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Effect of Barapukuria power plant on environment

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Abstract: A study was conducted at Barapukuria Coal Fired Power Plant to asses the pollutant (SO_2) emission rate and its impact on human health due to air pollution in the study area by collecting secondary data from the power plant authority. The study results revealed that the SO_2 emission, Suspended particulates matter (SPM) and sound noise was found within the allowable limit. But the long term cumulative effect of SO_2 and SPM is a threatened issue for the environment. Therefore, the impact of Barapukuria thermal power plant needs confirmation through repeated long term studies.
Key words: SO_2 emission, health impact, noise level.

Introduction

The way of development of any nation is closely related with her level of energy consumption. The direct relationship between the per capita energy use in 1996 of USA (8503 kgoe), Canada (10500 kgoe), for example, truly reflect their higher standard of living compared to those of India (476 kgoe), Pakistan (446 kgoe) and Bangladesh (197 kgoe) (Islam, 2001). Bangladesh, like many other third world countries, has been rated poor for its low per capita energy use. Although it is a natural resources rich country but now it is going on a severe energy crisis. Yet there have been significant discoveries of commercial energy resources in the country specially coal, intensive exploration and exploitation of these energy resources can boost the economic development and facilitate industrial growth. Coal, the most important fossil fuel remained esseneial in achieving a diverse, balance and secure energy mix. Coal had a crucial role in meeting current needs and was a resource bridge to meet future goals through the enhancement of knowledge and technology (Singh, 2005). To overcome the energy crisis, establishment of Boropukuria Power Plant Project is such type of indeavour for energy production starting in early 2005. Barapukuria power plant site is located about 1 km north of the Barapukuria coal mine mouth. The installed capacity of the power plant is 2×(125) MW(Mega watt). It will burn 720,000 tons (approx.) coal in a year from the nearby coalmine. Worldwide coal provides about 40% of the total electricity produced and countries closely associated with coal for electricity production include Australia (100%) Poland and Denmark (95%), China and India (70%) (Kural, 1994). Barapukuria coal mine will produce 3,333 tones of coal per day. This coal is therefore, suitable for power generation. So it is a part of two in one project where one component is Coal mine and another is Power generation.

Since the main composition of coal is formed by Ash, Volatile matter, Carbon, Sulfur etc, electricity generation from coal causes unbearable pollution. The power plant will burn 720,000 tones coal in a year and will emit a huge amount CO_2, SO_X, NO_X, SPM, Ash, volatile organic matter and various organic matters though the chimneys. Again the trace elements contained in coal (and others formed during combustion) are a large group of diverse pollutants with a number of health and environmental hazards. They are a public health concern because at sufficient exposure levels they adversely affect human health. On the other hand, the exposure of employees to high noise levels is more in the coal based thermal power than in the natural gas based or the hydroelectric plant. However, the increased transportation activities due to the operation of the power plants have led to an increase in noise levels in the adjacent localities.

While coal was poised for significant growth, it faced significant and mounting social and environmental challenges. Environmental concerns would be the key to the coal industry's future. The primary concerns at the regional levels had to do with the environmental impacts on air, water, land forest, bioderversity, climate and the costs of mitigating these. The challenges was to apply the right technology in the most efficient and environmentally friendly way. As the experience of coal mining and generating power by using coal in a country like Bangladesh is rare, research works are necessary to evaluate its environmental impact and to come to a peaceful decision of the conflict of environmental and socioeconomic effect of mining. Now it is a claim of time to study the effect of establishment of power plant on environment and local people. For this the present study was conducted to estimate the pollutant (SO_x) emission rate from the power plant and to perform risk assessment of health impacts and sound level observation.

Materials and Methods

The study was conducted on 2007, at Barapukuria Coal Fired Power Plant to asses the pollutant (SO_2) emission rate and health impact due to air pollution in the study area. Pollutant (SO_2) emission rate from the power plant was calculated by using the collected data from power plant authority. Noise level in the study area was calculated by comparing the sound level adjacent of the study area and the limits for noise according to the Bangladesh Environmental Conservation Rules. The study team of the Barapukuria has been measured the sound level at the study area by sound level meter Na-20. Change in mortality from exposure to SPM can be estimated from the dose-response relationship developed by Ostro(1994).

Results and Discussion

Ambient noise and SO_x emission rates: Emission sources of a power plant that had a major impact on the environment were noise and flue gas. The project area was quite noiseless as there were no activity other than agriculture and small business in the area prior to the intervention of development of coal mine and coal based power plant which area in the process of being established. So it was felt that the noise level at the base line situation in the project area was within the allowable limits of the standard set by DOE (Department of Environment). From Table 1 it had been shown that the highest sound level at Parbatipur upazila was in the morning (60 db) which was under allowable limit (60-70 db) according to the Bangladesh environmental conservation rules (Table 2). So it was clear that the sound level of that area was quite normal and within the allowable limit.

Table 1. Sound level near Barapukuria power plant on 15.05.2005

Sl. No.	Observation time	Sound level in decibel (db)		
		Lower	Highest	Allowable limit
01	Morning (8.30 am)	30	60	60-70 db
02	Afternoon (12.45 pm)	25	60	do
03	Evening (6.30 pm)	20	55	do

Table 2. The limit for noise according to the Bangladesh environmental conservation rules

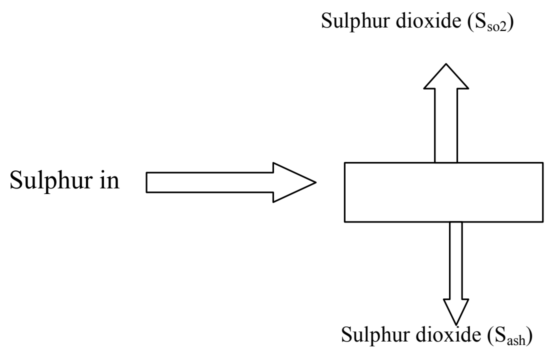
Area category	Unit	Standard value	
		Day time	Night time
A. Silence zone	Db (A)	45	35
B. Residential area	Db (A)	50	40
C. Commercial area	Db (A)	70	60
D. Industrial area	Db (A)	75	70

The most harmful substances from flue gases for the environment were SO_x, NO_x and CO_2. Out of these pollutants, SO_x emission rates had been calculated in the following way-.

A. E**stimated Pollutants emission from the power plant**

Ash content = 16.35%, S content =0.64%, Annual coal consumption = 720,000 tons (Source: Petro Bangla**)**

For estimate of SO_2 emission rate by using the mass-balance approach, we being by drawing a mass – balance diagram:



The mass balance equation may be written as-

$S_{in} = S_{ash} + S_{so2}$

From the data, the mass of 'sulfur' in is-

$S_{in} = 720{,}000 \times \frac{0.64}{100} = 4608$ ton/y

The sulphur in the ash is 16.35% of the input sulfur

$S_{ash} = \frac{16.35}{100} \times 4608 = 753.408$ ton/year

The amount of sulphur available for conversion to SO_2

$S_{so2} = S_{in} - S_{ash} = 4608-753.408 = 3854.592$ ton/year

The amount of sulphur formed is determined from the proportional weight of the oxidation reaction.

$S + O_2 \longrightarrow SO_2$

GMW = 32+30 = 64

The amount of sulphur dioxide formed is then $\frac{64}{32}$ of the sulphur available for conversion.

$S_{so2} = \frac{62}{32} \times 3854.592 = 7468.272$ ton/year = 0.85 ton/yr.

$= \frac{7468.272 \times 10^3 \times 100}{365 \times 24 \times 3600} = 236.28$ gm/sec.

Calculated SO_x loading was 0.85 ton/hr which was almost same of monitored emission (0.735 ton/hr), (Recorded from Computer Based Monitoring System of Barapukuria power plant).

SOx emission rate was also calculated (1.1 ton/hr) by using the fuel consumption rate and emission factor which was almost same of the previous result (0.85 ton/hr)-

B. Emission calculation

E = A × EF × (1- ER/100), Where, E = Emissions, A = Activity rate, EF = Emission Factor, ER = Overall emission reduction efficiency;

Emission factor for SO_2 emissions (in Kg) from a power plant is 157×S kg

S is the sulfur content of the coal as a percentage, S = 0.64%, Annual coal consumption = 720,000 tons (Source: Petro Bangla)

Sulphur dioxide reduction efficiency = 85.5% (Source: Computer based monitoring system in full load condition)

Emissions = 720,000 × (157 × 0.64/100000) × (1 – 85.5/100) = 97.67 Kg/year = 1.1 ton/hr.

As the monitored emission from the Barapukuria power plant was within allowable limit, the SO_x emission rate was also within the allowable limit. This was possibly due to high SO_2 reduction efficiency (85.5%) of the stacks of power plant. The stack height of Barapukuria power plant was 100 m but the calculated height was 95.4 meter which was less than the existing height. So, stack height was within allowable limit-

C. Stack height calculation of Barapukuria power plant

The stack heights have been calculated according to the Bangladesh environmental conservation rules as: H = 14 [SO_2 emission (Kg/hr)], the average SO_2 emission will be on average 600 Kg/h from that a stack height $H = 14 \times 600^{0.3} = 95.4$ meter

Health impact: Change in mortality from exposure of Solid Particulate Matter (SPM) was 8 (approximately) which was the sign of death of 8 more people per year from the total population of that area (476,280) due to change in SPM. On the other hand, Change in lower respiratory illness (per child), Change in Asthma Attack per person, Change in respiratory symptoms (per person) and Change in Chronic Bronchitis (per person) were 3.38×10^{-4}, 6.52×10^{4}, 3.66×10^{-3} and 1.224×10^{-6}. This indicated that due to change in SPM emission mortality had been increased but the increasing rate was not destructive. The health impact due to air pollution was calculated in the following way-

Estimated SPM by air sampler = 0.06 mg/m^3 within radius 500 m.

[Source: Computer based monitoring system of power plant]

Change in mortality = $0.096 \times$ change in SPM $\times C \times P = 0.096 \times 0.02 \times 0.0079 \times 476{,}280 = 7.22 = 8$ (round)

Change in lower respiratory illness (per child)

= $0.0169 \times$ change in SPM = $0.0169 \times 0.02 = 3.38 \times 10^{-4}$

Changes in asthma attack (per person)

= $0.326 \times$ change in SPM = $0.326 \times 0.02 = 6.52 \times 10^{-4}$

Changes in respiratory symptoms per person

= $0.0183 \times$ changes in SPM = $0.0183 \times 0.02 = 3.66 \times 10^{-3}$

Changes in Chronic bronchitis per person

= $6.12 \times 10^{-5} \times$ changes in SPM = $6.12 \times 10^{-5} \times 0.2 = 1.224 \times 10^{-6}$

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