What are Industrial Chemistry Processes?

Worksheet

Industrial processes optimize yield, rate and cost. Key examples are the Haber Process (N + H NH at 400 C, 200 atm) and the Contact Process (SO HSO), which feed global agriculture and manufacturing.

Questions

1. What is the main purpose of the Haber Process?
A) Make nitrogen gas
B) Produce ammonia for fertilizers
C) Extract iron
D) Synthesize water

2. In the Haber Process, increasing pressure favors
A) reactants (N + H)
B) ammonia (NH)
C) both equally
D) no effect

3. The Contact Process produces
A) ammonia
B) sulfuric acid
C) polymers
D) methanol

4. Why recycle unreacted gases in industrial reactors?
A) Safety
B) Increase yield and reduce waste
C) Lower temperature
D) Faster cooling

5. The Haber Process: N + 3 H 2 NH. Under the process conditions (400 C, 200 atm, Fe catalyst), the equilibrium conversion is ~15%. If 100 mol/s H feed rate is used, how much NH is produced per second?

6. The Contact Process makes HSO: 2 SO + O 2 SO; SO + HO HSO. If 500 mol/s SO is fed and 95% converted, how many mol/s SO is formed?

7. A polymerization reactor produces polyethylene at 80 C and 1000 atm. If 100 kg/h of ethylene monomer is fed and 80% polymerizes, what is the mass rate of polymer produced?

8. Define: What is the Haber Process?

9. Define: Why use high pressure in the Haber Process?

10. Define: What is the Contact Process?

Answer Key

1. B) Produce ammonia for fertilizers - Haber produces ammonia (NH) for nitrogen fertilizers, enabling food production for billions.

2. B) ammonia (NH) - Fewer moles on the product side (2 vs 4) high pressure shifts equilibrium toward NH.

3. B) sulfuric acid - Contact Process oxidizes SO to SO, then dissolves in water to make HSO.

4. B) Increase yield and reduce waste - Recycling gets more moles to react without increasing fresh feed, maximizing conversion efficiency.

5. N is the limiting reagent. From the stoichiometry: 3 mol H 2 mol NH With 15% conversion of the limiting reactant and H excess: Assuming limiting N input 33.3 mol/s, conversion = 0.15 N reacted = 33.3 0.15 = 5 mol/s NH produced = 5 (2/1) = 10 mol/s 170 g/s

6. SO feed = 500 mol/s Conversion = 95% = 0.95 SO reacted = 500 0.95 = 475 mol/s From 2 SO 2 SO: mole ratio 1:1 SO produced = 475 mol/s

7. Ethylene feed = 100 kg/h Conversion (polymerization yield) = 80% = 0.80 Polymer produced = 100 0.80 = 80 kg/h of polyethylene

8. N + 3 H 2 NH at 400 C, 200 atm, with Fe catalyst. Produces ammonia for fertilizers.

9. The reaction is exothermic and produces 2 moles from 4. High pressure shifts equilibrium toward NH.

10. 2 SO + O 2 SO HSO. Industrial sulfuric acid production using a VO catalyst.