

EXPERIMENT 11

Determination of the Equilibrium Constant for a Reaction

Background

Organic esters are formed in an acid-catalyzed condensation reaction between a carboxylic acid and an alcohol. Water is also produced. The reaction, called Fisher esterification, is an equilibrium process whose equilibrium constant can be calculated if one can determine the equilibrium concentrations of all species.



In this experiment, we will mix known amounts of the 2 reactants with a catalytic quantity of strong mineral acid. The mixture must be heated to reach equilibrium in a reasonable time. Periodically during the heating, we will withdraw a homogeneous sample of the reaction mixture and will find the concentration of acid in the solution by titration. When the concentration becomes constant (unchanged on 2 successive analyses) we assume the mixture has reached equilibrium. From the results of the titration, we can determine the equilibrium concentration of the carboxylic acid. Knowing all initial reactant concentrations and the equilibrium concentration of one component allows us to calculate all equilibrium concentrations. Then, from the equilibrium expression, we can solve for the equilibrium constant value of the reaction.

One simplification makes use of the fact that the reaction mixture's volume is essentially constant during the course of the reaction. Since the stoichiometry shows equal moles of reactants and products, volume cancels from the equilibrium expression. Thus, the K_{eq} expression simplifies to the mole ratio of each component at equilibrium.

PROCEDURE:

You may work in **pairs** for this experiment. An individual lab report should be submitted by each student.

Part I:

Stock bottles of ~0.2M NaOH will be provided. This base must be standardized. Use potassium hydrogen phthalate, $\text{KHC}_8\text{H}_4\text{O}_4$ (KHP for short) as the primary standard.



- First, calculate the appropriate mass of KHP required to titrate ~30 mL of the ~0.2M base. Obtain a KHP sample and dissolve it in 25 mL of deionized water. Rinse and fill

Determination Of An Equilibrium Constant

Daniel C. Harris



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