelling in a cluster of Bangladesh was studied using Industrial Source Complex (ISC3) modelling [6]. Energy conservation and pollution control was priority in Indian brick industry [7]. To implement effective air pollution control strategies in polluted cluster, it is essential to properly identify the local air quality regimes based on the levels and behaviours of air pollutants. Cluster Analysis for Daily Patterns of SO_2 and NO_2 Measured by the DOAS System in Xiamen [8]. The quality of air depends on key chemicals emitted in to the atmosphere during the emissions and deposition processes. Metrological factors also play a critical role in ambient concentration of air pollutants. In order to arrest the deterioration in air quality and to determine the existing quality of air, assessment is necessary to evaluate seasonal variations of particulate matter, ash, SO_2, NO_2, etc. during pre-operation and operational sea-

sons of Jirania brick industries cluster.

2 SITE DESCRIPTION

Jirania Brick Industries cluster has been located at the latitude between N $23^0 50.334^/$ to N $23^0 48.579^/$ and the longitude between E $91^0 23.708^/$ to E $91^0 30.457^/$. It is the largest brick industries cluster in Tripura, India. Sub-Divisional Head Quarter of Jirania is located at the centre point of the study area. Agartala, the state capital of Tripura and also the District Headquarter of West Tripura District located nearly at an aerial distance of about 16 Km from the site. The national highway NH-44 connects Jirania with the Agartala by road. This apart, there is a Railway Station at Jirania within the vicinity of Jirania Brick Industries cluster which connects the State Capital & other neighboring States of NE Region by rail. Other small urban centre namely Jirania Nagar Panchjayet is situated within the study area.

3 METHODOLOGY

Ambient air quality monitoring was conducted using Respirable Dust Sampler (Envirotech APM 460 XNL) with gaseous pollutant attachment (Envirotech APM 411 TE) at 6 locations in Jirania Brick Industries Cluster. The scope of this monitoring is to capture existing ambient air quality and also to analyse trend of depletion of air quality at the cluster and its adjacent area. The location of the brick fields and the predominant wind direction is given importance in selection of the ambient air quality sampling stations in the study. The dispersion of gaseous and particulate emissions depends on the predominant wind directions and affects the receptors located at downwind. Monitoring of PM_{10}, SO_2 and NO_2 was carried out at a flow rate of 1.0- 1.04 m^3/min for 24 hours using preweighed cellulose filters, Whatman (EPM-2000) of 20 x 25 cm in size. The filter papers contained with respirable fraction of fine dust re-weighed after sampling, in order to determine the

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mass of the particles. The SO_2 and NO_2 samples are taken for every 8 hours. Freshly prepared the Potassium Tetrachloro-mercurate solution (TCM) was used as absorbing solution to absorb SO_2 in the impinger at the time of sampling. On the other hand, nitrogen dioxide (NO_2) is absorbed in absorbing solution prepared by dissolving sodium hydroxide in distilled water and adding sodium arsenide. The sampling instrument was fixed at the height of 3 m above the ground level. Representative air samples of SO_2 & NO_2 were analysed in the Air Laboratory of Tripura State Pollution Control Board, India. Spectrophotometer (model Spectronic 21D) was used for determination of absorbance. Determination of calibration curve was done using regression analysis by the method of least squares. Calibration factor of both gaseous pollutants are calculated separately by determining the slope of the line of best fit. The Calibration Factors for both pollutants as generated are being used to calculate the concentration of SO_2 & NO_2. The analytical values of PM_{10}, SO_2 & NO_2 are compared with the CPCB standard to find out deterioration in local air quality if any. The levels of deterioration of air quality are expressed in terms of low, moderate, high and critical by calculating an excedence factor (EF). The excedence factor is the ratio of annual mean concentration with that of respective standard. An EF value more than 1.5 indicates critical pollution. Simultaneously, high pollution means the when EF is between 1-1.5, the EF ranges between 0.5-1 is called moderate pollution and EF values less than 0.5 is expressed as low pollution.

4 RESULTS AND DISCUSSIONS

Observed air quality data of Jirania Brick Industries Cluster for pre-manufacturing season (August-October) and manufacturing seasons (November to March) are presented in table-1. During pre-manufacturing season, PM_{10} concentration was found in the ranges of 74.54 - 142.31 µg/m³. On the other hand, the PM_{10} concentration was found between 145.94 - 278.39 µg/m³ during brick manufacturing season. The maximum PM_{10} concentration reported at Binapani and lowest values PM_{10} concentration reported at Majlishpur during both seasons. Secondary information and field level survey data revealed that activities associated with green bricks production, movement of vehicles, loading & unloading of vehicle on approach road, firing of bricks, huge brick industries in a small area, close proximity of National Highway etc. are somewhat responsible to contribute certain amount of PM_{10} concentration in ambient air in and around the cluster. Analysis of recent data reveals that annual average concentration of PM_{10} of all the monitoring stations was higher than the permissible limit of 60 µg/m³. Comparing the PM_{10} concentration between pre-manufacturing season (August-October) and manufacturing seasons (November to March), it is very clear that activities of brick industries greatly influence in PM_{10} concentration. The pollutants coming from different sources travel and affect the nearest human settlements. Though, their direction of dispersion solely depends on prevailing wind direction that changes from season to season.

For assessing gaseous pollutants such as NO_2 and SO_2, the hourly mass concentration values have been analyzed and compared with the prescribed National Ambient Air Quality Standard. The value of SO_2 ranges 8.63 µg/m³ to 26.91 µg/m³ during pre-production season and 25.64 µg/m³ to 82.76 µg/m³ while bricks production. The maximum SO_2 value of 82.76 µg/m³ reported at station AS-5 which is beyond the prescribed CPCB standard. However, the SO_2 concentrations of all other stations are within the prescribed CPCB Standard. Huge quantities of burning of low quality coal for bricks production cause high concentration of sulpher dioxide in and around the Jirania area. Moreover, the continous vehicular movement through the National Highway-44 and other human activities are also causing another factor leading to high concentration of SO_2 in the air in Jirania Brick Industries Cluster. Trend of depletion of air quality are presented graphically in fig. 1 and fig. 2.

NO_2 is basically produced from burning of fuel including coal, petrol and diesel. NO_2 causes smog and acid rain. With a view to understanding the recent trend, NO_2 samples were analysed and compared with the prescribed standard of CPCB. The analytical value of NO_2 ranges 10.31 µg/m³ to 16.65 µg/m³ during pre-production season and 14.27 µg/m³ to 34.11 µg/m³ at the time of production season. The values of NO_2 concentration of Jirania exhibits an increasing trend of depletion of air quality though there is no established threshold health impact from exposure to NO_2.

Exceedence Facor of various pollutants as calculated are presented in the table 2. From the table 2, it appears that exceedence factor of PM_{10} is more than 1.5 and exceedence factor of NO_2 and SO_2 are 0.232 and 0.436 respectively. Overall exceedence factor of PM_{10}, SO_2 & NO_2 is 0.736. It is to be noted that value of exceedence factor more than 1.5 is considered as critical pollution. Similarly, value of exceedence factor between 1- 1.5 and 0.5- 1.0 are treated as High pollution and Moderate polluition. Thus, it is presumed that the Jirania brick industries cluster moderately polluted area.
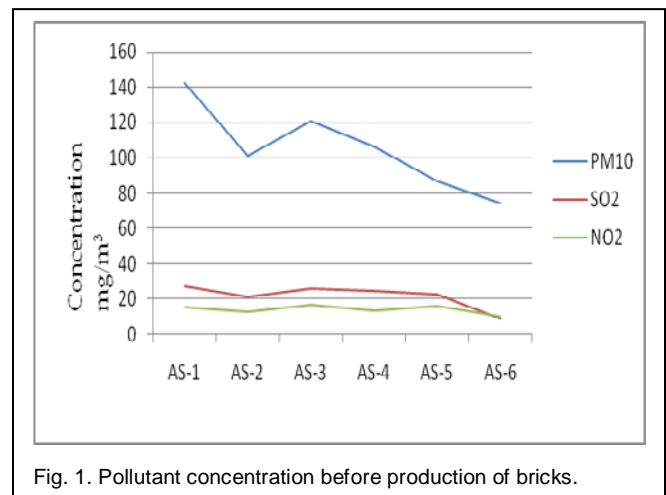
5 FIGURES AND TABLES

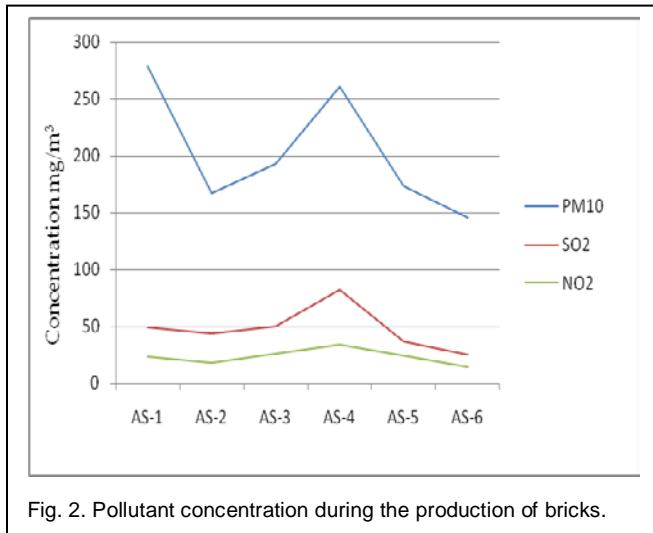Fig. 1. Pollutant concentration before production of bricks.

Fig. 2. Pollutant concentration during the production of bricks.

TABLE 1
STATUS OF AIR QUALITY IN JIRANIA BRICK INDUSTRIES CLUSTER

Station	Before starting bricks production			During the bricks production season		
	PM_{10} [µg/m³]	SO_2 [µg/m³]	NO_2 [µg/m³]	PM_{10} [µg/m³]	SO_2 [µg/m³]	NO_2 [µg/m³]
AS-1	142.31	26.91	15.07	278.39	50.01	23.00
AS-2	101.34	21.07	12.69	167.48	44.17	17.56
AS-3	120.58	25.38	16.65	193.42	50.26	25.55
AS-4	106.59	24.37	13.48	260.42	82.76	34.11
AS-5	86.65	22.08	15.86	173.20	37.32	24.59
AS-6	74.54	8.63	10.31	145.94	25.64	14.27

TABLE 2
Exceedence Factor of Pollutants

Pollutant	Observed Mean Concentration	Prescribed Standard	Exceedence Factor
PM_{10}	154.238 µg/m³	100 µg/m³	1.542
NO_2	18.598 µg/m³	80 µg/m³	0.232
SO_2	34.883 µg/m³	80 µg/m³	0.436

6 CONCLUSION

Finding of present study is that the Jirania Brick Industries Cluster modereately polluted industrial cluster in respect of air quality. Particulate matter emisiosion from the brick industries is mainly responsible for deterioration of ambient air quality of Jirania Brick Industries Cluster apart from the other gaseous pollutants. Moreover, unscientific siting of 64 brick industries in small area is also responsible degradation of ambient air quality. These apart, continous vehicular movement through national highway and traditional Jhum cultivation may also contribute few air pollution loads in the study area. Use of high quality fuel and efficient technology will be a solution for reduction of the Particulate matter and gaseous pollutant emission. Development adequate three tier plantation in and the periphery of brick industry is also suggested as preventive measures for arresting particulate matter emission within the study area.

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