PA02
Air Pollution Aspects of Dhaka City

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***Abstract*—This study is focused on the measurement of air pollution levels at traffic congestion and brick field. Indoor air pollution levels near to different types of cooker and in dwelling rooms have also assessed. It has been revealed that pollution level at traffic congestions has considerably improved due to large scale introduction of CNG vehicles in Dhaka city. Indoor pollution level assessment data show that cooks of Dhaka city are exposed to high concentration of CO, NO_x and SO_x. Some recommendations for air pollution control in Dhaka city are also incorporated in the paper.**

INTRODUCTION

Air pollution can be defined as any atmospheric condition in which substances (natural or man-made chemical compounds capable of being airborne) are present at concentrations high enough above their normal ambient level to produce a measurable effect on man, animals, vegetation, or materials. Air pollutants are hazardous to human health and at high enough concentrations can even be fatal. The most important pollutants are Carbon monoxide (CO), Sulfur dioxide (SO_2), Nitrogen oxides (NO_x), Ozone (O_3), Hydrocarbons (HC) and Suspended Particulate Matter (SPM). In the late 1970s, Environmental Protection Agency (EPA) of USA added lead (Pb) to this list. Particulate matter with an aerodynamic diameter of less than or equal to 10µm (PM_{10}) was added to the list in 1987.

Air pollution can cause drowsiness, eye irritation, throat irritation, persistent cough, asthma, nose blockage, respiratory infections, bronchial infections, colds and headaches in human being. Lead in air can affect the central nervous system, cause renal damage and hypertension. CO in air reduces the ability of blood to carry oxygen and exacerbates heart disorders.

Dhaka, one of the mega cities of the world, witnessed a very fast growth of urban population in recent times. Air pollution in Dhaka city is reported to be serious and damaging to public health. In the winter of 1996-97, air pollution of Dhaka city became the severest when lead in the air was reported higher than in the atmosphere of any other place of the world [1]. Concern over air pollution rate of Dhaka city ultimately led to the promulgation of National Ambient Air Quality Standards in Bangladesh in 1997.

A study of impact of auto-exhaust on air quality of Dhaka city has been conducted in the year 2000, it is revealed that traffic congestion, fuel quality and brick field emission are the main reasons of air pollution in Dhaka city [2]. To control air pollution level CNG at large scale has introduced in Dhaka city. Air quality of Dhaka city after large scale introduction of CNG vehicles has been studied in this investigation.

As people spend most of their time indoors and the concentrations of pollutants may build up in an enclosed space, the risk to health may be greater to exposure to air pollution indoor than outdoor. For the first time, indoor air pollution level of Dhaka city has also been assessed systematically during this study. Brick field emission level data have also presented. In this paper the results of investigation on air quality of Dhaka city have been assessed and put forward some recommendations.

EXPERIMENTAL

In this investigation Gastec technique (Japanese origin) is used for CO, CO_2, NO_x and SO_2 concentration determination. High Volume Air Sampler (Graseby Andersen) is used for PM_{10} concentration determination. Experiments are conducted in accordance with the procedure recommended by the manufacturers of the equipment.

RESULTS AND DISCUSSIONS

The ambient air quality of Dhaka city with respect to CO, SO_2, NO_x, CO_2 and PM_{10} is summarized in Table I.

Table I: Ambient Air Quality of Dhaka City

Location	Pollutant's Concentration				
	CO (µg/m^3)	NO_x (µg/m^3)	SO_2 (µg/m^3)	PM_{10} (µg/m^3)	CO_2 (ppm)
Mohakhali	2519	376	Trace	547.66	435
Farmgate	7730	752	Trace	289.92	590
Mogbazar	5726	339	Trace	383.53	475
Sonargaon	3435	75	Trace	161.93	500
Science Lab	5726	113	Trace	167.64	500

Note: Amended Bangladesh Standards [ECR,2005]
SO_2: 365 µg/m^3 (24-hour average)
CO: 10000 µg/m^3 (8-hour average)
NO_x: 100 µg/m^3 (Annual)
PM_{10}: 150 µg/m^3 (24-hour average)

A comparison between previous data and data obtained during this study has been presented in Fig. 1, Fig. 2, Fig. 3 and Table II. The standard limits of air pollutants set by the Department of Environment (DoE) of the Government of Bangladesh (GoB) are included in Table I. From the experimental values, it is apparent that in terms of PM_{10} the situation is alarming. The experiments are conducted during the period of 4pm to 8pm. It is selected because the previous work done by D. A. Begum [2] shows that the pollution level is high in Dhaka city during that period.

The concentration level of CO is within the limit of Bangladesh Standards [ECR, 2005]. But the concentrations of NO_x in the ambient air exceed the standard values set by the Department of Environment, GoB. But, it may be mentioned here that the standard value of NO_x set by the DoE is annual average and the results shown in Table 1 are 4 hours average.

Table II: Comparison of present SO_2 concentration with previous one [2] in ambient air.

Place	SO_2 concentrations, $\mu g/m^3$	
	Year 2000	Year 2010
Mohakhali	152	Trace
Farmgate	121	
Mogbazar	146	
Sonargaon	393	
Science Lab	146	

Most of the SO_2 present in air of Dhaka city originates from the sulfur present in Diesel. From Table II it is clear that, the level of SO_2 has decreased. This is due to the mass scale introduction of CNG-run vehicles in Dhaka city.

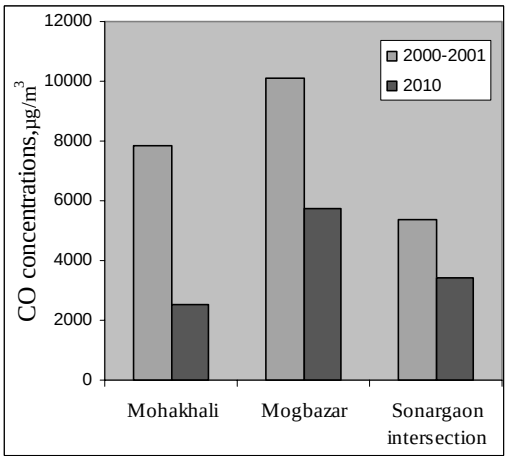

Fig. 1: Comparison of present CO concentration with previous one [2] in ambient air.

It is observed from Fig. 1 that, CO concentrations are decreased after CNG introduction and banning 2-strokes 3-wheelers. Fig. 2 shows the comparison of NO_x concentrations before and after large-scale CNG introduction. The level of NO_x has decreased significantly. Only at Mohakhali it is slightly increased because the NO_x concentration at Mohakhali was previously measured at different time than this study.

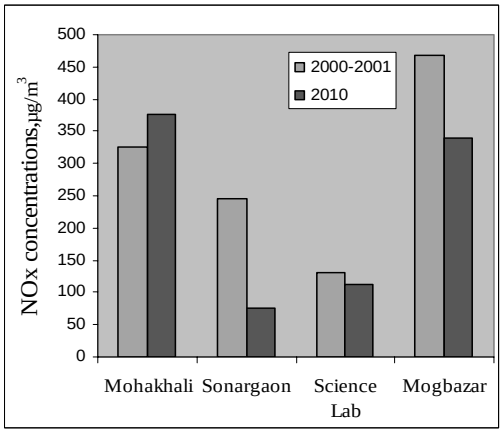

Fig. 2: Comparison of present NO_x concentration with previous one [2], [3] in ambient air

The concentration of suspended particulate matter in the ambient air varies greatly with weather conditions. It is observed form Fig.3 that the values have decreased in recent times. But it is still far from the Amended Standard of Bangladesh (150 $\mu g/m^3$). It is assumed that decreasing tendency of particulate matter emission is related to large-scale CNG-run vehicles.

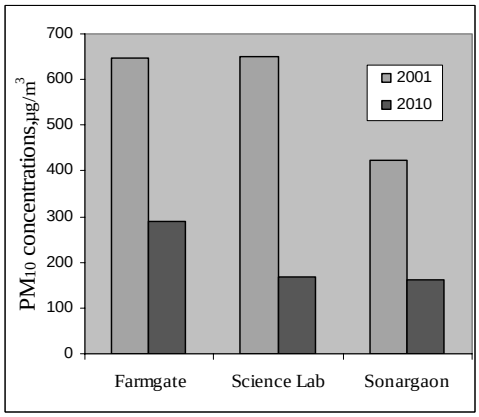

Fig. 3: Comparison of present PM_{10} concentration with previous one [3], [4] in ambient air.

Indoor Air pollution has not been studied much in Bangladesh. Under the supervision of D. A. Begum a study has carried out on indoor air pollution of Dhaka city [5]. This study has emphasized on different types of fuel used in household of Dhaka city. Suspended particulate materials are not measured in these studies. Only CO, NO_x and SO_2 emission levels are measured.

Table III: Pollution levels at kitchen having cookers using Different fuels. [5]

Fuel type	Pollutant's Concentration		
	CO ($\mu g/m^3$)	NO_x ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)
Leaf (coconut)	71575	376	528
Cow dung	1145	376	131
Bamboo	3436	941	1099
Charcoal	45808	941	1309
Coal	2863	75	491
Straw	34356	1129	0
Wood (Gozari tree)	5726	38	98
Mixture of Woods (Mango, korai, segun)	5726	376	16
Natural Gas	2290	75	0
Kerosene	1145	151	65

First eight of the fuels presented in Table III are burned in the same earthen cooker (*matir chula*). And the concentration of the pollutants is measured at the breathing level of a cook. So, it represents the real exposure of a cook to the pollutants. Table III indicates that, higher level of CO concentrations is recorded for leaf, charcoal and straw. Maximum SO_2 emission is recorded for charcoal and bamboo. NO_x level for straw is highest. As a result of exposure to smoke to these dirty cooking fuels many children and woman are getting sick. Slum dwellers using the first eight types of fuels listed in Table III are severely affected. But those who use kerosene and natural gas as a fuel are affected less.

Table IV: Indoor Pollution levels in Dhaka city.

Place	Pollutant's Concentration		
	CO ($\mu g/m^3$)	SO_2 %	NO_x ($\mu g/m^3$)
BUET Cafe	229	Nil	Trace
Shahid Smrity Hall, BUET	115	Nil	Trace
Home in Palashi	115	Nil	Trace
Note: No Bangladesh Standards for Indoor Pollution. Bangladesh Standards [ECR,1997] for, Residential and Rural ($\mu g/m^3$) SO_2: 80 CO: 2000 NO_x: 80			

From the experimental values of Table IV, it is apparent that indoor pollution levels at places other than kitchen (with respect to CO, SO_2 and NO_x) in Dhaka city is not an immediate concern for health.

Numerous brick making kiln operating in the dry season are one of the major sources of air pollution in Dhaka city. From Table V, it has been noticed that the concentration of SPM is higher than the Bangladesh standard value for SPM ($400\mu g/m^3$) and other pollutants level are within the limit.

Table V: Pollutants levels around brickfield in Dhaka city [6].

Place	Pollutant's Concentration			
	CO ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	HC %	SPM ($\mu g/m^3$)
Edge of the cluster	2863	131	0.01	780.7
Center of the brickfield cluster 1	2978	157	0.02	1390
Center of the brickfield cluster 2	3207	157	0.01	728.5

CONCLUSION

The air quality has improved after large-scale launching of CNG driven vehicles, introducing lead free petrol and banning 2-strokes 3-wheelers. This recently assessed air quality of Dhaka city has revealed that more actions should be undertaken to improve the air quality.

RECOMMENDATIONS

Vehicular emission can be reduced by replacing old, worn-out vehicles. It can also be done by appropriate engine design, control strategies and maintenance services. The engines of the existing petroleum fuel based vehicles are to be modified so that they can use CNG. Catalytic converter, efficient filters and adsorbers can be used for vehicular exhaust gas treatment for new model vehicles having appropriate control systems.

Eastern Refinery Limited (ERL) is about 50 years old now. It has to do the necessary revamping. Catalytic reforming and hydrofining processes are to be installed in ERL so that it can produce unleaded gasoline and low sulfur diesel. The proposed new refinery may be so designed that it produces low sulfur diesel and unleaded petrol.

Appropriate transportation planning is to be adopted to introduce efficient mass transit. Rickshaws are to be gradually phased out from the main roads. They may be allowed to operate in lanes and by-lanes only. The reason behind this is that they slow down the traffic, thus causing higher pollution. Better traffic control and management with flyovers, one-way streets, multistoried parking, metered parking etc. are to be introduced. Past studies show that traffic congestion is the main reason behind high level of pollutants concentration at roadside of Dhaka city [7]. Railway around Dhaka city, flyovers, elevated highways, underground railways if they are found to be cost-effective, are to be constructed to avoid traffic congestion.

Efficient solid waste management system should be introduced. Door to door household waste collection, collection of medical wastes from the hospitals and sorting out at sources of different wastes should be done. Solid waste is to be centrally processed to valuable products.

For reduction of brick field emission level, stack heights should be increased. New and improved technologies of brick-making should be introduced. Low sulfur coal should be used in brickfields instead of high sulfur coal.

Proper ventilation of kitchen, efficient cooking devices as well as quality fuel, can reduce the indoor air pollution.

DoE and Bangladesh Road Transport Authority (BRTA) should enforce their regulations strictly. Government has to ensure effectiveness of control programs through ambient air quality monitoring. Coordination between DESA, DWASA and BTTB is needed to reduce the concentration of suspended particulate matter in the air of Dhaka city. Social awareness about the consequences of environmental degradation is to be created through mass media such as TV, radio and newspaper.

ACKNOWLEDGEMENT

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