Equilibrium and the Haber process

Edexcel GCSE Chemistry (1CH0) · Foundation and Higher

Answer on your own paper. Show your working where needed.

1. The reactor equation

Nitrogen reacts reversibly with hydrogen to make ammonia. Write a balanced symbol equation that shows the reaction is reversible.

2. Readings in a closed container

In a sealed vessel, the amount of ammonia stops changing even though nitrogen and hydrogen remain. Explain why a constant amount of ammonia does not show that the reactions have stopped.

3. Running the Haber process

Name the catalyst and give the approximate temperature and pressure used in the Haber process. State a source of the nitrogen.

4. Choosing a fertiliser

A grower uses ammonium nitrate, NH_4NO_3, as a source of nitrogen. The crop also needs the other two nutrients in an NPK fertiliser. Name those two elements and explain why ammonium nitrate alone cannot supply them.

5. Higher · compressing a gas mixture

$N_2O_4(g) \rightleftharpoons 2NO_2(g)$. The sealed mixture is compressed at constant temperature. Predict what happens to the equilibrium amount of NO_2 and explain why.

6. Higher · choosing a temperature

Ammonia formation is exothermic. An engineer proposes lowering the reactor temperature. Compare the effects on equilibrium yield and rate. Explain why the factory uses a compromise temperature.

7. Make a fertiliser from ammonia

A factory makes a nitrogen fertiliser by reacting ammonia with nitric acid. Name the fertiliser and describe the type of reaction.

Would replacing nitric acid with sulfuric acid make the same salt? Explain.

8. Higher · comparing factory proposals

Proposal A raises pressure at constant temperature. Proposal B adds a more active catalyst at the original temperature and pressure. For a fresh feed, compare the effects on the initial rate and equilibrium yield of ammonia. Give one practical drawback of A.

9. Extra challenge · Compare two ways of making a fertiliser

A laboratory needs a few grams of ammonium sulfate crystals. A factory needs a continuous supply of the same fertiliser.

Describe how the laboratory can make the salt from ammonia solution and dilute sulfuric acid. Compare its method with large-scale production, including the source of the starting chemicals.

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