INVESTIGATION 7

Copper Extraction

Lab

PURPOSE

- Measure the amount of copper metal you can extract from copper (II) carbonate, the main ingredient in the mineral malachite
- Model an environmentally sound, modern method of extracting copper profitably from tailings

INTRODUCTION

Most metals are found in Earth combined with other elements. The term **ore** is used to describe a piece of Earth's crust that contains profitable amounts of a metal. Malachite is an ore that is common in the Southwest of the United States and is a form of copper (II) carbonate, with the formula $CuCO_3Cu(OH)_2$. The green corrosion that forms on copper due to weathering, such as seen on the Statue of Liberty, has the same composition as malachite. The reactions of malachite are similar to those of copper (II) carbonate.

Commercial copper mining has gone on in many regions of the United States for over 100 years. Most of the copper mines use the open pit method of extracting ore. In the early days the technology for extracting metal from the ore was

Fig. 7-1
Open Pit Copper Mine

crude. To yield salable amounts of metal, the ore had to be at least 2.5% copper by mass. A lot of copper was left behind in the residue, or **tailing piles**, because the technology was not able to remove it profitably. As time went on, our technology improved, and profitable amounts of copper were taken from lower grade ores. By the year 2000, American miners were making a profit on ore that was 0.44% copper. Old tailing piles that accumulated around the mines still had valuable copper in them, but it was easier and cheaper to dig new ore out of the ground and process that for the metal, both here and overseas.

From an environmental point of view, the old tailing piles are a major contributor to water pollution. Many copper ores contain sulfides, which, mixed with water become strongly acidic. These acid waters can then leach metals out of the waste piles, making the run-off water even more toxic. This problem is especially severe in arid regions where water is already at a premium. In many areas of the West the mines and their tailings were abandoned as the price of copper fell and offshore sources became cheaper, but the pollution remained.

In the last 15 to 20 years a few small companies have developed processes to remove profitable amounts of copper from the old tailing piles. This practice helps revitalize the local economy, removes some of the tailings, and improves water quality. In this lab, you will model methods used in the Southwest to reduce the tailing piles, clean up the environment, and, at the same time, turn a profit.

Fig. 7-2

Tailing Piles at an Open Pit Mine

Materials

- safety goggles
- dilute sulfuric acid
- wash bottle
- water, distilled
- copper (II) carbonate
- balance
- glass rod
- Bunsen burner
- iron filings
- 2 beakers, 250 mL
- filter paper
- funnel

Procedure

Step 1 Add 6 g of copper (II) carbonate to a dry beaker and add 10 mL distilled water.

Step 2 Carefully add 15 mL of 6M sulfuric acid.
WEAR EYE PROTECTION.

Step 3 Heat gently and stir with a glass rod.

Step 4 Add 2.7 g of iron filings and stir until there is no more color change in the solution.

Step 5 Place your name on a clean, dry piece of filter paper and record its mass.

Step 6 With the wash bottle, flush the liquid and solid from the bottom of the beaker into the folded filter paper in a funnel. Be sure to rinse all the solid into the filter. Allow the solution to drain fully into the beaker under the funnel and then rinse the filtrate with more distilled water.

Step 7 When all the water has drained through the filter, remove it from the funnel, then open it up carefully on a tray to dry overnight.

Step 8 During the next lab period, record the mass of the dry filter paper and filtrate. Measure the mass of copper collected.

Step 9 Calculate the percent yield, based on the expected amount of copper metal.

Data and Calculations

Step 10a Write the correct chemical equations for the reactions in this lab.

b Show your data table and measurements for your yield of copper.

c Calculate your expected yield of copper from the balanced equation.

d How many grams of copper did you collect, compared to your expected yield? What was the percent yield in your experiment?

Problems

Read the questions below. Conduct independent research, if necessary, to respond fully.

1. From your research, describe how the method you modeled is used in the metal industry. How could it be used on a large scale?

2. There are many other minerals mined in the United States and around the world that leave large tailing piles. Describe a method for cleaning tailing piles for a mineral other than copper.

3. Explain how cyanide is used to mine gold. Why is this such a controversial method in the Northern Rocky Mountains? What environmental problems does this method present?

4. Describe an alternate method of mining gold without the use of cyanide.