

Investigating Equilibrium in a Cobalt(II) Chloride System

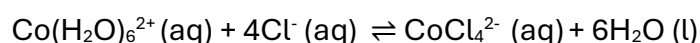
Aim

To investigate how changes in chloride ion concentration and temperature affect the position of equilibrium in a cobalt(II) chloride system.

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Background Theory

In aqueous solution, cobalt(II) ions exist in equilibrium between two complexes:



- Pink complex: $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$
- Blue complex: $[\text{CoCl}_4]^{2-}$

According to **Le Chatelier's principle**, increasing chloride ion concentration or temperature will shift the equilibrium position.

Materials

- Cobalt(II) chloride hexahydrate ($\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$)
- Distilled water
- Sodium chloride (NaCl) (solid or concentrated solution)
- Test tubes (3–4)
- Test tube rack
- Droppers or pipettes
- Beakers
- Hot water bath
- Ice bath
- Stirring rod

Safety

- **Cobalt(II) chloride is harmful if ingested** and may cause **skin/eye irritation**
- Avoid inhalation of dust and contact with skin
- Wear: Safety glasses, Lab coat, Gloves

Method

Part A: Effect of Chloride Ion Concentration

1. Add approximately 5 mL of cobalt(II) chloride solution to a test tube (pink colour observed).
2. Add a small amount of solid NaCl or a few drops of concentrated NaCl solution.
3. Gently swirl and observe any colour change.
4. Record observations.
5. Add distilled water to the same test tube and observe any reversal of colour.

Part B: Effect of Temperature

1. Place a fresh sample of the cobalt(II) chloride solution in a test tube.
2. Add NaCl until the solution turns blue.
3. Place the test tube in a hot water bath and observe the colour.
4. Transfer the same test tube to an ice bath and observe any change.

Results / Observations

Condition	Colour change observed
Part (A) Addition of NaCl to original solution	
Part (A) Increase volume by addition of water	
Part (B) Applying heat	
Part (B) Cooling	

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Discussion

Conclusion

Extension Questions

1. Explain why dilution shifts the equilibrium to the left.

2. Is the forward reaction endothermic or exothermic? Justify your answer.

3. Predict what would happen if more NaCl was added after cooling.
