CALIFORNIA STATE SCIENCE FAIR
2005 PROJECT SUMMARY

Name(s)
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Project Number
S0523

Project Title
Elucidation of Molecular Structure and Bonding by Viscosity

Abstract

Objectives/Goals
I wanted to determine whether viscosity would be useful to reveal characteristics of functional groups of molecules that change in biochemical processes, such as fermentation.

Methods/Materials
I investigated the viscosity of compounds and aqueous solutions as a function of temperature using a Cannon Fenske viscometer. Reference compounds included alcohols, ketones, organic acids, methylated aromatics, salts, peroxide, and water. Juice was extracted from Citrus aurantium, Vitis vinefera, and Vitus labrusca and then a portion was anaerobially fermented prior to measuring viscosity on the raw and fermented juices. The displacement time between viscometer fiducial marks for each compound was plotted and the velocity and acceleration corresponding to the displacement time was determined from the slope of the data.

Results
A matrix was developed that correlates changes in the direction of the viscosity acceleration vector over temperature with functional structure, enabling the category identification of unknown species. This was successfully employed to assess the efficacy of anaerobic fermentation and conversion to alcohol of fruit juices, achieving the initial research goal. The independence of viscosity with mass concentration was demonstrated by cleaving solutions of polyvinyl alcohol.

Conclusions/Discussion
Slight differences in structure that establish polarity and a dipole moment make substantial differences in viscosity by enabling inter-molecular bonds. Viscosity acceleration vector changes over temperature provide a classification basis to identify compounds of similar molecular structure. This allows me to postulate that there is a diffusion-based, second order, temperature-dependent, transport process occurring of greater complexity than given by either the colligative models of Poiseuille and Einstein or the thermal activation relationship identified by Carrancio.

Summary Statement
I found that temperature-based changes in the acceleration vector direction of fluids effusing through a viscometer provided a basis to identify the functional structures of the solutes.

Help Received
My judges at the county science fair provided explanations of the role of polarity and the dipole moment in the observed results. Len Thibodeau of Brookfield Engineering explained how to calibrate a viscometer. My parents helped with board layout.