Chemiluminescent Ammonia Fountain

Introduction

As ammonia gas dissolves in water, the pressure inside the inverted flask is lowered. This decrease in pressure draws the two solutions into the flask, which react to form a glowing chemiluminescent ammonia fountain.

Concepts

- Chemiluminescence
- Solubility of gases

Materials

Ammonium carbonate, $(NH_4)_2CO_3 \cdot H_2O$, 0.5 g
Ammonium hydroxide, NH_4OH, conc., 2–3 mL
Cupric sulfate, $CuSO_4 \cdot 5H_2O$, 0.4 g
Hydrogen peroxide, H_2O_2, 6%, 25 mL
Luminol, 0.2 g
Sodium bicarbonate, $NaHCO_3$, 24 g
Sodium carbonate, Na_2CO_3, 4 g
Water, distilled
Erlenmeyer flasks, 1-L, 2
Glass tubing, 12 cm
Medicine dropper
Ring stand with clamp
Round-bottom flask, 1-L
Rubber stopper, 2-hole
Rubber tubing, 45 cm
Tubing connector, T-shaped

Safety Precautions

Ammonia vapor is severely toxic and irritating by inhalation and may be fatal. Use only under a fume hood. Ammonia is also a moderate fire risk. Wear chemical splash goggles, chemical-resistant gloves and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

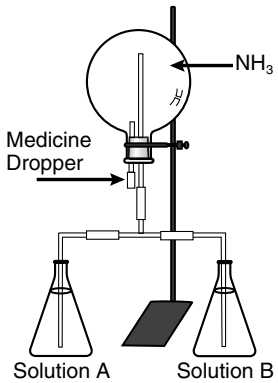
Preparation

In a 1-L Erlenmeyer flask, dissolve 4 g of sodium carbonate in approximately 600 mL of distilled water. Add 0.2 g of luminol, stir to dissolve. Add 24 g of sodium bicarbonate, 0.5 g of ammonium carbonate and 0.4 g of cupric sulfate. Stir to dissolve. Dilute to 1000 mL with distilled water. Stir. This is Solution A.

In a second 1-L flask, add 25 mL of 6% hydrogen peroxide. Dilute to 1000 mL with distilled water and mix well. This is Solution B.

Procedure

1. Prepare the two-hole rubber stopper with water in the medicine dropper as shown in the diagram. Use rubber tubing to connect the glass tubing pieces.
2. Under an operating fume hood, add a few milliliters of concentrated ammonium hydroxide to the round-bottom flask and place it on a warm hot plate until the liquid evaporates.
3. Stopper and invert the flask. Clamp it to the ring stand as shown in the diagram.
4. Attach the rubber tubing from the flask to the T-shaped tubing connector and from each side of the connector to the two 1-L Erlenmeyer flasks full of solutions.
5. Turn down the lights. The darker the room, the more dramatic the effect.
6. Initiate the reaction by squeezing the medicine dropper and allowing a few drops of water to enter the flask.



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7. The partial vacuum produced by the ammonia gas dissolving in the water will draw the solutions up into the round bottom flask. As the two solutions mix, they create a beautiful chemiluminescent effect.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The remaining solution may be flushed down the drain with excess water according to Flinn Suggested Disposal Method #26b.

Connecting to the National Standards

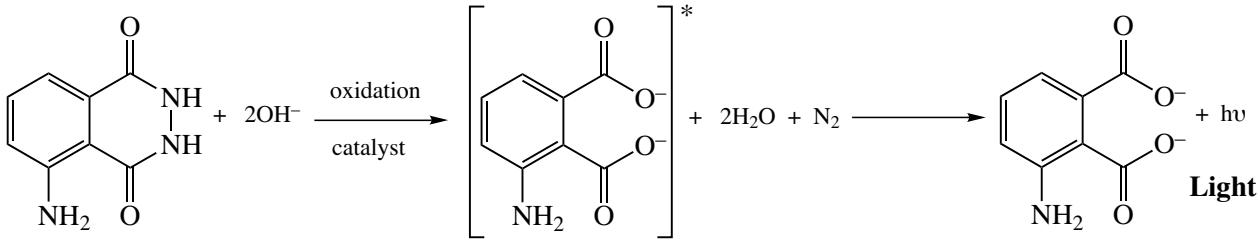
This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter, transfer of energy
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions, interactions of energy and matter

Discussion

Ammonia fountains dramatically show the solubility of ammonia gas in water. Initially, the flask is full of ammonia gas. When a few drops of water are injected into the system, some of the ammonia dissolves in the water. This lowers the pressure inside the flask, drawing up the two solutions. When the solutions enter the flask, more ammonia gas will dissolve, increasing the pressure difference to such a degree that a fountain effect is created.

Chemiluminescence is a process by which energy of a chemical reaction is converted into light energy. Light is produced when electrons drop from an excited or high energy level to a stable or lower energy level. In chemiluminescence, a reaction produces a molecule that is in an excited state. As the electrons in this molecule return to their ground state, energy is released in the form of light. The reaction of luminol with the other chemicals to create the chemiluminescent effect is shown below.



Luminol **Excited State**

References

Shakhashiri, B. Z. *Chemical Demonstrations;* University of Wisconsin: Madison, 1985, p 156–167.

Thomas, N. *J. Chem. Ed. 1990, 67*, 431.

Materials for the *Chemiluminescent Ammonia Fountain* are available from Flinn Scientific, Inc.

Catalog No.	Description
A0226	Ammonium Carbonate, 100 g
S0051	Sodium Carbonate, 500 g
L0078	Luminol, 5 g
H0028	Hydrogen Peroxide, 6%, 500 mL

Consult the Flinn Scientific website for current prices.