## 5.4 Catalytic Oxidation of Ammonia with Copper

**Subject:** Oxidation/reduction, kinetics

**Description:** When a heated copper coil is suspended over concentrated ammonia, it catalyzes the oxidation of ammonia to $NO_2$ releasing more heat. The added heat continues to heat the copper wire to its melting point.

**Materials:**
Copper wire, coiled with a hook at the top (Alternatively use a small piece of copper foil attached to the end of the wire)
50 mL concentrated ammonia‡
500 ml wide mouth flask
Bunsen burner
Tongs
Matches

‡Ammonia is located in the cabinets under the hood.

**Pre-Class Preparation:**
1. Place 50 mL of ammonia into the flask.
2. Test the length of the wire so that it hangs 4-5 cm above the surface of ammonia. Alternatively, use a small piece of copper foil attached to a copper wire.

**Procedure:**
**Perform this reaction in the hood!** Use the document camera to display the reaction in ISB135.
1. Light the Bunsen burner.
2. Dim the lights.
3. Heat the copper wire until it glows red hot.
4. Place wire in flask with ammonia and hook it on the side of the flask.
5. Observe the reaction in a darkened room.

**Discussion:**
The copper wire catalyzes the oxidation of ammonia vapors with $O_2$ in the air. The oxidation reaction is so exothermic it causes the wire to continue to heat up and will eventually become molten. The reaction is given below:

$4\ NH_3(g) + 5O_2(g) \rightarrow 2NO(g) + 6H_2O(g) + \text{heat}$

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$

If the reaction continues to the point of the copper melting and falling into solution, the solution will turn blue due to formation of an ammonia-copper ion.

**Note:** Platinum wire works better than copper. According to Shakhashiri, copper may not be as effective or as visible.

**Safety:** $NO_2$ gas is extremely toxic. Perform this reaction in the hood. Concentrated ammonia can cause burns and is irritating to the eyes, skin, and respiratory system. Use appropriate protective equipment.

**References:**

1. B.Z. Shakhashiri; *Chemical Demonstrations: A Handbook for Teachers of Chemistry*; Wisconsin; 1985; Volume 2; p. 214-215
2. L. Summerlin, C. Borgford, J. Ealy; *Chemical Demonstrations: A Sourcebook for Teachers*; 1985; p. 84
3. H.N. Alyea, F.B. Dutton, Eds., *Tested Demonstrations in Chemistry, 6th ed.*; Journal of Chemical Education; Easton, Pennsylvania; 1965
4. Purdue University Department of chemistry lecture demonstration website: http://chemed.chem.purdue.edu/demos/main_pages/19.5.html