Thermodynamics of Ligand Binding

by Peter Lye, Max Gunter

Experiment Overview

In this experiment, a synthetic and non-natural porphyrin ligand, *meso*-tetraphenylporphyrin will be used as a tetradentate ligand for zinc ions, and the thermodynamics of binding of an extra ligand to the zinc will be investigated. Students prepare 10 solutions containing the zinc porphyrin complex with varying amounts of an allocated *p*-substituted pyridine, as the ligand. The visible spectra are recorded of each solution and the binding constants determined. The equilibrium constants for the zinc tetraphenylporphyrin with the *p*-substituted pyridines follow the order which would be predicted on the basis of the electron-donating or electron-withdrawing nature of the *para*-substituent.

Level of Experiment

This experiment is currently performed at the third year undergraduate level. However it could be easily included at the second year undergraduate level with the focus simply on the binding of a single ligand.

Keyword Descriptions of the Experiment

Domain
inorganic chemistry, biological chemistry

Specific Descriptors
thermodynamics, complexation, Beer's law, electronic spectroscopy

Course Context and Prerequisite Knowledge and Skills

This experiment was previously part of the laboratory course for a unit titled 'Biological Chemistry' at the University of New England. However in 2006 the experiment will become part of the laboratory course in a new unit titled 'Biological Inorganic Chemistry'. As such the knowledge required by students to complete the experiment is a basic knowledge of thermodynamics, in particular metal-ligand binding, and an understanding of the electronic spectra of coordination complexes.

Students will need to have a basic level of laboratory proficiency and the ability to operate a UV Visible spectrometer. For data analysis students are strongly encouraged to use a spreadsheet program, such as Microsoft EXCEL.

Time Required to Complete

Prior to Lab: 30 min
In Laboratory: 3 h
After Laboratory: 2 h

Experiment History

This experiment has been run within the Chemistry Department at the University of New England for over ten years. It has been part of the laboratory course of third year units in Advanced Inorganic Chemistry, Biological Chemistry and now Biological Inorganic Chemistry.
he experiment has been adapted from an article published in the *Journal of Chemical Education* by Beckmann *et al.* in 1976.

References

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