Information about Tie Dyeing
(Please Do Not Write on this Paper!)

Exploring Dyes

Introduction

The synthetic dye industry began with a serendipitous discovery. In 1856, eighteen-year-old William Perkin, a student at the Royal College of Chemistry in London, England, was trying to synthesize quinine, a drug used to treat malaria. What he got was a vibrant purple solution that easily colored silk. The dye was called mauve. It quickly became a commercial success and by 1870, cloth could be made in more colors than had ever been possible with dyes produced from natural sources such as flowers and vegetables.

In this investigation, you will explore the importance of molecular structure and polarity in the commercial world of dyes. Some natural fibers, such as silk and wool, are essentially protein molecules. Since proteins are made from amino acids, which have many polar sites on them, they have a strong affinity for dyes that are either polar or ionic. On the other hand, nylon has no polar sites at all except at the ends of its molecular chain (which is hundreds or even thousands of atoms long) so it is very resistant to dye. In between these extremes are fabrics such as dacron and rayon, each with only a few polar sites. As you might predict, they show intermediate attractions for dyes.

In order to dye the low-polarity fabrics, a process called mordanting can be used. The term comes from the Latin word *mordant*, which means "bite." In a sense, the dye can "bite into" the fabric. The process of mordanting alters the molecular structure of the fabric by affixing metal ions to it. These ions then bind the dye to the fabric.

In this lab, you will dye a strip made of six different fabrics with two different dyes. The fabric strip that you will use is composed of (in order) wool, orlon, dacron, nylon, cotton, and acetate rayon. You will determine the attraction of each material for dye by measuring the intensity of color—the darker the color, the stronger the attraction. From your results, you will determine which end is the wool. You will then determine the extent to which mordanting improves the dye-holding capability of the six fibers tested.

More information about Tie Dyeing

Discussion

The art of dyeing clothing fibers probably originated in India or China no later than 2500 B.C. Most natural dyes came from parts of plants such as the bark, berries, flowers, leaves, and roots. Because these dyes did not have a strong attraction for the fibers being dyed, a process known as mordanting was used to improve colorfastness. To react with acidic dyes, fibers were treated with basic or metallic mordants which might include solutions of aluminum, copper, iron, or chromium salts. Compounds formed by the dye and the mordant, called lakes, prevented the colors from washing out and made the color longer lasting. Such natural dyes became less and less important as synthetic dyes that produced brighter colors were developed. Today, logwood black is the only natural dye widely used.

In 1856, William Henry Perkin began the synthetic organic chemical industry by accidentally discovering the purple dye, mauveine, when he tried to produce quinine from aniline. The synthetic dyes were known as coal tar dyes because the six-membered ring structures of carbon atoms were all derived from coal tar. Congo Red was the first dye discovered with so great an affinity for cellulose that a mordant was not required.

About 100 years after Perkin's first discovery, fiber-reactive dyes capable of forming covalent linkages with the fiber were discovered. A fiber-reactive dye is washfast. During dyeing, dye molecules must diffuse from the aqueous solution and into the fibers. Fibers such as cotton absorb water readily and are said to be hydrophilic, while fibers such as polyester absorb water with difficulty and are described as hydrophobic. Dyeability is influenced if a fiber can somehow carry an ionic charge and better interact with oppositely charged colored ions. To dye cellulose, a reactive dye must combine with the hydroxyl groups in the fiber.

Tie-dyeing is one of the oldest methods of printing designs on fabrics. Typically, parts of the fabric are bunched together in a design and knotted or tied together with string. Tied sections are protected from absorbing the dye and patterns are created.