# Report on equilibrium

Health & Medicine, Stress

Chemical equilibrium refers to the condition that occurs when the both the concentration of the reactant and product in a chemical reaction have not net change over time (Helmenstine). There are many chemical reactions that do not go on to completion. These reactions go on until equilibrium is attained. However, the system at this point is not static but dynamic with the forward and the reverse reactions still in progress. Equilibrium reactions are very common throughout chemistry, and most of the biochemical processes taking place in life involve equilibria.

One useful feature of an equilibrium reaction is the fact that the equilibrium state can be altered by changing the reaction conditions. Changes taking place in equilibrium can be predicted using Le Châtelier’s principle. This principle states that a chemical system that is at equilibrium will react to a stress by shifting the position of equilibrium in order to reduce the stress. Some of the factors that may cause stress to a system include change in concentration of reactants or products, volume, pressure and change in temperature (Oliver and Kurtz).

In this experiment, three equilibria were investigated and the effect of changing concentration and temperature on the system using Le Châtelier’s principle examined. The three chemical systems that were investigated were:

- Dissociation of acetic acid:

CH3COOH(aq)+H2O↔CH3COO-aq+H3O+aq

- The interconversion between blue tetrachlorocobaltate ion, [CoCl4]2-, and the pink hexaaquocobalt(II) ion, [Co(H2O)6]2+

CoCl42-+6H2OL↔CoH2O63+aq+4Claq-

- The dissolution of ammonium chloride, $NH_4Cl$:

$NH_4Cl_S \leftrightarrow NH_4{}_{aq}^{+} + Cl_{aq}^{-}$

# Methods

Materials

The materials that were used in the experiment were 1M $CH_3COOH$ solution, 0. 1M $CoCl_2$ in 95% ethanol solution, solid $CH_3COONa$, 12M HCl solution, methyl orange indicator and 3mL saturated $NH_4Cl$.

# Procedure

Goggles were obtained and hot water as well as ice bath prepared. For all processes, any changes in color or appearance of the solutions were recorded.

# Acetic Acid Dissociation

Into two large test-tubes, 1mL of 1M $CH_3COOH$ was transferred and one drop of methyl orange added. The mixture was mixed thoroughly. With one of the test tubes being used as color control, a small amount of sodium acetate, $CH_3COONa$, was added into the other test tube. The content was mixed thoroughly observing any color change. The test tube was placed in the hot water bath and changes in color observed. The content in both test tubes was disposed in the inorganic waste container.

$[CoCl_4]^{2-}$ / $[Co(H_2O)_6]^{2+}$ Equilibrium

In 95% ethanol solution, 3mL of 0. 1M $CoCl_2$ was placed in into a clean, dry test tube and the color recorded. Another drop of distilled water was added and the content mixed thoroughly noting any color change. One drop of water was added continuously until a color change was noted. After that one drop of water was added. To the same test-tube, one drop of 12M HCl solution was added, and the content stirred thoroughly. More drops of 12 M HCl were added while stirring until a change in color was observed. One more drop of HCl was added. Water was added drop wise until color change was observed. The test tube was put in the hot water bath and stirred frequently and changes in color noted. The test tube was then placed in an ice bath, stirred and any change in color noted. The content was disposed in the Inorganic Waste container.

## Dissolution of Ammonium Chloride

Into a clean dry test tube, 3mL of saturated ammonium chloride, NH4Cl, solution was added, and the appearance of the solution noted. One drop of 12M HCl was added to the test tube and stirred well. More drops of HCl were added until a change in appearance of the solution was detected. The test tube was put in the hot water bath for 3 – 4 minutes and any changes in appearance noted. The test tube was placed in tube in the ice-water bath, stirred frequently until a change occurred in the appearance of the solution. In another clean, dry test tube, enough NH4Cl was added to the test tube. Distilled water was added drop wise while stirring thoroughly after each addition and the change of test tube to either being cold or warm tested. The test tube content was disposed in the inorganic waste container.

## Results

Acetic Acid Dissociation

Addition of more CH3COONa resulted to the solution turning yellow. Placing the test tube in hot water bath did not cause change in color.

$[CoCl_4]^{2-}$ / $[Co(H_2O)_6]^{2+}$ Equilibrium

Addition of ethanol solution to $CoCl_2$ resulted to a purplish blue color. Addition of distilled water in the test tube resulted in the color turning from purplish blue to light pink. When 12 M HCl was added, the color of the solution returned back to blue. Addition of distilled water turned the solution pink while heating in hot water bath turned the color blue. Placing the test tube on the ice bath turned the color of the solution pink.

## Dissolution of Ammonium Chloride

The solution of ammonium chloride had a clear appearance. Addition of 12 HCl, placing in hot water and placing in the ice bath did not change the appearance of the solution. However, adding the distilled water resulted to the test tube very cold.

## Discussion

Methyl orange was used to detect changes in the equilibrium position. As the $[H_3O^+]$ content in the solution increased and as the $[H_3O^+]$ decreased, the color turned yellow. Addition of more $CH_3COONa$ increased the product of the reaction and thus creating stress on the right side of the equilibrium. This resulted in the use of $[H_3O^+]$ to form $CH_3COOH$ which resulted in the color change to yellow. Increase in temperature does not offer stress to either of the sides and hence the lack of color change.

Initial addition of ethanol solution to $CoCl_4$ resulted to a purplish blue color since $CoCl_4^{2-}$ was the most abundant. Addition of distilled water in the test tube increase stress by having excess of the reactants and thus the equilibrium shifted to the right forming more of $Co(H_2O)_6^{3+}$ and hence the change of color to pink. Adding 12 M HCl resulted to stress on the right side where Cl- product was in excess. The reaction reacted by shifting to the left where more $CoCl_4^{2-}$ is formed and hence the change of color to blue. Addition of distilled water increased the reactant shifting the reaction to the right increasing $Co(H_2O)_6^{3+}$ and hence the change of color to pink. Increase in temperature favors the reverse reaction while reduced temperature favors the forward reaction.

There is no stress addition when 12 HCl is added to an ammonium chloride solution. Similarly, increase or decrease in temperature does not adds stress to the reaction. However, addition of distilled water facilitated the ammonium chloride to dissolve a process that endothermic in nature. This was the reason behind the test tube being very cold.

## Works Cited

Helmenstine, Anne Marie. Chemical Equilibrium. 2013. 1 April 2013. .

Oliver, John and Jim Kurtz. Le Chateliers Principle. 2013. 1 April 2013. .