Kinetics of the Reaction of Hydrazobenzene with (tBuClip)Ni

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Introduction

With the increase in global warming caused by the release of greenhouse gases, finding new ways to produce and store energy is extremely important. Current renewable energy sources such as solar or wind are hampered by inefficient methods of storing energy. Finding ways to efficiently store energy using chemical oxidations or reductions would greatly enhance the viability of renewable energy.

Project Overview

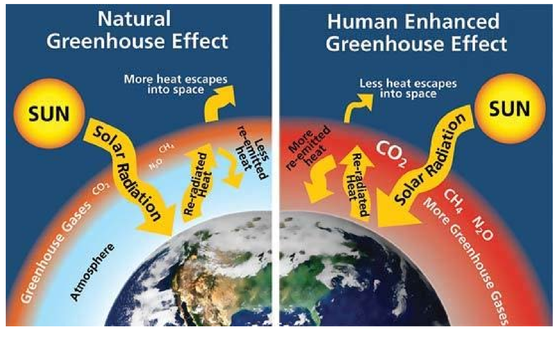
This project is focused on finding efficient means of storing electrical energy in chemical fuels. Dehydrogenation reactions between hydrazobenzene and Group 10 metal complexes of a bis(iminosemiquinone) ligand have shown possible concerted mechanisms which may be useful for developing efficient methods for interconverting electrical and chemical energy. To confirm this hypothesis, the reaction rates between analogous nickel and platinum compounds are being measured using UV-visible spectroscopy.

Experimental Procedure

A (tBuClip)Ni (100 µL) complex was combined with a 25mM, 50mM, 75mM, and 100mM solution of hydrazobenzene. This reaction is done in a dry box to avoid contact with air. The absorbance of each concentration was measured using an ultraviolet visible spectrophotometer, and the results were calculated using first order rate law. UV-visible spectrophotometers use both visible and ultraviolet light to measure the level of absorbance during a reaction. The change in absorbance over time is used to determine the rate of the reaction.

High School Focus

It is known that carbon dioxide gas present in the upper atmosphere traps heat and thus acts like a global blanket. The sun warms the surface of the Earth and the heat normally radiates back out into space. Because CO_2 (gas) at some level is naturally present in the Earth's atmosphere, a certain amount of this blanket effect is normal. However, the widespread combustion of fossil fuels in our modern world has produced vast quantities of carbon dioxide gas, thus thickening the blanket. Much of the heat energy ends up trapped in our atmosphere. In the past century, the amount of carbon dioxide in our atmosphere has increased to the point where scientists are concerned that our planet is slowly warming up. This phenomenon is called the greenhouse effect and is associated with global warming.

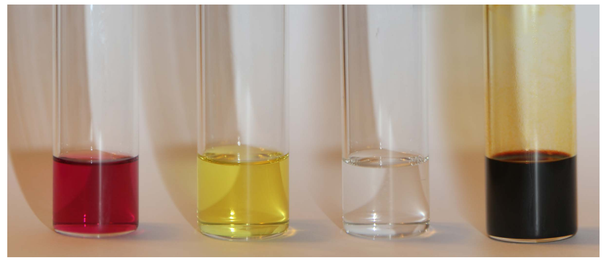


High School Lab Experiment

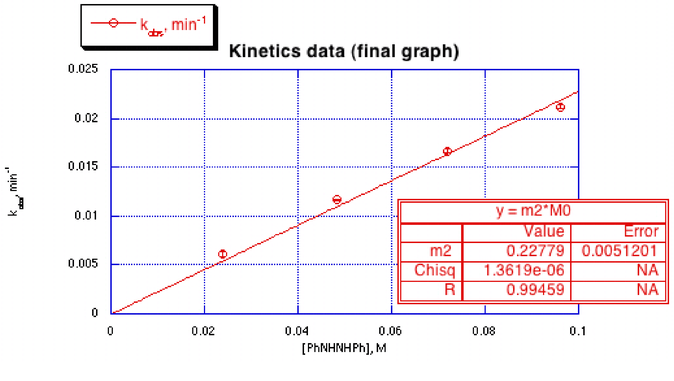
Experimentally students will use kinetics to provide information about the iodination of acetone in an acidic aqueous solution. The students will use HCl(aq), acetone, and KI_3 in various concentrations so that they can measure the rate of reaction. The triiodide ion has a yellow-brown color in solution which will disappear as the reaction reaches completion. The students will use several concentrations and record the time of disappearance of each. They will then use the following rate law to determine the kinetics.

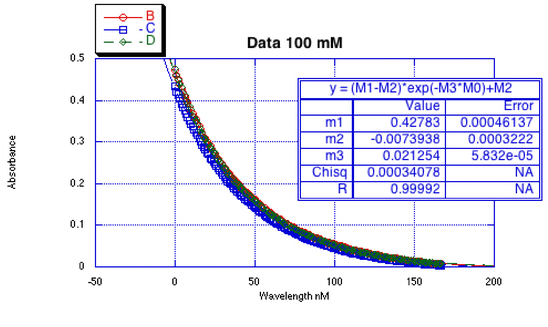
- Rate = $k[\text{acetone}]^m[I_3^-]^n[H^+]^p$

The kinetics for this lab experiment can be determined without the use of a UV-visible Spectrophotometer that was used in the (tBuClip)Ni kinetic reaction, since the completion of the reaction coincides with the disappearance of color.



Data/Observations





Conclusion

The (tBuClip)Ni compound was reacted with various concentrations of hydrazobenzene as the first part of two kinetic experiments to determine the mechanism of reactions between hydrazobenzene and Group 10 metal complexes of a bis(iminosemiquinone) ligand . (tBuClip)Ni followed a clear linear rate of reaction depending on the hydrazobenzene concentration. The next step will be to see if a platinum complex behaves in the same manner. The data from this reaction will also be useful for explaining kinetic reactions in the high school classroom.

Acknowledgements

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Brown Group – Thank you for letting me see the potential of teaching. I hope that my students will someday achieve the same high level of scientific competence and knowledge that all of you so obviously possess.

http://i.livescience.com/images/i/000/053/475/i02/Greenhouse-effect.jpg?1370382117