Percent Composition and Formula of a Hydrate

**Objective**: To determine the percentage of water in a hydrate and the empirical formula of an unknown hydrate.

**Materials**:

* Hot Plate
* Evaporating dish
* Balance
* Crucible Tongs
* Weigh Boat
* Ceramic Tile
* Goggles
* Apron
* 5 grams of Copper(II) Sulfate

Chemicals & Safety/Recycling/Disposal

*Copper(II) Sulfate*

1. Skin and respiratory irritant
2. Moderately toxic by ingestion and inhalation.

MSDS Source: http://www.flinnsci.com

**Procedure**:

1. With the hot plate, heat the evaporating dish for 2 minutes on the highest setting. Allow it to cool for 3 minutes on the ceramic tile.
2. Measure and record the mass of the evaporating dish.
3. Measure and record the mass of 5 g of the unknown hydrate. Record 2 physical properties of the hydrate and transfer it to the evaporating dish.
4. Heat the evaporating dish by gradually increasing the heat from a setting of 3 to high over a 3 minute period and then heating on the high for 5 minutes. Then allow it to cool for 5 minutes.
5. Measure and record the mass of the cooled evaporating dish and dehydrated chemical.
6. Reheat the evaporating dish with the hydrate by gradually increasing the heat from a setting of 3 to high over a 2 minute period and then heating on high for 1 minute. Then allow it to cool for 5 minutes.
7. Measure and record the mass of the cooled evaporating dish and dehydrated chemical. Record two physical properties of the new compound.
8. Dispose in the waste container provided, rinse and dry the evaporating dish, and clean up your area.

**Data**:

Physical Properties:

1. Blue, granular solid
2. Odorless

Observations:

1. Initially, it looked as though the blue color intensified.
2. The heated hydrate could be heard popping and sizzling as the heat intensified.
3. The color of the mixture started losing it blue color for a lighter and whiter appearance with a dull gray on the edges of the mixture.
4. No mass change occurred after the 1st heating.

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| **OBJECT** | **MASS** |
| COOLED EMPTY EVAPORATING DISH | 36.58 g |
| STARTING HYDRATE | 5.01 g |
| HYDRATE (1st Heating) | 3.41 g |
| HYDRATE (2nd Heating) | 3.41 g |
| WATER REMOVED | 1.60 g |

Calculations:

1. CuSO 5H O = 249. 71 g/mole

Cu = 63.55 g/mole

S = 32.06 g/mole

O = 4 x 16.00 g/mole

5H O = (10 x 1.01) + (5 x 16.00) = 90.1 g/mole

of H O in CuSO 5H O

1. Mass of Dish and Hydrate = 39.89 g

Mass of Dish = 36.58 g

Mass of the hydrate used = 39.89 g – 36.58 g = 5.01 g

Mass of Anhydrous compound after 1st heating = 3.41 g

Mass of Anhydrous compound after 2nd heating = 3.41 g

1. Total mass of water removed from the hydrate = 5.01 g – 3.41 g = 1.60 g

Questions:

1. 18.02 g/mole of H O
2. CuSO = 159.61 g/mole
3. The mass of the crucible is irrelevant and would not affect the results of the experiment because the data needed to determine the percentage of water in hydrate and its empirical formula is the mass of the amount of water in the hydrate and the mass of the hydrate.

**Conclusion**:

This lab was performed to determine the percentage of water in a hydrate and find its empirical formula. To find this, a hydrate was heated to evaporate all of its water. The masses of the hydrate and its anhydrous remains were measured to calculate the amount of water removed and the percentage of water in the hydrate. Throughout the hydrate’s heating, some popping and sizzling occurred as well as a note loss in blue color. The hydrate lost a total of 1.6 g of water in the first heating, and no water was lost in its second heating. The percentage of water was calculated to be % and the empirical formula was calculated to be A possible source of error for the experiment is the use of a faulty balance that could have given misreadings in the mass of the dish, the hydrate, and its anhydrous counterpart. The use of a faulty heating plate could have not allowed for full evaporation of the water from the hydrate and thus affect the results of the experiment as well. The experiment should be repeated multiple times to ensure precision and accuracy. Different hot plates can also be used to ensure that the quality of the materials does not interfere with the results. In conclusion, water was found to be make up about 1/3 the composition of Copper(II) Sulfate Pentahydrate.

Percent Error: