DYE: MARTIUS YELLOW

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ABSTRACT:

Dye is a coloured substance that chemically bonds with the substrate to which it is being applied in an aqueous solution. It often requires a mordant to quicken the process of the dye on the finer substance used to impart colour to textiles, paper, leather, and other materials such that the colouring is not readily altered by washing, heat, light, or other factors to which the material is likely to be exposed. One of the oldest dyes was created using 1-naphthol and is called Martius yellow. This research paper aims to experimentally test and analyse Martius Yellow in great detail. The goal of this research is to comparatively synthesise and analyse the categoric results of solubility, density, melting, boiling point and application of the Dye Martius Yellow on Fabric at different quantitative levels. This ultimately resulted in the formation of dye without the requirement of mordant, soluble in water and absolute alcohol with the practical yield to be categorised as an excellent result.

INTRODUCTION:

The practice of dyeing textiles has its roots in the Neolithic era, and over time, people have employed readily accessible materials to colour their fabrics. In ancient and mediaeval societies, rare dyestuffs like Tyrian purple and crimson kermes, known for their vivid and lasting hues, held significant value as luxury items. Plant-derived dyes such as indigo extracted from Indigo leaves, saffron from dried flowers of colour, and madder from roots of madder plants played a crucial role in the economies of Asia and Europe, serving as essential trade commodities. In various regions like Asia and Africa, intricate patterns on fabrics were achieved through resist dyeing methods, allowing for controlled colour absorption in piece-dyed cloth. The inception of synthetic dyestuffs marked the advent of synthetic organic chemistry. Initial endeavours in creating artificial dyes included Woulfe's production of Picric Acid and Runge's use of urine. Despite these early efforts, the impracticality of high raw material costs hindered their widespread preparation and commercial viability.

Recognized as the pioneer of synthetic dyestuffs, William H. Perkin achieved a significant breakthrough in 1865 by synthesising the inaugural synthetic dye, Perkins mauve. Perkin later expanded his operations to include the production of the dye. At present, the dye industry serves as a focal point for innovation due to the increasing demand in the contemporary textile industry, as well as in areas such as food, hair colour, and the biological sector because of its sustainability, efficiency, cost effectiveness and to match the demand of style & fashion globally.

Let's dive into the difference between some dyes.

Dye type	Detail description	Uses
Acid Dye	• An acid dye is a dye that is typically applied to a textile at low pH. Acid dyes are anionic, soluble in water and are essentially applied from the acidic bath. • These dyes possess acidic groups, such as SO_3H and COOH, which are applied on wool, silk and nylon when the ionic bond is established between the protonated $-NH_2$ group of fibre and the acid group of dye	• They are mainly used to dye wool and silk. Some acid dyes are used as food colourants and some can also be used to stain organelles in the medical field.
Basic Dye	• Basic dyes are called cationic dyes because the cationic part of basic dyes is responsible for colour production. • Basic dyes are salts of organic bases. The basic dye molecule has a positive charge, which is different from most dyes which have a negative charge or no electric charge.	• Basic dyes are very important in the textile industry. Basic dyes can be used to dye many different fibres, including natural fibres such as wool, silk and cotton. They can also be used to dye acrylic fibres and their lightfastness on acrylic fibres is very good.
Nitro Dye	• These are poly-nitro derivatives of phenol containing at least one Nitro group at the ortho or para position relative to a hydroxyl group and are yellow-coloured. The nitro group acts as a Chromophore and the hydroxyl group acts as Auxochrome.	• Nitro dyes are mainly used in dyeing wool, silk

Dye type	Detail description	Uses
Mordant Dye	• These dyes are adjective in nature and do not directly adhere to the fabric. • They necessitate a mordant, such as a metal hydroxide for acidic dyes or tannic acid for basic dyes. • The fabric intended for dyeing undergoes a preliminary treatment by immersion in a solution containing the metallic salt or tannic acid, followed by immersion in the dye solution.	• Chromium salt is used as a dye for dyeing wool and printing. Cotton with modern aluminium is also used as a model for dyeing and printing.

Apart from these above mentioned, there are numerous dyes: Natural dyes, Synthetic dye, direct dyes, disperse dyes, sulphur dyes, pigment dyes, reactive dyes, macromolecular dyes, metallized dyes, naphthol dyes, pre-metallized dyes, gel dyeing, azo dyes, aniline dyes, anthraquinone dyes and many more.

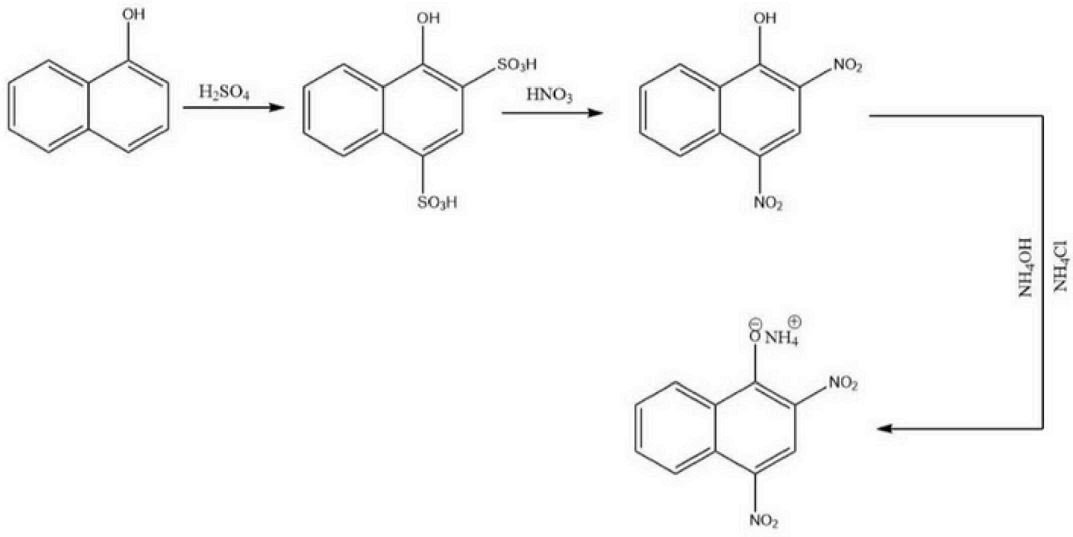
MARTIUS YELLOW: It is prepared by the action of nitric acid on 1-naphthol-2,4-disulphonic acid and is commonly used to dye fabrics. Martius yellow is coloured Nitro-aromatic, non-volatile, pH-ionisable dye.

MATERIALS:

To carry out this experimental we require 1g of 1-naphthol, 2 ml of concentrated H_2SO_4, 1.2ml of concentrated HNO_3, 2ml ammonium hydroxide, 2gm of ammonium chloride, 100 ml conical flask, Ice to cool, a thermometer to measure the temperature, pipette, beaker, 4 ml of water, 5 ml of Ice water, 30ml of hot water, burner for heating, ethyl-alcohol, heating clay apparatus.

METHODOLOGY:

These are the steps to follow one by one to get the desired result : In a 100ml conical flask dissolve 1gm of 1-naphthol in 2 ml of concentrated H_2SO_4 by heating in a steam bath for 5-10 minutes. Cool the flask by keeping it in an ice bath and then add 4 ml water to it. When the temperature inside the flask is below 10°C, add in a portion with constant stirring 1.2ml of concentrated HNO_3 taking care that the temperature does not rise above 10C during the addition process. After the addition is complete remove the flask from the ice bath, keep it at room temperature for a few minutes and then heat it to 50C in a water bath for 2-5 minutes. Cool, add 25 ml ice water to the flask and stir the reaction product. Collect the yellow dye on a Buchner funnel and wash it with water.



Heat the solid yellow with 30 ml of hot water and 2 ml of ammonium hydroxide in a 400 ml beaker on a water bath until the solid completely dissolves. Filter the solution while still hot and add 2gm of ammonium chloride to the filtrate. The nitro dye separates in the form of its ammonium salt. Cool and collect the orange-coloured salt. For the application process - Add the salt to a beaker and dilute it with the help of ethyl-alcohol, take a piece of fabric or material and tie the Heating clay apparatus to it. Dip this into the beaker. The colour of the fabric starts to transform instantly, leave it for 10 minutes. The dye is imparted on the fabric and the product is ready.

RESULT:

The dye Martius yellow is soluble in water and for absolute alcohol requires a little shaking to be completely soluble in 100% alcohol. The melting point is above 200 C, and the weight of the compound is 1.28g which provides a practical yield of 73.5% considered as a categorical result to be excellent. The dye was imparted on the fabric within the time of 10 minutes without any requirement of mordant because of its preeminent density.

CONCLUSION:

The synthesis of dye Martius yellow was carried out by using 1- naphthol through the action of nitric acid with 2-4-disulphuric acid, yielding orange salt which resulted to be soluble in water and absolute alcohol, and the application was carried out on the fabric with the help of ethyl-alcohol. The density of dye Martius Yellow was so promising, that there was no necessity or demand for a mordant to quicken on the fabric comparatively to other dyes which often requires a mordant, dyes which are categorised as mordant dyes. Yet, there remains further exploration to be undertaken in terms of applying these dyes to various sets of fabrics. This involves experimenting with diverse quantitative levels, employing varying temperatures, and utilising different methods which may yield better results.

REFERENCES

Arun Sethi, Systematic lab experiments in organic chemistry, New Age International (P) limited publishers, 2010.

Gurdeep R. Chatwal, Synthetic dyes (Fourth revised enlarged edition), Edited by M. Arora, Himalaya Publishing House, 2016.

M.S. Yadav, Synthetic Dyes, Campus Books, 2010.

About the contributors: Luminar Satla, currently in the third year of Chemistry at K.J. Somaiya College of Science and Commerce, brings a passion for unravelling the complexities of chemical compounds. Collaborating with her, Jamila Sarang, also in her third year but specializing in Biochemistry, adds a unique perspective to their research endeavours. Together, they delve into the nuanced realms of chemistry and biochemistry, exploring the interdisciplinary facets of their shared interest. Their joint effort focuses on the research topic of "Dye: Martius Yellow," promising to contribute valuable insights and exemplify the synergy of dynamic fields of study.