DO Ni^{2+} AND Cu^{2+} FORM BIS- OR TRIS- COMPLEXES? (#3.2)

A CCLI EXPERIMENT
Computers in Chemistry Laboratory Initiative

Learning Objectives

The objectives of this experiment are to ...

- understand how a simple calorimeter is used to determine the maximum number of ethylene diamine (*en*)molecules that will chelate to aqueous Ni^{2+} and Cu^{2+}.
- understand the effect of structure of a coordination compound on its reactions.

Background

Transition metal ions combine easily with neutral molecules or anions (ligands) to form coordination complexes. The number of ligands that bind to a metal center (its coordination number) may vary from 3 to 8, depending on various factors. Most complexes have the coordination number of 6, and in almost all of these complexes, the ligands are arranged around the metal center in octahedral geometry as shown in Figure 1. In this experiment, we will study reactions of two octahedral complexes: $[Ni(H_2O)_6]^{2+}$ and $[Cu(H_2O)_6]^{2+}$ and determine the structure of the **en** complex for each. Step wise displacement for the monodentate NH_3 is discussed compared to that of the bidentate **en**, in which each replacement occurs with evolution of heat.

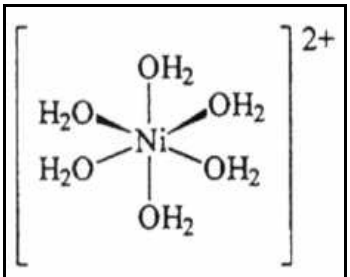

Figure 1. Diagram showing the octahedral structure of the $[Ni(H_2O)_6]^{2+}$ complex ion.

The $[Cu(H_2O)_4(NH_3)_2]^{2+}$ complex poses an interesting question which the students explore for a solution.

The thermochemistry of the nested beaker calorimeter and the reactions is studied.

Experiments Performed

1. Temperature probe calibration
2. Reaction of $[Ni(H_2O)_4(NH_3)_2]^{2+}$ with ethylene diamine. Includes four additions of ethylene diamine with cooling to room temperature in between to determine when all water molecules have been replaced.
3. Reaction of $[Cu(H_2O)_4(NH_3)_2]^{2+}$ with ethylene diamine. Also includes four additions of ethylene diamine with cooling to room temperature in between to determine when all water molecules have been replaced.
4. Data Analysis: Procedures are given to guide the data analysis.

Instructor Resources Provided

5. Sample Report Sheets providing the format to organize the data collection with sample data.
6. Questions to consider, answer and turn-in with suggested answers.
7. Tips and Traps section to assist the instructor with potential problems and solutions.
8. Sample ***MicroLAB*** screen shots and graphs.
9. Laboratory preparation per student station.

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