Ostwald Oxidation of Ammonia

Endothermic and Exothermic Reactions

Introduction

A beautiful incandescent reaction of ammonia being oxidized to a nitrate by a red-hot platinum catalyst.

Concepts

- Catalysis
- Equilibrium
- Thermochemistry
- Industrial Chemistry

Materials

Ammonium hydroxide, NH_4OH, concentrated, 100 mL
Platinum wire, 20 cm
Bunsen burner
Erlenmeyer flask, 500 mL
Glass tubing
Oxygen source
Plastic tubing

Safety Precautions

Ammonia is toxic and irritating by inhalation. Inhalation may be fatal. Perform only under an operating fume hood. This reaction gets very hot! Occasional explosions can occur if mixture is enriched with pure oxygen. Perform demonstration behind a safety shield. 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.

Procedure

1. Pour 100 mL of concentrated ammonium hydroxide into a 500-mL Erlenmeyer flask.
2. Darken the room if possible.
3. Coil the platinum wire and heat it with the Bunsen burner until it begins to glow.
4. Put the wire in the flask and hook it over the mouth of the flask so it hangs.
5. The wire will glow red due to the reaction. (To assist the reaction, swirl the flask to release more ammonia.)
6. Perform this part of the demonstration behind a safety shield. To intensify the reaction, add pure oxygen to the ammonium hydroxide by connecting plastic tubing to an oxygen source. Then connect the plastic tubing to a long piece of glass tubing. Gently and slowly bubble the oxygen into the ammonium hydroxide. Be careful as this may cause small explosions.

Disposal

Dispose of the excess ammonium hydroxide solution according to Flinn Suggested Disposal Method #10. Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste.

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Discussion

Before the 19th century the major source for ammonia was through the decomposition of natural organic materials. This was very inefficient and produced a low yield. When the Haber process was invented in the early 20th century, ammonia was able to be mass produced. The Haber process is an important industrial process that produces ammonia from hydrogen and nitrogen. The Ostwald oxidation converts ammonia first to the oxide, then to nitrates. Nitrates are important to the fertilizer and explosives industries.

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O + 215 \text{ kcal}$$

$$2NO + O_2 \rightarrow 2NO_2 + 27.8 \text{ kcal}$$

$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO \text{ (recycled)}$$

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

Constancy, change, and measurement

Content Standards: Grades 9–12

Content Standard B: Physical Science, structure and properties of matter, chemical reactions, interactions of energy and matter

Content Standard G: History and Nature of Science, nature of scientific knowledge, historical perspectives

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Ostwald Oxidation of Ammonia* activity, presented by George Gross, is available in *Endothermic and Exothermic Reactions*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Ostwald Oxidation of Ammonia* are available from Flinn Scientific, Inc.

Catalog No.	Description
A0174	Ammonium Hydroxide, NH_4OH, concentrated, 100 mL
GP3050	Erlenmeyer Flask, 500-mL
GP9005	Glass Tubing
AP8373	Plastic Tubing
P0145	Platinum Wire, inch
LB1080	Oxygen Gas, Refillable Cylinder
SE260	Safety Shield, 15″ x 16″

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.