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Summary

Description	Chromatography is an essential physical technique that allows the constituent components of a mixture to be identified, separated, and purified in preparation for qualitative examination. Paper chromatography (PC) is a sort of planar chromatography, which refers to a stationary phase that is a solid, flat surface. In this illustration stationary phase is a particular kind of paper (Whatman quantitative filter paper grade 41). The fundamental idea behind paper chromatography is the differential passage of a mixture's constituent parts through filter paper or chromatography paper. A quick method for separating mixtures of metal ions, amino acids, carbohydrates, colors, and pharmaceuticals is paper chromatography (PC). For this qualitative analysis, only a very small sample is needed. Metal cation separation has seen increased by the use of the PC approach. Here, the experiment shows how PC may be used to separate metal ions (Mo6+ & W6+) based on their colored spots and the retardation factors or retention factors (Rf) values by using different eluting solutions.
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Chapter-34

Innovative Method for the Separation of Metal ions (Mo^{6+} and W^{6+}) by Paper Chromatographic Technique

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Principle:- Chromatography is an essential physical technique that allows the constituent components of a mixture to be identified, separated, and purified in preparation for qualitative examination. Paper chromatography (PC) is a sort of planar chromatography, which refers to a stationary phase that is a solid, flat surface. In this illustration stationary phase is a particular kind of paper (Whatman quantitative filter paper grade 41). The fundamental idea behind paper chromatography is the differential passage of a mixture's constituent parts through filter paper or chromatography paper. A quick method for separating mixtures of metal ions, amino acids, carbohydrates, colors, and pharmaceuticals is paper chromatography (PC). For this qualitative analysis, only a very small sample is needed. Metal cation separation has seen increased by the use of the PC approach. Here, the experiment shows how PC may be used to separate metal ions (Mo^{6+} & W^{6+}) based on their colored spots and the retardation factors or retention factors (R_f) values by using different eluting solutions.

Keywords: *qualitative analysis, chromatographic jar, spotting capillaries, colored spots, retention factor, under graduate experiment*

1. PC Experiment : Separation of Metal ions (Mo^{6+} and W^{6+}) by 1(N) $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ Solution

Materials and method

Experimental

Required chemicals and apparatus

(i) Jar for chromatography, (ii) Measuring cylinder, (iii) Capillary, (iv) Tiny test tube, (v) Beakers (10mL, 100mL, and 500mL), (vi) Grade 41 Whatman quantitative filter paper, (vii) Sodium molybdate, (viii) Sodium tungstate, (ix) 1(N) $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ solution.

Required solution

- (i) Solution of metal salts: To make a saturated solution, metal salts were dissolved in 1 mg/mL of distilled water in a 10 mL beaker. Metal salts: $\text{Na}_2\text{MoO}_4 \cdot 2\text{H}_2\text{O}$ & $\text{Na}_2\text{WO}_4 \cdot 2\text{H}_2\text{O}$
- (ii) Eluting agents used: 100ml 1(N) copper (II) chloride solution was prepared in a 250 mL beaker with distilled water.

Green developer

500 mL distilled water is used as green developer.

Procedure

A Whatman 41 grade filter paper strip was positioned inside the chromatographic jar, with a dot placed approximately 0.5 centimeters from the bottom, serving as the starting point for development. Saturated solutions of metal salts/oxides were individually administered using fresh capillaries at two locations near the top of the chromatographic paper. Subsequently, the chromatographic paper containing the two metal spots was left to dry outside. Once dried, the spotted paper strip was re-suspended in the chromatography jar filled with green solvent (distilled water). The bottom end made contact with the solvent, while the upper end was fastened to a steel bar. As the green solvent ascended through the paper strip, carrying the metal ions, it reached the topmost portion of the paper strip. Upon removal from the chromatography jar, the solvent front was marked using a pen. The paper strip was then dehydrated to remove excess solvent. Following this, eluting agents as specified were sprayed over the dry filter paper. In PC experiment 5, upon reaction with 1N copper (II) chloride CuCl_2 solution, a green coloration and a light sky blue coloration spot emerged immediately (Figure 1c), indicating the identification of Mo^{6+} and W^{6+} ions, respectively. All colorful zones were marked with pencil for identification purposes.

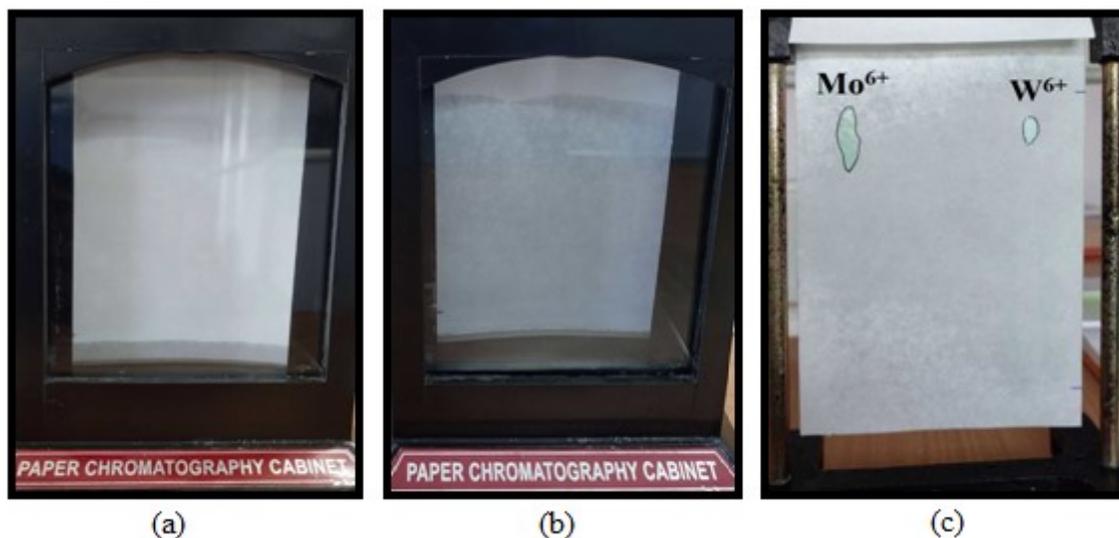
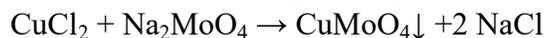


Figure 1. Separation of transition metal ions (Mo^{6+} and W^{6+}) by PC

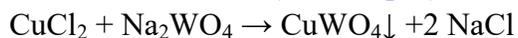
Results and Analysis

Reactions Involved During Formation of Color Spots by Interaction with Solute Zone

Green and light sky blue coloration spots on the filter paper are the result of mixing sodium molybdate, $\text{Na}_2\text{MoO}_4 \cdot 2\text{H}_2\text{O}$ and sodium tungstate, $\text{Na}_2\text{WO}_4 \cdot 2\text{H}_2\text{O}$ with copper (II) chloride CuCl_2 solution to create CuMoO_4 and CuWO_4 respectively.



(Green spot)



(Sky Blue spot)

Data Analysis

By contrasting their color spots and retention factor values, two cations, Mo(VI) and W(VI), were recognized and distinguished from each other. When the aqueous solution of copper (II) chloride reacted with sodium molybdate ($\text{Na}_2\text{MoO}_4 \cdot 2\text{H}_2\text{O}$), cupric molybdate (CuMoO_4) was formed, resulting in the emergence of the first spot as green (Mo^{6+}). On the other hand, when sodium tungstate ($\text{Na}_2\text{WO}_4 \cdot 2\text{H}_2\text{O}$) reacted with the aqueous solution of copper (II) chloride, CuWO_4 was produced, giving rise to the appearance of the second spot (W^{6+}) as light sky blue. The travel distance of one solute zone represented by Mo^{6+} (d_{s1}), and the travel distance of another solute zone represented by W^{6+} (d_{s2}) were measured. Subsequently, the values of retardation factors (R_f) were calculated and summarized in Table-1. This comparison facilitated the clear identification and differentiation of Mo(VI) and W(VI) ions.

$$\text{Retention Factor } (R_f) = \frac{\text{Distance travelled by the centre of solute zone in cm } (d_{s1} \text{ or } d_{s2})}{\text{Distance travelled by the solvent front in cm } (d_m)}$$

Table 1: Separation of metal ions (Mo^{6+} and W^{6+}) by paper chromatography

Experiment Name	Solution used (Cation Present)	Eluting Solution	Color of the spot	Distance travelled by solute (ds) (cm)	Distance travelled by solvent (dm) (cm)	R_f value = ds/dm
Separation of metal ions (Mo^{6+} and W^{6+}) by paper chromatography	$\text{Na}_2\text{MoO}_4 \cdot 2\text{H}_2\text{O}$ (Mo^{6+})	1N solution of $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ (aq)	Green	12.5 (d_{s1})	13.1	0.95
	$\text{Na}_2\text{WO}_4 \cdot 2\text{H}_2\text{O}$ (W^{6+})		Light sky blue	11.7 (d_{s2})	13.1	0.89

3. Conclusion

Using water as mobile phase (developer), separation of metal ions [Mo^{6+} & W^{6+}] has been done by taking eluting agent like copper (II) chloride, CuCl_2 solution based on their colored spots and the retardation factors or retention factors (R_f) values. Thus, by using this improved technique, make paper chromatography easy to separate two cations [Mo^{6+} & W^{6+}] from the same group of the analytical table.

References:

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