Determination of the Equilibrium Constant for a Chemical Reaction

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Course

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Date

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Purpose of the Experiments

The main purpose of conducting this experiment is to determine the equilibrium constant for a chemical reaction.

Abstract

The first procedure involved was setting up the laboratory equipment to conduct the experiments. Each reactant's solution was poured into five test tubes with 10 ml of volume. The respective reagents were mixed and stirred to ensure they dissolved proportionally. Afterward, the spectrophotometer was used to determine the volume of the absorbance. Finally, the concentration for each product was determined and used to determine the value of the equilibrium constant. The objective of the experiment was achieved since the value of the constant of equilibrium for each volume of reactants and product was the same.

Introduction to Equilibrium Constant

In most instances, whenever a chemical reacts, the reaction does not halt; rather, it is subjected to other intermediate states where the reactant and product have a concentration that is not affected by time. This state where the concentration is not affected is called chemical equilibrium. Therefore, the law of equilibrium demands that the ratio of the reactant and products should be equal to the ratio of some constant K_C for the reaction (Rodríguez. et al., 2021). This experiment will focus on studying the equilibrium properties of a chemical reaction between iron (III) and Fe^{3+} and thiocyanate ion, SCN^{-}.Hypothetically speaking, it is believed that the equilibrium constant for all reactants and products should be the same.

Procedures of the Experiments

1. Take five test tubes and label them. The test tubes are labeled according to numbers one to five or as indicated in the test tube rack.
2. Pour 30Ml of 2.00×10^{-3} M Fe (NO_3) 3 into a dry 100ml beaker. Ensure you pour out the solution into the beaker while observing the accuracy of the volume
3. Add another 20ml of 2.00×10^{-3} M KSCN into another beaker dry beaker. This is done carefully with the appropriate volume of KSCN.
4. Pipet 1.00, 2.00, 3.00, 4.00, 5.00 Ml from KSCN beaker to respective test tubes. The pipet is done for the respective solution while mixing the solution.
5. Pipet the approximate Ml of water to each test tube so that the total volume will be 10ml
6. Add respective reagents to the respective and ensure you stir the mixture properly.
7. Place a small mixture in test tube 1 in a spectrophotometer and determine the absorbance value at 447 nm.
8. Obtain the concentration of $FeSCN^{2+}$ from the calibration curve or the equation and record the values
9. Prepare a solution of a known $FeSCN^{2+}$ concentration by pipetting 10.00ml of a special Calibration solution

Steps of Calculating the Equilibrium constant

1. The following steps were used in the determination of the equilibrium constant.
2. The initial number of moles for the reagents was obtained using the molarity of a respective solution.
3. The number of moles of the product formed was determined

4. The number of moles of reagents that were present in the equilibrium was obtained
5. The concentration for each of the species that were present in the equilibrium was also calculated
6. The value of the constant K was obtained using the formulae.

Raw Data

The following data from the experiments will be used to calculate moles and equilibrium constant.

Table 1: Respective Tubes of the Water Added and the Reactants

	Respective Test tube number				
	1	**2**	**3**	**4**	**5**
The volume of Fe (NO_3) 3	**5**	**5**	**5**	**5**	**5**
Volume of KSCN	**1**	**2**	**3**	**4**	**5**
The volume of water added	**4**	**3**	**2**	**1**	**0**

Table 2: Respective volumes of the mixtures and absorbance

Mixture	Volume of 2.00×10^{-3} M Fe (NO_3)	Volume of 2.00×10^{-3} KSCN(ML)	Volume of water(ML)	Method 1 Absorbance	$FeSCN^{2+}$
1	**5.00**	**1.00**	**4**	**0.108**	0.282×10^{-4} **M**
2	**5.00**	**2.00**	**3**	**0.194**	0.507×10^{-4}
3	**5.00**	**3.00**	**2**	**0.241**	0.630×10^{-4}
4	**5.00**	**4.00**	**1**	**0.330**	0.862×10^{-4}
5	**5.00**	**5.00**	**0**	**0.463**	1.210×10^{-4}

Calculation of the Equilibrium Constant

The number of moles is calculated by the formulae:

$$M_A = \frac{Moles\ A}{Volume\ of\ solution, v}$$

$$Moles\ A = M_A \times Volume$$

Therefore, for each solution, we can calculate the moles of each solution as demonstrated in table 3 below.

Table 3: Respective values of moles obtained

	Respective Test Tube Number				
	1	**2**	**3**	**4**	**5**
The volume of Fe (NO_3) 3	**5**	**5**	**5**	**5**	**5**
Moles of Fe^{2+}	20.00×10^{-6}	20.00×10^{-6}	20.00×10^{-6}	20.00×10^{-6}	20.00×10^{-6}
Moles SCN					
Volume of KSCN	**1**	**2**	**3**	**4**	**5**
The volume of water added	**4**	**3**	**2**	**1**	**0**

Conclusion

From the tables, it is seen that the moles of the reactants and products are the same. Hence the constant of equilibrium for each product is the same. Therefore, the aim of the investigation was achieved, and the outcomes can be used to conduct further analysis.

Reference

Rodríguez de San Miguel, E., González-Albarrán, R., & Rojas-Challa, Y. (2021). Conditional equilibrium constants reviewed. *Critical Reviews in Analytical Chemistry*, 1-23. C