Equilibrium le chatelier's principle

Introduction:

Equilibrium is defined as the point at which the forward and reverse rates of a reaction are equal (1). A system in dynamic equilibrium is a specific example of a system in a steady state. In this steady state the rate of inputs and outputs in the system is equal, so the makeup of the system is unchanged over time (3).

Le Chatelier's principle can be used to predict how a change in conditions will affect chemical equilibrium. This principle states that " if a chemical system at equilibrium goes through a change in concentration, temperature, volume, or pressure, than the equilibrium shifts to offset the change;" furthermore, any change in these areas initiates an opposite reaction in the affected system (2). This principle is used to influence the results of reversible reactions (1). Once a reaction has reached equilibrium, the equilibrium concentrations of each reactant and product are known, one can use an equation to determine the equilibrium constant (3). The constant always has the same value as long as the temperature remains constant (2). The equation used to determine this constant is defined as the concentration of the products (to the power of the stochiometric coefficients) over the concentration of the products also to the power of the stoichiometric coefficients (3).

Once you know to what side of the reaction equilibrium shifts to you can determine the dominant species or coordination compound. A coordination compound is defined as a compound that contains a coordination complex, which is a structure made up of a central atom bonded to a surrounding assortment of molecules or ligands (1). Coordination is a reference to the coordinate covalent bonds between the ligands and the central atom (1). These bonds occur through the donating or accepting of electron pairs. Groups donating electron pairs are the ligands (Lewis bases) while groups accepting pairs are usually transition metal cations (1).

The purpose of this lab is to learn how to apply this background information to better understand how changes in equilibrium mixture are affected by artificially applied changes. Once the changes are applied predictions are made for shifts in equilibrium. Students will carry out the experiment and determine what side equilibrium actually shifts to. This determination, through the use of Le Chatlelier's principle, will then be used to determine which is the dominant species, or coordination complex in each reaction.

Procedure:

Throughout the experiment the color and observations were continuously made. The cobalt (II) complexes were prepared by adding 3 mL of deionized water to the solid CoClv(2)•6Hv(2)O. In another test tube 3 mL of 12 M HCl was added to the solid CoClv(2)•6Hv(2)O. 0. 309 g of CuClv(2)•2Hv(2)O was dissolved in a small beaker and the color was recorded; 10 mL of deionized water Next, the solution was evenly poured into three test tubes. In the hood, 4 mL of 6 M NHv(3) was added dropwise to the first test tube until the solution became clear to form [Cuv(9)NHv(3))4(Hv(2)O)v(2)]^{2}+. In the second test tube, 10 drops of NaOH was added and observations were recorded to form Cu(OH)v(2). We measured 5 mL of 6 M HCl and added it to the third test tube to form [CoCl4]^{2}??.

15 mL of a 0. 1 M solution of CoClv(2)•6Hv(2)O was placed in a small beaker. Using a pipet, 2. 0 mL of the solution was poured into each of the five labeled test tubes. Test tube #1 was set aside and used as a control. Set up separate charts for the addition of reagents (HCl, NaCl, and HNOv(3)), addition of water to test tube #3, heating to 100 ? C test tube #2-5, and cooling to 0 ? C test tube #2-5. Each chart should contain a prediction, observations, and predominant complex column.

0. 3 g of CuClv(2)•2Hv(2)O was placed in an 125 mL Erlenmeyer flask and dissolved by 3mL of deionized water; observations were made. A chart was set up for the addition dropwise of NHv(3) (45 drops), HCl, and H2O to a flask and observations were recorded. Half of the solution was poured into a beaker. One was heated; the other was cooled, and compared. The heat was turned up high to boil the solution and observations were made.

Discussion:

This experiment related Le Chatelier's Principle to shifting equilibrium. There is a large effect on the position of equilibrium by the addition of a species which participates this equilibrium. When a species is added that reacts and forms a predominant complex the equilibrium will shift to keep everything equal. An example of this is when HCl is added to the cobalt complex. The shifting of equilibrium can be seen when the solution starts out at pink color and when HCl is added it changes color to blue. The predominant complex is Cobalt Chloride. Water was added the above solution and the complex turned back to pink. The predominant complex turned from cobalt chloride to [Co(H2O)6]2+. Water is not directly participating in equilibrium but it still reacts with species in the solution and therefore indirectly causes a shift in equilibrium. Water is a solvent and any solvent does not appear in the equilibrium equation although it will still have an effect of equilibrium. This effect is the same as mentioned before in the idea that the solvent could react with a species in the solution and cause an inequality in equilibrium therefore causing a shift.

1. Science Encyclopedia database. http://science. jrank. org/pages/1771/Coordination Compound. html. (Accessed November 1, 2009)
2. Clackamus Community College database. http://dl. clackamas. edu/ch105-03/dynamic. htm (Accessed November 1, 2009)
3. Chemguide database. http://www. chemguide. co. uk/physical/equilibria/lechatelier. html