

Paper Chromatography

Separation of Ink Pigments

Introduction

Many inks are actually mixtures made up of several basic pigments. Each pigment may have a different color, a different structure and different physical and chemical properties. The pigments in an ink mixture may be separated using paper chromatography.

Concepts

- Mixture vs. pure substance
- Separation of a mixture
- Chromatography
- Adsorption

Background

The word *chromatography* is derived from two Greek words meaning color (*chroma*) and writing (*graphia*)—"color writing." The term was coined by the Russian chemist Michael Tswett in 1903 to describe a new technique he had invented to separate the pigments in green plant leaves. Tswett found that in addition to chlorophyll, the green main pigment, plant leaves also contained red and yellow secondary pigments. The results were beautifully "written in color" when a plant extract was passed through a column containing a clay-like absorbent solid.

One hundred years after Tswett's discovery, chromatography has evolved into the most important tool chemists have for separating the components in a mixture. Some examples of different types of chromatography and their uses include:

- Gas chromatography, which is used in forensics and toxicology to analyze drugs and other substances in blood samples.
- Cell-permeation chromatography, which is used to separate and purify proteins.
- Ion-exchange chromatography, which is used to remove ions from water (water softening).

Paper chromatography is an example of a more general type of chromatography called *adsorption chromatography*. The paper acts as an adsorbent, a solid which is capable of attracting and binding the components in a mixture (see Figure 1). The mixture to be separated is "spotted" onto the surface of the paper, and a solvent is

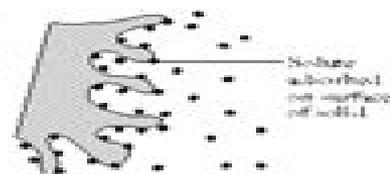


Figure 1.

then allowed to seep or flow through the paper. If one of the components in the mixture is more strongly adsorbed onto the paper than another, it will spend a smaller fraction of time free in solution and will move up the paper more slowly than the solvent. Components that are not strongly adsorbed onto the paper will spend a greater fraction of time free in solution and will move up the paper at a faster rate. This "partitioning" of the components of a mixture between the paper and the solvent separates the components and gives rise to different bands. If the components of the mixture are colored, like the pigments in an ink, the bands are easy to see.

Experiment Overview

The purpose of this experiment is to determine if an ink sample is a pure substance or a mixture. The pigments in different inks will be separated using paper chromatography.

Pre-Lab Questions

1. Read the background section and the Procedure—why is a pencil rather than a pen used to mark the "starting line" in step 2?
2. The solvent in this experiment will flow upward through the paper against gravity, via capillary action. What is capillary action, and what causes it?
3. There are basically two types of pens—water-soluble and "permanent markers." What type of pen will probably give better separation in this paper chromatography experiment with water as the solvent? Explain.
4. Think back to your "coloring book" days as a child. What combinations of colors can be used to make black? Predict the color pigments that may be present in black ink.

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