EXPERIMENT-5

STUDY OF SHIFT IN EQUILIBRIUM IN THE REACTION OF FERRIC IONS AND THIOCYANATE IONS:

AIM:

Study of shift in equilibrium in the reaction of ferric ions and thiocyanate ions by increasing the concentration of any one of these ions.

THEORY:

The equilibrium reaction between ferric chloride and potassium thiocyanate is conveniently studied through the change in the intensity of colour of the solution.

$$Fe^{3+}(aq) + SCN^{-}(aq) \rightleftharpoons [Fe(SCN)]^{2+}(aq)$$

(Blood red colour)

The equilibrium constant for the above reaction may be written as:

$$K = \frac{[[Fe(SCN)]^{2+}(aq)]}{[Fe^{3+}(aq)][SCN^{-}(aq)]}$$

Here K is constant at a constant temperature. Increasing the concentration of either Fe^{3+} ion or thiocyanate ion would result in a corresponding increase in the concentration of $[Fe(SCN)]^{2+}$ ions. In order to keep the value of K constant, there is a shift in equilibrium, in the forward direction and consequently an increase in the intensity of the blood red colour which is due to $[Fe(SCN)]^{2+}$. At equilibrium colour intensity remains constant.

MATERIAL REQUIRED:

- Beakers (100 mL) : Two
- Beaker (250 mL) : One
- Boiling tubes : Six
- Burettes : Four
- Glass droppers : Two
- Test tube stand : One
- Glass rod : One

- Ferric chloride : 0.100g
- Potassium thiocyanate : 0.100g

PROCEDURE:

(i) Dissolve 0.100 g ferric chloride in 100 mL of water in a beaker and 0.100 g potassium thiocyanate in 100 mL of water in another beaker.

(ii) Mix 20 mL of ferric chloride solution with 20 mL of potassium thiocyanate solution. Blood red colour will be obtained. Fill this solution in a burette.

(iii) Take five boiling tubes of same size and mark them as a,b,c, d and e.

(iv) Add 2.5 mL of blood red solution to each of the boiling tubes from the burette.

(v) Add 17.5 mL of water to the boiling tube 'a' so that total volume of solution in the boiling tube 'a' is 20 mL. Keep it for reference.

(vi) Now take three burettes and label them as A, B, and C.

(vii) Fill burette A with ferric chloride solution, burette B with potassium thiocynate solution and burette C with water.

(viii) Add 1.0 mL, 2.0 mL, 3.0 mL and 4.0 mL of ferric chloride solution to boiling tubes b, c, d and e respectively from burette A.

(ix) Now add 16.5 mL, 15.5 mL, 14.5 mL, and 13.5 mL of water to boiling tubes b, c, d and e respectively from burette C so that total volume of solution in each boiling tube is 20 mL.

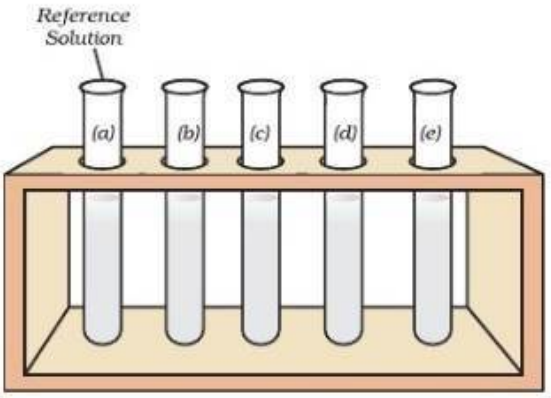

Fig. 4.1 : Set up of experiment for observing equilibrium, each boiling tube contains 20 mL solution

(x) Compare the colour intensity of the solution in each boiling tube with the colour intensity of reference solution in boiling tube 'a'.

(xi) Take another set of four clean boiling tubes. Add 2.5 mL of blood red solution to each of the boiling tubes from the burette. Repeat the experiment by adding 1.0 mL, 2.0 mL, 3.0 mL and 4.0 mL of potassium thiocynate solution from burette B to the boiling tubes b′, c′, d′, and e′ respectively followed by addition of 16.5 mL, 15.5 mL, 14.5 mL and 13.5 mL of water respectively to these test tubes. Again compare the colour intensity of the solution of these test tubes with reference equilibrium solution in boiling tube 'a'.

(xii) Record your results in tabular form as in Tables 4.1 and 4.2.

(xiii) You may repeat the observations with different amounts of potassium thiocyanate and ferric chloride solution and compare with the reference solution.

Table 4.1 : Equilibrium shift on increasing the concentration of ferric ions

Boiling Tube	Volume of ferric chloride solution taken in the system in mL	Change in colour intensity as matched with reference solution in boiling tube "a"	Direction of shift in equilibrium
a	Reference solution for matching colour containing 2.5 mL blood red solution + 17.5 mL water (20 mL equilibrium mixture)		Equilibrium position
b	1.0		
c	2.0		
d	3.0		
e	4.0		

Table 4.2 : Equilibrium shift on increasing the concentration of thiocyanate ions

Boiling Tube	Volume of thiocyanate solution taken in the system in mL	Change in colour intensity as matched with reference solution in boiling tube "a"	Direction of shift in equilibrium
a	Reference solution for matching colour containing 2.5 mL blood red solution + 17.5 mL water (20 mL equilibrium mixture)		Equilibrium position
b′	1.0		
c′	2.0		
d′	3.0		
e′	4.0		

PRECAUTIONS:

(a) Use very dilute solutions of ferric chloride and potassium thiocyanate.
(b) Compare the colour of the solutions by keeping the boiling tube and the reference test tube side by side.
(c) To judge the change in colour of the solution in an effective manner, note the colour change in diffused sunlight.
(d) Use boiling tubes of the same size.