Experiment Time: 2019 / 05 / 14 14 : 00 ~ 16 : 30 Laboratory: DS2B409

Experimental Report

Experiment Course Title: Experimental of College Chemistry I

Experimental Project Name:

Determination of nitrogen oxides in the air

Name: 易弘睿 Yi Hongrui Student No.: 20186103

College: JCI Specialty: Mechanical Engineering

Class: ME01 Mentor: Chen Gang

Score:

Teacher Comments:

1. Purpose

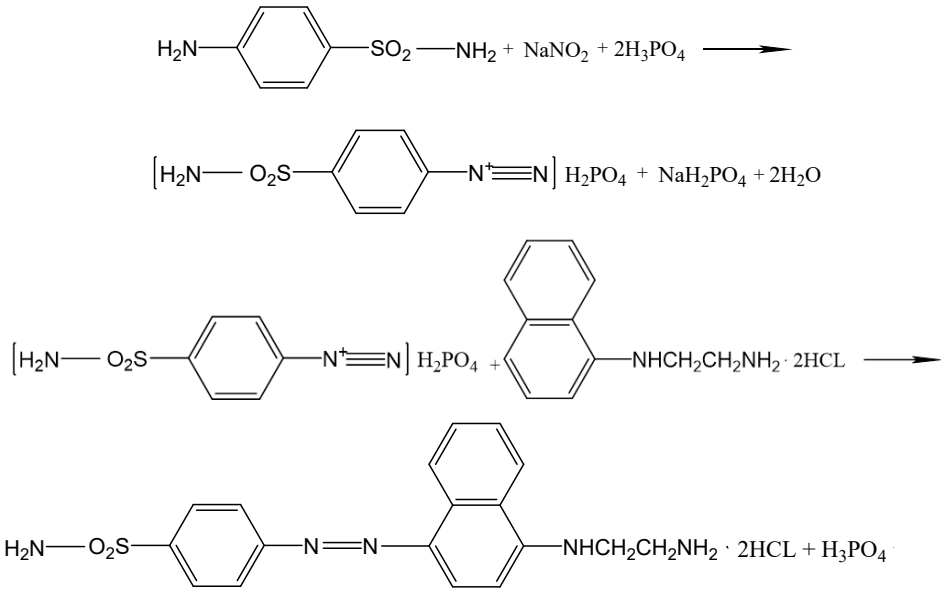
1） Understand the determination of NO2 content in the air

2） Familiar with the construction of spectrophotometer and the use of spectrophotometer

2. Principle and Method

$CuSO_4 \cdot 5H_2O$ is a kind of blue translucent crystal. And it belongs to triclinic crystal system. Its luster is like glass, crispy and brittle. Molecular weight is 248.68 g/mol, the content of water is 36%. The informal name is blue-stone, which is dissolved in the water easily but difficultly in the ethanol. It will be weathered in the dry air, plus, when the temperature is 230℃, it will lose all of the hydrate to change to the white cupric sulfate.

$$2NO_2+2NaOH \rightarrow NaNO_2+NaNO_3+H_2O$$



Standard solution configuration: weigh 0.01500g $NaNO_2$, use absorption liquid (0.1mol·dm^{-3} NaOH solution) to attenuate the solution to 1dm^3 This solution, contain 150μg $NaNO_2$ in each 1cm^3, which called stock solution. Fetch 5cm^3 stock solution, use absorption liquid to attenuate it to 1000cm^3, use this solution as standard solution NO.1, every 1cm^3 standard solution NO.1 is equal to 1 μg NO_2. Fetch another 20cm^3 stock solution, use absorption liquid to attenuate it to 1000 cm^3 use as standard solution NO.2, every 1cm^3 standard solution NO.2 is equal to 4 μg NO_2.

According to the following table configuration, with a suction tube to absorb a liquid, were added to the volumetric flask. According to the following table configuration, with a suction tube to absorb a liquid, and added to the volumetric flask.

Add the developer to each volumetric flask, set the volume to the mark with distilled water, and shake evenly. Placed for 30 minutes, put the solution in each tube into 1cm cuvette, use the blank reagent as a contrast, in the spectrophotometer on the determination of the standard solution of the absorbance, use 540nm as the wavelength.

NO.1	0	1	2	3	4	5
NO.1 solution/ cm3	0	0.5	2.0			
NO.2 solution/ cm3				1.5	3.0	5.0
Absorb solution/ cm3	5.0	4.5	3.0	3.5	2.0	0
NO2 content/ μg	0	0.5	2	6	12	20

(Table 1)

Use a 100cm^3 syringe, inhalation of 5cm^3 0.1$mol \cdot dm^{-3}$ NaOH as absorption liquid, put a latex plug on the injection port, prevent the liquid from flowing out from the syringe. Then, take the air sample to the 100 cm^3 scale line of the syringe (actually just need 95 cm^3 air sample) , remove the latex cover, slowly absorb the ninety five milliliters of gas, re-apply the latex cover, violently shake for five minutes, push the absorption liquid of NO_2 in the colorimetric tube. Add the color reagent to each of the colorimetric tubes which containing the sample and the white solution, oscillate evenly, place 30min. Put the solution in each tube into 1cm cuvette, use the blank reagent as a contrast, in the spectrophotometer on the determination of the standard solution of the absorbance, use 540nm as the wavelength.

3. Materials and Instruments

Instrument：

Colorimetric TubeX1, Colorimetric Tube rackX1, PipetteX1, Pipette rackX1, Glass beadX1, AurilaveX1, Volumetric FlaskX1, Injection SyringeX1, SpextrophotometerX1, Latex TubingX1

Material：

NaOH(0.1mol·dm-3), NaNO2(s), Tartaric Acid(s), Hydrochloric acid naphthalene ethylene diamine (s), H3PO4 (1:19).

4. Experimental Records and Calculation

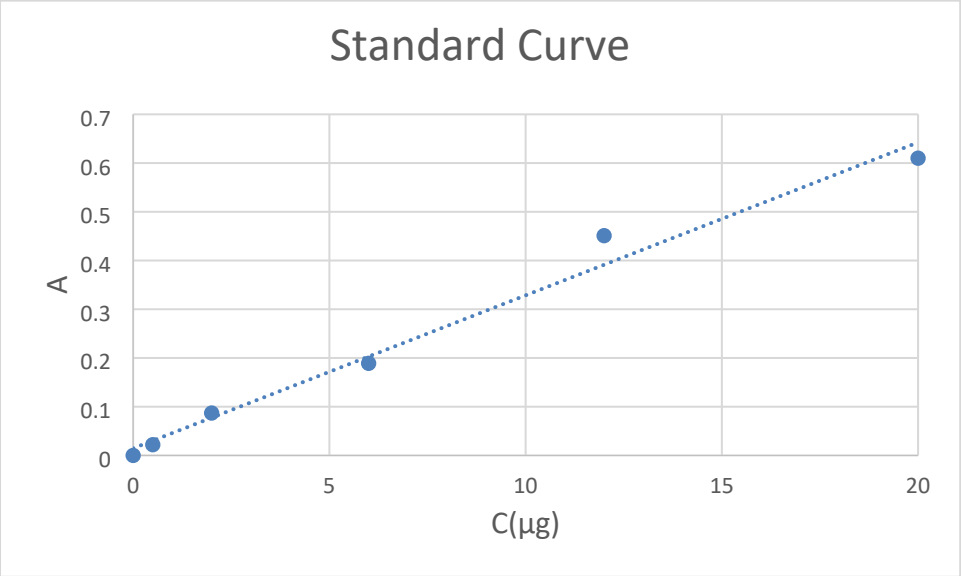
Spectrophotometer model: 722s; Wavelength: 540nm; Cuvette thickness: 540 cm;

Room temperature: 22.60℃; Atmosphere pressure: 96.94 kp;

Tube	0	1	2	3	4	5
NO_2(μ g)	0	0.5	2	6	12	20
Absorbance	0	0.022	0.087	0.189	0.451	0.610

(Table 2)

By using excel tool we get the follow figure.



(Figure 1)

The equation is y = 0.0314x + 0.0146.

According to the common formula for gas conversion.

$$\frac{P_1 v_1}{T_1} = \frac{P_2 v_2}{T_2}$$

According to PV=nRT and $P*V/T=P_0*V_0/T_0 \rightarrow V_0 = V_1*P_1*T_0/(P_0*T_1)$.

We get $V_0 = 95.00*96.94*273.15/(101.325*(22.60+273.15))=83.94cm^3$.

According to the standard curve, A=0.0314*C+0.0146.

The sample C(NO2)= (0.020-0.0146)/0.0314=0.17 μ g.

Use the following formula to calculate the concentration of NO2 ($mg \cdot m^{-3}$).

$$X = \frac{1000c}{v_0}$$

X—NO2 concentration in the air

c—The water content in the sample

v_0—Converted to the standard state of the sampling volume (cm^3)

$X=1000C/V_0=1000*0.56/83.01=2.03mg/ m^3$

5. Results and Discussion

Results

Nitrogen dioxide is harmful gas. Therefore, how to test the air in the nitrogen dioxide is very significant. The purpose of experiment is to evaluate the NO_2 content of the sample solution by plotting the standard curve and calculating the NO_2 concentration in the air. As the result, the NO2 concentration in this experiment in the air is 2.03mg/ m^3.

Error Analysis

The curve fitting is relatively linear, and the R^2 is 0.9834. However, there are some aspects may cause:

A) When using pipette to transfer material, there may be reading error.

B) During extracting the NO_2 gas, some gas may escape due to the poor airtightness of the equipment.

C) When shaking the syringe, gas may not react with NaOH completely.

When transfer the solution, there may some residue which stays in the equipment.

Discussion

According to the environmental quality standards, the concentration should not be far above 0.30mg/m^3. However, the result is 2.03mg/ m^3. It proves that there is air pollution around us. However, the great value may be caused by system error or random error, because the accurate concentration in the box is unknown, the percentage error cannot be determined.