Analysis of Silver in an Alloy

To determine the **% silver** in an alloy of silver, sterling silver (925).

In this experiment, an **alloy of silver** is analyzed to determine its **silver content**. The mass of a **silver-copper alloy** is measured. The silver is oxidized and then precipitated. From the **mass of the silver precipitate** formed and the **mass of the original alloy sample**, the **% of silver** in the alloy can be calculated. Because the results are based on the mass of a product, this procedure is classified as a **gravimetric analysis**.

Silver and **copper** are **below H^+** in the activity series. Neither reacts with hydrochloric acid nor sulfuric acid. The **"oxidizing" acid**, **nitric acid HNO_3** is required. In acidic solutions, the **nitrate ion NO_3^-** is an excellent oxidizer, and it will oxidize **$Ag_{(s)}$ to $Ag^+_{(aq)}$**, and oxidize **$Cu_{(s)}$ to $Cu^{2+}_{(aq)}$.** The reduction product is the gas **nitrogen monoxide NO**. As the colorless nitrogen monoxide gas forms, it immediately reacts with oxygen in the air to produce the orange-brown and very toxic gas **nitrogen dioxide NO_2**. The half-reactions are as follows:

Oxidation: $Ag_{(s)} \rightarrow Ag^+_{(aq)} + e^-$ $\quad$ $Cu_{(s)} \rightarrow Cu^{2+}_{(aq)} + 2e^-$

Reduction: $4H^+_{(aq)} + NO_3^-{}_{(aq)} + 3e^- \rightarrow NO_{(g)} + 2H_2O_{(l)}$

EQUIPMENT

electronic balance	beakers, 100mL and 250mL
weighing paper	graduated cylinders, 10ml and 25mL
microspatula	rubber policeman
hot plate	drying oven
filter flask	watch glass
vacuum tubing	filter paper
funnel	Buchner funnel

Chemicals

silver-copper alloy, sterling silver	sodium chloride, $NaCl_{(s)}$
nitric acid, HNO_3, 8M	distilled water, wash bottle

PROCEDURE:

1. Obtain a piece of filter paper to fit in the Buchner funnel and measure its mass on the electronic balance.

2. Mass silver alloy sample (between 0.100g and 0.500g) and transfer it to a clean 100mL beaker.

3. With graduated cylinder, carefully pour 10mL of 8M nitric acid into the beaker with the alloy. Place the beaker on a hot plate (turned to low heat setting 3).

4. Place the open end of the funnel (whose narrow end is attached to vacuum tubing) over the top of the beaker. Attach tubing to water faucet aspirator. Turn on the faucet. This will safely remove any gas that rises from the reaction mixture. Gently swirling the beaker speeds the reaction. Reaction is complete when a light turquoise, clear solution results.

5. Calculate the excess amount of sodium chloride needed to precipitate all silver ions by finding twice the stoichiometric amount. With weighing paper, mass this amount of NaCl on the balance using a microspatula.

6. With graduated cylinder, pour 25mL distilled water into 250mL beaker and dissolve the NaCl by mixing well with glass stirring rod.

7. Slowly add the sodium chloride solution to the silver/copper ion solution in 100mL beaker. Stir with stirring rod, and use distilled water to rinse any solution clinging to the rod back into beaker.

8 Gently heat (without boiling) the mixture for about 15 minutes (at same setting 3). This will allow precipitate particles to grow larger so they are easier to filter.

9. Attach the Buchner funnel to filter flask. Remove vacuum tubing from the funnel and attach to the filter flask. Turn on the faucet. Squirt some distilled water through the filter with suction to seat the filter paper firmly in bottom of the crucible.

10. Carefully pour the precipitate mixture into the crucible. Use a little distilled water and the squeegee end of the rubber policeman to quantitatively transfer ALL precipitate from beaker to filter. Rinse the precipitate in the filter several times with distilled water.

11. Carefully remove the wet filter paper with the precipitate by peeling the sides with a microspatula. Place the wet precipitate and filter paper on a watch glass labeled with your initials and place in 110^{o}C drying oven overnight.

12. Next day, find the mass of the filter paper and silver chloride on the same balance used previously.

13. From your data, calculate the %silver in your sample.

Consider and answer the following questions for discussion and analysis:

1. Why is a two-fold excess of chloride ions added to the reaction mixture?
2. Why is it not necessary to weigh the NaCl on a high accuracy balance?
3. Why is it necessary to wash the precipitate with water? List all ions washed off it.
4. Why is it important that the precipitate be dry and the crucible be cool before the final weighing?