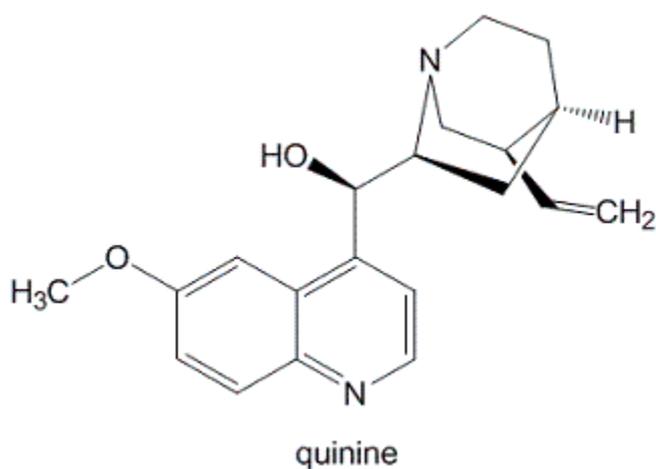


Determination of Quinine using a Non Aqueous Titration Method

by Bill van Bronswijk, Alasdair P. Lee

Experiment Overview

Water is so familiar and accessible as a solvent that its properties are usually taken for granted and underlie most general statements about inorganic compounds. However, the chemistry of many compounds is not accessible in aqueous systems, or when water is present. Therefore there are very practical reasons for exploring solvents other than water, Here we explore the acid / base characteristics of quinine in anhydrous acetic acid.



For non-aqueous systems, as with water, the solvents acid-base properties place a limit on the range of the acid strengths of the solutes in it. Many acids and bases are too weak to be titrated in aqueous solution and require either an alkaline (for acids) or acidic (for bases) solvent to increase the degree of dissociation in order to become titratable. Since the strongest acid that can exist in a solvent is the solvent acid itself all more acidic solutes are converted into the solvent acid. A similar situation is evident with bases. Therefore the range of solutes that are strong acids in any chosen solvent (i.e. those that are completely converted to the solvent acid) varies with the intrinsic strength of the solvent. In an acidic solvent, such as glacial acetic acid, some solutes that are completely dissociated in water are not completely dissociated in the new medium, that is, they are weak acids in the new medium. In some cases weakly acidic materials in water are basic in acetic acid.

Titration in non-aqueous media have particular relevance to pharmaceutical preparations and forensic science where the subjects for analysis are weak or very weak acids or bases. In this experiment an acid solute that is completely dissociated in glacial acetic acid, such as perchloric acid, is a much stronger acid than in water and can be used to determine very weak organic bases, such as quinine, codeine, caffeine, ephedrine or vitamin B₁. By selecting an alkaline medium, such as tetrabutylammonium hydroxide compounds such as succinic acid and salicylic acid can also be determined.

Learning Experience

As a contextual analytical and forensic learning tool this experiment is ideal. The subject matter is topical for forensic chemistry and the approach stresses analytical accuracy as a goal. The experiment supports a fundamental area of chemistry, that of acid base chemistry, as well as introducing students to the importance of thinking outside the box for analysis methods.

Level of Experiment

Third year undergraduate

Keyword Descriptions of the Experiment

Domain

analytical chemistry, inorganic chemistry

Specific Descriptors

quinine, alkaloid chemistry, non aqueous titration, acid / base chemistry

Course Context and Prerequisite Knowledge and Skills

The experiment supports lecture and assignment material focussed on non aqueous solvent extraction and general chemistry in non aqueous media. The experiment supports work at first and second year on acid base chemistry particularly Brønsted-Lowry theory, the solvent system and levelling. The emphasis is on developing an analytical approach appropriate to the skills required by the minerals, forensic / analytical and pharmaceutical industries. The students also attempt an assignment investigating the solubility of various inorganic and organic materials in liquid ammonia. The emphasis of the assignment is on comparing solubilities in water and ammonia in terms of solvation and lattice energies to develop a general picture of how the solvent influences chemical reactions. This lab experiment explores solvent levelling and acid base chemistry. The forensic and pharmaceutical interest is contained in the object of the analysis. Quinine is not the only alkaloid that can be used and for variety between groups caffeine, or codeine sulphate in paracetamol can be successfully substituted.

Time Required to Complete

Prior to Lab: 1.5 h

In Laboratory: 4 h

After Laboratory: 1 h (write up)

Experiment History

The experiment originates from the introduction of titrations in non aqueous media to general analytical chemistry with reference to the development of the inorganic course to cater for pharmacy, forensic and mineral science students. The experiment was developed by Professor van Bronswijk with some later development work and educational analysis by Dr Lee. The determination of alkaloids can be problematic as they are weak bases and although aqueous titration

determinations are available, the use of a non aqueous medium allows a much more accurate and reproducible experiment for undergraduate class purposes.

Comments

The use of perchloric acid and acetic anhydride in an undergraduate experiment challenges the students to work with potentially dangerous compounds and mixtures, possibly for the first time in their careers. However, handled correctly this experiment presents no additional risk to students that cannot be avoided through good laboratory practice. It is recommended that students wear rubber gloves during the experiment. The experiment should be performed with some secondary containment, either fume hood or within a deep acid resistant tray.

A small excess of acetic anhydride should be included in the acetic acid preparation to ensure the complete removal of all water. The presence of water is the most common reason for poor results and the most common source of water is the glass electrode. When performing the experiment it must be remembered that the electrode must not be cleaned with water between titration runs and should be thoroughly dried prior to use.

References

Fifer, C. W. & Wollish, E. G. (1952). Potentiometric titration of salts of organic bases in acetic acid. *Analytical Chemistry*, **24**, 300-306.

Hädicke M. & Howorka, K. (1960). Title. *Pharmazeutische Zentralhalle für Deutschland*, **99**, 312.

Huber, W. (1967). *Titrations in Nonaqueous Solvents*. New York, NY: Academic Press NY, p. 252.

Kucharsky, J. & Safarik, L. (1965). *Titrations in Non-Aqueous Solvents*. New York, NY: Elsevier, p. 286.