The Chromatography Centrifuge

Separation of Mixtures

Introduction

Use spinning (radial) paper chromatography to separate the components of an ink mixture from a water-soluble, felt-tip pen. The chromatography centrifuge device allows separations to be performed faster and easier than traditional methods and results in amazingly beautiful radial chromatograms.

Concepts

- Chromatography
- Separation of mixtures

Background

Chromatography is probably the most useful method of separating organic compounds for identification or purification. There are many different types of chromatography but most work on the principle of absorbance. The two important components of chromatography are the *absorbent* and the *eluent*. A good absorbent is usually a solid material that will attract and absorb the materials to be separated. Paper, silica gel, or alumina are all very good absorbents. The eluent is the solvent which carries the materials to be separated through the absorbent.

Chromatography works on the principle that the compounds to be separated are slightly soluble in the eluent and will spend some of the time in the eluent (or solvent) and some of the time on the absorbent. When the components of a mixture have varying solubilities in the eluent, they can then be separated from one another. The polarity of the molecules to be separated and the polarity of the eluent are very important. This affinity for the eluent versus the absorbent is what separates the molecules.

In paper chromatography, the absorbent is the paper itself. The eluent can be any number of solvents; in this lab, the eluent is water. Water is a very polar molecule. The polarity of the eluent is important in paper chromatography since a small change in polarity can dramatically increase or decrease the solubility of organic molecules. The organic pigments in the inks, which will be "spotted" onto the filter paper, separate out as they are carried with the water at different rates. Those molecules that have a polarity closest to the polarity of the water will be the most soluble, and will move outward on the radial chromatogram the fastest.

The inks in felt-tip pens are mixtures made up of several different organic compounds, or pigments. Each of these pigments has a different molecular structure and, usually, a different polarity. These pigments can be easily separated using paper chromatography, because even when mixed together, they tend to maintain their characteristic physical properties.

The typical paper chromatography method requires a full 20–30 minutes to perform because the developing solvent (usually water) must migrate along the length of the piece of paper through capillary action. While the results are impressive, the length of time required to complete a lab of this type can be a major drawback.

If the paper chromatography system is spinning, the length of time needed for the solvent to migrate along the paper can be greatly reduced. The spinning action (or centrifugal force) of the chromatography centrifuge accelerates the radial flow of water through the adsorbent (filter paper), forcing the mobile phase (water) outward through the filter paper. As a result, the water migration is faster than it would be via simple capillary action. This effect is similar to that observed when pressure is applied in a chromatography column. Impressive results are obtained in less than 30 seconds!

Materials

Beaker or small container (for water)
Chromatography centrifuge device
Filter paper, 12.5-cm diameter
Markers, water-soluble (or felt-tip pens)
Pencil tip (or sharp object such as a push pin)
Pipets, Beral-type
Plastic rotating disk (with small hole in center)
Water, tap

Safety Precautions

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Wear protective eyewear and an apron, as water may be thrown from the spinning platform. Do not touch the motor axle while the rotor is spinning. Remove the battery from the centrifuge device when not in use. Wash hands thoroughly with soap and water before leaving the laboratory.

Procedure

1. Obtain a piece of filter paper. Determine the center of the piece of filter paper. To do this, set the plastic disk onto the motor axle of the centrifuge device. Set the piece of filter paper onto the plastic disk and mark the center hole. Use a sharp pencil tip or push pin to puncture a small hole into the center of the piece of filter paper.
2. Using a black (or dark-colored) water-soluble marker, draw four to six small dots in a circular or random pattern around the center hole in the filter paper. *Note:* You may wish to use two different markers and alternate the dots in a circle around the center hole (see Figure 1).
3. Place the plastic rotating disk (with a center hole) onto the exposed motor axle of the chromatography centrifuge. Set the filter paper on the disk. The axle should penetrate the center hole of the filter paper to secure the paper to the rotating disk (see Figure 2.) *Note:* This avoids the use of tape to hold the filter paper, although that is an option if necessary.
4. Start the motor running by completing the circuit on the centrifuge using the attached alligator clips. Watch the disk rotate around in a circle. Using a Beral-type pipet, add a few drops of water on the center of the rotating piece of filter paper. Add additional (yet minimal) drops of water if necessary. *Note:* If water is added too quickly, water and ink can be thrown from the disk.
5. Watch carefully and make observations as the filter paper rotates on the centrifuge. The radial chromatogram is done when the water line is near the edge of the filter paper. Disconnect the clips. Lay the disks flat to dry.

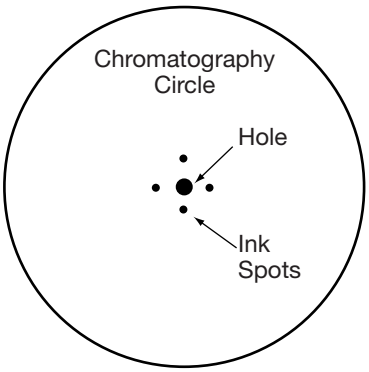

Figure 1

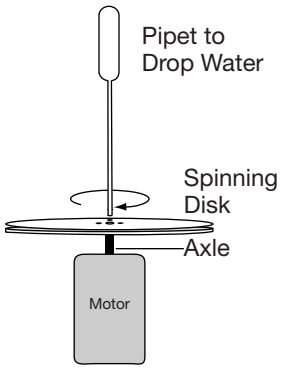

Figure 2

Disposal

The filter paper disks can be saved or discarded in the trash. Save all other materials for future use.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12

Evidence, models, and explanation
Form and function

Content Standards: Grades 5–8

Content Standard B: Physical Science, properties and changes of properties in matter, understanding of motions and forces

Content Standards: Grades 9–12

Content Standard B: Physical Science, structure and properties of matter, motions and forces

Acknowledgments

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Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of *The Chromatography Centrifuge* activity, presented by Jeff Bracken, is available in *Separation of Mixtures* and in *Classroom Fun*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *The Chromatography Centrifuge* are available from Flinn Scientific, Inc.

Materials required to perform this activity are available in the *Chromatography Centrifuge Kit* available from Flinn Scientific. Materials may also be purchased separately.

Catalog No.	Description
AP5992	Chromatography Centrifuge Kit
AP8466	Marking Pen Set (8 pens)
AP6202	Bracken Demonstration Spinner
AP3104	Filter Paper, Qualitative, 12.5 cm

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.