Paper Chromatography[1]

SATURDAY COLLEGE

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Introduction

Separating impure mixtures into pure substances is among the most important and fundamental of skills which must be learned by a chemist. The study of pure substances requires that the chemist learn many different techniques of separation so as to pursue the study of properties of pure substances and their reactions.

In 1906 the Russian botanist Alexandr Tswett found that he could extract the plant pigments that produce the fall colors in leaves by grinding them up in a solvent. If he poured the solvent extract containing the mixture of dissolved pigments through a tube full of powdered chalk ($CaCO_3$, or calcium carbonate), the various pigments separated into colored bands as the extract percolated down through the powdered chalk. He carefully removed the column of chalk from the tube and separated the colored bands. Extraction of the different colored bands with the solvent produced solutions of the separated pigments for study.

Many common materials around us are made up of mixtures of compounds. Examples are: gasoline, ink, cosmetics, dyes, and pigments. It is often very difficult to separate these mixtures, especially if the components are chemically very similar. One way to do this takes advantage of the slight differences in the components' solubilities, which are due to slight differences in their chemical structure. This separation method is called thin layer, or paper, chromatography. Paper chromatography can separate very small quantities of substances from each other. It is also possible with reasonable certainty to determine the identity of one or more separated substances if one knows ahead of time that a certain known substance may be present in the mixture that is being separated. Ink (both black and colored, fountain, ball-point and felt-tipped) is usually a mixture of two or more substances. Many inks respond well to the separation method of paper chromatography. Today you will have an opportunity to see what happens when one or more inks are subjected to this method of separation.

Procedure

1. Place a paper towel in front of you on the lab bench.
2. Obtain a strip of filter paper. Draw a light pencil line 1/2" from the bottom, using your width gauge.
3. Place the strip of filter paper on the paper towel.
4. Using several pens (your own, if you have one, and various others around on the lab bench) to put small spots on the pencil line. Do not place a spot closer than about 1/16" to either edge, nor exactly at the mid-point of the pencil line. If one or more of the pens is a ball-point pen, press very lightly

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[1]Thanks to Dr. John Hewitt for his helpful discussions on this topic and for letting me borrow liberally from his original manuscript.

to make your spot. If you press too hard, the capillaries in the cellulose of the paper will flatten and the chromatography solvent will not flow evenly up the paper.
5. Holding the paper by a corner, wave it in the laboratory air for about two minutes so that the solvent of the ink will evaporate.
6. Fold the paper into a lengthwise V-shape so it will not sag when wet with the solvent. Do not fold the paper so that the crease occurs right where you have spotted the paper.

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V-shaped fold

*************
*     |     *
*     |     *
*     |     *
*     |     *
*     |     *
*     |     *
*     |     *
*     |     *
*     |     *
*     |     *
*     |     *
------------- <-- pencil line and ink spots
*     |     *
*43 26|39 62* <-- pen number
*     |     *
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7. Place the strip CAREFULLY in the bottle with the spot at the lower end. Make sure the spot is not submerged in the solvent. If it is, you must remove the paper, draw a pencil line a little higher on a new paper strip, and put new spots on the line. DO NOT SHAKE THE BOTTLE and gently set it at the back of your laboratory bench so that you can watch the progress of the solvent front as it travels up the paper by capillary action.
8. Repeat this process with two more strips of chromatography paper, using the other two bottles at your station.
9. Be patient and watch the solvent front slowly migrate up the paper. When the first bottle shows a solvent front within about 1/4" of the top of the strip (don't open the bottle to look. Simply look through the glass), open the bottle and carefully remove the strip. Place it with the crease of the "V" point up at you so that you can see the migration of the ink colors.
10. Do the same for each of the other strips that you have placed in bottles.

Observations

1. Complete a table, following the example of the one showing the chromatography of two black pens, below:

Pen #	color	number of components	colors of components	movement
100	black	3	black	not at all
			yellow	fast
			dark blue	slow
103	black	4	black	not at all
			orange	fast
			yellow	medium
			dark blue	slow

2. A component always migrates up the paper at the same rate, as long as the paper and the solvent are the same. Sometimes pens of different brands and colors use identical components. By looking at the position of all of your pure components, see if you can determine if any components might be identical to one another. On the table above, mark the first set of possibly identical components with an "A", the second set with a "B", and so on.
3. If you have time, choose two pens that you think have at least one identical component. Re-spot a piece of chromatography paper, dry it as before and place it in the bottle. When the solvent has migrated near the top of the strip, remove it and fill in the table with the information from that sample.

Equipment and materials

90 chromatography bottles (4 oz wide mouth bottles)
50 felt-tipped pens
2 liters chromatography solvent made as follows and ready to deliver 5 mL by automatic pipette:

Equal parts by volume of
- n-amyl alcohol
- ethanol
- 2M ammonia

1000 chromatography strips (Whatman #1), 1-3/4" x 2-3/4"

30 width gauges, 1/2" wide, 2" long, made of 3x5" card stock O.K.

Notes for presentation

Important Skill that a Chemist must learn:

Separation
Analysis
- Qualitative
- Quantitative

Synthesis
Writing Reports