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 **Experiment 3: Dyes and Dyeing**

**Purpose of Experiment/ Background**

The colors that we see every day are due to a specific object being able or unable to absorb a specific wavelength of light. The color that it does NOT absorb, is the color that we are able to see. Chromaphores are molecules or part of molecules which give an object its color. The chromaphore is what reflects the wavelength and in turn, what allows us to see the color that we see. Chromaphores have a conjugated system of double bonds which means that they have pairs of double bonds separated by single bonds. Azo dyes are the most popular and they are created by the coupling of a compound containing a diazonium group to a phenol group or any other aromatic compound. The purpose of this experiment is to create a dye to soak the test fabric in to see how different affinities to the dye due to the different bondings that each fabric has affects the color that the test fabric turns out to be.

**Procedural Steps**

Diazotization of Sulfanilic Acid

-Use 50 mL Erlenmeyer flask by dissolving and boiling 2.4 grams of sulfanilic acid monohydrate in 25 mL of 2.5% sodium carbonate solution.

-Let the solutions cool under tap water and add .95 grams of sodium nitrate and stir until everything dissolves

-Pour this solution into the flask that contains about 15 grams of ice and 2.5 mL of concentrated hydrochloric acid

-Within a minute or two, diazonium salt will separate into a powdery white precipitate and be ready for use

Methyl Orange

-Mix 1.6 mL of dimethylaniline and 1.25 mL of glacial acetic acid in a test tube

- In a 250 mL beaker, use the suspension of diazotized sulfanilic acid from Experiment 1 and while stirring, add the solution of dimethylaniline acetate

-Clean and rinse the test tube with small amounts of water and add it to the beaker

-Within a few minutes of stirring and mixing thoroughly the red (acids stable) form of dye sould separate

-A stiff paste should result in 5-10 minutes and 18 Ml of 2M sodium hydroxide is then added to produce the orange sodium salt

-Heat the mixture to the boiling point while stirring and a large part of the dye should dissolve

-Allow the beaker with the solution to cool in a pan of ice and water undisturbed

-When cooled thoroughly, collect the product on a Buchner funnel and use saturated sodium chloride solution rather than water to rinse the flask and wash the dark liquor from the filter

-The crude product can be crystallized from water, not dried.

Direct Dyes

-To prepare the dye bath, we need 30 mL beaker with 50 mg of Methyl orange, 0.5 mL of 10% sodium sulfate solution, 15 mL of water, and 5 drops of 10% sulfuric acid

-place a piece of test fabric, a strip ¾ inches wide in the bath for 5 min at a temperature near the boiling point

-Remove the fabric from the dye bath and allow it to cool

-Wash the fabric thoroughly with soap under running water before drying it

**Methyl Orange**

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**The conjugated system in the methyl orange forms the basis of that chromaphore which allows for it to absorb light and cause the fabric we are testing to be colored.**

**Experimental Observations and Data**

The first step in diazotization of sulfanilic acid, the product was a purple color but when mixed with sodium nitrate, it turned a darker brown/yellow color. In the last step of the first experiment, the result was a white precipitate forming and collecting in the bottom of the beaker and that was the diazonium salt. Using the suspension of diazotized sulfanilic acid from experiment one and stirring the acetate solution into it, it created a magenta/purple color from being an orange/red paste. When we added NaOH, it went back to orange. When allowing it to cool undisturbed, the dye became a shade of red. When cooled thoroughly through a Buchner funnel, the remaining product was little pieces of foamy orange solids. After we prepared the dye bath with methyl orange, sodium sulfate, water, and sulfuric acid, we place a clean completely white strip od testing fabric. After allowing the bath to heat up near boiling point with the test strip inside it, we removed the test fabric and washed it with soap and water. We saw that the fabric had many shades of red/ orange and pink on it. Below are the pictures of the methyl orange dye that we used and the test fabric after washing it: 

**Conclusion and Discussion**

After preparing the dye bath that contained near boiling water, Methyl Orange, sodium sulfate solution and sulfuric acid, we placed the test fabric inside for 5 minutes and the results were and were not what we have expected. Since the test fabric was all the same color (white) before we placed it in the bath, I thought that the entire strip would be dyed one color. But since different sections of the fabric was dyed differently, I realized that the fabric was made of different fabrics that bonded differently to the dye. The fact that the test fabric turned out to be nicely developed yet different shades of red, orange and yellow means that there are sections on the test strip have different affinities to the dye that we’ve created due to the different bonding. Some of our colleagues had darker shades of the colors that we had on our test strip. This is either because they had different types of fabric on their test strip or because they allowed the fabric in the hot bath with they dye to stay in longer than we have since we’ve only put it in there for exactly 5 minutes and not more. Although the latter may be a possibility, I don’t think it is the reason why because if both fabrics have the same type of bonding to the dye than both should be the same color no matter the time elapsed in the hot bath.

**Post Laboratory Questions**

1). Which one of the following molecules has the longest pi-system (# of conjugated double bonds)?

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2).The following molecule is Nylon 6,6. It is a polyamide and it is a commonly used synthetic fabric. Name two types of intermolecular (NON-covalent) interactions which would cause a dye to bind to nylon?

-Van der Waals

-Hydrogen Bonding