**Hydrate Composition**

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**ABSTRACT**

The composition of hydrated ionic salts was determined by using the law of definite proportions which says that a compound is formed by two or more elements that are proportionally fixed in mass. The anhydrous salt I used (CaSO4) was first heated up and cooled using a crucible, Bunsen burner and a desiccator. After the anhydrous salt was cooled to room temperature, it was weighed using an electronic balance. This was repeated until the mass remained constant. The temperature was taken for the anhydrous salt and then the hydrated salt after water was added when the mass stabilized. The change in temperature represented the change of an anhydrous salt to a hydrated salt.

1. **INTRODUCTION**

Hydrate composition can be determined because we know a compound is composed of a number of elements that are proportionally fixed in mass. Due to the law of definite proportions, we are allowed to find the mass of water by subtracting the mass of the hydrated salt from the mass of the anhydrous salt. By finding the mass of water from the hydrated salt, we can calculate the molar mass of water and find out how many moles of water are found in a mole of anhydrous salt. The number of moles of water and anhydrous salt provides us with a ratio of atoms that is used to find an empirical formula of the hydrated ionic salt.

1. **EXPERIMENTAL**

The anhydrous salt I used was Calcium Sulfate (CaSO4). It was white in color and was powdery in texture. The mass in grams of the anhydrous salt was measured after measuring the masses of the crucible and the crucible with salt and then taking the difference between the two masses. I used a Bunsen burner to heat the crucible with salt and used a desiccator to cool the salt. After the crucible with salt was fully cooled, I measured and recorded the weight. This heat and cool cycle was repeated until the mass stabilized at a constant mass. The temperature of the salt was also taken using a thermometer before and after water was added. This entire process was used for both trials one and two.

The equipment we used for this experiment were: Bunsen burner, crucible, electronic balance, thermometer, wired triangle, iron ring, crucible tong, dropper.

1. **RESULTS AND DISCUSSION**

Table 4.1 contains data of the masses of the crucible and the crucible with salt before and after heat and cool cycles. The mass of the hydrated salt was calculated by subtracting the mass of the crucible from the mass of the crucible with salt before it was heated which was 1.878 g. The mass of the anhydrous salt was calculated to equal 1.756 g. The difference between these two masses provides us the mass of water in the hydrated salt which will allow us to calculate the moles of water in the hydrated salt. The masses of the hydrated salt and anhydrous salt were different because heat was used to evaporate the water in the hydrated salt which resulted in the anhydrous salt. The difference between these masses would tell us how much water evaporated from heating the hydrated salt.

The mole of water in the hydrated salt was equal to 6.777 \* 10-3 and the mole of the anhydride was equal to 1.291 \* 10-2. The ratio of these two numbers shows us how many moles of water is equivalent to 1 mole of anhydride. From my data, the average value empirical formula of the hydrated salt is: CaSO4 \* 1.9 H2O. The number 1.9 which represents *x* is not to the correct precision but is close to the true value which is 2. However, a source of error that could have changed the result would have been the inaccuracy of the mass measurement because the electronic balance reading kept fluctuating and never stopped at one particular mass. The integer *x* or 1.9 is an appropriate value because the true value is 2 moles of water for every 1 mole of anhydride. The percent error in this value is: ((2 – 1.9) / 2) \* 100 = 5%. The percent error of 5% is most likely due to the inaccuracy of the electronic balance that was used to measure the mass of the hydrated and anhydrous salts.

1. **TABLES**

Table 4.1: The masses (g) of a crucible with salt are weighed before and after heat and cool cycles; Trial 1.

|  |  |  |
| --- | --- | --- |
| Object | m (g) | Notes |
| Clean, dry crucible | 25.305 | Cleaned with water and dried |
| Crucible with salt (before heating) | 27.183 | 22 degrees Celsius  White, powdery |
| Crucible with salt after 1st heat/cool cycle | 27.012 | Wired triangle shows whether the flame is too hot or not  Still powdery but a little more chunky |
| Crucible with salt after 2nd heat/cool cycle | 27.010 | Powdery and white in color still |
| Crucible with salt after 3rd heat/cool cycle | 27.061 | 21 degrees Celsius |

Table 4.2: The masses (g) of a crucible with salt are weighed before and after heat and cool cycles; Trial 2.

|  |  |  |
| --- | --- | --- |
| Object | m (g) | Notes |
| Clean, dry crucible | 25.402 | Cleaned with water and dried |
| Crucible with salt (before heating) | 26.434 | 23 degrees Celsius  White, powder |
| Crucible with salt after 1st heat/cool cycle | 26.333 | White, powder |
| Crucible with salt after 2nd heat/cool cycle | 26.326 | White, powder |
| Crucible with salt after 3rd heat/cool cycle | 26.320 | 23 degrees Celsius  No change in temperature |

1. **CALCULATIONS**

TRIAL 1

Mh (hydrated salt) = 27.183 g – 25.305 g = 1.878 g.

Ma (anhydrous salt) = 27.061 g – 25.305 g = 1.756 g.

Mh – Ma = Mw (mass of water) = 1.878 g – 1.756 g = 0.122 g.

Molar mass of H2O = 2 H (2 g) + 1 O (16 g) = 18g.

0.122 g (Mw) / 18 g (molar mass of H2O) = 6.777 \* 10-3 (moles of water in hydrated salt).

Molar mass of CaSO4 = Ca (40 g) + S (32 g) + 4 O (16 g) = 136 g.

1.756 g (Ma) / 136 g (molar mass of CaSO4) = 1.291 \* 10-2 (moles of anhydride).

(1.291 \* 10-2) / (6.777 \* 10-3) = 1.905 moles of water : 1 mole of anhydride.

Average value of ratio = 1.9 moles of water : 1 mole of anhydride; CaSO4 \* 1.9 H2O.