Industrial equilibrium: yield and compromise

Student activity • observation and reasoning

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The question

Is maximum equilibrium yield the best operating choice?

Compare hypothetical operating choices for ammonia production. Explain a temperature/pressure compromise without presenting invented data as industrial measurements.

Equipment

- Booklet, pencil, periodic table and optional molecular model kit

Desk activity only; keep small model pieces away from mouths.

Course coverage: Chemistry only: 3.22C. Application of equilibrium principles; no high-pressure apparatus.

Plan, model or apparatus sketch

Draw a labelled structure or model to explain your reasoning for this lesson.

Method and reasoning

Read the whole sequence before starting

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1. Use the exothermic ammonia equation and label its four-to-two gas ratio.

2. Rank low and high temperatures for equilibrium yield, holding pressure fixed.

3. Rank low and high pressures for equilibrium yield, holding temperature fixed.

4. Compare a low-temperature slow-reaction option with a warmer faster-reaction option. Explain why yield alone cannot determine output per hour.

5. Identify energy, compression, equipment and safety costs associated with higher pressure.

6. Write a justified recommendation including catalyst use and recycling unreacted gases; distinguish equilibrium yield from process conversion.

Cleanup

- Return shared equipment and retain corrected reasoning.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Qualitative scenarios only, not plant data: A uses lower temperature and moderate pressure; B uses warmer conditions at the same pressure; C uses the warmer temperature and higher pressure. $N_2+3H_2 \rightleftharpoons 2NH_3$ is exothermic. No numerical optimum can be calculated from this information.

Task	My structure / working	Reason / correction
Temperature options		
Pressure options		
Recommendation		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Which temperature favours ammonia at equilibrium?

2. Which pressure favours it?

3. Why might warmer operation be chosen?

4. Name two high-pressure costs.

5. Does a catalyst raise equilibrium yield?

6. How can recycling improve use of the feed gases?