

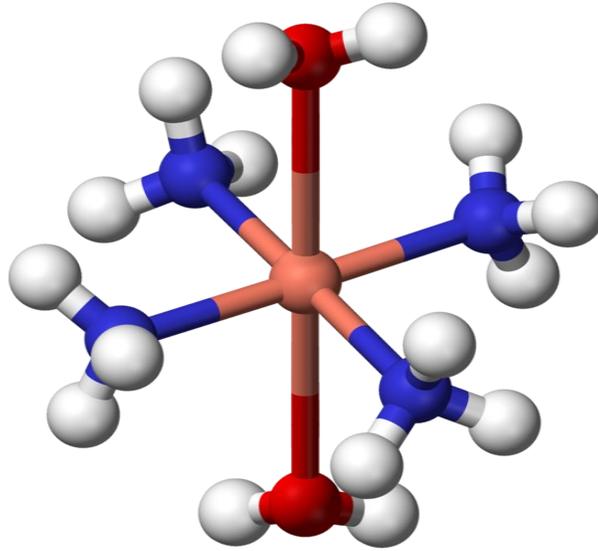
Synthesis of Schweizers Reagent then Precipitation of Rayon by Acidification by Disulfideprotein

The synthesis of Schweizers reagent is interesting. To synthesize it you must be able to synthesize cupric hydroxide. Cupric hydroxide is usually formed by dissolving copper sulfate in water and then adding sodium hydroxide. The problem with this method is that it is quite sloppy and you must rinse and wash the cupric hydroxide because a black product also forms along with other contaminants. I found a different method of synthesizing Schweizers reagent using only copper sulfate and ammonium hydroxide. The use for this process/synthesis is a less time consuming, easier method of making Schweizers reagent. Why? Schweizers reagent is used in the process of making rayon (artificial fiber). Many home chemists could use the 3 step technique for synthesizing Schweizers reagent but it is less time consuming and messy to just use the 2 step process. Schweizer reagent is: $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2](\text{OH})_2$ (**Shown Below**). The equation for this reaction is as follows: $\text{CuSO}_4 + 2 \text{NH}_4\text{OH} = \text{Cu}(\text{OH})_2 + (\text{NH}_4)_2\text{SO}_4$ then: $\text{Cu}(\text{OH})_2 + 4 \text{NH}_4\text{OH} = [\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2](\text{OH})_2 + 2 \text{H}_2\text{O}$ the great part about this reaction is that the ammonium sulfate does not interfere with the rest of the chemical reactions in making rayon or other fibers.

The reaction can be reversed back to reactants and a new insoluble complex making it prime to precipitation of the solute when acidified (specifically hydrochloric acid). When hydrochloric acid is added to the ammonia complex it converts back to cupric hydroxide and makes a new compound: Ammonium chloride. When sulfuric acid is added to the ammonia complex it makes cupric hydroxide and ammonium sulfate. Though after the rayon precipitates out it is destroyed and broken down by the sulfuric acid which is why this is not used for this process because of this reason. When HCl is added to the Schweizers reagent with the cellulose dissolved in it the reaction reverses and becomes ammonium chloride and cupric hydroxide. When it is acidified by a weak acid such as acetic acid (from observations) barely any rayon is formed.

This precipitates out because of the simple fact that when the acid is added it converts the complex to a different complex that the solute is not soluble in.

Please note that this reaction is reversible when the ammonia is evaporated. When it is evaporated you should be left with cupric hydroxide.



*Illustration 1: Schweizers Reagent:
tetraamminecopper dihydroxide*

This is great for making rayon, because cellulose is soluble in Schweizers reagent but can be regenerated by acidification of the solution. Cellulose is a sugar and has the chemical formula: $C_6H_{10}O_5$. It is a polysaccharide made of Beta D-Glucose molecules linked together. We are incapable of metabolizing cellulose and derivatives of it such as rayon but we do produce it for clothing. It (rayon) is a rearrangement of cellulose. They are chemically identical to each other but are structurally different.

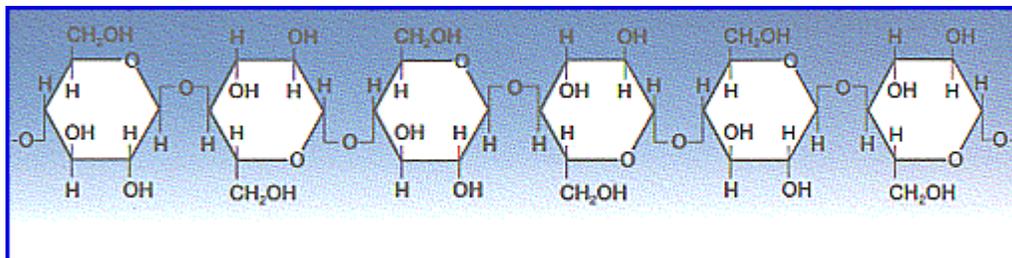


Illustration 2: Cellulose Molecule

Rayon: The only difference is the structure of the cellulose and in such we are not altering the chemical formula of the cellulose.

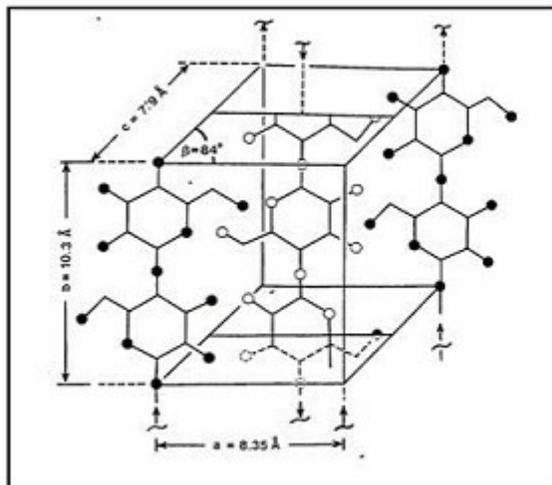


Illustration 3: Rayon Molecule

Equipment:

- Needed equipment: 1 beakers 500ml, 1 1000ml Erlenmeyer or other flask/beaker, 1 a syringe or a pipet.
- Chemicals needed: Copper sulfate, ammonium hydroxide, hydrochloric acid.
- Stoichiometric amounts (first reaction): CuSO_4 : 159.610 g NH_4OH : 70.0918g = $\text{Cu}(\text{OH})_2$: 97.5611 $(\text{NH}_4)_2\text{SO}_4$: 132.1402 g
- Stoichiometric amounts (second reaction): $\text{Cu}(\text{OH})_2$: 97.5611 NH_4OH : 140.1836g = $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2](\text{OH})_2$: 201.7139 g
- That in turn gives the theoretical yield for Schweizers reagent.
- **The amounts that were used in the experiment where .1 mole amounts, this is much more plausible for general experimental use. The amounts shown in the pictures were not measured out but an average was used because I do not have pictures from the original experiment and are for illustrative purposes.**

Steps:

15.9g of copper sulfate was weighed out and put in a 500ml beaker. A 10% ammonia solution was used and so 70.9g of ammonia solution was used and poured into a separate 1000ml flask.

The copper sulfate was put into the 1000ml flask containing the ammonia solution using a funnel. There was a precipitation of cupric hydroxide and in the process some

Schweizers reagent was be formed. This is because of the NH_4OH making the cupric hydroxide and then combining to make Schweizers reagent. When all the reactents are combined the solution should look somewhat similar to this:



Illustration 4: Cuperic Hydroxide

The solution was stirred vigorously for 2-5 minutes. After that 70.9 more grams of ammonia were added to the flask containing the cupric hydroxide solution. Stir if necessary. There should be a very noticeable change in color from a light blue to a very dark almost purple blue. This was the Schweizers reagent.

To test it I extracted 10 ml of the solution and put this in a 25ml beaker. Then I added 5ml hydrochloric acid. Ammonium chloride out-gassed from the solution and cupric hydroxide re-precipitated from the solution.

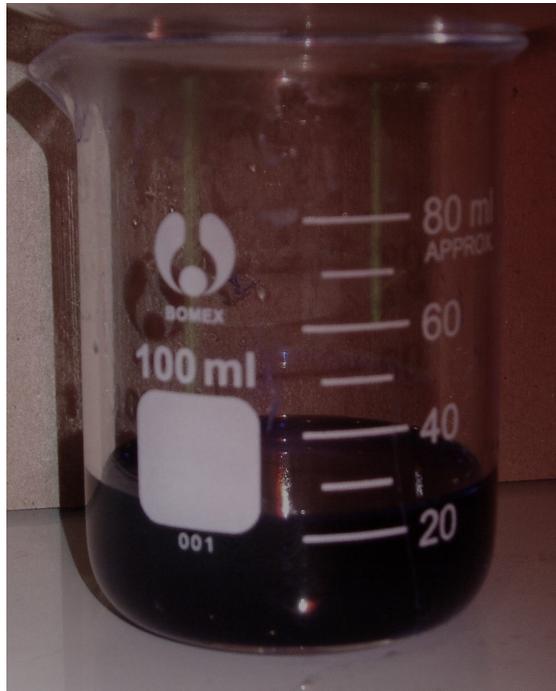


Illustration 5: Schweizers Reagent

Rayon:

Toilet paper was added to the solution in small amounts until no more could dissolve. Any remaining cellulose was taken out of the solution.

A 500ml beaker filled with hydrochloric acid was prepared. This was poured into the solution until no more rayon was precipitated out of the solution. White ammonium chloride gas was released.

Please note that there will be ammonium chloride gas coming out of the beaker, it is not incredibly toxic but not be ingested/inhaled because of the minor lung irritation. Please see the link for the MSDS down below.

Conclusion: Rayon precipitated out of the solution when it was acidified. It made fiber strands in the solution that could be gathered by filtration. Rayon precipitated out of the solution because when the solution was acidified it change the complex to a different one in which the solute was insoluble in. Please note that I use .1M or less than that quantities of chemicals. But what ever you do in the 3rd step keep the cupric sulfate in excess.

Notes on Storage: Schweizers reagent should be stored in an air tight container. It should NOT be stored in a way that the ammonia can evaporate and reverse back to cupric

hydroxide. Store at room temperature in a dry area.

Sources:

- <http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/C/Carbohydrates.html> (for the second picture)
- Wikipedia.org (for the first picture)
- <http://web.utk.edu/~mse/Textiles/Rayon%20fibers.htm> (for the third picture)

MSDS:

- HCl: www.inchem.com.ph/productpages/hcl_msdms.pdf
- Ammonium Hydroxide: <http://www.sciencestuff.com/msds/C1225.html>
- Ammonium Chloride: http://mubychem.com/MSDS/ammonium_chloride%20MSDS.htm