Copper (II) Sulfate

Project Based Learning

Copper (II) Sulfate is probably the most important and most widely used of all copper compounds.

PART 1: GETTING TO KNOW COPPER (II) SULFATE

1. What is the chemical formula for copper (II) sulfate? _____
2. What is the molar mass of copper (II) sulfate? _____

✓ Read about its properties, uses, bonding, structure, and intermolecular forces: Copper (II) Sulfate

PART 2: THE DEHYDRATION AND REHYDRATION OF COPPER (II) SULFATE

Copper (II) sulfate is an example of a compound that exists as a hydrate, more specifically an inorganic hydrate.

✓ Read about hydrates: What Are Hydrates?

anhydrous - Form of a compound that lacks water.

hydrate - A hydrate is any compound that has absorbed water molecules from its environment and included them in its structure.[3]

pentahydrate - A chemical compound with five molecules of water.

Copper (II) sulfate is a white crystalline powder in its anhydrous state. However, copper (II) sulfate occurs most commonly as a hydrate, more specifically a pentahydrate because it contains five water molecules. It is a blue granular crystalline solid in its pentahydrate form.[1] We will be observing what happens when we dehydrate and then rehydrate the pentahydrate form of copper (II) sulfate.

3. What is the chemical formula for copper (II) sulfate pentahydrate? _____
4. What is the molar mass of copper (II) sulfate pentahydrate? _____
5. When the pentahydrate was heated what happened? _____

_____

6. What happened when we added water and rehydrated its anhydrous form? _____

_____

QUESTION: What is the difference between a hydrate and an aqueous solution?

A hydrate is any compound that has absorbed water molecules from its environment and included them in its structure. An aqueous solution is where the solid compound (solute) is dissolved in the water (solvent). Water in its liquid state is the dominant compound in an aqueous solution.

PART 3: THE USES OF COPPER (II) SULFATE

7. Copper (II) sulfate has many practical uses in everyday life. Research all the different ways this chemical is used in our lives. How many can you find?

1) _____
2) _____
3) _____
4) _____
5) _____
6) _____
7) _____
8) _____
9) _____
10) _____
11) _____
12) _____
13) _____
14) _____
15) _____
16) _____

PART 4: COPPER (II) SULFATE AND BLUE-GREEN ALGAE

8. What is blue-green algae? _____

_____

_____

_____

9. Research the effects of blue-green algae in ponds and explain them. _____

_____

_____

_____

_____

_____

_____

How to Control Blue-Green Algae

Non-Chemical Management Options

1. Physical Management Options:

Floating, blue-green algae can be mechanically or physically controlled by using a rake, fishing net (called a seine), wire screen, or other similar device to filter out the algae.[5] Or the algae can be physically cut and removed from the pond. Another method to physically control algae is by replacing the pond water. Exchange of water from a well or other source that does not have an algae bloom will dilute the algae in the pond. This is not a practical option for most pond owners unless their ponds are very small and they have wells close by.[2] These methods are very laborious and short-lived as the algae will return quickly.

Non-toxic dyes or colorants prevent or reduce aquatic plant growth by limiting sunlight penetration, similar to fertilization. However, dyes do not enhance the natural food chain and will suppress the natural food chain of the pond.[2]

2. Biological Management Option:

While many microscopic animals (zooplankton) eat blue-green algae, there are no practical ways to increase their populations, so no biological control is possible.[2]

Chemical Management Options

Copper (II) Sulfate is probably the most commonly used algal treatment because of its availability and low cost. Applying far more copper sulfate than necessary is uneconomical and ecologically undesirable. Excessive amounts of copper can kill fish and other bottom organisms, and copper tends to accumulate in bottom sediments.[4]

1. Explain the different physical management options when it comes to controlling blue-green algae in ponds?_____

   _____

   _____

   _____

   _____

2. Why are these not good options? _____

   _____

   _____

3. What is an example of a biological management option to control blue-green algae? _____

   _____

4. Why is that not a good option? _____

   _____

5. What is the most popular treatment for controlling blue-green algae and why is it so popular?

   _____

   _____

✓ Watch this video (speaker is a non-native English speaker, so you will want to turn on captioning to help you understand): TREATING POND ALGEA USING COPPER SULFATE

6. When mixing the $CuSO_4$ aqueous solution to help control blue-green algae what happens to the $CuSO_4$ atoms? _____

7. The concentration of copper (II) sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$) solution recommended for application is 1.0 mg/L.[4] **Calculate the molarity of this solution.** Make sure to include the water molecules (pentahydrate) in the molar mass calculations of the copper (II) sulfate.

Only the copper in solution (copper ions) not copper precipitate is effective in controlling floating algae. Applying citric acid ($C_6H_8O_7$) along with copper sulfate enables copper to remain in solution for a longer period, enhancing its algicidal (killing or preventing the growth of algae) effect. A ratio of copper sulfate to citric acid of 2:1 by weight has been found effective in controlling blue-green algae.[4]

8. Using the concentration of copper (II) sulfate in question #7 and knowing that a 2:1 ratio of copper (II) sulfate to citric acid will help the solubility of copper, **calculate the molarity of the citric acid solution you would want to use.**

PART 5: MAKING YOUR OWN COPPER (II) SULFATE SOLUTIONS

1) On a separate sheet of paper, write your materials and procedure to create a 50.0 mL $CuSO_4$ solution of 0.20 M concentration. Make sure and include all calculations.

2) Now write a procedure to dilute the solution from #1 to 0.10 M concentration. Make sure and include all calculations.

3) ***After you get approval from your teacher***, you may go and create your copper (II) sulfate solutions following the procedures you wrote.

PART 6: ELECTROPLATING USING A COPPER (II) SULFATE SOLUTION

We will be using your diluted copper (II) sulfate solution to plate a nail with copper.

- ✓ Watch this video: Copper Electroplating and fill in the blanks with the correct words.

_____ is a process that uses electric current to cause a metal, which has been dissolved in a solution, to form a solid metal coating on a separate metal electrode. Common metals used as the coating are _____, _____, _____, and _____. When we mix copper (II) sulfate into water it creates a conductive solution made up of positive _____ ions and negative _____ ions. Once all the wires are hooked up and the nail is submerged in the conductive copper solution, _____ travel from the negative terminal of the battery, through the metal _____ and into the solution. From there they travel through the conductive solution and towards the _____ anode and back into the positive terminal in the battery. The electrons traveling through the nail cause it to have a _____ charge. The positive _____ ions in the solution are attracted to the negatively charged nail, coating it in a thin layer of _____. The copper ions that leave the solution need to be _____. The replacement copper ions come from the copper _____, which slowly releases copper ions into the solution to maintain a copper (II) sulfate solution. The longer you leave the charged nail into the solution, the _____ copper will attach to it.

Materials

Sandpaper	1" binder clip	Coiled copper wire
2 non-galvanized nails	Battery clip w/ alligator clips	
Pencil	9v battery	

Procedure

1) Add copper (II) sulfate crystals to your diluted solution. Your solution should be dark blue.
2) Prepare the non-galvanized nail for copper-plating by sanding it with sandpaper. Dry it off with a paper towel.
3) Partially suspend the nail in the solution by clipping the nail in the binder clip, threading the pencil through the steel arms of the clip and placing the pencil across the mouth of the beaker so that the nail hangs into the solution.
4) Hang the coiled copper wire over the side of the beaker and into the solution. Make sure the copper wire and the nail are kept on separate sides of the beaker.
5) Let's connect the battery: Snap the 9v battery into the battery clip. Attach the negative alligator clip (black) to the steel arm of the binder clip (nail). The alligator clips should NOT touch the solution.
6) Closely watch the end of the nail that is submerged in the solution. Then attach the positive alligator clip (red) to the top of the copper wire. What did you notice?
7) An electrical circuit has now formed with the positive electrodes & negative electrodes and an electrical current is flowing.
8) Leave the circuit running for 30 seconds.
9) Disconnect the alligator clip from the coiled copper wire. Disconnect the alligator clip from the steel arm of the binder clip (nail). Carefully pull out the nail and notice the change. Gently dry with a paper towel.
10) Perform STEPS 2-11 again with the 2nd nail.

Resources

(1) "Copper (II) Sulfate." Chemical Compounds. *Encyclopedia.com.* 3 Mar. 2021 https://www.encyclopedia.com.

(2) How to Control Blue-Green Algae. (2020, December 02). Retrieved March 07, 2021, from https://aquaplant.tamu.edu/how-to-control-blue-green-algae/

(3) Sarikas, Christine. *What Are Hydrates? Definition, Naming, and Examples*, 7 Mar. 2021, blog.prepscholar.com/what-are-hydrates-definition-naming-and-examples.

(4) *Using Copper Sulfate to Control Algae in Water Supply Impoundments*, Illinois State Water Survey, 1989.

(5) WFSCAgriLife. (2014, September 23). Controlling Algae in Farm Ponds. Retrieved March 07, 2021, from https://www.youtube.com/watch?v=rj59ouOEgyE