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**Preparation of Nitrogen Monoxide and Study of Its Chemical Properties (microscale experiment)**

**Teachers’ Notes**

**Preparations of solutions**

1. **FeSO4/H+(aq) (for preparation of NO and testing the properties of NO):** Weigh 33.8 g of FeSO4·7H2O(s) and dissolve it in 90 cm3 of deionised water, and then add 10 cm3 of concentrated sulphuric acid *(corrosive)*.
2. **KMnO4/H+(aq):** Weigh ~0.002 g KMnO4(s)and dissolve it in 90 cm3 of deionised water, and then add 10 cm3 of 1 M sulphuric acid.
3. **Br2(aq)**: Add a few drops of bromine into 100 cm3 of water. *(Bromine is corrosive)*

**Sample Results**

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|  | Observations |
| Appearance of the solid NaNO2. | White crystalline solid. |
| Appearance of the acidified FeSO4 solution. | A clear light green solution. |
| Mixing NaNO2(s) with acidified FeSO4 solution. | A colourless gas is formed. The solution turns into dark brown. |
| Washing NO(g) with deionised water. | The gas remains colourless. |
| Appearance of NO(g). | A colourless gas. |
| Before and after adding NO(g) to  (1) acidified KMnO4(aq). | The pale purple solution turns into colourless. |
| (2) Br2(aq). | The pale brown solution turns into colourless. |
| (3) acidified FeSO4(aq). | The pale green solution turns into yellowish brown. |
| After mixing NO(g) with air (O2(g)). | The colourless nitrogen monoxide gas turns into brown. |

**Questions**

1. In the reaction between NaNO2(s) and FeSO4/H+(aq),
2. which one is the limiting reagent? Given: The FeSO4 solution is prepared by dissolving 33.8 g of FeSO4·7H2O in 90 cm3 of water, followed by addition of 10 cm3 of concentrated sulphuric acid.



No. of mole of NaNO2(s) added (mol) = 0.25 / MW(NaNO2) = 0.0036

No. of mole of FeSO4(aq) used (mol)

= 33.8 / MW(FeSO4·7H2O) (4 / 100) = 0.00486 (in excess)

The ratio of NaNO2(s) to FeSO4(aq) should be 1 to 1, so NaNO2(s) is the limiting reagent.

1. calculate the theoretical volume of NO(g) produced. Assume the gas is produced under room temperature and pressure.

As the NaNO2(s) is the limiting reagent, the volume of NO(g) can be calculated with the number of mole of NaNO2(s) used.

No. of mole of NO(g) produced (mol)

= no. of mole of NaNO2(s) added (mol) = 0.0036

Theoretical volume of NO(g) produced (cm3)

= 0.0036 24.0 1000 = 86

1. which one is the oxidising agent and which one is the reducing agent? Explain your answer in terms of the changes in oxidation numbers.

The oxidation number of N in NaNO2 decreases from +3 to +2, it is reduced and so NaNO2 is the oxidising agent.

The oxidation number of Fe in FeSO4 increases from +2 to +3, it is oxidised and so FeSO4 is the reducing agent.

1. write down the half-equations for the oxidation and reduction occurred in the reaction between NaNO2(s) and FeSO4/H+(aq).



1. what is the observable change occurred in the reaction between NO(g) and FeSO4/H+(aq)? Write a balanced equation for the reaction.

The pale green colour of the acidified FeSO4(aq) turned into yellowish brown.



(Teachers may refer to the ‘brown ring test’ for more details of this reaction and the product formed, in which the Fe presumably carries a formal charge of +3.)

1. What is the observable change occurred in the reaction between NO(g) and acidified KMnO4(aq)? Write a balanced equation for the reaction.

The pale purple colour of the acidified KMnO4(aq) turns into colourless. The MnO4- ion is reduced to Mn2+ ion.



1. What is the observable change occurred in the reaction between NO(g) and Br2(aq)? Write a balanced equation for the reaction.

The brownish colour of the Br2(aq) turns into colourless.



1. What is the observable change occurred in the reaction between NO(g) and O2(g)? Write a balanced equation for the reaction.

The colourless gas turns brown.



**Notes for Teachers about the Experiment Procedure**

1. The experiment should be carried out carefully, as nitrogen monoxide reacts readily with O2(g) in air to give the poisonous brownish NO2(g).
2. Remind students to check the syringe before use. The plunger of the syringe should move smoothly inside the syringe. Also, they have to make sure the syringe does not leak.
3. In the preparation of NO(g) from NaNO2(s) and FeSO4/H+(aq), the amounts of reagents used should not exceed those described in the students’ handout so as to prevent an excessive amount of NO(g) produced.
4. In the study of the properties of nitrogen monoxide, follow the procedure described in the students’ handout carefully so as to minimize the release of NO(g) to the surroundings.