TESI 04 LESSON PLAN

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July 29, 2004

State/National Standards Focus

National Standards Content Standard B (Physical Science): Chemical Reactions

Wisconsin State Standards Performance Standard D.12.4: Explain how substances, both simple and complex, interact to produce new substances.

How Lesson Meets Goals of the Standards

Through the completion of this experiment students will observe the products of single replacement and double replacement reactions, write and balance equations describing the reactions, and identify products of the reactions through observation and inference. Problems of scaling chemical processes from the bench top to the industrial scale will be discussed along with problems and potential opportunities for recycling materials.

Lesson Objectives

1. The students will write and balance five chemical equations which have been observed throughout the process of completing the experiment.
2. The students will use vacuum filtration to recover suspended particles from a colloidal suspension.
3. Students will correctly identify the copper or copper minerals in a recovered sample of copper material.

Materials

Copper (wire or some form of waste containing copper)
Nitric Acid (6 M)
Sodium Hydroxide (6M)
Hydrochloric Acid (6M)
Aluminum (Sheet or wire)
Standard Chemistry Laboratory Glassware and Equipment

Instructional Activities

Safety Information

The processes described below use strong acids and bases (6 M HCl, 6M HNO_3, 6 M NaOH) and generate gasses that should be handled in a chemical fume hood. Safety instruction regarding the handling of these materials must be provided and reviewed with the students. All materials used and generated in this procedure are hazardous and should

only be handled while wearing proper safety gear such as laboratory apron and goggles. If there is any doubt regarding the student's abilities to appropriately handle the materials this activity should not be considered. Only a brief description of the procedure is given below. Specific instructions may be obtained from Tim Corcoran or the Interdisciplinary Approaches to Chemistry curriculum's *Reactions and Reasons* module.

Day 1

Students start the experiment by combining the copper and the nitric acid in a beaker placed under the fume hood. Caution! NO_2 gas is generated in this step and is hazardous. The product of this reaction is copper (II) nitrate.

While reaction occurs students are introduced to the basics of metallic mining including specifics of the Cu mining process in the Keweenaw Peninsula. Discussion of the materials needed to support our current standard of living and the concept that we need to obtain basic resources from the earth are covered at this time.

Each group of four students (one lab table) will be assigned to cooperatively generate a report on the different aspects of copper. Each person will be responsible for one part of the report. The assigned parts will be: 1. Sources of copper used in the U.S. 2. Methods of copper extraction from the ore. 3. A historical perspective of copper from the copper age to modern times. 4. Uses of copper.

Day 2

The copper (II) nitrate is taken through four reaction stages during this period. Sodium hydroxide is added to the copper (II) nitrate to form copper (II) hydroxide. The copper (II) hydroxide is heated to form copper (II) oxide and the precipitate is allowed to settle. After decanting the clear solution from the solid copper (II) hydroxide, hydrochloric acid is added to the copper (II) oxide forming copper (II) chloride. An aluminum strip is then placed in the beaker to cause the reduction of the copper (II) chloride to copper. The beaker containing the copper, aluminum and solution is allowed to sit overnight.

Day 3 and 4

The excess aluminum is removed from the copper and the solution decanted. The copper precipitate is cleaned with hot distilled water, the excess solution decanted (saving the filtrate), and the copper is transferred to an evaporating dish. The copper is dried. Problems typically occur during the drying of the copper including the formation of black, bright green or bluish green solids that yield several hundred percent error when compared to the original mass of the copper. Other problems that occur include the obvious loss of copper particles during decanting due to the fine particle size and lack of settling that occurs.

During the drying process students are guided, through discussion, to note the problems encountered during the cleaning and decanting are problems that industries face in the production of many products. Peninsula Copper Industries' process can be used as an example. Settling rate of the particles and ideas to speed that rate may be discussed.

Vacuum filtration can be used (side arm flask and aerator) to retrieve the copper that fails to settle from the filtrate.

Day 5

Written report assigned on Day 1 of activity is reviewed by the students in their groups of four and then collected. The samples that did not dry properly (forming malachite and azurite) are set out and students are given an identification key to copper bearing minerals including malachite, azurite, and chrysocolla. Students are instructed to make identifications of the possible minerals that formed by noting the physical characteristics (color) and chemical formulas. Samples of malachite (collected TESI04, Bumbletown), chrysocolla (collected TESI04, Bumbletown), and azurite (purchased TESI04, Seaman Mineral Museum) will also be displayed to help in the identification. The identifications are verified and results of the experiment discussed.

In a check-off procedure the student's balanced equations are checked for accuracy, questions are asked regarding the steps of the procedure and the physical characteristics of the copper compounds, and students are asked potential products from various reagents that might be added at some point in the procedure i.e. What compound could potentially form if H_2SO_4 were added to the copper (II) oxide? (copper (II) sulfate). Or if H_2CO_3 were added? (copper (II) carbonate). In the final step, the students will take their dried copper (no matter what form it may be in), grind it in a mortar and pestle and place in a film canister. Shaking the canister will suspend the dust inside the canister. The students can hold the top of the canister next to the air intake port of a lit Bunsen burner and open the canister lid. This will (should) result in the Bunsen burner flame turning green due to the uptake of the copper particles into the air/methane mixture (reminiscent of the fire circle at the Caledonia Mine). The atomic spectra of various elements can be discussed.

Enrichment

The spectra of elements can be further explored by the use of dried samples of the chlorides of lithium, potassium, strontium, barium, and sodium and testing in the same manner as described in the Day 5 procedures.

Research ideas can be generated and researched regarding the recycling of Cu or other minerals.