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Separation of Cations (Pb^{2+} , Ag^+ , Hg_2^{2+}) or (Pb^{2+} , Cd^{2+}) Mixture by Paper Chromatography

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Analytical Chemistry

Theory

Paper chromatography (PC) is the simplest type of chromatographic methods, it is used for **qualitative** and **quantitative** analysis..

What are the Paper Chromatography (PC) System Components ??

Paper Chromatography (PC) System Components

A) Paper

Usually filter paper is used

B) PC chamber:

This is used for the development

The chamber maintains:

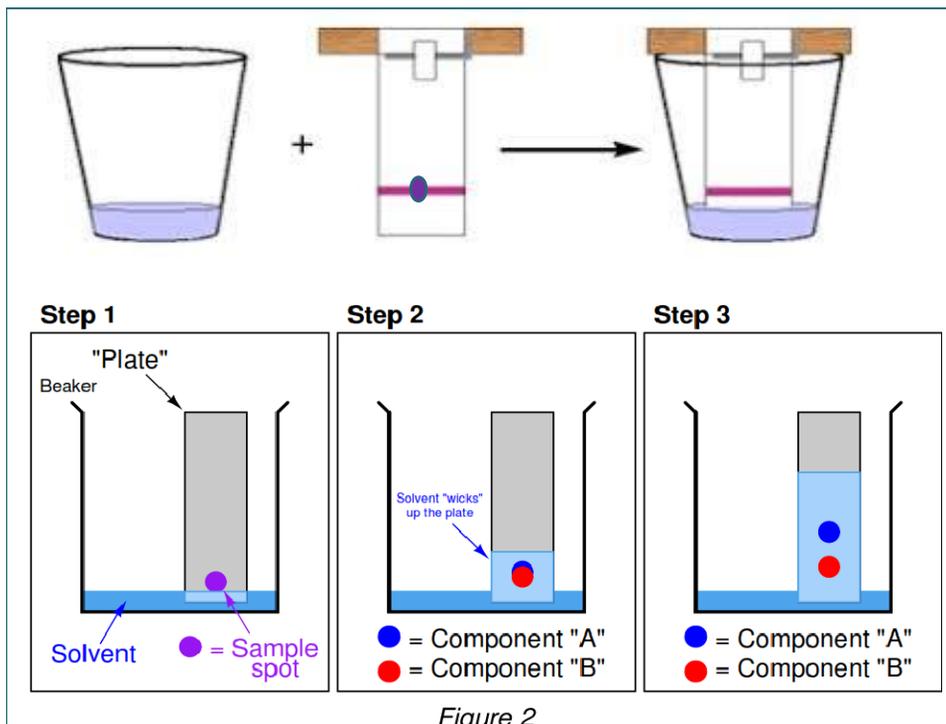
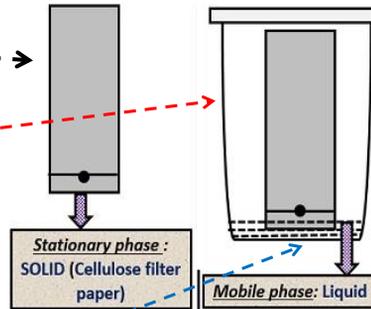
- Uniform environment
- Prevents the evaporation of solvents
- Keep the process dust free

C) Mobile phase:

Solvent or solvent mixture recommended for the purpose.

The mobile phase used should be;

- Highest purity
- Chemically inert with the sample, stationary phase.



Theory

A small amount of sample is placed near one end of absorbent paper, so that it forms a small patch. The chromatogram developed by immersing the end of paper into suitable solvent diffuses through the paper by capillary action.

Theory

The component of sample moved by different velocity depending upon the **solubility** of them and **partition**. The metal ions rendered visible in to form of colored bands by spraying with a suitable reagent. The resulting chromatogram is described by **R_f** value.

$$R_f = \frac{\text{Distance travelled by solute from baseline (cm)}}{\text{Distance travelled by solvent from baseline (cm)}}$$

R_f : Retention factor, or retardation factor

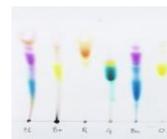
- Ions; **Pb²⁺, Ag⁺, & Hg₂²⁺** are detected by **K₂CrO₄**.
- Ions; **Pb²⁺ & Cd²⁺** are detected by **H₂S**.

Detection of Components

After development, the next important step is to detect the separated components so as to determine their respective R_f values.

1- Coloured Substances

Xanthophylls, Chlorophylls, Carotenes, inks components, may be located visually.



2- Colourless Substances

Alkaloids, steroids, amino acids

Can be detected by using I_2 -vapours

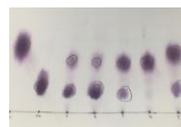


or UV-light



3- Specific Detecting Reagents :

- Ninhydrin reagent : for amino-acids
- $KMnO_4$: for elements like silver, lead, & mercury
- H_2S or Rubenic acid: for elements like lead and cadmium

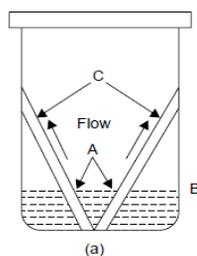


Many ways of Paper Chromatography

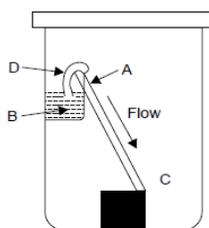
1) Ascending

2) Descending

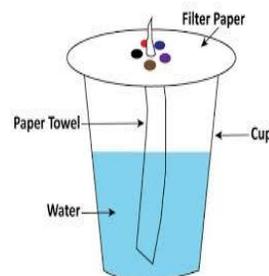
3) Circular



(a)



(b)

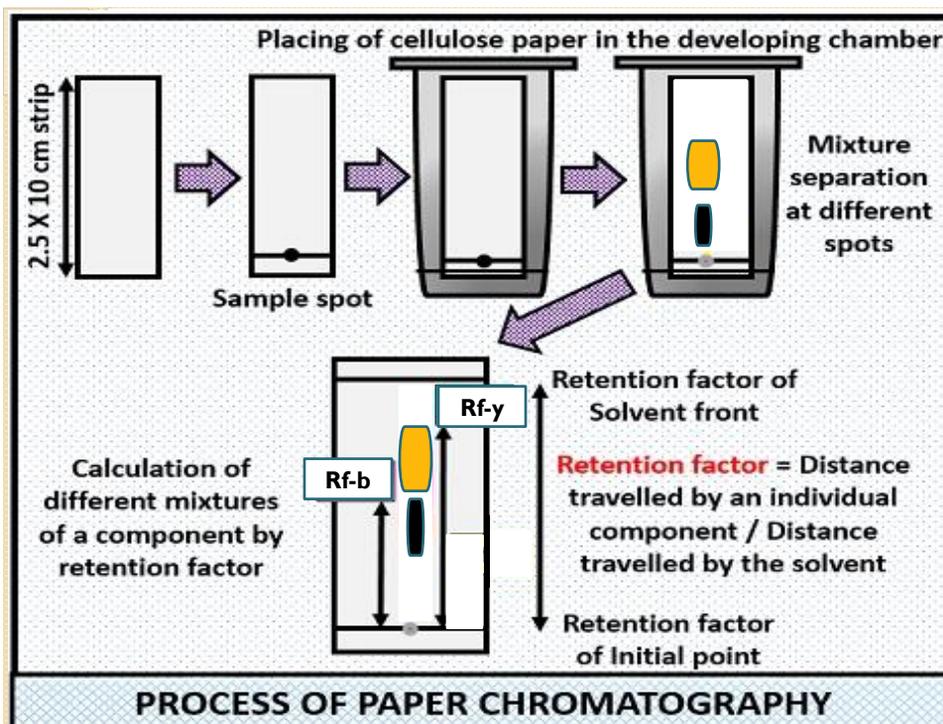


- (a) : Ascending Flow A = Starting position of sample(s) ; B = Solvent System ;
C = Chromatographic Surface ;
- (b) : Descending Flow A = Starting position of sample(s) ; B = Developer ;
C = Chromatographic surface ; D = Cotton wick ;

Procedure:

- 1- Cut the paper with suitable size for the jar of chromatography.
- 2- Draw a line about (2cm) from the end of paper (base line).
- 3- Put symbol x on the mid of base line: the sample (a mixture of Pb^{2+} & Cd^{2+} cations) injected on this symbol by capillary tube
- 4- Dry the paper.
- 5- Immerse the paper in the mobile phase which is the following mixture; (Tertiary butyl alcohol, 1M HNO_3 , and Acetone in a ration (2:1:2).
- 6- Allow the solvent to diffuse until front line (3/4 length paper).
- 7- Remove the paper, permit the solvent to evaporate.
- 8- Spray/immerse with H_2S when cations are Pb^{2+} Cd^{2+}
- 9- Calculate R_f

Black , Yellow



Today's Experiment:

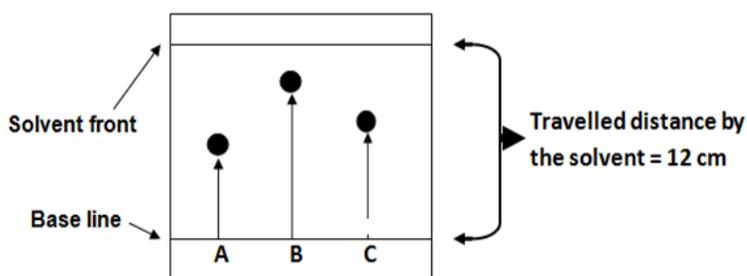
Exp.\ Results in the following table shows separation of lead and Cadmium ions on a paper chromatogram. Find R_f for lead and Cadmium?

| Ions | Distance of components (cm) | Travelled distance of solvent front (cm) | R_f value |
|---------|-----------------------------|--|-------------|
| Lead | 8.7 | 11.5 | ??? |
| Cadmium | 9.9 | 11.5 | ??? |

Q1\ Results in the following table shows separation of **A**, **B**, and **C** compound on a paper chromatogram. Find R_f for **A**, **B**, and **C** and arrange them according to their solubility?

| No. | compound | Travelled distance (cm) |
|-----|----------|-------------------------|
| 1 | A | 7.5 |
| 2 | B | 5.7 |
| 3 | C | 6.0 |
| 4 | Solvent | 10 |

Q2 Results on the following paper chromatogram shows separation of A, B, and C compound. Retardation factor (R_f) for A, B, and C are equal to 0.25, 0.75, and 0.5 respectively. **Find travelled distance for A, B, and C compound and arrange compounds according to their solubility?**



Q3 In view of the following table information on a thin layer chromatogram:

| No. | Components | Travelled Distance (cm) |
|-----|------------|-------------------------|
| 1- | A | 1 |
| 2- | B | 3 |
| 3- | C | 6 |
| 4- | Solvent | 9 |

- Calculate the retention factor for A, B, and C components?
- Order the solubility of A, B, and C components in mobile phase and stationary phase?

Home works

Q4\ Difference between Paper and Thin layer chromatography?

Q5\On paper chromatogram, pray with K_2CrO_4 is used when the separated cations are Ag^+ , Pb^{2+} , Hg_2^{2+}

What are the presented colors for each cations on paper chromatogram after using the reagent?