Cosmo School

Chemistry

Class-9

Chapter-7

Chemical reactions

Subject teacher- Syeeda Sultana

Lecture sheet with worksheet-7

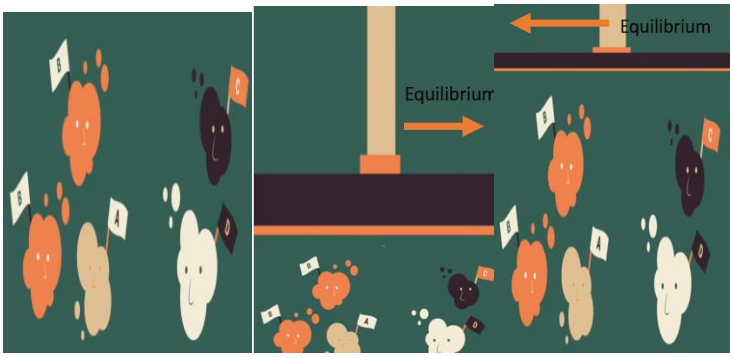
Date-04.11.2020

Unit-1:Effect of changes to pressure chemical equilibrium

If we increased or decreased pressure, the system becomes stressed and is no longer at equilibrium. This stress to a system/chemical reaction at equilibrium is only applicable to gaseous systems. Solids and liquids aren't affected by pressure as much, that means the effect of changes to pressure is only applicable to gaseous reactions. For this stress, we will examine a hypothetical reaction at equilibrium: Here reactant A reacts with 2 moles reactant B to form 1 mole product C and 1 mole product D.

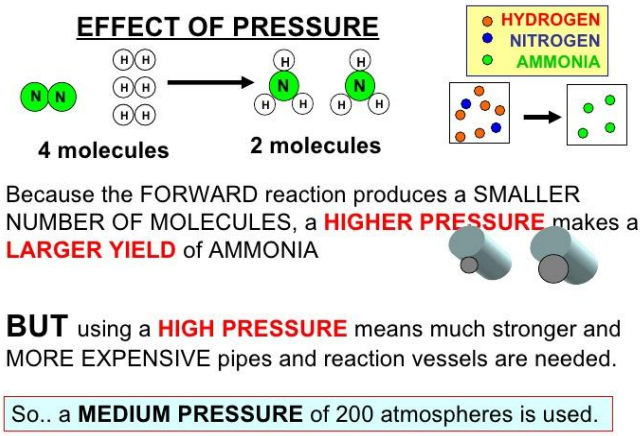
$A + 2B \rightleftharpoons C + D$

An increase in pressure means that there is a decrease in volume, so there is less space for the movement of molecules. A decrease in pressure means that there is an increase in volume, so there is more space for the free movement of molecules. We know that if we decrease the volume, the pressure will go up. Since the smaller the volume, the denser the particles or molecules, and they will hit the sides/walls and exert pressure. If there is a discrepancy in the number of moles of particles(reactants or products) on either side of the equilibrium, it will shift towards the side with fewer particles so as to minimize the additional pressure. if we decrease the pressure, that means increase the volume, thereby, lowering the pressure, the equilibrium would shift towards the side with fewer particles which lowers the pressure on the container. if we increase the volume, by lowering the pressure, the equilibrium would shift towards the side with more particles(moles) in order to regain some of the lost pressure.



In our example, an increase in pressure will cause equilibrium to shift to the right, since there are fewer moles, 2 moles on the right compared to 3 moles on the left that means on the reactant side. A decrease in pressure will shift the equilibrium to the side with more moles, so in our

example, equilibrium shifts to the left. So, an increase in pressure favours the side with fewer moles, and a decrease in pressure favours the side with more moles.



Example-1:

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

In this reaction the total number of reactants is 4 (1 mole of N_2 and 3 moles of H_2) but the total number of moles of product (NH_3) is 2.So, if pressure is increased then forward reaction will occur to minimize the effect of increased pressure as a result production of NH_3 will increase. So, equilibrium will shift in the direction with fewer molecules or moles that means equilibrium will shift to the right.

But in decreasing pressure the equilibrium will shift to the left side with more molecules increasing the rate of backward reaction. That means production of ammonia will decrease. It is experimented that at 200-250 atm pressure maximum NH_3 can be produced.

Example-2:

$$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$$

In this reaction the total number of reactants is 2 (1 mole of N_2 and 1mole of O_2) but the total number of moles of product (NO) is 2.Since the reaction has no change in the number of moles on either side of the equilibrium, there is no effect of changes in pressure.

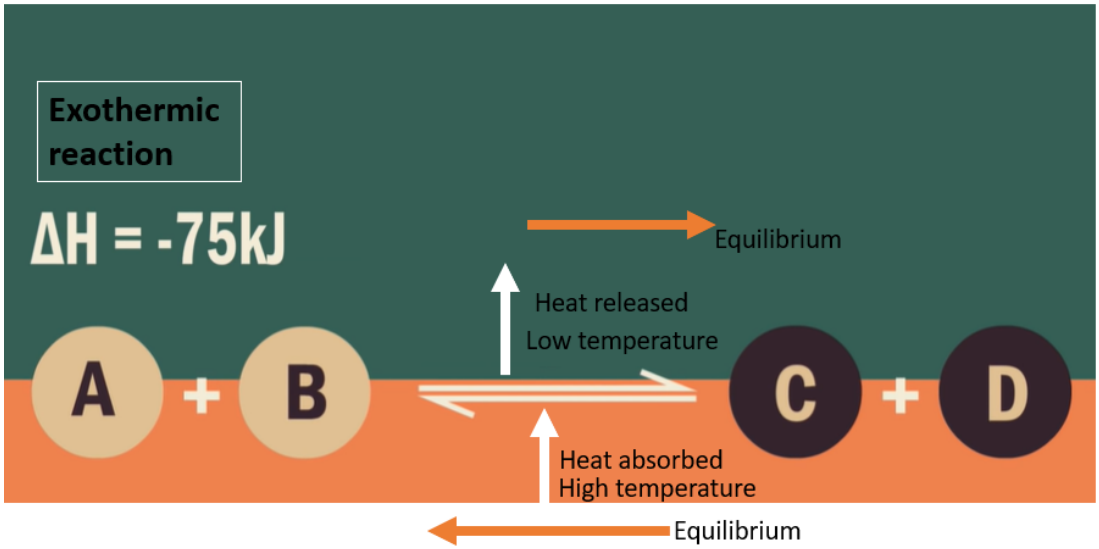
Unit-2: Effect of changes to pressure chemical equilibrium

Now we have to know what happens to a system at equilibrium when temperature is changed, we must first consider the energetics of the reaction in question. If the forward reaction is exothermic, then the reverse reaction must be endothermic. Let's examine the hypothetical reaction,

$A + B \rightarrow C + D \qquad \Delta H = -75kJ$

This means that 75kJ of energy is released when the forward reaction occurs, and 75kJ is absorbed when the reverse reaction occurs. So an increase in temperature would mean that the endothermic reaction would be favoured, to remove the excess heat, therefore counteracting the imposed stress that means neutralizing the effect of increased temperature. And the equilibrium

would shift towards the left from right increasing the rate of backward reaction. Decreasing the temperature would cause the system (chemical reaction) to produce more heat energy; therefore the exothermic reaction would be favoured. An increase in temperature favours the endothermic reaction. A decrease in temperature favours the exothermic reaction.

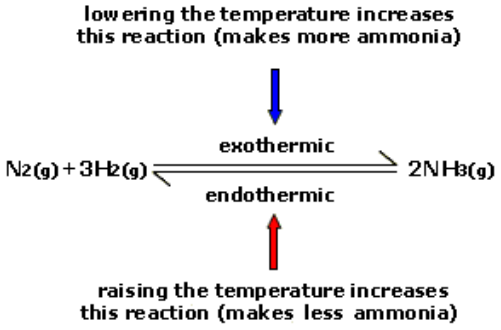


Example-1:

$N_2 + 3H_2 \rightarrow 2NH_3$ Exothermic (gives out heat energy)

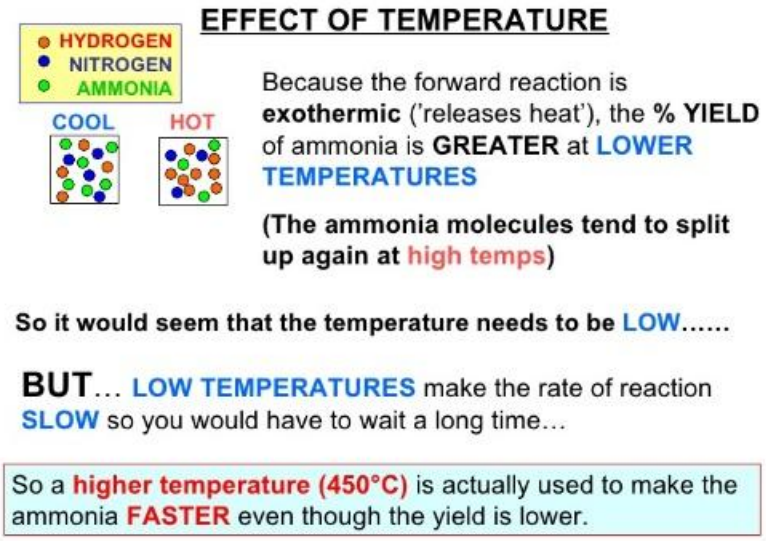
$N_2 + 3H_2 \leftarrow 2NH_3$ Endothermic (takes in heat energy)

$$N_2 + 3H_2 \underset{\text{Endothermic}}{\overset{\text{Exothermic}}{\rightleftharpoons}} 2NH_3$$



For the above exothermic reaction, according to Le-Chatelier's principle, if temperature increases the equilibrium state will be shifted to the left side increasing the rate of edothermic backward reaction to remove the excess heat and to restore the equilibrium. As a result less amount of product NH_3 will be obtained because of reverse reaction.
If temperature decreases the equilibrium state will be shifted to the right side increasing the rate of exothermic forward reaction to produce heat energy and to restore the equilibrium. As a result high amount of product NH_3 will be obtained because of forward reaction.
But decreasing temperature is unfavourable for reaction rate. So to increase reaction rate, temperature has to be increased. To solve this problem catalyst should be used. It is

experimented that maximum amount of NH_3 can be produced at 450-550^0 C temperature and 200 -250 atm pressure in presence of Fe catalyst.



Exercise:

1. Explain the effect of pressure and temperature on the following reactions-
   i) $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$ $\Delta H = +52$ kJ/mol
   ii) $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$ $\Delta H = +ve$

Creative questions:

1. i) $FeCl_3 + SnCl_2 \rightarrow FeCl_2 + SnCl_4$
   ii) $AlCl_{3(s)} + 3H_2O_{(l)} \rightarrow Al(OH)_{3(s)} + 3HCl_{(aq)}$

   a) What is rate of reaction?
   b) Differentiate between oxidation number and valency.
   c) The reaction no (i) is a redox reaction –explain.
   d) How many types of reactions could be included in reaction no (ii). Explain.

2. i) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$ $\Delta H = +180$kj
   ii) $N_{2(g)} + 3H_{3(g)} \rightleftharpoons 2NH_{3(g)}$ $\Delta H = -92$kj
   iii) $2FeCl_2 + Cl_2 \rightarrow 2FeCl_3$

   a) Write down the Le Chatelier's principle.
   b) Differentiate between hydrolysis and hydrationreactions.
   c) Redox and addition reactions, both are present in equation (iii). Explain.
   d) Explain the effect of temperature and pressure in reactions (i) and (ii).