PENANG SANGAM HIGH SCHOOL
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LESSON NOTES

Subject: Chemistry **Year/Level:** 12

Week 16

Strand	3 Quantitative Chemistry
Sub Strand	3.3 Physical chemistry
Content Learning Outcome	To discuss the effect of pressure on different types of reactions, mostly Haber process.

3. Pressure

- Pressure only affects gaseous system (where the reactants and products are in gaseous form).
- Gas particles in a container collide with the walls of the container, exerting a force called the **pressure of the gas.**
- The more the collision between the gas particles and the walls of the container, the greater the gas pressure.

Ways to increase gas pressure:

1. Adding more gas particles to a closed system
2. Reducing the volume of a closed system.

- **An increase in pressure favours the side which has lesser number of moles**.This is because as the pressure increases, the system acts to oppose the change by reducing the pressure and this is done by decreasing the amount of gas particles.
- **A decrease in pressure favours the side which has more number of moles**. In reactions where the total number of moles of reactants and products is the same, pressure changes have no effect on the equilibrium.

Example: The Haber process (Production of Ammonia)

Raw materials: hydrogen and nitrogen.

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g) \qquad \Delta H = -92\ kJ/mol$$

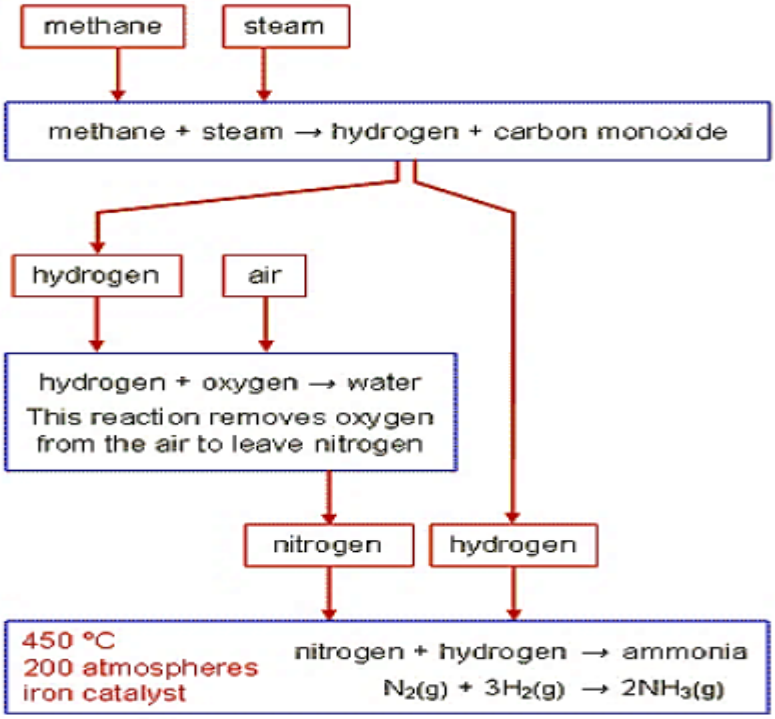
Nitrogen and hydrogen react together under these conditions:

- a high temperature - about 450 ºC
- a high pressure - about 200 atmospheres
- an iron catalyst

*The reaction is reversible, thus some nitrogen and hydrogen remain mixed with the ammonia. The **reaction mixture is cooled** so that **ammonia liquefies** and can be removed. The remaining nitrogen and hydrogen are **recycled**.

Note: Adding a **catalyst increases the rate of both the forward and backward** reactions and this causes equilibrium to be established more rapidly. Therefore, a catalyst does not alter the equilibrium position since there is no overall change in the relative amounts of reactants and products present.

The flow chart below shows the main stages in the Haber process



Effect of pressure on this reaction

$$N_{2\,(g)} + 3H_{2\,(g)} \rightleftharpoons 2NH_{3\,(g)}$$
1 mole 3 moles 2 moles

An increase in pressure will favor the product side (i.e. NH_3) because it has only 2 moles of ammonia. Therefore, equilibrium shifts from left to right, forming more ammonia since the forward reaction is favored. This will reduce the amount of gas particles present in the mixture.

A decrease in pressure favors the reactants as there are altogether 4 moles on the reactant side. Therefore, equilibrium shifts from right to left, forming more H_2 and N_2, since the backward reaction is favored. This will increase the amount of gas particles present in the mixture.

Activity

Using the production of ammonia equation: **N_2 (g) + 3H_2 (g) ⇌ 2NH_3 (g)** **ΔH= -92 kJ/mol**

a) Describe the shift in equilibrium for the system when:

- More NH_3 is added. _____
- N_2 is removed. _____
- H_2 is added. _____

b) In order to get the maximum possible percentage of ammonia in the equilibrium mixture, would you choose to use a high or a low temperature? Explain your answer.

_____
_____
_____
_____