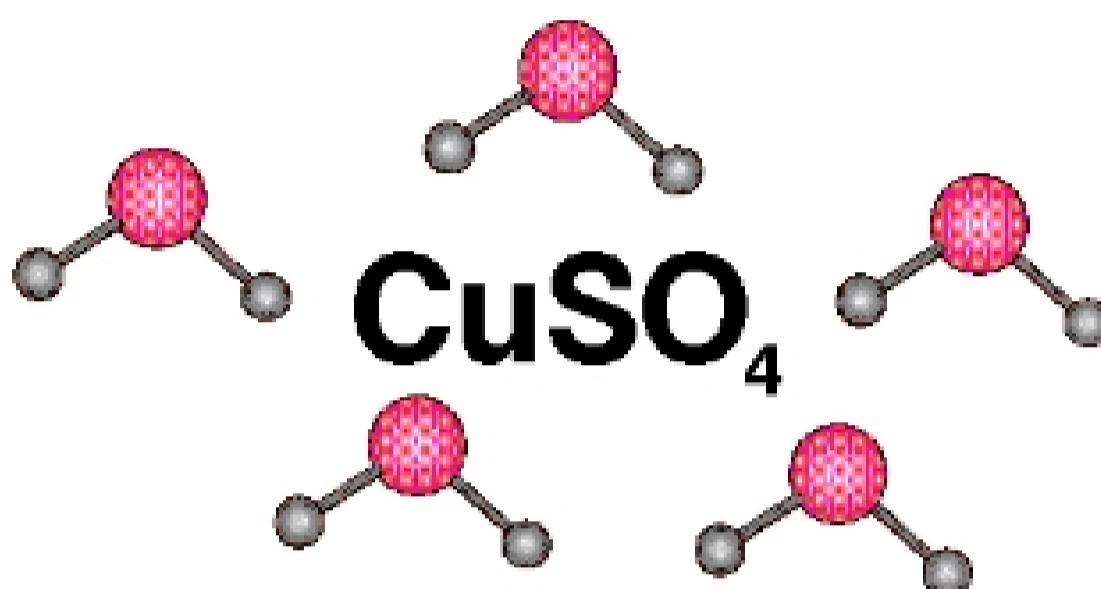


HYDRATES:

An Investigation of Ionic Compounds Containing Water Molecules in Their Structure



Copper Sulfate Pentahydrate

INTRODUCTION

Controlling the amount of water moisture present in the air is very important. Skin becomes too dry during the winter when humidity levels are too low due to heating a sealed home. Many people choose to use humidifiers in order to replenish moisture to help alleviate sore throats, cracked furniture and static electricity. By contrast, during the summer months dehumidifiers can be very useful. VCRs won't work when there is too much humidity (dew indicator) in the machine. Dehydrated foods are also very important.

Sometimes chemicals are used to control the moisture level. Have you ever heard of putting rice in a salt shaker to minimize the clumping caused by humidity? Ever wondered about that little packet of "rocks" that is commonly found in the carton of a new VCR, TV, stereo or other electronic equipment? The "rocks" are a calcium or magnesium salt material that acts as a desiccant and absorbs the moisture. Other chemicals, such as cobalt chloride, are used as humidity indicators, changing colors according to hydration.

For instance, the copper sulfate used earlier in the semester was stated to be CuSO_4 , but it actually had absorbed 5 moles of water for every 1 mole of CuSO_4 and should have been correctly labeled as $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, copper (II) sulfate pentahydrate.

The water in these compounds can be removed quantitatively by heating the compound with a bunsen burner. The loss in mass of the compound after losing the water can be used to calculate the amount of water originally in the hydrated sample. When all the water has been removed, the ionic compound is said to be anhydrous. Once a true hydrate had been heated and the water is driven off, one can regenerate the original compound by adding water (i.e. the process is reversible).

Hydrates are often shown as $\cdot\text{H}_2\text{O}$ (after the formula for the ionic compound; means + H_2O) to indicate the connection of the water to the anhydrous material. Hydrates are named by the Greek prefixes attached to the word hydrate (as in the naming of nonmetallic compounds):

$\cdot\text{H}_2\text{O}$ monohydrate	$\cdot 6\text{H}_2\text{O}$ hexahydrate
$\cdot 2\text{H}_2\text{O}$ dihydrate	$\cdot 7\text{H}_2\text{O}$ heptahydrate
$\cdot 3\text{H}_2\text{O}$ trihydrate	$\cdot 8\text{H}_2\text{O}$ octahydrate
$\cdot 4\text{H}_2\text{O}$ tetrahydrate	$\cdot 9\text{H}_2\text{O}$ nonahydrate
$\cdot 5\text{H}_2\text{O}$ pentahydrate	$\cdot 10\text{H}_2\text{O}$ decahydrate

Magnesium sulfate (epsom salts) can be a hydrated salt. Upon heating, the water is separated from the salt, leaving only anhydrous magnesium sulfate. By comparing the mass of the hydrate and the anhydrous form, the number of moles of water combined with one mole of anhydrous magnesium sulfate can be determined and ultimately the formula for the hydrate. How can one tell if a chemical is hydrated? How can the amount of water absorbed be determined? What is the correct formula for the hydrate? What chemical would be a "better" desiccant? This experiment will help in answering these questions.

TECHNIQUES

Using a crucible



1. To clean: place a few drops of 1M ammonia (NH_3) in the empty crucible and scrub with a paper towel. Wear gloves during the process.



At 1M, ammonia still has a strong odor and can be corrosive!

2. Rinse the crucible with distilled water and place the empty crucible on a pipet stem triangle supported by a ring and ringstand.
3. Heat the crucible until the bottom glows dull red. NOTE: The flame should remain below the bottom of the crucible.
4. After 5 minutes, remove the flame and let the crucible cool to room temperature on the triangle.



DO NOT TOUCH -- Hot crucibles look the same as cool crucibles.

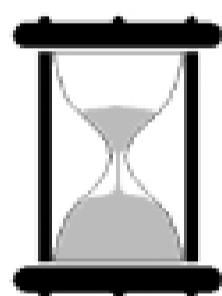
5. When cooled, use the large tongs to move the crucible to the bench top.
6. To heat the sample: Pour the sample into a cleaned crucible. Using tongs, put the crucible on the triangle. Heat gently for the first few minutes, then heat until the crucible glows red. The tip of the inner blue cone is directly under the

crucible. Continue heating for 10 minutes. If using the cover as well, set it slightly ajar over the crucible so that the water vapor can escape.

7. Remove heat and cool to room temperature while still on the triangle. Setting a hot crucible on a cooler surface, such as a bench could cause it to break.

SAFETY

- Hot crucibles look the same as cool crucibles. Allow the crucible to cool on the ceramic triangle. Handle the crucible and crucible lids with care as they break easily.



MUCH TIME WILL BE SAVED IF PART II IS STARTED AND THEN PART I IS PERFORMED DURING THE WAITING PERIODS.

EXPERIMENTAL PROCEDURE

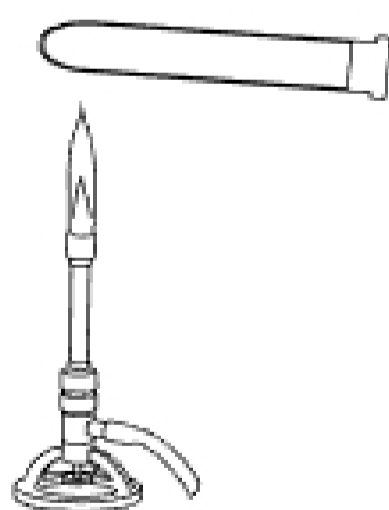


will appear to indicate helpful hints, additional information, or interesting facts.

I. Hydrate test

A. Copper sulfate

1. Put about $\frac{1}{2}$ inch of hydrated copper sulfate crystals in a dry test tube. Hold it over the flame with a test tube holder and heat it for a few minutes with the mouth of the tube slightly below the base of the tube.



TIP THE TEST TUBE SLIGHTLY DOWNWARD

2. Allow the test tube and its contents to cool.