Equilibrium and the Haber process

AQA GCSE Chemistry (8462) · 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. Recovering ammonia

Gas leaving the reactor contains nitrogen, hydrogen and ammonia. Describe how a factory can collect ammonia from this mixture and use the remaining gases to make more product.

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 · Choose reactor conditions (Higher)

A factory compares 400 °C and 250 atm with 450 °C and 200 atm. Predict which combination gives a higher equilibrium yield of ammonia.

Explain why the initial rate cannot be ranked from these changes alone. Suggest one cost or safety check before changing the conditions.

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