

Quantitative Colorimetric Analysis of Phosphate Content in Water

An Inquiry-Base Experiment

Summary

References:

1. <http://faculty.coloradomtn.edu/jeschofnig/drowned.htm>
2. A. D. Eaton, L. S. Clesceri and A. E. Greenberg, "Standard Methods for the Examination of Water and Wastewater", 19th ed., 1995, 4-106 to 4-115.

Phosphates can be found in water obtained from natural sources such as river or underground water as well as in wastewater. There are several ways for detecting the orthophosphate in water. The stannous chloride method involves the formation of molybdophosphoric acid with subsequent reduction by stannous chloride to form an intensely colored molybdenum blue. A colorimetric method can be employed to detect the amount of molybdenum blue, and hence, the amount of phosphate in sample can be determined.

In the present project, imagine that you are the technician of the Food and Hygiene Department. You are required to determine the identity of a mineral water sample that has been sold in a grocery shop. The phosphate contents of the collected water samples are determined.

By participating in this project, students will learn

1. how to convert a colorless analyte into colored species with which it can be determined by colorimetric technique.
2. how to do quantitative analysis *via* plotting of calibration curve.
3. how to draw scientific conclusion from the experimental results.

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A Case Study

Lab Documentation

Introduction

The Food and Hygiene Department received a complaint that a grocery shop in Yuen Long has sold bogus mineral water. They sent an officer there to investigate the case. He obtained a bottle of mineral water from the shop. In addition he got two more water samples. One was the tap water from the grocery shop and the other one was from a nearby river. All three water samples plus a bottle of mineral water from the manufacturer were sent to the chemical laboratory for analysis.

You are the technician of the chemical laboratory. From the appearance of the water samples, you guess that the mineral water sold by the shop is probably obtained from the nearby river. As the water from the river may contain certain amount of phosphate released from the farm land, you decide to determine the phosphate content of the water samples in order to find out the source of the mineral water sold by the shop.

Phosphates can be found in water obtained from natural sources such as river or underground water as well as in wastewater. There are several forms of phosphates. Orthophosphate is the most stable type of phosphate. Meta, pyro and polyphosphates are known as condensed phosphates. The condensed phosphates are good metal chelating agents. However, they are unstable in water and convert slowly to orthophosphate. Apart from the inorganic phosphates as mentioned above, organic phosphates are also present in water and are produced mainly by biological processes.

There are several ways for detecting the orthophosphate in water. You decide to use the stannous chloride method. In this method, the phosphate in the sample is reacted with ammonium molybdate to form molybdophosphoric acid. It is then reduced by stannous chloride to form a compound that has a very intense blue color. A colorimeter will be employed to measure the light absorption of the standard solutions and samples at the selected wavelength.

Experimental Procedure

Instrument:

UV-Visible Spectrophotometer

Chemicals:

1000 ppm PO_4^{3-} Stock solution

Ammonium molybdate solution

Tin(II) chloride solution

Preparation of Standard Solutions:

1. Pipette 5.00 mL of PO_4^{3-} stock solution to a 100-mL volumetric flask. Make up to volume using deionized water.
2. In five 50-mL volumetric flask, prepare standard solutions containing 1, 2, 3, 4 and 5 ppm of PO_4^{3-} using the solution prepared in step 1.

Color Development and Measurements for Standards and Samples:

1. In a 50-mL conical flask, pipette 25.00 mL of standard solution or sample solution. Add 1mL of ammonium molybdate solution measured with a cylinder and 2 drops of tin(II) chloride solution. Swirl the solution gently.
2. Wait for 10 minutes. A blue color will develop.
3. Measure the visible spectrum of the solution in the range of 400 to 800 nm.
4. Select the wavelength which gives the highest sensitivity for quantitative measurements.
5. Measure the absorbance of the blank solution, five standard solutions and the sample solutions at the selected wavelength.

Data Analysis

1. Plot the calibration curve by using the results obtained with the standard solutions.
2. Draw the best straight line through the points.
3. Calculate the amount of PO_4^{3-} in the sample solutions.

Conclusion

What conclusion can be drawn from the obtained experimental results? Discuss.

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Data Sheet

Name of Participants: _____

Selected Wavelength for Quantitative Analysis: _____ nm

Concentration of Standard (ppm)	Absorbance

Plot the data on a graph paper and obtain the slope and intercept for the best straight line ($y = mx + b$).

$m =$ _____ and $b =$ _____

Sample Source	Absorbance	Amount of PO_4^{3-} (ppm)

[illegible]