**Formula of a Hydrate**

**Introduction**

A hydrate is a compound that has water molecules "trapped" in the structure of the crystal. The water molecules are not bonded to the main structure; rather they are surrounded by it. By changing the structure of the main molecule, the water molecules can be released. An easy way to accomplish this is to heat the hydrated (water-containing) compound. After the water is removed, the compound is said to be anhydrous. In this experiment, we will determine how many water molecules are trapped inside each molecule of copper (II) sulfate. Thus, we will determine the formula of hydrated copper (II) sulfate.

From the last lab, we know that when copper and sulfate combine, it forms the formula CuSO4. The 1:1 ratio of cupper ions to sulfate ions is due to the relative charge of each ion. In this lab, we want to find the ratio of CuSO4 to water, so we may complete the formula of the hydrate: CuSO4 • ? H2O. In order to find the ratio of how many copper (II) sulfates to how many water molecules, we must use the concept of the mole. If we can find the moles of CuSO4, and the moles of H2O, we can find the simplest, whole number ratio between the two. This will provide the coefficient to fill in the ? in the formula of the hydrate.

**Procedure**

Put on your safety glasses or goggles.

1. Assemble a Bunsen burner. Obtain a crucible and lid. Clean the crucible by heating it in a clay triangle until the bottom glows red for five minutes. Once the crucible is clean, handle it only using a pair of crucible tongs. This is to avoid burns as well as not to add the mass of fingerprints to the crucible. Allow the crucible to cool on the bottom of a ring stand or in a desiccator for about five minutes.

2. Obtain about 5 grams of hydrated copper (II) sulfate.

3. Determine the mass of the empty crucible, without the lid. (WARNING! Never weigh a crucible while hot. Not only will it damage the balance, but it will also not be an accurate measurement!) Record this value in the data table.

4. Add the hydrated copper (II) sulfate to the empty crucible, and determine the mass without the lid. Record this value in the data table.

5. Set the crucible in the clay triangle. Place the lid on top of the crucible. Be sure to tip the lid slightly to one side, so that air may freely enter the inside area. Heat the crucible until the bottom glows for 5 minutes. Remove the heat, and allow the crucible to cool on the bottom of the ring stand, or in a desiccator.

6. Determine the mass of the crucible (without the lid) and now anhydrous copper (II) sulfate, and record the value in the data table.

7. Repeat steps 5 and 6. Continue to repeat steps 5 and 6 until nearly the same number is obtained. Record the final value in the data table.

8. Clean up all equipment and your area, as described on your cleaning checklist on the back of the equipment list in your drawer. Dispose of the copper (II) sulfate in the solid waste container. Wash your hands, and return your safety glasses to the storage cabinet. MAKE SURE THE GAS IS TURNED OFF. Return to the classroom.

Crucible data table

|  |  |
| --- | --- |
| mass of empty crucible |  |
| mass of crucible and CuSO4 • ? H2O |  |
| mass after 1st heating |  |
| mass after 2nd heating |  |
| mass after 3rd heating, if needed |  |
| mass after final heating |  |

**Analysis questions**

1. Find the exact mass of the hydrated copper (II) sulfate, CuSO4 • ? H2O, using only numbers in the data table above.

2. Find the mass of the water evaporated from the hydrate.

3. Find the mass of the anhydrous (dry) copper (II) sulfate, CuSO4.

4. Convert the mass of anhydrous (dry) copper (II) sulfate, CuSO4, to moles.

5. Convert the mass of water to moles.

6. Find the ratio of moles of CuSO4 to moles of H2O. \_\_\_\_\_\_\_\_\_\_ : \_\_\_\_\_\_\_\_\_\_\_

7. Express the ratio from calculation #6 in its simplest, whole number ratio. \_\_\_ : \_\_\_

8. Write the complete formula for copper (II) sulfate hydrate.

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