

Colour Fastness Properties of Some Disperse Dyes on Nylon

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Abstract— This study investigates the color fastness properties of several disperse dyes applied to nylon fabrics. Disperse dyes, known for their hydrophobic nature, are widely used on synthetic fibers like nylon due to their compatibility with non-polar surfaces. The research focuses on evaluating the fastness of these dyes to various conditions, including washing, light, and perspiration. Nylon, a synthetic polyamide fiber, presents unique challenges in dyeing due to its high crystallinity and strong intermolecular hydrogen bonds. To address these, a selection of disperse dyes with varying molecular structures was tested under controlled dyeing conditions. Fastness tests were conducted in accordance with ISO standards to measure resistance to fading and staining. The results revealed a correlation between dye molecular structure and fastness properties, with certain dyes exhibiting superior performance in terms of wash and light fastness. The findings offer valuable insights into optimizing dyeing processes for nylon fabrics, ensuring both durability and aesthetic appeal. This study contributes to the broader understanding of dye-fiber interactions and the development of more sustainable dyeing techniques in the textile industry. Using accepted procedures, the fastness qualities of these various dyes were evaluated after they were applied to nylon fabric. The dye sample B was found to have better fastness to washing, pressing, and light when compared to dye A.

Keywords— Disperse Dyes: Nylon Fabric: Heat Setting: Dye Uptake: Fabric: and Durability.

I. INTRODUCTION

Fabric production heavily depends on textile coloration as it shapes both the design qualities and operational characteristics of clothing materials and industrial fabrics. Among synthetic fibers, nylon has become extensively utilized because it exhibits superior mechanical properties which involve excellent tensile strength along with elasticity and long-term durability and resistance to abrasion. Acid, premetallized, mordant, reactive, and dispersion dyes are among the dye classes that can be used on nylon fabrics because of their hydrophobic nature and the presence of primary amino end groups in the polymer. Levelling dyeing issues arise because anionic and premetallized dyes are both susceptible to variations in the chemical and physical characteristics of the fibers. Excellent stripe coverage and good levels can be achieved with disperse dyes. However, their poor-to-moderate build-up qualities and limited washing fastness limit them to common use on nylon fibres. The necessity to create a class of dispersed dyes specifically for dyeing nylon fabric is becoming increasingly important due to the growing use of nylon. Disperse dyes are organic colors that vary in the type of chromophore they contain and have a very low water

solubility. These include azo, anthraquinone, nitro, methine, benzodifuranone, and quinoline-based molecules. They are frequently used on hydrophobic fibers like nylon and polyester [2]. This is due to their remarkable colour fastness and the ability to produce a large variety of colour shades [25]. though they are not ionic and do not have a water-soluble group, they are frequently substituted azo, anthraquinone, or diphenylamine compounds that have been shown to have prospective research use in the creation of good light-resistant dyes [30]. James Badiley and Holland Ellis are credited with discovering dispersion dyes in 1924. However, when polyester and secondary cellulose acetate emerged in the 1950s, their chemistry changed because of their low substantivity for natural fibres [12].

Based on several studies, disperse dyes are less expensive than the majority of synthetic dyes, which allowed them to quickly re-place conventional natural dyes in the dyeing business [15]. Furthermore, specialized disperse dyes that have demonstrated remarkable biological efficiency against certain Gram-positive and Gram-negative pathogenic bacteria as well as fungi have recently been synthesized in addition to being used primarily for dyeing [8], [13]. Polyesters are among the most widely used kinds of polycondensation polymers that have an ester functional group on the main chain. Of all the synthetic fibres, polyester is the most produced and has a highly compact and crystalline structure [4], [6]. Disperse dyes have demonstrated good to exceptional light and washing fastness qualities, making them generally regarded as the most appropriate for colouring polyester [5]. Nylon is synthetic and may be dyed with dispersion dyes, just as polyester [24]. The dyeing process for its amorphous structure is less energy-intensive than that for polyester since it is carried out at the boil [20], [3].

This study aims to evaluate the colour fastness properties of selected disperse dyes on nylon fabric. The research analyzes dyeing efficiency together with wash fastness, light fastness, perspiration fastness, and rubbing resistance. These research findings will reveal how suitable these dyes are for extended use in developing colour-resistant nylon fabric products.

II. MATERIALS AND METHODOLOGY

A. Materials

Electrical oven, dye bath, pressing iron, ply wood, glass rod, analytical balance, and 100cm³ measuring cylinder.

Reagents used were of analytical grade and were prepared in line with standard methods as described within the Manual for nor-mal Analytical Procedures (1999). Distilled water, dispersant, brown disperse dye, and yellow disperse dye are among the chemicals utilized.

B. Dyeing Nylon Fabric

2.0 g of the dye was weighed and dissolved in 100 cm³ of room temperature water to create a 2% dye stock solution. A 1:50 material to liquid ratio was used throughout the dyeing procedure. A filter paper was used to help squeeze out extra water after the fabric sample had been wetted. The sample was then added to the dye bath, which was set at 50 °C. Later, the temperature was raised to 100°C for 20 minutes, and dyeing was carried out for another 60 minutes at this temperature. Following dyeing, the cloth was taken out again, properly cleaned with water, allowed to air dry, and then sent for testing of its fastness [19], [7].

C. Washing

Following the dyeing and steaming stages, the washing process comprised three steps, including, Thorough rinsing with cold water, Treatment with hot water and, Final rinse with cold water. Subsequently, the samples were dried and evaluated for colour strength concentration.

D. Fastness Properties

I. Rubbing fastness

Before being examined, the dyed fabric piece was scrubbed on a smooth dry white cloth and later observed. The staining of the adjacent white cloth was observed and assessed which agrees with the test method provided by ISO 105-X12: 2001 method (dry and wet) standard. [27].

II. Washing fastness

Before being removed and thoroughly rinsed with water, the dyed sample was submerged in a detergent solution that contained 0.50 g of detergent in 30 cm³ of distilled water. The sample was then allowed to air dry, and the colour changes were correlated with the standard gray scale rating (grade 1-5), where 1 represents poor and 5 represents excellent [19].

III. Fastness to light

The resistance of a dyed or printed fabric to fading when exposed to daylight is measured by the light fastness test. The dyed sample was placed in the sun for three hours while being securely fastened to a white piece of cardboard. The changes in shades were related to the standard gray scale rating (grade 1-5) where 1 is poor and 5 is excellent [7].

IV. Hot pressing fastness

Using the ISO 105-POI 1993 standard method, wet, moist, and dry pressing fastness experiments were carried out. To create a composite specimen, the dyed fabric (5 x 4 cm) was sandwiched between two pieces of dried white cloth. After that, a hot pressing iron was placed on top and left for 15 seconds. Using grayscale, the amount of discoloration of the nearby white fabric was then evaluated [27].

III. RESULTS AND DISCUSSION

The gray scale assessment for washing fastness showed excellent results for Sample B because of its disperse brown dye component, which had the best fastness properties. Both dyes A and B provided excellent light fastness results, although dye B demonstrated superior absorption capacity compared to dye A. The fastness tests showed great performance when dry and when damp, but the samples showed unsatisfactory results during wet pressing tests and generally displayed weak resistance to pressing tests. Both rub fastness outcomes confirmed that dye B shows strong absorption capacity on nylon fabric material.

TABLE 1: Fastness Properties

Specimen	Fastness Properties					
	Rubbing	Washing	Light	Pressing		
	Fastness Staining	Fastness Staining	Fastness Staining	Fastness Staining		
				Dry	Wet	Damp
A	3	3	3	2	2	2
B	2/3	4	4	2	2/3	2

KEY: Specimen A: Nylon fabric dyed with disperse dye yellow. Specimen B: Nylon fabric dyed with disperse dye brown

IV. CONCLUSION

The dyed samples exhibited varying depths of dyeing. The results of the washing fastness test indicate that the dyes demonstrated strong adhesion to nylon fabric. However, the light fastness test revealed that dyes A and B had poor resistance to light exposure. Overall, the washing fastness of the dyes was generally good. When comparing the fastness properties of dyes A and B, dye B exhibited superior fastness performance.

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