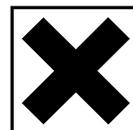


D-block ions as catalysts

Introduction

Transition metals and their compounds are important catalysts in industry and in living systems. Some industrial reactions which are catalysed by transition metals and their compounds include:

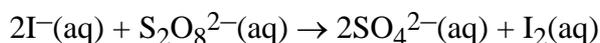


- *Haber Process* (iron or iron(III)oxide)
- *Contact Process* (vanadium(V) oxide)
- Hydrogenation of unsaturated oils in margarine manufacture (finely divided nickel).

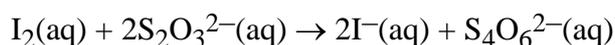


These are examples of **heterogeneous** catalysts. However, transition metals ions can also act as **homogeneous** catalysts because they have variable oxidation states.

Today, you are going to study the effect of some transition metal ions on the oxidation of iodide ions by peroxodisulphate ions, $\text{S}_2\text{O}_8^{2-}$. This occurs according to the following equation:



A convenient way to measure the rate of this reaction is to add a fixed volume of sodium thiosulphate solution to the reaction mixture. This reacts with the free iodine formed in the reaction:



When the sodium thiosulphate has been used up, the free iodine is produced. If some starch solution has also been added, a deep blue colour will be produced.

Apparatus

Goggles

Bench mat

10cm³ measuring cylinder

25cm³ measuring cylinder

100cm³ conical flask

1cm³ and 10cm³ bulb pipettes

pipette filler

teat pipettes

stopwatch

0.1M sodium thiosulphate ☒

0.2M potassium iodide ☒

saturated potassium peroxodisulphate solution ☒

starch solution (indicator)

de-ionised water

0.1M solutions containing:

$\text{Cr}^{3+}(\text{aq})$, $\text{Fe}^{3+}(\text{aq})$, $\text{Cu}^{2+}(\text{aq})$, $\text{Co}^{2+}(\text{aq})$ ☒☒

Methods

1. Put the following solutions into the conical flask: 10cm³ of 0.2M potassium iodide; 10cm³ of 0.1M sodium thiosulphate; and 5cm³ of starch solution.
2. Add 20cm³ of saturated potassium peroxodisulphate solution. Write down your observations.
3. The change that you have observed should help you to work out how you can study the effect of adding small quantities of transition metal ions (in solution) on the rate of the oxidation reaction.

Write a brief plan of the experiments you are going to carry out and give it to your teacher for checking.

4. Carry out your experiment, and record your results in an appropriate way.

At the end of your practical work, note any modifications you might have made while carrying out your plan.

D-block ions as catalysts

Technician's Notes

Per pupil

1 x 10cm³ measuring cylinder
1 x 25cm³ measuring cylinder
1 x 100cm³ conical flask
1 x de-ionised water bottle (please make sure that additional supplies are available)
1 x pipette filler
1 x teat pipette
1 x stopwatch

access to:

1cm³ and 10cm³ bulb pipettes

Reagents

0.1M sodium thiosulphate, Na₂S₂O₃ (allow 80cm³ approx. per student)

0.2M potassium iodide, KI (allow 80cm³ approx. per student)

starch solution (indicator) (allow 40cm³ approx. per student)

saturated potassium peroxodisulphate solution, K₂S₂O₈ (allow 160cm³ approx. per student)

For 1dm³, put 75g of K₂S₂O₈ into about 200cm³ of distilled water.

Warm and stir to dissolve.

Add to about 700cm³ of distilled water on the magnetic stirrer, then make up to 1dm³ with distilled water. On cooling, some white crystals will form on the bottom – this is normal.

For the following reagents, any soluble form will do (e.g. nitrates, chlorides, sulphates).

Allow approx. 10cm³ per student of 0.1M solutions of:

Cr ³⁺	chromium(III)
Fe ³⁺	iron(III)
Cu ²⁺	copper(II)
Co ²⁺	cobalt(II)