Experiment 6

DETERMINATION OF COPPER IN DRINKING WATER BY ATOMIC ABSORPTION SPECTROSCOPY

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Abstract

The amount of copper in Anytown drinking water was determined by the calibration method using atomic absorption spectroscopy. Calibration standards were prepared from a 1000 ppm Cu stock. The absorption of each solution was measured on a graphite furnace atomic absorption spectroscopy. From the calibration curve the amount of copper was determined to be 190.0 ± 0.6 ppb, which is within the limits established by the EPA.

Introduction

The presence of copper in drinking water is usually due to corrosion of copper plumbing, which is by far the greatest cause for concern. Although copper is required by the body in very small amounts EPA has found copper to potentially cause various health effects when people are exposed to it at levels above the Action Level, currently set to 1.3 ppm, for relatively short periods of time. These effects range from stomach distress to liver damage and anemia.[1] Analyses that enable the determination of copper in drinking water can assist in determining whether or not drinking water sources meet EPA standards.

In this experiment the amount of copper in locally obtained tap water was determined by graphite furnace atomic absorption (GFAA) spectroscopy using calibration standards. The quantitation is based on the fact that the amount of light absorbed by a carefully measured volume of solution is directly proportional to the amount of copper in that solution. In GFAA spectroscopy light (UV or visible) coming from an external lamp source is directed inside a miniaturized graphite tube (or furnace) into which a small volume of solution was previously introduced either manually or mechanically.[2] The calibration curve, obtained from the absorbance data of standard solutions with varying concentrations of copper, was used to calculate the ppb concentration of copper in drinking water.

Experimental

A. Materials. A 1000. ppm Cu stock solution, 50 (v/v) % aqueous HNO_3, and 0.50 (v/v) % aqueous HNO_3 were provided by the instructor. Tap water was collected from the Science Building tap, Anytown, Anystate the day before the analysis was performed. All glasswares and pipet tips used were cleaned with soap and water, rinsed with deionized (DI) water, soaked overnight in 2 (v/v) % HNO_3, and rinsed again with DI water.

***B. Solution Preparation*.** Four 100.0 mL standard solutions with 200., 100., 50.0, and 10.0 ppb Cu were prepared by serial dilution of the 1000. ppm stock using 0.50 % aqueous HNO_3 as diluent. Soon after collection the water sample was preserved by the addition of 50 (v/v) % aqueous HNO_3 until the pH was below 2. About 2 mL of the 0.50 % aqueous HNO_3 was used as blank solution during the analysis.

***C. Instrumentation*.** Absorbance measurements were performed on a PE AAnalyst 600 Graphite Furnace Atomic Absorption Spectrometer 9based on Zeeman background correction) equipped with an 80-cup autosampler and water recirculator. Sample, standard, and blank solutions were pipeted onto 2 mL plastic cups and loaded on the autosampler according to the following sequence: blank, lowest to highest standard, then sample. All absorbance readings were done in triplicates. The software XXX was used to run the spectrometer and gather data. The procedure for running the software and spectrometer, provided by the instructor, was followed without modification. The following instrumental parameters were used for Cu analysis:

Drying time and temp: 30 s @ 125 ^{0}C
Ashing time and temp: 30 s @ 900 ^{0}C
Atomizing time and temp: 10 s @ 2700 ^{0}C
Purge gas: 99.999 % Argon
Wavelength: 324.7 nm

***D. Data and Error Analysis*.** The calibration curve and data generated by the software during the analysis was used directly. The precision of the analysis was determined from the standard deviation of the ppb Cu reported for the sample, also provided on the printout.

Data and Results

The absorbance data for the standard solutions are shown in Table 1. As expected, the absorbance of light increased with increasing concentration of copper. The calibration curve (Figure 1) clearly shows the linear relationship between absorbance and concentration. From this curve the concentration of copper in the water sample was determined to be 190.0 ± 0.8 ppb, as shown in Table 2.

Table 1. Absorbance data for the calibration standards.

ppb Cu	Absorbance	Mean Absorbance	Standard deviation
10.0	0.058 0.060 0.058	0.059	0.001
50.0	0.332 0.340 0.328	0.333	0.006
100.	0.656 0.659 0.648	0.654	0.006
200.	1.349 1.346 1.346	1.348	0.002

Table 2. Absorbance data and calculated concentration of Cu for Anytown water.

Sample	Absorbance	Calc. ppb Cu*	Standard deviation
Anytown water	1.274 1.268 1.276	190.0 189.3 190.1 **mean ppb Cu = 190.0**	**0.6**

* Calculated from the slope of the calibration curve.

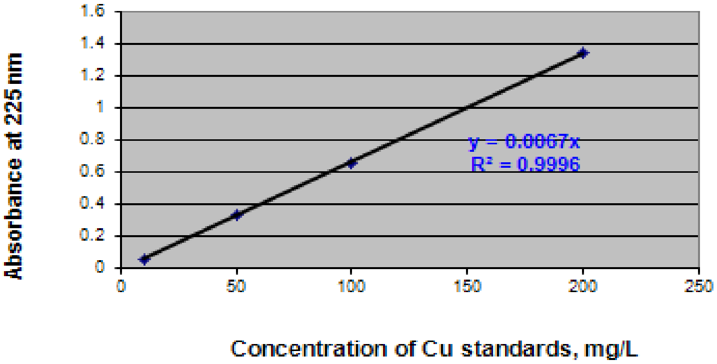

Figure 1. Calibration curve for the determination of copper in Anytown water.

Discussion

The linearity of the calibration curve in Figure 1 indicates that absorbance of light is indeed proportional to analyte concentration and as such is a useful analytical technique. The mean copper concentration of 190.0 ± 0.6 ppb is way below the Action Level for copper established by the EPA. The result was not surprising due to the copper piping in the building from which the sample was taken. We were not expecting the level to be way over the limit either because there is no known sources of contamination from copper. Finally, in this experiment, graphite furnace atomic absorption spectroscopy proved to be a fast and effective method of measuring levels of copper in drinking water.

References

1. http://www.epa.gov/safewater/dwh/c-ioc/copper.html

2. D.A. Skoog, F. J. Holler, and T. A. Nieman, *Principles of Instrumental Analysis*. Saunders College: Philadelphia, 1998. (5th edition)