Homogeneous and Heterogeneous Equilibria

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Introduction

A system in which all reactants are in same phase is known as homogeneous system.

For example in the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, all the reactant and products are in gas phase so this is a homogeneous system.

Homogeneous Equilibria

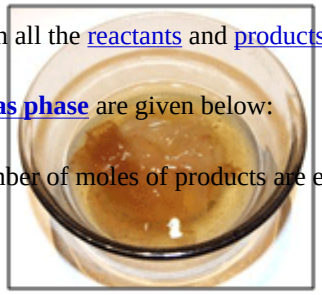
When in a equilibrium reaction all the reactants and products are in same phase, it is known as homogeneous equilibrium.

Examples of equilibrium in **gas phase** are given below:

(I) The reactions in which number of moles of products are equal to number of moles of reactants

$H_2 + I_2 \rightleftharpoons 2HI$

$N_2 + O_2 \rightleftharpoons 2NO$



(II) The reactions in which number of moles of products are not equal to number of moles of reactants

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

$2\ SO_2 + O_2 \rightleftharpoons 2SO_3$

$PCl_5 \rightleftharpoons PCl_3 + Cl_2$

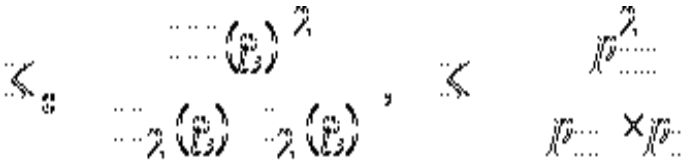
Examples of equilibrium in liquid phase are:

$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$

Expression for equilibrium constant:

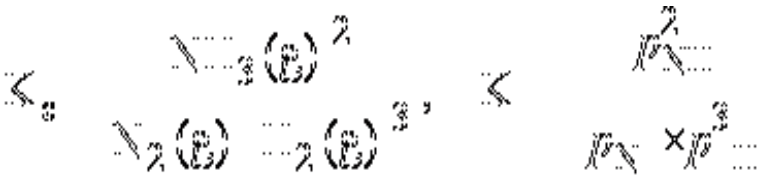
For the reaction of hydrogen and iodine to form hydrogen iodide

$H_2(g) + I_2(g) \rightleftharpoons 2HI\ (g)$

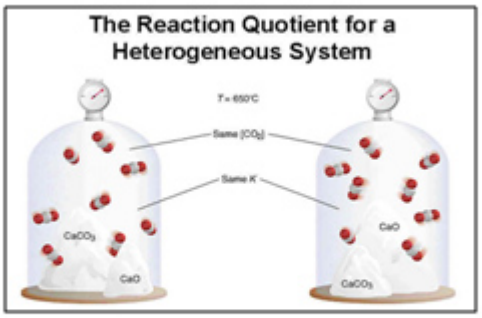


For the reaction of formation of ammonia from hydrogen and oxygen

$N_2 + 3H_2$? $2NH_3$



Heterogeneous Equilibria



Heterogeneous Chemical Equilibrium

The equilibrium in which the reactants and products of a reaction are present in two or more than two phases, is called a heterogeneous equilibrium.

Some **examples** of heterogeneous equilibrium are:

$CaCO_3(s)$? $CaO\ (s) + CO_2\ (g)$

$3Fe\ (s) + 4H_2O\ (g)$? $Fe_3O_4\ (s) + 4H_2\ (g)$

$H_2O\ (l)$? $H_2O(g)$

$Ag_2O(s) + 2HNO_3(aq)$? $2AgNO_3(aq) + H_2O(l)$

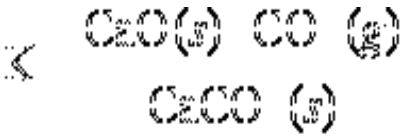
The position of the heterogeneous equilibrium is independent of the amount of pure solid or pure liquid present in the reaction mixture.

As the concentration of solids and liquids remains almost constant during the reaction they do not appear in the equilibrium expression.

Expression for equilibrium constant:

For the decomposition of calcium carbonate to calcium oxide and carbon dioxide

$CaCO_3(s)$? $CaO\ (s) + CO_2\ (g)$



But by convention $[CaCO_3\ (s)] = 1$, $[CaO\ (s)] = 1$

Hence, $K = [CO_2\ (g)]$

It is better to express the concentration of a gas in terms of partial pressure, the equilibrium constant of this reaction can be is expressed as

Above equation explains why concentration of CO2 becomes constant after the equilibrium is attained in the decomposition of calcium carbonate in a closed vessel.

(ii) For the equilibrium

$H_2O\ (l)$? $H_2O(g)$

But by convention $[H_2O(l)] = 1$

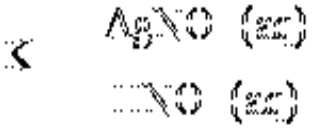
Hence, $Kc = [H_2O(g)]$

Or, in terms of pressure, 

This explains why[vapour pressure](#) of water is constant at constant temperature.

(iii) In the reaction of silver oxide with nitric acid

$Ag_2O(s) + 2HNO_3(aq)$? $2AgNO_3(aq) + H_2O(l)$



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as [Ag O(s)] =1, [H O (l)]=1

Why vapour pressure of water is is constant at constant temperature?

Try to answer. Still need help? Want to know more about it?Click here to schedule live help from a certified tutor!

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Reference Links:

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2. http://www.brightstorm.com/science/chemistry/chemical-equilibrium/heterogeneous-equilibrium-homgeneous-equilibrium
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