

Determination of Nitrogen oxides concentration in the atmosphere of the faculty of pharmacology's laboratories

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ABSTRACT

Background: Nitrogen oxides occur in the atmosphere in six forms of namely: N_2O , NO , NO_2 , N_2O_3 , N_2O_4 and N_2O_5 . Among these oxides NO_2 is the most important air pollutant because of its relatively high toxicity and its ubiquity in ambient air. In this research Griess-Saltzman method was utilized for determination of nitric oxide and nitrogen dioxide in the atmosphere of different laboratories in the Faculty of Pharmacology of Ahwaz Jondishapur University of Medical Science.

Methods: As it is reported in Griess-Saltzman method, NO_2^- produce a purple color with absorbing solution containing: Sulfanilic acid, Glacial Acetic acid and N-(1-Naphthyl)-Ethylenediamine Dihydrochloride. The maximum wavelength absorbed by this colored solution is 550 nm.

Results: Calibration curve was obtained in concentration range of $0.04-0.44 \mu\text{g}\cdot\text{ml}^{-1}$ of NO_2^- (eq. $A=0.9C+0.002$ $R^2=0.999$). Between and within days mean reproducibility of the measurements were 2.2 and 1.91, respectively. Nitric oxide and nitrogen dioxide concentrations in central, chemistry, hydrology, toxicology and pharmacology labs absorbed into absorbing solution were measured from the calibration curve.

Conclusions: The statistical results showed that there was difference between NO_2 concentration at working and non working conditions of each laboratory. There was no difference between NO concentration of working and non working conditions of the laboratories. Also there was difference between NO and NO_2 concentration of each laboratory. Final evaluation of the results indicated that NO and NO_2 concentrations in the Faculty of Pharmacy laboratories atmosphere are lower than EPA reported value.

Keywords: Griess-Saltzman method, Nitrogen oxides, N-(1-Naphthyl)-Ethylenediamine Dihydrochloride

INTRODUCTION

Air Pollution has accompanied human life from the very time he discovered fire, But in different eras different aspects of pollution has been under the focus of attention (1). Air is a mixture of different gases that Oxygen and Nitrogen form its highest portion (2). Air pollution is defined as the existence of unpleasant and unwanted materials in the air in such amount that can become harmful.

Unpleasant material can affect human, plants, materials and other things like world ecosystem or mystifying the air and causing unpleasant smells or unpleasant scenes (3). Atmospheric conditions can sometimes play an effective role in scattering the pollutants and bring about a pleasant condition or increase the air pollution (4). Nitrogen Oxides consist of Nitric Oxide NO , Nitrogen Dioxide NO_2 , Nitrogen Trioxide N_2O_3 , Nitrogen Pentoxide N_2O_5

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N_2O_5 , Oxide Nitro N_2O and Tetraoxide di Nitrogen N_2O_4 . The last two of these oxides can not be found in the environment. Generally speaking Nitrogen Oxides are called NO_x .

There are consequences if more than standard densities of Nitrogen Oxides will present in atmosphere:

Lung and respiratory problems, sensitive eyes and throat, met-hemoglobin production and problems with sense of smell and uneasiness in nasal cavities are among the effects of contacting with Nitrogen Oxides. (5) Based on the reports of EPA¹ among the sources of Nitrogen Oxide production in the air %49 goes to transportation vehicles, %27 to electrical services and facilities, %19 to industries and trade centers and %5 to other sources (6). The reported threshold amount of EPA for Nitrogen Oxides in open air is $0.053 \mu\text{gr. in mm}$ (5). One of the simple and accurate methods of measuring the range of Nitrogen Oxides is Griess-Saltzman method that is generally used to measure the range of these oxides in the air. In this method environmental air is pushed through the absorbing solutions and change of color in this solution is measured in 550 nm wavelength by spectrophotometer². (7)

There are other methods of measuring NO_x in which Griess-Saltzman method or its modified versions are used. (8-25). In this research the researchers tried to indicate the range of NO_x (which are mostly NO and NO_2) in laboratories of pharmacy faculty as their source of production and compared against each other and with the standard ranges.

METHODS AND MATERIALS

1- Materials used: N-(1-Naphtyl)-Ethylenediamine Dihydrochloride, Sulfanilic acid, Glacial Acetic acid, Nitritsodium Dichromate Potassium.

2- The equipments used:- Japanese JASCO spectrophotometer 7800

- Digital Presica XB220A scale made in Switzerland with 0.0001 gr. Accuracy of measurement

- SIBATA air suction pump made in Japan with AC100V, 6.5 A, 50/60Hz features

- L&R Ultrasonic device model T-14 made in the United Stated

3- Preparation of the solutions: %0.1 N-(1-Naphtyl)-Ethylenediamine Dihydrochloride solution: 0.0500 gram N-(1-Naphtyl)-Ethylenediamine Dihydrochloride is measured by the digital scale and was put in a 50 milliliter balloon and 10 milliliter of distilled water was added and total solution reached to the indicator line. The resulting solution is N-(1-Naphtyl)-Ethylenediamine Dihydrochloride.

NO_2 absorbing solution: 2.5177 grams of dehydrated Sulfanilic acid was measured by the digital scale and poured into a 500 millimeter balloon. 250 milliliter distilled water was added to it and solved for 10 minutes by an ultrasonic equipment: then 70 milliliter of Glacial Acetic acid was added to this solution. Then 10 milliliter of %0.1 -(1-Naphtyl)-Ethylenediamine Dihydrochloride was added to it. Then pouring enough distilled water the level of solution reached the indicator line and was solved. The resulting solution was used as the absorbing solution of NO_2 .

Mother Nitrite solution (22 $\mu\text{gr. In milliliter}$): 0.0150 grams of sodium nitrite was measured by digital scale and was poured in a 500 milliliter balloon and was solved in the minimum amount of water and after adding distilled water reached the indicator level of balloon and was mixed thoroughly. This solution is 22 $\mu\text{gr. In milliliter nitrite}$. Then calibration solutions in density of 0.44-0.4 were produced through phase by phase attenuation.

%10 Dichromate Potassium: 10 grams of Dichromate Potassium was measured by the digital scale and put in a 100 milliliter balloon and was reached to the indicator level by adding distilled water and was solved thoroughly.

¹ Environmental Protection Agency

² Spectrophotometer

Sampling system: air suction pump was set on the rate of 4 liters in minute and the air in laboratory environment was gathered in the absorbing solution for one hour at this speed.

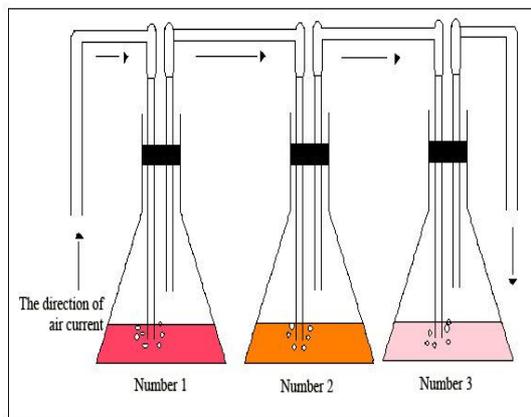


Figure 1. Absorbing system of NO_x designed at the library

Figure 1. shows how the air emitting from the pump comes into the absorbing and oxidizing solutions. Since NO should turn into NO₂ to be absorbed in absorbing solution, in Arlene number 2 we put dichromate potassium to do the oxidizing process.

Method: we put 0.2, 0.4, 0.85, 1.3 and 2.2 milliliter of standard 2 μgr. /milliliter Nitrite solution In 10 milliliter balloons numbered 1 to 5 and reached it to the specified level with absorbing solution. The resulting solutions have 0.04, 0.08, 0.17, 0.26 and 0.44 μgr. /milliliter density of NO₂. Their level of absorption was checked in 550 nm wavelength, while the machine was set zero in this wavelength. Then the absorption curve based on the density of the solution was drawn which is represented in diagram 1.

Sampling from the laboratories: Devising sampling system shown in figure 1 and 2 in each laboratory was executed. In these experiments beaker 1 contains 10 milliliter of adsorbing solution, beaker 2 contains 10 milliliter of %10 dichromate potassium solution, and beaker 3 contains 10 milliliter absorbing solution. The level of absorption in solutions after reaching 10 milliliter was

read and defined according to calibration curve, the results of which has been shown in table 1.

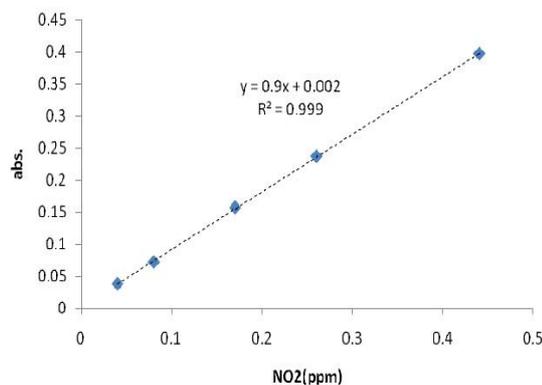
Totally Sampling was done in working and nonworking conditions for 15 days in 5 laboratories; During three days for each laboratory and during each day 3 sampling phases were performed at different times. By working condition we mean the conditions that any activity such as educational classes or research projects were been done in laboratory, and by nonworking condition we mean the condition that in which the laboratory was inactive.

Sampling was done in central laboratories, analytic chemistry, hydrology, toxicology and pharmacognosy laboratory.

RESULTS

The relevant Calibration curve is shown in figure 1.

Figure 1: NO₂ calibration curve in density of 0.04-0.44 μg.ml⁻¹ in 550 nm wavelength



NO₂ calibration curve in density of 0.04 to 0.44 μg.ml in 550 nm wavelength has line equation of A= 0.9C+0.002 and R²=0.999.

In table 1 the average density of NO₂ and NO laboratory samples has been recorded by nanogram in milliliter. In each of the laboratories 3 days and each day 3 sampling was performed and the samples were collected in both working and nonworking

conditions. Each of these numbers represent the average of three measurements in a case.

Table 1: Average amount of NO₂ and NO density in the air of laboratory in each day and in working and nonworking conditions

Laboratory Name	Condition	Density of NO (ppb)	Density of NO ₂ (ppb)
Central	Working	0.34	3.21
	Nonworking	0.2	2.24
Analytic Chemistry	Working	0.33	2.215
	Nonworking	0.28	1.28
Hydrology	Working	0.85	5.7
	Nonworking	0.315	3.465
Pharmacognosy	Working	0.04	3.14
	Nonworking	0.115	1.585
Toxicology	Working	0.28	2.62
	Nonworking	0.45	2.93

To observe the efficiency of this method its reproducibility was taken into account that is shown in table 2.

Table 2: The results of the reproducibility of the samples

Standard Density (ppm)	%RSD	
	between Days	within day
0.04	4.47	1.25
0.08	1.13	3.47
0.17	1.02	1.02

To do the comparisons between the measures of NO and NO₂ density in the air of laboratories in Pharmacy Faculty in

working and nonworking conditions Paired Sample T-test was used which suggested that there is a meaningful difference between the density of NO and NO₂ between the laboratories (p=0). There is not any meaningful difference between the density of NO in working and nonworking conditions (p=0.344). The difference of NO₂ density in working and nonworking condition was, however, meaningful (p=0.003). In figure 2 the amount of Nitrogen Oxides in the air of different laboratories in working and nonworking conditions were compared with each other. Moreover in figure 3 the sum of the amounts of Nitrogen Oxides in working and nonworking conditions was compared with the reported standard by EPA.

The results of the comparison of the amounts of Nitrogen Oxides in laboratories were compared with each other and with the reported standards by EPA:

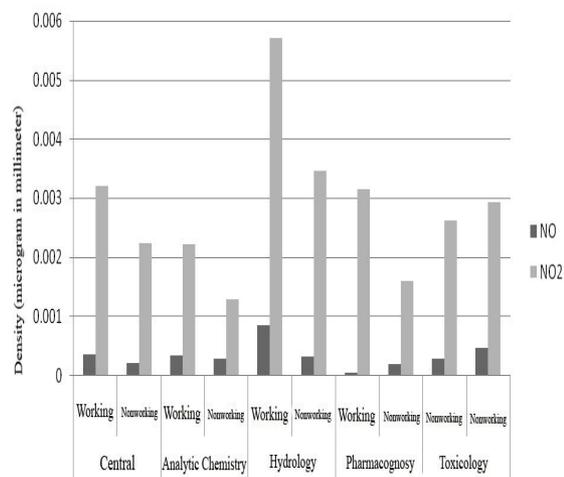


Figure 2: The comparison of amounts of Nitrogen Oxides in the air of laboratories of Pharmacy Faculty in working and nonworking conditions

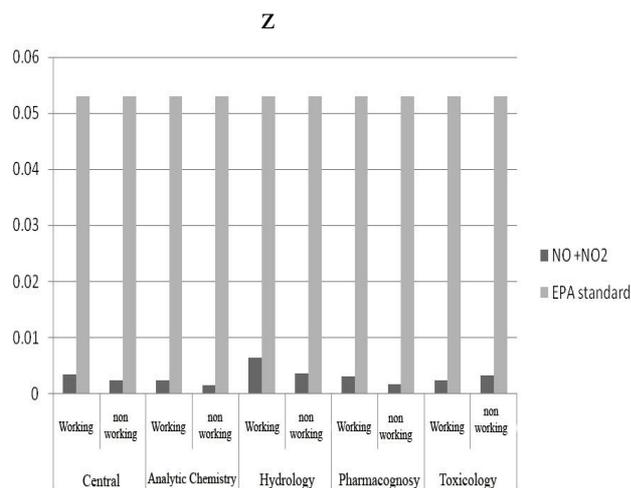


Figure 3: the comparison of the amounts of Nitrogen Oxides in the air of laboratories in Pharmacy Faculty in working and nonworking conditions with reported standards by EPA

DISCUSSION

Generally speaking, regarding table 2 density of NO in the air of all the laboratories is very low compared with NO₂ in the similar situations, because as soon as it enters into the air turns into NO₂ Oxide. Regarding the statistical outputs of Paired sample t-test (with P-value as the index); Its results has been represented in table 4; Here it is resulted that the difference between the density of NO and NO₂ in both working and nonworking conditions in all the laboratories are meaningful. The difference between the density of NO₂ in working condition and its density in nonworking condition in all the laboratories is meaningful. After comparing the amounts of Nitrogen Oxide in the air of the laboratories with the reported standard amounts by EPA and based on what is brought in diagram 3 all the amounts in this research show a meaningful difference in accordance with the standard amounts and are lower than that. And in that case the range of the density of the nitrogen pollutants in the air is not harmful for the workers. Moreover considering the diagrams number 2 and 3 and table 1 it is clearly concluded that:

1- In Pharmacognosy and toxicology that the flame is used less often in either working or nonworking days, there is a lower density

of Nitrogen Oxide. In toxicology laboratories the density of the Nitrogen Oxide in nonworking days is more than working days that is probably due to the pollution entered from the outside of the laboratory or other sources. This can also be observed in Pharmacognosy laboratory.

2- In hydrology laboratory in which the experiments should be done in sterilized environment, flame is used much more often; therefore the density of Nitrogen Oxides in the air of the laboratory is high in working days. During the nonworking days because of a proper air-conditioning the density is relatively lower than that of a working day.

3- In the laboratory of the analytic chemistry the experiments about general and mineral chemistry is done which demands the frequent use of flame. The density of the Nitrogen Oxides in the air of the laboratory is considerable. The results showed that air-conditioning in this laboratory is not efficient, because the density of Nitrogen Oxides in the air is high in nonworking days.

4- In the central laboratory that atomic absorption and flame photometer is used, in working days (the days when the systems are functional) the density of the Nitrogen Oxide is considerable and in nonworking days this density subsides to a considerable extent. The density of NO_x will increase even more if another source is added to these cases.

As it is stated in table 2 the reproducibility of this method that is defined according to the variations of (RSD%) was observed for 1 and 5 days. The results suggest that the functional method has a great level of accuracy. RSD% for the data in these days for the densities of 0.04, 0.08 and 0.17 µgr. In milliliter is relatively reported as 1.25, 3.47 and 1.02.

CONCLUSION

Final evaluation of the results indicated that NO and NO₂ concentrations in the Faculty of Pharmacy laboratories

atmosphere are lower than EPA reported value.

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