Experiment 5 – Percent Water in a Hydrated Salt

Pre-Lab Hints

1. Note definition of deliquescent in the introduction.
2. See side notes for part A, as well as part 1 of Technique 15C in the front portion of your lab manual.
3. Mass of water in sample is the mass lost by heating (initial minus final).
   Water % is 100 % times the g of water divided by the initial g of hydrate sample.
4. a. See step A1 in the procedure.
   b. A hot sample on the balance creates air currents and causes thermal expansion.
   Both of these factors decrease the accuracy of the measurement.
5. Water mass is the difference between the hydrate mass and anhydrous mass.
   Be sure to subtract mass of crucible and lid to obtain mass of salt samples.
   Water % is 100 % times the g of water divided by the g of hydrate sample.
   Skip standard deviations. Write all calculations down on a separate sheet of paper.
6. a. Find mass (g) of 7 moles of water.
   Then, find the formula weight (g/mol) of anhydrous $FeSO_4$.
   Formula weight of hydrate is the sum.
   Water % is 100 % times the water mass divided by the formula weight of hydrate.
   b. Multiply the % from part 6a times the sample mass in part 6b.

Procedure Notes

- Do not forget to record the anhydrous salt's **name** on your report sheet.
- Use three different samples of the **same salt** for the experiment.
- Be sure to clean crucible with HCl and HNO_3 (~ 1 ml each) before firing!
- Use **gloves** when handling the acids, and dispose of the acids in the appropriately labeled **waste jar**.
- Do **not** handle fired crucible with your hands at any time.
  You can burn yourself *and* contaminate the crucible at the same time.
- Use a pair of tongs for the crucible, and a pair of forceps for the desiccator chamber's lid.
- Review Techniques 15B and 15C (front portion of your lab manual).
  Note Figures **T.15c** and **T.15e** (with those techniques) for firing and for heating sample.
- Cool crucible only in dessicator provided. See Figure **T.15b** (with the lab techniques).
- Dispose of all solid residues in the appropriately labeled **waste jar**.
- Skip portions involving standard deviation.
- Show **all** calculations for **all** three trials.
- Determine **n** (rounded to an integer), using the equation in the calculation notes.
  Include this calculation with your report sheet.
- Put your calculated integer value for **n** into the chemical formula of your hydrate.
  For example, n = 5 for $CuSO_4$, so its hydrate formula is $CuSO_4 \bullet 5H_2O_{(s)}$.

Calculations

Water Mass = (Hydrate Mass) – (Anhydrous Mass) = (Initial Mass) – (Final Mass)

$$\text{Water \%} = \frac{(\text{Water Mass})}{(\text{Hydrate Mass})} \times (100\%)$$

For salt $AB{\bullet}nH_2O_{(s)}$, find n using the following equation. Use your experimental water % as the grams of water (per 100 g hydrate) in the top of the numerator. Then, 100 % minus that water % is the grams of the anhydrous salt (per 100 g hydrate) in the top of the denominator. Determine anhydrous g/mol as the molar mass of the salt without the water. Once you have the n value, round it to an integer, and use it to write the chemical formula of the hydrate, such as $CuSO_4{\bullet}5H_2O_{(s)}$. Write calculations for water % and n on a separate sheet of paper.

$$n = \frac{\text{moles water}}{\text{anhydrous moles}} = \frac{\text{grams of water divided by its molar mass}}{\text{grams of anhydrous salt divided by its molar mass}} = \frac{\left[\frac{(\text{water \%})}{(18.0\ \text{g/mol})}\right]}{\left[\frac{(100 - \text{water \%})}{(\text{anhydrous g/mol})}\right]}$$

Lab Questions

1. Suppose water vapor condensed on the crucible after it was fired, but before it was initially weighed. The condensation caused the mass measurements of both the empty crucible, and the crucible with the hydrated salt, to be higher than actual. What happens when the hydrate mass is calculated by taking the difference between the measurements?

2. The condensed water (on the crucible in question 1) evaporates when the hydrate is heated in the crucible. Providing that the condensation does not recur on cooling, what now happens to the calculations for the lost water mass and the water percentage? Explain your answer.

3. Suppose you touched the crucible with oily fingers after weighing it initially, but before the hydrate was weighed. What happens when the hydrate mass is calculated by taking the difference between the measurements? If the oil evaporates along with the water when the hydrate is heated, what now happens to the calculations for the lost water mass and the water percentage? Explain your answers.

4. Suppose a small portion of your hydrate sample is actually the anhydrous salt. What does anhydrous mean? How will this affect the calculations for the lost water mass and the water percentage?

5. Suppose you do not heat your sample a second time to be sure that all the water is removed. How does this affect your final mass measurement for the anhydrous salt? How will this affect the calculations for the lost water mass and the water percentage?