Determination of Copper in Aqueous Solutions by Chelation with Diethylthiocarbamate

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Background and Purpose
Monitoring water contaminants is a chief concern of groups like the Environmental Protection Agency. The effects of these contaminants can range from giving the water a displeasing taste to causing major central nervous system problems. The contaminants come in a wide range as well, from huge synthetic molecules to natural minerals or metal ions, like copper. Copper primarily comes from the diet of an individual, but is usually not enough to exceed the daily recommended amount.(1) This makes copper in drinking water the likely source for excess copper intake. Copper in the water mostly comes from two sources: contamination by industrial wastes or natural deposits and corrosion of copper or brass plumbing within the home. Exposure to copper in higher-than-normal levels in drinking water can result in gastrointestinal distress (vomiting, stomach cramps, diarrhea) while intentional exposure to very high levels can result in liver and kidney damage or even death.(1)

A common way to analyze the copper content in an aqueous sample is by chelation with the solid sodium diethylthiocarbamate (DDTC). Derived from the Greek word for a lobster's claw, the chelate is a metal stabilized by one or more ligand atom.(2) DDTC is very hygroscopic white or off-white solid and sold as a tetrahydrate.

The purpose of this research was to determine the amount of copper can be determined by chelation with the DDTC using three spectrophotometric techniques: UV-Visible spectrophotometry, Raman spectrophotometry, and flame atomic absorption spectrophotometry (FAAS).

UV-Visible Spectrometry
Determine concentration of copper via absorption of light. Chelate is a brown color; the higher the absorbance, the more concentrated the solution.

Raman Spectrometry
Utilizes functional groups of the DDTC in chelate to determine concentration. Ideally, there would be a change in area of peaks specific to chelate. Unfortunately, this was not the case. No reference spectra could be found for the DDTC or the chelate. The spectrum of the chelate in ethanol revealed no new peaks from the solvent, however, there appeared to be some variation in the baseline around the peaks from 1800 – 1600 cm⁻¹. Integration showed that there was no trend.

Flame Atomic Absorption Spectrometry
Light from the copper HCL is absorbed by the copper in the sample (chelate). The more copper, the higher the absorbance. Unfortunately, the FAAS was not up and running by the end of the project (but not for the lack of trying).

Conclusions and Future Works
The biggest problem is finding a way to use the chelate to quantify the amount of copper in Raman. Possible solutions are to try the experiment with new DDTC, try different solvents, or make the solutions more concentrated. Also, FAAS needs to be verified, but it should work.

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References

Diagram of the major components of the flame atomic absorption spectrometer.