Reactions in Non-Ideal Solution - The Effect of Ionic Strength on the Rate of Reactions between Ions in Aqueous Solution (The Kinetic Salt Effect)

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Practical:

Summary: 1. In this experiment the Kinetic Salt Effect (the impact that increasing ionic strength has on the rate of a reaction in ionic solution) is explored. Students compare their findings to theoretical predictions. While being a simple experiment it offers several points of consideration for the student, making it an effective learning tool:

- Indirect measurements of chemical species. The reaction product (iodine) is difficult to measure directly, thus it is simpler and more accurate to monitor its production indirectly.
- The effect that altering a reaction mixture can have on the rate of a reaction. The reaction studied in the experiment is:

2I - + S 2O 82 - -> I 2 + 2S 2O 42 -

The observed effect (reaction rate increases with increasing ionic strength) can be explained simply as the positive ion of the added electrolyte (Mg2+) draws the two negatively charged reactants closer, increasing the chance of a successful reaction. Students gain confidence when they are able to explain (perhaps with some prompting) an observation in a way that is clearly easy to understand. (Note that this can be expanded upon, however, if lecture material covers more extensive properties of ionic solutions including the Debye-Hückel theory of ionic solutions and the affect of ‘ionic atmosphere’ on ion reactivities.)

- While the equation(s) used are ‘simple’, they do require quite a bit of number crunching, which leads to satisfaction when completed successfully.
- Recognising a linear form of an equation and

subsequent plotting of relevant data is always beneficial in Chemistry!

- Comparing experimental results with theoretical proposals triggers students to critically assess the applicability of theory to experiment. In this experiment, the theory is not obeyed (however limiting slopes may show that the theory is approached). Calculations show clearly that one assumption connected to the theory is not met (ionic strength exceeds the limit on which the theory is based). Students can therefore realise that failure to comply with theoretical expectations is not always simply due to 'student error', and it is therefore imperative that applicability of theory to each experimental protocol is also assessed.
- Activated Complex Theory describes the reaction taking place, and is introduced in the Background Theory for the experiment.

Abstract

This experiment has a direct bearing on kinetics (with respect to reaction rates, catalytic effects etc.). It also deals with ideal and non-ideal solutions, ionic strength, activity coefficients, Debye-Hückel theory related to ion-ion reactions, and activated complex theory (ACT). Knowledge in these areas would naturally assist students, however the concepts are not too complicated and are covered in the laboratory notes.

Experimental skills required are the ability to use volumetric glassware – and simply being able to work a stopwatch.

Duration

Prior to Lab	30 min - 1 hr (reading)
In Laboratory	2 – 3 hrs
After Laboratory	2 – 3 hrs (plotting data, analysing results, calculations, report writing)

Further comments

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