Seperating metal cations using paper chromatography

Science

Lab #3 Separating Metal Cations by Paper Chromatography

Introduction/Purpose: In chemistry, it is important to effectively analyze the components in a given mixture. In order to do so, chemists will analyze a mixture either qualitatively or quantitatively using different methods and equipment. Qualitative analyses are subjective, and only gather “ non-numerical” data such as the color, appearance, and smell of the components. This data is intended to obtain physical information on the components present.

While quantitative analyses are objective, and use “ numerical” data to gather the quantity of the components present. Quantitative data can be given in terms of height, area, volume, weight, speed, time, temperature, etc. Each method of data analyses provides chemists with specific types of information that can be used to draw conclusions about the experiments they have performed. This lab utilized both quantitative and qualitative data by using the Paper Chromatography method for determining the metal cations present in an unknown sample.

This was performed by using reagents that reacted with the metal cations deposited on the paper. The retention factor of each known cation was calculated in order to determine which metal cations were present in two unknown samples. Objective: Effectively use Paper Chromatography to analyze quantitative and qualitative data of different metal cations, in an effort to correctly identify two unknown samples of metal cations, by comparing them against a chromatogram with known component reactions.

This lab also aids in better understanding the importance of developing a chemist’sobservationand data recording methods, as some of the reactions

are faint, or may degrade over a short period. Material & Equipment: 1) Personal Protective Equipment (PPE) 2) 600 ml beaker 3) Plastic wrap 4) Rubber band 5) (3) Paper filters 6) (2) 11 x 14 cm pieces of chromatographic paper 7) Pencil 8) Metric ruler 9) Capillary tube 10) Paper towels 11) 10 ml of 6M HCL 12) 35 ml of Acetone ((CH3)2CO) 13) Metal cations- Iron(III), Cobalt(II), Nickel(II), and Copper(II) 14) Two unknown sample cations 5) Reagents: Potassium ferrocyanide, Potassium thiocynate in acetone, Dimethyl glyoxime in ethanol 16) 50 ml beaker with 25 ml of ammonium hydroxide 17) Fume hood Procedure/Methods: 1) *See the attached pre-lab outline for the procedure/order of operations used in completing this lab experiment* 2) *The procedure was altered at step #9 with direction from the lab instructor. Chromatogram #2 was not spotted with the four known metal cations. * Three pieces of filter paper were used to practice spotting with the four known metal cations.

The filter paper was folded into four separate sections and a small sample of the known metal cation was spotted onto a marked point. This process was repeated for each piece of filter paper. Filter sample #1 was spotted using potassium ferrocyanide; filter sample #2 was spotted using potassium thiocynate in acetone; and filter sample #3 was spotted using dimethyl glyoxime in ethanol. Using three separate samples allowed the group to analyze the qualitative results (color change) of the interactions with each of the four metal cations.

This provided preliminary data that was used to hypothesize which compound would be best to spot the known metal cations on chromatogram #1. After reviewing both the interaction results, and the retention values

(RF), we then determined which reagent provided the most identifiable interaction with each of the metal cations. Equation 1. [pic] Data: *See attached Data Sheets* Results: The lab instructor reported the results of the correct unknown metal cations as follows: 1) Unknown #1 = Copper) Unknown #2 = Iron and Nickel As shown on Data Sheet #2, our lab group concluded that the unknown metal cations were as follows: 1) Unknown #1 = Cobalt 2) Unknown #2 = Iron Qualitative Data (Chromatogram #1): The first observations made of chromatogram #1 were those of the physical changes in the color of the metal cations after they were exposed to the developing solvent. The colors observed for the metal cations were as shown by the corresponding bar graph in Figure 1 below.

Copper = Light Brown, Nickel = Pink, Iron = Blue, and Cobalt = Green Quantitative Data (Chromatogram #1): After the qualitative observations were analyzed and recorded, the spotted sections of each metal cation were marked with a pencil at the highest migration distance of the substance. This measurement was then used in calculating the Rf value of each metal cation, using Equation 1 above, and represented in Figure 1 below. Copper = . 7, Nickel = . 1, Iron = 1, and Cobalt = . 5 Figure 1. [pic] Qualitative Data (Chromatogram #2):

The first observations made of chromatogram #2 were those of the physical changes in the color of the metal cations after they were exposed to the developing solvent. The colors observed for the metal cations were as shown by the corresponding bar graph in Figure 2 below. Unknown #1 = Green, and Unknown #2 = Blue Quantitative Data (Chromatogram #1): After the qualitative observations were analyzed and recorded, the spotted sections of

each metal cation were marked with a pencil at the highest migration distance of the unknown substance.

This measurement was then used in calculating the Rf value of the unknown metal cations, using Equation 1 above, and represented in Figure 2 below. Unknown #1 = . 41 and Unknown #2 = . 91 Figure 2. [pic] Conclusion: The qualitative and quantitative data of the known metal cations from chromatogram #1 were used to determine the metal cations that composed Unknown sample #1 and #2, in chromatogram #2. Unknown #1 was developed using KSCN/acetone, and Unknown #2 was developed using K4Fe(CN)6. However, it is unknown why we chose to use that reagent as opposed to the other two available.

It is also clear that a deviation from the procedure caused us to erroneously streak our chromatogram unknowns with only one reagent. Failing to spot and streak chromatogram #2 with all reagents prohibited our ability to analyze the sample after exposure to all reactions. As shown from the results of the filter paper samples, we were able to see qualitative changes on Fe, Cu, and Co with the use of potassium ferrocyanide, Fe, Cu, and Co with the use of potassium thiocynate in acetone, and Fe, Co, and Ni with the use of dimethyl glyoxime in ethanol.

Although the colors in each reaction were different with each of the reagents used on the filter paper samples, the use of each reagent would have provided us with a number of visual changes to identify. Those observations would have been marked, and prompted more calculations of the Rf values associated with each reaction, allowing for a more thorough evaluation and determination of the unknown metal cations present.

Although we were able to accurately detect the presence of Fe in unknown sample #2, it is evident that if the chromatogram had been exposed to the dimethyl glyoxime in ethanol, we would have detected the Ni as well. The exposure of the filter sample containing the Ni, to dimethyl glyoxime in ethanol, yielded the only visual reaction, out of all three reagents tested. This labs results further solidify the need to conduct the procedure as thoroughly as possible, and if there are feelings of inadequacy, we perform the procedures that we feel will enable us to procure the most accurate results.