

Dyeability and Dyeing Properties of Disperse disazo Dyes on Polyester and Nylon Fabrics

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ABSTRACT

The four properties in general the dye must possess are intense colour, solubility in aqueous solution, substantivity and colorfastness. The modern tendency in textile dyeing is towards insistence on dyes which possess good fastness properties to light, washing, rubbing and bleaching. Further it may be considered as an ingenious developments and modification of dyeing. Dyeing of fiber depends on the secondary forces between dye and fiber and penetration of the dye into fiber. Dyeing therefore implies some affinity between the fiber and dyes. Thus the dyes which possess this affinity are termed as substantive dyes. All fibers do not possess affinity for the same dyes for example many dyes for wool and silk have little affinity for cotton and rayon. Therefore dyestuff for dyeing of textile is generally classified according to their method of application. polyester is quantitatively the most important synthetic fiber because of inexpensive production from petrochemical raw materials and excellent textile properties alone and in combination with natural fibers is the universal applicability. Polyester fibers are hydrophobic and can be dyed easily with water insoluble small molecular dyes. Although a large variety of disperse dyes are available for coloring polyester fibers, most of disperse dyes are azo compounds.

Keywords: Disperse Dye, Affinity, Fastness, Nylon and Polyester

I. INTRODUCTION

Enormous disperse dyes are documented and their number is constantly increasing because of greater number of different fibers and other materials that require to be dyed. The four properties in general the dye must possess are intense color, solubility in aqueous solution, substantivity and colorfastness. The modern tendency in textile dyeing is towards insistence on dyes which possess good fastness properties to light, washing, rubbing and bleaching. A considerable craftsmanship or art is required to produce level results and to produce shades of color which match the certain specified standards. In this context, the present chapter deals with the study of

dyeing behaviour and dyeing properties of disperse disazo dyes on polyester and nylon fibers. To perform this task in a best way it is more reasonable to acquaint with the fundamentals of dyeing with disperse azo dyes and evaluation of dyed pattern in terms of dyeing properties. Dyeing of fiber depends on the secondary forces between dye and fiber and penetration of the dye into fiber. Dyeing therefore implies some affinity between the fiber and dyes. Thus the dyes which possess this affinity are termed as substantive dyes. All fibers do not possess affinity for the same dyes for example many dyes for wool and silk have little affinity for cotton and rayon. Therefore dyestuff for dyeing of textile is generally classified according to their method of application.

Polyester is quantitatively the most important synthetic fiber because of inexpensive production from petrochemical raw materials and excellent textile properties alone and in combination with natural fibers is the universal applicability. Polyester fibers are hydrophobic and can be dyed easily with water insoluble small molecular dyes. Although a large variety of disperse dyes are available for coloring polyester fibers, most of disperse dyes are azo compounds.

1.1. Dyeing Techniques

Three methods of dyeing can be used for introducing the dye in to or on to the fiber^{1,2} First method is the exhaustion dyeing in which diffusion of dissolved dye into the fibers takes place by using either batch dyeing or continuous dyeing. The second method is pigment dyeing in which insoluble dye is deposited on to the fiber and fixed with a binder. In third method referred as mass and gel dyeing, the dye is incorporated into the synthetic fiber during its production. In exhaustion dyeing process, highly or moderately substantive dyes are usually employed. The market share of this dyeing process exceeds that of mass and gel dyeing which in turn is more important than pigment dyeing. In exhaustion dyeing, a dye must be at least partially dissolved migrates by diffusion through the surface of fiber in to its interior. It is performed either by using batch dyeing or continuous dyeing technique.

The exhaustion dyeing process consists of three phases:

1. The dyeing phase (Diffusion of dye into fiber)
2. The equilibrium phase (penetration of dye)
3. The dye fixation phase (chemical interaction of dye with fiber)

In a continuous exhaustion dyeing, the dye is first dissolved or dispersed in the liquor and the dye liquor so produced is locally applied to the textile which continuously passes through. The diffusion transfer of the dye to the textile substrate is controlled by temperature and/or auxiliaries. In this technique, the conversion of white fibers to finished dyed textiles in a single operation is an elegant and hence very

attractive process. However, it is especially important in dyeing big lots.

The term batch-dyeing (bath dyeing) more commonly used today is a special type of exhaustion dyeing. It has the great advantage that it can be used at any stage of textile production that means on the fiber, the yarn, the textile or finished garment and wet also can be tested in dye bath. For example, woven textiles can be desized and then can be used in dyeing. Batch dyeing can be used as laboratory dyeing technique important for investigations of new dyes or formulations. It also helps in maintaining consistency of production. However the amount of textile material used for laboratory scale dyeing is often in the range of a few grams and the main aim is to match the dyed patterns and produce dyed material for fastness tests. Besides this, the factors to be considered include dyeing rate, batch time and cost. In the dyeing equipment, the three phases of exhaustion dyeing – exhaustion, equilibrium and dye fixation usually occur in succession.

In dyeing, the dyeing rate is the dominant parameter which can be controlled by heating profile and concentration of the dye in the liquor. Besides this, the dye must be absorbed to give a level result. A high liquor ratio (low dye concentration) leads to low dyeing rate but in case of dyeing with disperse dye, the concentration of the liquor remains constant as long as the dye is dissolved.

In case of batch dyeing with disperse dye, the dye is fixed to the substrate by using a dispersing agent (0.25-2 gm/L) at pH ~5. The dyeing occurs from the dilute solution. Actually as the absorption of the dye molecules by the dye fibre progresses, some more dye passes from dispersed state into solution maintain its equilibrium concentration in solution and on the fabric surface. As the disperse dyes applied in the form of very fine aqueous dispersion, particle size and dispersion stability are extremely important. Therefore fine, uniform and stable dispersion employed in dyeing results in to full color yield with good dyeing properties.

Further the compact nature of fiber plays an important role in dye uptake. More compact fine

structure, greater will be the hindrance to the diffusion of the dye molecules into fine structure. The fine structure of the fiber can be modified by mechanical as well as heat treatments. Polyester fibers are dyed almost exclusively in exhaustion dyeing process. Disperse dyes are most stable at a pH of 4-5, acetic acid being used preferentially for pH adjustment. A dispersing agent is also added to the dye-bath. Because of the slow diffusion of the disperse dye at boiling temperature, polyester fibers are dyed at 125-130°C under pressure. To develop a course of dyeing that is quick and efficient as possible, studies have been performed on optimizing the temperature time program.

The evenness of dye absorption that is level dyeing improved by using high temperature, prolong dyeing time or by dyeing in presence of leveling agent called carriers. Carriers are aromatic compounds exerting a swelling effect on polyester fibers and dissolving effect on disperse dyes. Carriers must be accurately dosed, otherwise it would result into decreased shade and affect the fastness properties. They are ecologically harmful and therefore technically outdated or used only when dyeing temperatures of 130°C are not possible (for example in case of wool). Thus various dyeing techniques have been developed to raise the rate of dyeing to the level of commercial acceptability either using working temperature upto 130°C (High temperature dyeing process) or by dyeing at the boiling temperature in the presence of carrier (Carrier dyeing process) or by Thermosol dyeing process.³⁻⁵ In the present study of dyeing of polyester, high temperature dyeing process is used as discussed in the experiment section of this chapter. The most important part of the dyeing process is the interaction between the textile and the dye liquor. As some dyeing processes are performed above the boiling point of water, high pressure dyeing has been designed in which dyeing can be carried out up to 140°C. When the dyeing process dye has reached equilibrium, the dye is usually still in the outer zones of the textile fibers. It is mobile, and can bleed out again at any time. Therefore in order that dye must be fixed, a process known as development, finishing or

after treatment is required depending on the chemistry of the dye. Thus fixation can be improved either by chemical reaction (oxidation soluble dyes to give insoluble pigment) or by deeper penetrations in to the fiber such as disperse dyes.

1.2. Dyeing with Disperse Dyes

According to the recommendation of the Society of Dyers and Colorists, a number of tests are used to characterize the dyeing properties of disperse dye⁶. The dominating characteristics of the dye are its coloring properties which are expressed as color strength and hue. In practice, color strength is often determined by measurement of extinction of the dye solution spectrophotometrically. Hue of a dyeing is always judged against a standard dyeing of equivalent color strength. Disperse dyes are the class of dyes for synthetic fibers. Most of the disperse dyes are azo compounds and they were originally developed for dyeing acetate fibers. With the emergence of synthetic fibers, they proved useful for polyester, polyamide and their blends with cotton, wool, polyester and nylon. The shades of the colors obtained with disperse dyes depends on the substrate. Disperse dyes are finely disperse products that have a solubility in the bath about (0.1 g/L). The solubilities of disperse dyes used for polyamide are somewhat higher than those of polyester dyes. In comparison with acetate or polyester, many shades on polyamide are bathochromically shifted from orange to red and red to violet. This is attributed to the interaction of the amide groups with the chromophores. The colors are generally vivid except for the red shades. Therefore disperse dyes are generally applied in dyeing lighter shades. Wet fastnesses deteriorate with increasing depth of the shade color. A wide range of disperse dyes of varying constitution is available which are suitable for many different substrate such as polyester, nylon, wool and its blends. Polyester is quantitatively the most important synthetic fiber. It inexpensive production from petrochemical raw materials and excellent textile properties alone and combination with natural fibers is the universal applicability. PES fibers are hydrophobic and therefore water soluble dyes do not attach. In contrast,

polyester fiber can be dyed easily with water soluble small molecular dyes. Since the preferred dyeing medium is aqueous liquor the poorly water soluble dyes must be dispersed before application. The rate of dyeing and solubility are influenced by many factors such as temperature, practical size, type of dispersing agent used etc.

The thermodynamic dyeing equilibrium of disperse dye between water and fiber follows the Nernst distribution law ⁷.

$$C_F/C_L = K \text{ at constant temperature}$$

C_F is concentration of the dye dissolved in fiber (solid solution) C_L is concentration of dye in the liquor at equilibrium K is the distribution coefficient.

The practical dyeing process must be established from dyeing experiments on the basis of trial dyeings with the help of color measurements. The dyeing process can also be controlled by using carriers which are aromatic compounds exerting a swelling effect on polyester fibers and dissolving effect on disperse dyes. The dyeing time can be reduced significantly by increasing dyeing temperature.

1.3. Testing of colorfastness

It is a fundamental requirement that colored textiles should withstand the conditions encountered during processing, following coloration and during their subsequent useful life. Consideration of the subjects of color fastness here is deliberately directed to an examination of the factors which determine the behavior of textile materials, when subjected to the conditions, encountered during processing and use, and the principles upon which color fastness testing must, in consequence be based. Thus dominating characteristics of a dye are its coloring properties. They are assessed by preparing a dyed test sample where color is evaluated. These three characteristics of color can be determined by colorimetry using standard sample. Color is a three dimensional quantity and must therefore be expressed as color strength, hue and chroma. This must in principle, always be done by human eye. However, colorimetry can be regarded as an alternative method which is more accurate and reproducible for color assessment. Thus to test a dye, dyed test specimen are prepared

from both sample dye and standard under identical conditions and then assessed visually or colorimetrically.

In practice, color strength is often determined by measurements of the extinction of the dye solution according standard method. Further, there are several different tests for the fastness of textiles, each for determining the resistance of the color to one of agencies. These may conveniently be divided in to liquid and non-liquid treatments. The former include wet processes, such as washing with soap or treatment with water alone and also with bleaching solutions, acids, alkalis and perspiration including non-aqueous solvents. Non-liquid treatments include rubbing, exposure to light and gaseous impurities in the atmosphere and dry test, as in ironing. The behavior of any given dye in certain of these tests, e.g. with bleaching agents or non aqueous solvents, could be reasonably well predicted from properties determined simply; its resistance to decolorizing and its solubility. Several other tests, however, including those for fastness to gases, light and washing, cannot be correlated readily with any single property of dye. Among these, light fastness, washing fastness and rubbing fastness have received more attention than any other fastness properties because of their technical importance and scientific interest⁸. Therefore we have selected these three properties to be measured to evaluate color fastness of all disperse dyes on dyed polyester and nylon fabrics.

In the 1980s most of the standard methods for testing colorfastness were revised and some new methods were introduced⁹. The test methods published as international standard **ISO 105** contains more than 70 different test procedures have been revised, and the different parts have been given code numbers used for instance

1.3.1. ISO 105-BO2 for testing the "color fastness to artificial light: Xenon arc lamp fading test". The following brief discussion pertains to some of the selected standard test methods important in the studying color fastness properties¹⁰.

1.3.2. ISO 105-BO1: A specimen of the dyed fabrics and reference (wool) were exposed to daylight under

prescribed conditions, including protection from rain. Colorfastness is assessed by comparing the change in color of the test specimen with that of references as per blue wool scale.

1.3.3. ISO 105-BO2: For testing the “color fastness to artificial light: Xenon arc fading lamp test”: a specimen of the textile is exposed to artificial light under prescribed conditions, along with blue wool references. Two different sets of blue references exist, which are not interchangeable. Color fastness is assessed by comparing the change in color of the specimen with that references using blue scale.

1.3.4. ISO 105-CO1: Color Fastness to washing: A specimen of the textile in contact with one or two specified adjacent fabrics is agitated mechanically under specified conditions of time and temperature in a soap solution, then rinsed, and dried. The change in color and the staining undyed adjacent fabrics was assessed according to the following gray scale.

1.3.5. ISO 105-EO4: Color Fastness to perspiration: Specimen of the textile in contact with adjacent fabrics are treated in two different solutions containing histidine, drained, and placed between two plates under specified pressure in a test device and the change in color of each specimen and the staining of the adjacent fabrics are assessed with the gray scales.

1.3.6. ISO 105-X: Color fastness to miscellaneous agencies such as carbonizing with sulphuric acid (XO2), Mercerizing (XO4), Organic solvents (XO5), Soda boiling (XO6), Hot pressing (XO11), Rubbing (XO12). For example ISO 105-XO12 is the test method for color fastness to rubbing. In this method specimens of the textile are rubbed with a dry rubbing cloth in a suitable testing device. Two alternative sizes of rubbing finger are specified. The staining of the rubbing cloths is assessed with the gray scale.

1.4. Dyeing of Polyester and Nylon Fabrics

To examine the dyeing behaviour of heteraryl disperse dyes on polyester and nylon fabrics. For this purpose the disperse dyes of Mannich bases were used for dyeing polyester and nylon fabrics according to procedure reported in literature.

Dyeing behaviour of dyed fabrics was assessed by determination of percentage dyebath exhaustion and fixation of the dye.

Assessment of dye performance on both the fabrics was carried out by studying color fastness properties to light, washing and rubbing of the dyed patterns.

II. METHODS AND MATERIAL

Polyester blend (80% polyester and 20% cotton) fabric was purchased from Rustam mil, Ahmadabad, Gujarat, India. and that of nylon (67% nylon) was purchased from Sapana Mill, Surat, Gujarat, India. The other textile auxiliaries used were: dispersing agent (Dadamol), wetting agent (Noigen X-100) of L.R. grade, detergent (Sodium lauryl sulphate), DMF (LR grade) as solvent. dyeing was carried out in a Laboratory High Temperature Breaker Dyeing N/C Machine.

2.1. Dyeing Conditions:

Weight of fabric :2 g, MLR:80: 1 (160 ml), Amount of dye :40 mg (2%), Time:60min, Dispersing agent :80 mg, pH :4-5.5, Wetting agent :2-5 drops, Temperature :130°C(Polyester) 0-95°C(Nylon)

The dyeing on polyester fabric was carried out in two steps: The first step was the pre-treatment of the fabric and second step was preparation of dye bath and dyeing.

In the pretreatment of fabrics, 2.0g of fabric was introduced in a beaker containing 2% solution of non-ionic (sodium lauryl sulphate) detergent and soda ash (2%) in water. The content was heated to 70°C for 30–40 minutes. The pattern was then squeezed,

dried and subsequently used for dyeing.¹¹

For the dyeing of fabric, the (40 mg) was dried, powder and then used in dyeing the fabric. The dye bath was prepared according to the following procedure: A laboratory model glycerin-bath high-temperature metallic beaker-dyeing machine was used. A paste of dye (40mg) was prepared with dispersing agent (Dadamol 80mg) and 2 to 4 drop of wetting agent (Noigen x-100) by mulling them very

well in a small pastel. To this paste 2ml of DMF was added to completely dissolve the dye. This solution was transferred to 250 ml beaker and the pastel was washed with 10 ml of water, two or three times in order to transfer all the dye in beaker (dye bath). This solution was diluted to 160 ml with water with rapid stirring to obtain an aqueous dispersion of dye. The pH of dye bath solution was checked and adjusted to 4-5.5 using acetic acid to give dye solution. This solution was then transferred to a metallic beaker provided with a lid and a screw cap. Before closing the lid and tightening the metal cap over the beaker, a pretreated pattern of fabric (2g) of (polyester and nylon) was rolled into the beaker. The beaker was then placed vertically on the rotatory carrier inside the tank and the clamp plate was firmly tightened. The rotatory carrier was then allowed to rotate in the glycerin-bath. The temperature of bath was raised to 130°C and 90-95°C respectively for polyester and nylon fabrics at the rate of 2°C/min. The dyeing was continued for 60 minutes under pressure. After cooling for an hour, the beaker was removed from the bath and washed thoroughly with water. The mother liquor after dyeing was decanted into 250 ml volumetric flask containing 40ml DMF. The dyed pattern was washed several times with cold distilled water. The washings were collected into the same decanted dye bath liquor and finally it was diluted to 250 ml with distilled water and used for exhaustion study. The dyed pattern was washed several times with cold water followed by detergent (0.2g) and sodium carbonate (0.1 g) in water (100ml) at 80°C for 30 minutes. Finally it was washed thoroughly with water and dried at room temperature.

2.2. Dyeing Behaviour

The dyeing behavior of the disperse dyes was investigated by measuring dye exhaustion and fixation on the polyester and nylon fabrics by procedures reported in literature.¹²

2.2.1. Measurement of Exhaustion

The extent of exhaustion was determined according to literature procedure¹² by measuring the absorbance

of solution the residual dyebath collected after dyeing. Thus a stock solution of residual dye after dyeing was prepared by collecting and diluting the mother liquor of dyebath and washings of the dyed pattern in a volumetric flask (250ml) containing DMF (40 ml). Dye sample solution an aliquot (5 ml) of stock solution was further diluted to 25 ml with DMF and used for measurement of absorbance. Four standard solutions with different concentrations of each dye were prepared in water containing small volume of DMF for dissolution of dye. Finally the absorbance of these four solutions were measured at predetermined λ_{max} . A calibration graph was plotted and a straight line was obtained. The concentration of the diluted residual dye sample was calculated from this plot and the percentage exhaustion was obtained. For illustration this data treatment are shown for **1aD₁** as a representative of two groups of dyes (**Fig. 1**).

2.2.2. Measurement of Fixation

For fixation measurement, four standard solutions of dye of different concentrations (4-16 ppm) were prepared from a stock solution of dye (100 ppm) prepared in H₂SO₄. The absorbance of these four solutions was measured at a predetermined λ_{max} and a calibration curve is constructed by plotting absorbance versus concentration of standard solutions. Then, a sample of undyed fabric (0.1 g) was dissolved in 25 ml of concentrated sulphuric acid and this solution was used as a reference solution in colorimetric measurement. A dyed fabric (0.1 g) was dissolved in 15 ml cold concentrated sulphuric acid by stirring the fabric for 10-15min in sulphuric acid.

Fig. 1 Data Treatment for Dye Exhaustion

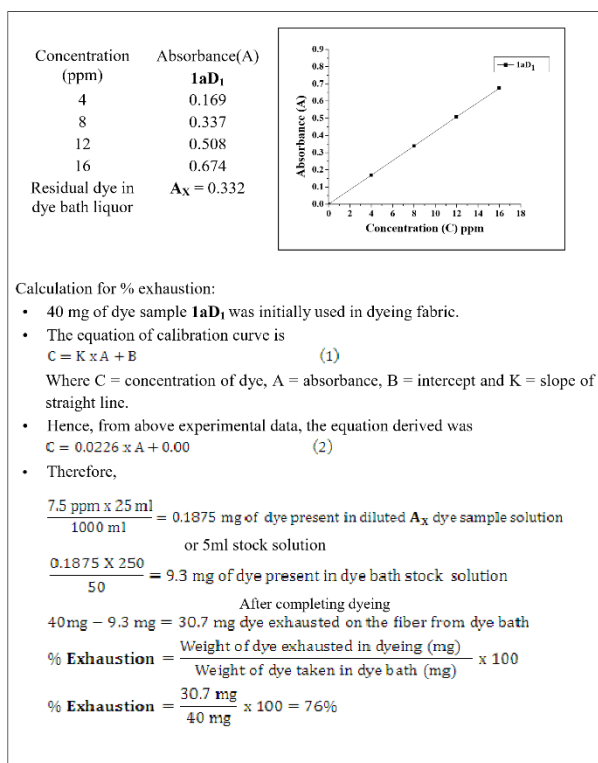
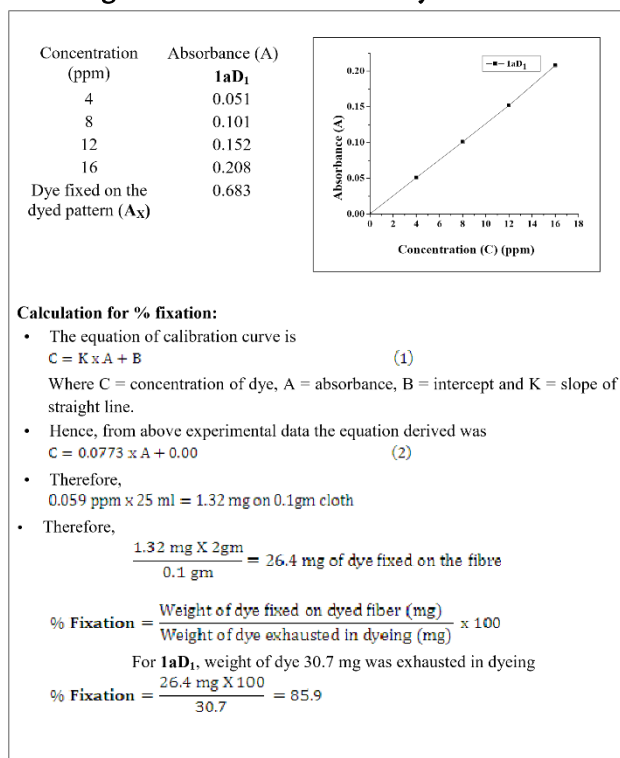


Fig. 2 Data Treatment for Dye Fixation



The solution was then diluted to 25ml with sulphuric acid. The absorbance of this solution was measured at same λ_{max} . From the calibration curve the concentration of the dye solution was calculated and hence amount of dye fixed on the fabric was estimated. For illustration this data treatment are

shown for dye 1aD₁ as a representative of all the dyes (Fig. 2)

2.3. Dye Performance

2.3.1. Fastness to light

Estimation of light fastness requires the exposure of test patterns to daylight (ISO 105-BO1)¹³. A specimen of the dyed fabrics and reference (wool) were exposed to daylight for 60 h. Colorfastness is assessed by comparing the change in color of the test specimen with that of references as per blue wool scale (1-8) where 1-very poor, 3-moderate, 5-good, 7-excellent and 8-outstanding.

2.3.2. Fastness to washing

The study was carried out according to the ISO test method 2 (ISO 105-CO2)¹⁴ in following manner. A specimen of the textile in contact with one or two specified adjacent fabrics is agitated mechanically under specified conditions of time (45min) and temperature (50°C) in a soap solution, then rinsed, and dried. The change in color and the staining undyed adjacent fabrics was assessed according to the following gray scales: 1-poor, 2-fair, 3-moderate, 4-good, 5-excellent

2.3.3. Fastness to rubbing

The rubbing fastness was carried out according to the ISO 105-X12 (1993)(E)¹⁵ in following manner. The dyed fabric was placed on the base of a crockmeter, so that it rested flat on the abrasive cloth with its long dimension in the direction of rubbing. For dry rubbing test, a square of white testing cloth was mounted over the end of the finger which projects downward on the dry specimen sliding back and forth 20 times by making 10 complete turns of the crank at the rate of one turn per second. For wet rubbing test, the testing square thoroughly wet in distilled water and squeezed between filter papers through hand wringer under standard conditions. The rest of the procedure is the same as the dry crocking test. The staining on the white cloth was assessed according to the international Gray scale.

III. RESULTS AND DISCUSSION

The disperse disazo dyes of two groups were applied at 2% depth on polyester and nylon fabrics. All disperse disazo dyes were investigated for their dyeing behaviour in terms of dye exhaustion, fixation and color fastness properties on polyester and nylon fabrics by using the procedures as discussed earlier. Visual observation of the dyed patterns mounted on the shade cards have shown a color gamut varying from light yellow to violet shades with good levelness, brightness and depth on the fabrics. The variation in the shades of the dyed fabrics results from both the nature and position of substituent on the benzene or naphthalene ring of the phenolic coupling component. Outstanding characteristics of dyes are that they give deep bathochromicity and bright hues with level dyeing because of the heteroatom present in the Mannich base diazonium component. However, there was a little variation in colour shade of the dyed

fabric of the dyes dihydroprimidinones (O-heteroatom) and that of corresponding dyes of dihydropyrimidinethione (S-heteroatom).

Washing Fastness:

Polyester→2aD₂, 2aD₅ Nylon→2aD₂, 2aD₅

Light Fastness:

Polyester→1aD₃, 1aD₉ Nylon→1aD₁, 1aD₉, 1aD₁₀

Rubbing Fastness (Dry):

Polyester→1aD₄ Nylon→1aD₇

Rubbing Fastness (Wet):

Polyester→1aD₄ Nylon→1aD₈

Scrutinization data of exhaustion and fixation of dyes on fabrics reveals that two groups of disazo dyes (MBUD and MBTDgroup) showed the percentage dye exhaustion in the range of 85-94% on both the fabrics. (Expect that of parent 1a-series of MBUD on nylon gave ~77.13%). Shade, exhaustion, fixation and fastness properties of disazo dyes 1aD₁₋₁₀ series and 2aD₁₋₁₀ are shown in **Table 1** and **Table 2** respectively.

Table 1: Shade, exhaustion, fixation and fastness properties of disazo dyes 1aD₁₋₁₀

Gray scales: 1= poor, 2= fair, 3= moderate, 4= good, and 5= excellent

Blue wool scale (1-8) where, 1-very poor, 3-moderate, 5-good, 7-excellent and 8-outstanding.

N = nylon, P = polyester

Dye	Visual Color		Exhaustion (%)		Fixation (%)		Light fastness		Wash fastness		Rubbing fastness			
											P		N	
	P	N	P	N	P	N	P	N	P	N	Dry	Wet	Dry	Wet
D ₁	Turmeric	Turmeric	76.33	93.93	85.90	83.20	4	4	1-2	2	3-4	4-5	4	4-5
D ₂	Purple brown	Purple	87.68	75.28	83.96	90.70	5	5	4-5	3-4	2-3	4-5	3-4	3-4
D ₃	Light orange	Light brown	82.70	76.78	81.17	89.37	5	4	3-4	4-5	3-4	3-4	4-5	3-4
D ₄	Light maroon	Light orange	84.37	92.19	78.76	81.84	4	3	4	4	5	4-5	3-4	3-4
D ₅	Brown	Light brown	91.11	93.95	79.13	80.64	4	5	4-5	4-5	4	4-5	3	4
D ₆	Light brown	Buff	83.61	88.43	80.72	84.32	5	4	4-5	4	4-5	4-5	4	4-5
D ₇	Orange	Turmeric	92.55	91.70	84.40	80.86	4	2	3-4	4	5	5	4	4
D ₈	Brown	Light brown	91.70	78.06	80.86	82.18	4	5	3-4	4-5	3-4	4-5	4-5	4
D ₉	Light purple	Light purple	88.06	79.22	82.18	91.83	4	4	3	2	5	4	4	4-5
D ₁₀	Maroon	Dark maroon	77.22	78.61	91.83	90.25	5	3	4-5	3	1-2	3	2-3	2-3

Table 2: Shade, exhaustion, fixation and fastness properties of disazo dyes 2aD₁₋₁₀

Gray scales: 1= poor, 2= fair, 3= moderate, 4= good, and 5= excellent

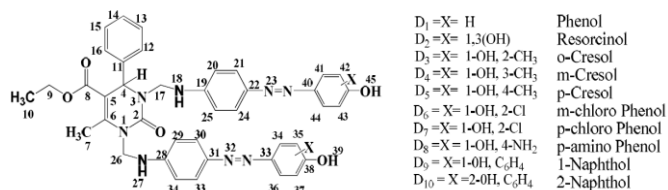
Blue wool scale (1-8) where, 1-very poor, 3-moderate, 5-good, 7-excellent and 8-outstanding.

N = nylon, P = polyester

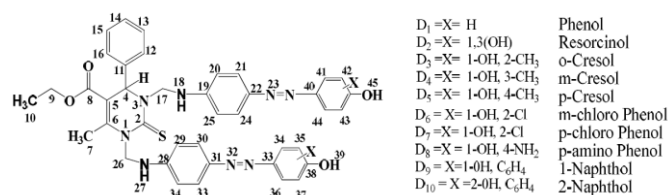
Dye	Visual Color		Exhaustion (%)		Fixation (%)		Light fastness		Wash fastness		Rubbing fastness			
	P	N	P	N	P	N	P	N	P	N	P		N	
											Dry	Wet	Dry	Wet
D ₁	Brown	Orange brown	89.00	87.71	78.66	79.31	4	4	4	3	3-4	3-4	3-4	4-5
D ₂	Purple	Purple	86.62	95.04	81.08	79.00	3-4	4	4-5	4-5	3-4	4-5	3	2-3
D ₃	Orange red	Orange red	93.61	85.25	84.12	78.66	5	5	4-5	4-5	3-4	3	4-5	4-5
D ₄	Orange	Orange	81.20	97.41	79.31	91.99	4	4	3-4	3-4	4-5	4-5	4-5	3-4
D ₅	Light brown	Light brown	84.42	93.81	83.37	83.62	3-4	3-4	3-4	4-5	3-4	4-5	4-5	3-4
D ₆	Brown	Brown	85.80	84.42	78.32	84.12	5	4	4	4	4-5	4-5	4-5	4-5
D ₇	Orange	Brown	80.22	85.80	83.62	78.32	4-5	4	4-5	4-5	4	4	4	4
D ₈	Buff	Light brown	87.55	89.30	79.00	81.08	4	4	3-4	4	2-3	4	4	4
D ₉	Light purple	Light purple	92.55	88.55	81.48	75.17	4	4	3-4	2-3	3-4	3-4	4	4-5
D ₁₀	Purple	Purple	88.55	86.60	83.46	77.13	5	4-5	3	4	3-4	3	4-0	4-5

It is to be noted that, the fixation of dye on fabric was calculated on the basis of dye exhausted in dye-bath and not on the basis of initial weight of dye taken in dye bath. Accordingly the fixation of dye 1aD₁ on polyester fabrics was ~86% corresponding 76% exhaustion. Further, all the dyes of two groups, gave the fixation was found to be good in the range of 80-85%. Thus, all the dyes showed higher percentage exhaustion and fixation on polyester as compared that on nylon indicating higher substantivity of the dyes for the substrate as well as to the relatively open structure of nylon which may readily allows the outward migration of the dye molecules.

The general structure of dyes in 1aD₁₋₁₀ series:



The general structure of dyes in 2aD₁₋₁₀ series:



The newly synthesized disperse disazo dyes gave fair to very good light, washing and rubbing fastness on each fabrics. The dyes giving the most promising fastness properties are:

IV. CONCLUSION

Remarkable degree of levelness and brightness after washing of dyed pattern is indicative of good penetration and substantivity (affinity) of the dyes on polyester and nylon fabrics. Thus, the combination with ease of preparation makes disazo dyes particularly valuable and economical.

V. REFERENCES

- [1] Peter M., Rouette, H.K. Grundlagender Textilverldung, Handbuchder Technologie

- Verfaher, Maschinen. . 13 ed. Frankfurt: Deutscher Fachverlag; 1989.
- [2] Zollinger H. Color Chemistry :Synthesis, Properties and Application of Organic Dyes and Pigments. New York: VCH; 1991:139-41.
- [3] Whittaker C.K., Wilcock, C.C. Dyeing with Coal Tar for Dyestuffs. London 1952.
- [4] Sadoovkorchagin F., Maketsky, A. Chemical Technology of Fibrous Material Moscow Mir Publication; 1973.
- [5] Shenai V.A. Chemistry of Dyes and Principles of Dyeing, . Bombay: Sevak Publication; 1973.
- [6] Report of the Committee on the Dyeing Properties of Disperse Dyes. Journal of the Society of Dyers and Colourists. 1977;93 (6) 228-37.
- [7] Ullaman's. Textile Auxailiaries to Tin, Tin Alloys and Tin Compounds. Encyclopedia of Industrial Chemistry. 6 ed: WILLEY-VCH; 2003:139.
- [8] Standard Methods of Dyes for Determination of the Colorfastness of Textiles. 3 ed. Bradford: The Society of Dyers and Colorists; 1962.
- [9] Smith P.J. Colour Fastness Testing Methods and Equipment. Review of Progress in Coloration and Related Topics. 1994;24 (1) 31-40.
- [10] Ullaman's. Textile Auxailiaries to Tin, Tin Alloys and Tin Compounds. Encyclopedia of Industrial Chemistry. 6 ed: WILLEY-VCH; 2003:246-54.
- [11] Shah T.B., Patel, S.B., Metha, T.B. Synthesis, Characterization and Dyeing Behavior of Oligomeric Trimethylolmelamine-1-Naphthol Acid Azo Dyes. International Journal of Polymeric Materials. 2009;58 (12) 681 - 91.
- [12] Kissa E. The Analytical Chemistry of Synthetic Dyes / Edited by K. Venkataraman. New York :: Wiley; 1977.
- [13] Ullaman's. Textile Auxailiaries to Tin, Tin Alloys and Tin Compounds. Encyclopedia of Industrial Chemistry. 6 ed: WILLEY-VCH; 2003:247.
- [14] Ullaman's. Textile Auxailiaries to Tin, Tin Alloys and Tin Compounds. Encyclopedia of Industrial Chemistry. 6 ed: WILLEY-VCH; 2003:248.
- [15] Ullaman's. Textile Auxailiaries to Tin, Tin Alloys and Tin Compounds. Encyclopedia of Industrial Chemistry. 6 ed: WILLEY-VCH; 2003:253.

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