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# Assessment of Nitrogen Oxides and Sulphur Dioxide Content in the Ambient Air near the Garments Industries of Bangladesh

## Research Article

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**Abstract**

The term Nitrogen Oxides ($NO_x$), is used to describe the sum of NO, $NO_2$ and other oxides of nitrogen and entire group of sulfur oxides expressed as $SO_x$. Nitrogen oxides play a major role in the formation of ozone in the atmosphere and sulphur dioxide is a highly reactive gas which affects both health and the environment. A variety of $NO_x$ and $SO_x$ compounds and their products occur both naturally and as a result of human activities. Therefore continuous monitoring of these gaseous pollutants in the air is essential to control the air quality. The objective of the research work is to assess the air quality of some major industrial areas of Bangladesh. The $NO_x$ and $SO_2$ content in the ambient air of three industrial areas have been investigated. Concentration of both gaseous pollutants in the ambient air of garments industries at Gazipur and Savar were found higher than Narayanganj. In this investigation the production house of the garment industries were marked as the main source of the $NO_x$ and $SO_2$.

**Keywords:** Nitrogen oxides; Sulphur dioxide; Ambient air; Gazipur; Savar; Narayanganj

## Introduction

Air pollution is one of the serious environmental problems confronting our civilization today. Air pollution means the presence of chemicals or particles in the air which are usually not present and which lower the quality of the air or cause detrimental to human health. Although some natural processes such as volcanic eruptions and wildfires may pollute the air but most often, it is caused by human activities such as transportation, industrial work, mining, construction, agriculture, smelting, etc. The pollutants are found in both gaseous and solid form (as particulate matter suspended in the air). The air pollutants such as Particulate Matter (PM), black carbon, Ozone ($O_3$), Nitrogen Oxides ($No_x$), Sulfur Oxides ($SO_x$), carbon monoxide, heavy metals or black smoke often investigated for the assessment of air quality [1,2].


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Anthropogenic emissions of nitrogen oxides are mainly the result of combustion processes, such as the combustion of fuel for vehicles or the combustion of coal, oil and natural gas for industrial processes. Most of the nitrogen oxides from diesel engines are emitted as Nitrogen Dioxide ($NO_2$), which is five times more toxic than Nitric Oxide (NO). Nitrogen dioxide, nitric oxide and other oxides of nitrogen are collectively called as $NO_x$ [3]. Nitrogen oxides contribute to a wide range of effects on public welfare and the environment, including global warming and stratospheric ozone depletion. The atmosphere polluted with $NO_x$ reacts with water to produce nitric acid. Such a precipitation contains elevated levels of hydrogen ions and causes acid rain which is equally detrimental to plants, humans, animals and our infrastructure [4,5].

$SO_2$ is the component of greatest concern and is used as the indicator for the larger group of gaseous Sulfur Oxides ($SO_x$). The main source of $SO_2$ in the atmosphere is the burning of fossil fuels by power plants and other industrial facilities. Exposure to $SO_2$ can affect the respiratory system, especially for people with asthma. Studies show connections between short-term exposure and increased visits to emergency departments and hospital admissions for respiratory illnesses, particularly in populations at risk (including children, the elderly, and asthmatics).

Bangladesh has now emerged a potential supplier of Readymade Garments (RMG) to both North America and Europe. Above 50% of Bangladeshi garment exports go to European Union and 44% of it's to USA [6]. Exporting of textiles and garments are the main source of foreign exchange earnings. However in terms of pollution, textile industries are one of the most polluting industries in the world [7]. With respect to environmental issue, these textile and dyeing industries now considered as a major environmental threat in the industrial area of Bangladesh [8]. Textile operation follows a huge amount of waste streams, including liquid, gaseous and solid wastes, some of which may be hazardous. Time dependent industrial operations may emit substantial quantity of atmospheric contaminants: CO, $CO_2$, $SO_2$, $NO_2$, $NH_3$, particulates and other wastes. In Bangladesh many small and medium RMG industries not only discharge untreated effluents in water but also emits air pollutants like suspended particulate matter (PM10 and PM2.5), $SO_2$, $NO_x$ content in air indiscriminately. These emissions have not only biological and but also environmental impacts like the induction of stress on human and animal health and also responsible to on earth's climate [9-12]. Ambient air quality monitoring is required to determine the existing quality of air, evaluation of the effectiveness of control program and to identify areas in need of restoration and their prioritization. The mean concentration of $NO_2$ was 3.1 Parts Per Million (ppm) around the chemical industry in Kwekwe, Zimbabwe [13]. In 2010, the seasonal variability of ambient $NH_3$, NO, $NO_2$ and $SO_2$ over Delhi, India has been reported by Sharma, et al. [14]. He also reported the observed concentration of $NO_x$ ranged between 9.83 μg/m$^3$ to 216.25 μg/m$^3$ in Gurgaon, Northern India in 2016 [15]. Tolerable range of $NO_x$ was found near cement industries Nimbahera, Rajasthan, India by Chaurasia S, et al. [16]. According to Choudhary, et al. the $NO_x$ content in the air of Rajasthan, India was found 38.39 μg/m$^3$ - 42.43μg/m$^3$ in 2017 [7]. Neelima N, et al. were investigated the air quality of Udaipur, Rajasthan, India and found the concentration of gaseous pollutants ($SO_x$, $NO_x$) below than the prescribed limit [17].

Industrial pollution is one of the problems presently facing Bangladesh [18]. Continuous monitoring and several efforts should be taken in the industrial zone to control the environmental problems. In Bangladesh, most of the garments factories are located at Gazipur, Savar and Narayanganj. Due to the saturated level of industries in this area the quality of the air is a matter of great concern. To measure quality of ambient air around garments industries, six RMG industries were taken into consideration. The main objective of this research is to determine the concentration of $NO_x$ and $SO_2$ in the ambient air around these garments industries.

## Materials and Methods

The $NO_x$ contents in the ambient air near the four points of six garments industries are measured by the standard method for measurement of air pollution, Part-6: Oxides of nitrogen (IS 5182-6) and $SO_2$ concentration was determined by IS 5182 (Part 2): 2001.

### Sample collection

The samples of ambient air were collected in plastic container by respirable dust sampler from six garments industries at Gazipur, Savar and Narayanganj region in August, 2017. About 30 mL of absorbing media in the impinger was connected to the gas sampling manifold of the gas sampling device and air was drawn at a sampling rate of 1 liter per minute for four hours. The industries where samplings were carried out located at different zones namely Kashimpur, Shreepur of Gazipur district, Nabinagar of Savar region and Fatullah of Narayanganj district. The six RMG industries are expressed as RMG-1, RMG-2, RMG-3, RMG-4, RMG-5 and RMG-6. Among of these six industries RMG-1 and RMG-2 are at Gazipur, RMG-3 and RMG-4 are at Savar, RMG-5 and RMG-6 are at Narayanganj. Samples have been collected to analyzed $NO_x$ and $SO_2$ concentrations at four different points of each industry i.e. east side, west side, north side and south side of factory. The collected samples were stored in ice box.

### Measurement of $NO_x$

Ambient nitrogen dioxides were collected by bubbling known volume of air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion produced during sampling were determined calorimetrically by reacting the nitrite ion with phosphoric acid, sulphanilamide and N-(1-naphthyl)-ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm [19]. A blank sample in the same manner was prepared by un-exposed absorbing agent and concentration of $NO_2$ was determined from the calibration curve.

### Measurement of Sulphur dioxide

The ambient air samples for sulphur dioxide were collected by absorbing $SO_2$ from known volume of air absorbed in a solution of potassium Tetrachloromercurate (TCM). A stable dichloro sulphitomercurate complex formed was then made to react with pararosaniline and methyl sulphonic acid. The absorbance of the colored solution was measured at 530 nm using spectrophotometer. The concentration of sulphate ions formed in absorbent was calculated according to modified West & Gaeke Method [20].


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## Results and Discussion

The six garments industries where investigation was carried out are 100% export oriented. The concentration of $NO_2$ in collected air at four different strategic points for each garment industries were given in Table 1. The measured average concentrations of $NO_2$ for RMG-1, RMG-2, RMG-3, RMG-4, RMG-5 and RMG-6 were 48.54 µg/m³, 20.45 µg/m³, 41.66 µg/m³, 37.72 µg/m³, 8.51 µg/m³ and 5.99 µg/m³ respectively. The detected concentrations of $NO_2$ at the different sampling point of each garments industry were ranged between 18.29-90.95 µg/m³, 2.03-44.21 µg/m³, 6.10-96.54 µg/m³, 12.70-84.86 µg/m³, 2.03-18.80 µg/m³ and 11.8-12.19 µg/m³ respectively. The maximum average concentration $NO_2$ was found for RMG-1 at Gazipur.

In all cases the highest concentration was found nearby the production section of the industries. The $NO_x$ mainly comes from the industrial boiler and industrial power sources. At RMG-3, highest concentration of $NO_2$ was found 96.54 µg/m³ at factory west side nearby production section. The average $SO_2$ concentrations for RMG-1, RMG-2, RMG-3, RMG-4, RMG-5 and RMG-6 were found 48.54 µg/m³, 20.45 µg/m³, 41.66 µg/m³, 37.72 µg/m³, 8.51 µg/m³ and 5.99 µg/m³ respectively (Table 2). The highest $SO_2$ concentration 80.42 µg/m³ was found for RMG-1 near by the production house. Like $NO_x$ the highest concentration of $SO_2$ for each industry was found near the production house of the garments industry and the concentration values tend to decrease away from the production section. This result is consistent with the findings of Chaurasia S, et al. [16]. This may happen as a result of air diffusion arising from the dispersion of contaminants through the air. Low surface wind speed, mixing height, temperature inversion, high pressure and poor maintenance within the plant may responsible for high pollutants concentrations. Pollutants may however not exist a long in the atmosphere; they can go through to land and water near or far distances, providing mutual relationship with air qualities, water quality and ecosystem health. The $NO_x$ and $SO_2$ concentrations at the garments industries at Narayanganj were found lower than that of Gazipur and Savar (Figures 1 and 2).

**Table 1:** Measured $NO_x$ concentration at different sampling points of six garments industries.

| Factory | East Side µg/m³ | West side µg/m³ | North Side µg/m³ | South side µg/m³ | Average µg/m³ | Standard deviation |
|---|---|---|---|---|---|---|
| RMG-1 | 45.22 | 39.69 | 18.29 | 90.95 | 48.54 | 30.56 |
| RMG-2 | 2.03 | 27.44 | 44.21 | 8.13 | 20.45 | 19.18 |
| RMG-3 | 6.10 | 96.54 | 48.27 | 15.75 | 41.66 | 40.78 |
| RMG-4 | 12.70 | 23.37 | 29.98 | 84.86 | 37.72 | 32.21 |
| RMG-5 | N.D | 18.80 | 13.21 | 2.03 | 8.51 | 8.98 |
| RMG-6 | 12.19 | 11.8 | N.D | N.D. | 5.99 | 6.92 |

**Table 2:** Measured $SO_2$ concentration at different sampling points of six garments industries.

| Factory | East Side µg/m³ | West side µg/m³ | North Side µg/m³ | South side µg/m³ | Average µg/m³ | Standard deviation |
|---|---|---|---|---|---|---|
| RMG-1 | 80.42 | 39.20 | 36.66 | 48.75 | 51.25 | 20.12 |
| RMG-2 | 10.83 | 29.85 | 37.50 | 2.08 | 20.06 | 16.41 |
| RMG-3 | 8.33 | 67.50 | 72.50 | 20.83 | 42.29 | 32.46 |
| RMG-4 | 5.42 | 47.50 | 37.50 | 25.84 | 29.06 | 18.07 |
| RMG-5 | 7.50 | 3.75 | N.D | 2.92 | 3.54 | 3.08 |
| RMG-6 | 7.50 | 29.16 | 17.91 | 37.08 | 22.91 | 12.93 |

## Conclusion

Though the number of factory is in small scale comparing with other countries, but the manufacturing process in Bangladesh has contributed to environment concern. As most of the factories still use old technology and not paid attention on the environmental pollution as well as air pollution and never conducted environmental impact assessment. Though the observed concentration values of $NO_x$ and $SO_2$ pollutant in this study appear to be fairly low but air pollutants can be noxious even at low concentrations, air quality issues should be considered and taken very seriously, owing to their ability to cause significant health and environmental damages and even death. In Bangladesh garments bear socio-economic status so it cannot be stopped. This investigation suggests that the increase of technical assistant, to set up the environmental legal instrument such as law enforcement, guideline etc. Department of Environment (DOE) should monitor at least 6 months after in every year to check the condition of air quality management, to ensure to check raw materials or fuels and equipment for good quality, to formulate potential medium and long term national strategies plan for air pollution management is required.

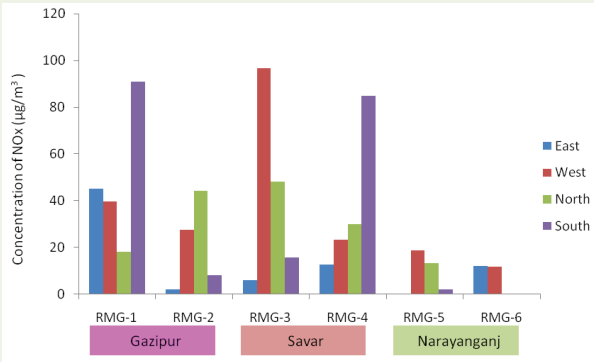


**Figure 1:** Distribution of $NO_x$ concentrations at different sampling points for six garment industries.

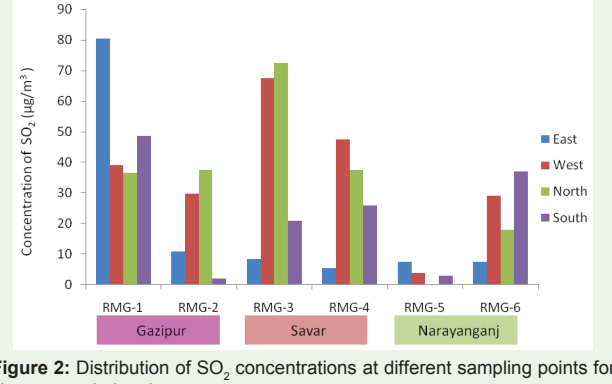


**Figure 2:** Distribution of $SO_2$ concentrations at different sampling points for six garment industries.



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