Recovery Of Copper Through Its Different Forms

We wanted to test the percent yield when changing Copper into different forms and mixing different compounds with it. When reacting the Magnesium stripes to regain the Copper that had transformed, we expected to get close to 100% yield; which showed that there were minimal errors in the procedure. We reacted to different compounds inside fume hoods as well as utilizing filtration, testing completeness with phenolphthalein/ red litmus paper, and Magnesium strips to ensure that the integrity of the experiment was not compromised. We found that the percent yield was not as close as we had hoped, about 64.34%. Conclusively, we found out that we cannot expect to reach 100% yield as there are many factors that play a role in completely reacting the compound in a given allocated time.

Introduction

We were reacting different compounds together and then trying to retrieve the reactants as a product. This was to test the conversation of mass theory; percent yield in any experiment should be close to 100% to fully prove that product mass could be created from reaction mass. If the experiment was flawless/ had minimal room for error, then it could be proven that no additional mass was lost or gained in the experimental procedures. While also calculating this yield, we were observing the different features of the compound, both chemical and physical. To help with this process, we captured photos to rely on the features of the substances. We were able to distinguish the outcome of the Copper at the end and how it was completely different from the beginning product, further providing evidence of percent yield. By basing our lab on these two principles, it helped reach different scientific conclusions about Copper and how it reactions differently to different compounds.

Experimental Design

Considering the experiment was lengthy, we divided the procedures up into two different sessions, which impacted how we operated towards the end of the first day.

By utilizing goggles and safety gloves, we eliminate the time constraints that would come when safety measures and would further protect our bodies from dangerous substances.

For the first section of the lab, we weighed out approximately 0.50 g of a shiny lustrous copper wire and add it to a mixture of Nitric Acid. Since the Nitric Acid was not initially reacting with the Copper, we had to apply heat with a Bunsen burner until it was just under from under the point of vaporization. While handling Nitric Acid, we had to take care not to physically be in contact with the compound as it can cause irritation and prevent us from moving further to heating the mixture. Since heating this mixture produces a dangerous odor and gas, we would need to carry out the Bunsen burner heating inside a fume hood. When this process was finished, we proceeded to dunk the hot substance in 300mL of water to let it cool down to room temperature for 10 minutes. Once the time had elapsed, we proceeded to transform this mixture to Copper (II) Hydroxide

Utilizing the 250mL beaker from the last process (which contained Cupric Nitrate), we continue

to add Sodium Hydroxide. Over a span of about a minute, we added approximately 31-32 mL to the beaker solution located in the fume hood to prevent inhalation of toxic odors. Over the span of 4 minutes, we noticed a reaction in the solution: the color changed to a dark blue color with formation of small sediments settling to the bottom. To fully ensure that this was completely reacted, we dropped a mL of additional Sodium Hydroxide (Additional precipitants signifies that it is not fully complete and more should be added until nothing else forms from each addition). In our run, we needed two additional mLs to ensure that it was truly complete and ready to move onto the next process; we noticed that nothing formed after the second mL addition. The next step that we would need to fulfill is to check if the mixture is considered basic with an additional step of testing with a red litmus paper. By taking a small sample and placing it on the paper, we noticed that it turned blue which signifies that it was basic (had it not been basic, we would need additional Sodium Hydroxide mLs). Since the mixture passed both tests, we could continue to the next process of changing the mixture to Copper Oxide.

Initially, we added about 50mL of deionized water to the mixture located in the fume hood and gently apply slight heat for around 10 minutes. Around the 7 minute mark, we noticed that the mixture started separating itself from the sediments and liquids. Since we applied a constant source of heat for 10 minutes, we cooled the 250mL beaker with our substances for an additional 10 minutes in the 300mL from previous steps. Just like the previous steps, we will need to test for completeness (without testing, we could end with varying results in the end). The process called for around 10mL phenolphthalein, but in our run we needed 15 since the color of the substance did not change to a light pink color. The pink color signified that the reaction was complete, a clear color signifying that it was not completely deacidified. Noting that we had added additional phenolphthalein, we made sure to take a picture to visually show that the equilibrium point had been met. The last test that we performed was using acetic acid, which tested the same pink color in the solution except that we had to constantly stir the substance to ensure that the test was fully passed. We used exactly 5mL, which the procedure called for: the substance remained pink and with consistent stirring the color disappeared. Concluding this step, we proceeded to transform this mixture once again to a different form, Cupric chloride through filtration.

The filtration was performed though vacuum filtration so that the suction force could assist with pulling the liquid from the filter paper into the filtrate below the funnel. The initial step was to pour the mixture from the previous steps into the filter paper inside the funnel to separate the solids from the liquids. Flushing the solids that are collected in the filter paper with water helps retain and keep only the solids. After “washing” the solid, we threw away the filtered liquid in the flask and utilized hydrochloric acid to react with the remaining solids. By using 12mL (required 10mL), we noticed within 3 minutes that the color changed to a greenish color with a slight aqua hue. Since this wasn’t enough, we decided to add an additional 11 mL to completely react with the unreacted solids inside the filter paper. Finally, we added some water (20mL total in 10mL increments) into the funnel to wash the remaining sediments from the filter paper into the filtrate. Since this was the last step for the first lab session of the week, we transferred the liquid from the filtrate into an Erlenmeyer Flask for storage for the next session.

This lab section required us to reverse the process around and try to regain the copper that we had added into the mixture. The reaction called for additional liquids, so we transferred the mixture into a larger beaker (250mL). This section converts the previous Cupric Chloride to a different form [Cu(NH3)4](OH)2. To begin this process, we added 6M ammonia into the mixture; 5mL initially and then the rest of the 15mL after observing for different physical and chemical

changes. Within the first 2 minute of adding the 5mL, we noticed that the mixture changed from a greenish hue to an aqua like color, not reaching the royal blue color that we had hoped for. Even after adding the remaining 15mL, the solution was not the color we wanted so we added an additional 2mL; finally the solution had reached a dark blue color. For our next reaction, we change this solution even further: into Copper Sulfate.

To complete this reaction, we utilized sulfuric acid (10mL). Since this caused the solution to heat up, we made sure to handle the beaker with care not to make it experience any type of thermal shock and crack. In our run, we had only used 4mL worth before that we noticed chemical changes in the substances. Within 5 minutes of adding the acid, the solution changed from the previous dark royal blue to a clear aqueous blue color that resembled something like a mouth wash solution. The heating from this reaction lasted for about 7 minutes before it dropped to room temperature while also producing a distinctive odor from the beaker itself. Since we didn't completely react all the sulfuric acid, we decided to keep the rest for the later part of the experiment.

This last part of the overall experiment was the most crucial as this is when we retain the lost copper through magnesium strip reaction and another trial of filtration. This step converts the Copper Sulfate into Copper in it's rawest form possible. Before reacting any of the magnesium strips, we must test it with red litmus paper for completeness. Upon contact with the paper, we found out that the mixture was not where it was supposed to be, so through trial and error we added an additional 8mL of the sodium hydroxide. When adding it into the mixture, we noticed that the mixture went from a blue/white milkish color. Testing it with the red litmus paper again proved that it changed to a blue which let us know that it was in fact complete and it allowed us to move to the most important part of the process of copper reaction. This part of the lab was the most trivial because the solution reacted with the magnesium strips very slowly and not as violent as we had hoped for. By weighing approximately 0.779g of the shiny definite shaped silvery strips, we added one to test how it would react with the solution. Immediately we noticed that there was foam forming and that the strip was actually fizzing and reacting with the solution like we had predicted. We slowly started to add all of the strips to the solution hoping that they would all react like the initial trial, but this was no good. The solution was becoming less and less reactive; we weighed another 0.750g of magnesium and slowly started to add this as well (according to the steps, since the solution did not get rid of its blue color. After finishing the second batch of strips, we noticed a few sediments settling on the bottom of the beaker and the color was somewhat separated: very light blue on top while clear liquid was sitting on the bottom. Since there were about 1 or 2 strips left floating around unreactive to the Copper Sulfate, we went ahead and finished the solution with 3mL of sulfuric acid. Within 5 mins, we noticed that the remaining magnesium strips starting bubbling again and reacting, corroding away; the solution was not completely a clear color that we were aiming for.

After letting the copper settle to the bottom of the beaker completely, we noticed that it wasn't completely in the same shape that it had entered as from the beginning of the experiment: it was now in a mushy smeary powder form that seemed as if it didn't have a definite shape. The final step was to completely filter the mixture to separate the copper from the liquid. After assembling the vacuum powered filtration, we poured the liquid into the funnel that contained a filter paper to retain the solids and prevent it from falling into the filtration below. When we were completely finished with nothing left to pour, we went to wash the filter paper to completely get rid of remaining liquids so that it wouldn't mess up our mass measurements in the final step. By using 25mL of deionized water, we poured in directly onto the filter paper and waited for the

water to settle into the filtration below. After that concluded, we removed the filter paper and dabbed the remaining water that was lingering with a towel; making sure to not rub, smear, or transfer the copper onto the paper as this would mess with the calculations.

Results

When we closely examined the filter paper that was produced in the final step of the procedures, we noticed that the copper was in a powder like form that didn't look like it had a definite shape. We took the mass of a plain filter paper without copper and the one we had with the copper and subtracted them from each other so that we could obtain the net mass. Overall, the paper with the copper weighed approximately 0.350g. We noticed that this was not comparable to the initial mass of copper that we initially put into the mixture and substance, so we compared this to each other. We found out that we had only regained about

Conclusion

Overall, we realized that a higher percentage could be obtained and that we could aim for a percentage closer to 100%; but in the real world, it would be a long a very grueling process to obtain this. Due to the nature of reproducing steps, this can lead to varying results, utilizing the same steps that were given doesn't necessarily guarantee a 100% recovery. There are many factors that play into this and everything has to be perfect to obtain that percentage. A possible retest would prove useful as it would prove whether or not this data/ datasets are precise by providing accuracy to test upon. By possibly giving the magnesium strips near the final part of the lab, we could potentially eliminate the possibly of losing mass.