Journal of Textiles, Coloration and Polymer Science

https://jtcps.journals.ekb.eg/

Effect of Various Parameters on Dyeing of Polyester, Cotton and Polyester/Cotton Blend with vat dye

Hamada M. Mashaly[1] and Nehal I. El-Sheikh[2]

[1]Institute of Textile Research and Technology, National Research Centre, Dokki, Giza, [2]Printing/ Dying/ Finishing Department, Faculty of Applied Arts, Beni-Suef University, Egypt.

IT HAS been found that cotton is the most comfort giving material found in nature, but for optimizing the cost and other quality parameters, sometimes it is needed to be blended with some synthetic material. Here again to obtain comfort and aesthetic appeal it is dyed with vat dye by varying some parameters like dispersing agent, wetting agent dyeing was carried out and the best result were studied which specified which is the optimum value of the auxiliaries for dyeing this p/c blend. Color strength and fastness properties were measured for the dyed fabrics. In general, the effects on Dyeing of Polyester, Cotton and Polyester/Cotton Blend with vat dye were explored.

Keywords: Open bath dyeing, Polyester/cotton blends, Vat dyes, Glucose, Fastness properties

Introduction

Dyeing is the process of imparting colors to a textile material through a dye (color). Dyes are obtained from flowers, nuts, berries and other forms of vegetables and plants as well as from animal and mineral sources. These are known as natural dyes. The other class of dyes is known as synthetic dyes. These are based on a particular type of chemical compositions. Some of these dyes are Acid (Anionic) dyes, Basic (Cationic) dyes neutral pre metalized dyes, sulphur dyes, vat dyes, reactive dyes, pigment dyes Color is applied to fabric by different methods of dyeing for different types of fiber and at different stages of the textile production process. These methods include direct dyeing; Stock dyeing; top dyeing; Yarn dyeing; Piece dyeing; Solution is pigmenting or dope dyeing, garment dyeing etc. Commercially polyester/cotton blended fabrics are dyed by two-bath or one-bath two-step dyeing method employing suitable dyes and chemicals for each fiber. Two bath dyeing methods are relatively long and complicated. The one bath two-step dyeing procedure is shorter as compared to two-bath method, but the drawbacks are lower dyeability and poor reproducibility.

Meena C.R. et al., have revealed that for the better dyeing of P/C blend (80/20, 67/33) the combination of Disperse / Reactive can be used[1]. Hossein Barani, et al pointed out that how we can vary the colour properties of PET. And their conclusion was to use the liposome dyes and increase in dyestuffs for the betterment of colour strength [2]. Najafil H. et al observed that in order to improve the adhesion of chitin to surface of P/C, we should change the pre-treatment process. And finally it concluded that the pre-treatment should be performed in NaOH solution in order to get better results [3]. Malik G. M, et alpointed out that the proper combination which should be acetified to gave disperse dyes. They evaluated the fastness of the fibre when above dye was used over it at HTHP [4]

Experimental

Materials

Fabrics

Cotton fabric: 100 %(125 gm/m^2), Polyester fabric: 100% (94.5 gm/m^2), Polyester/ Cotton blend fabric: 65/35% (107 gm/m^2), Polyester/ Cotton blend fabric: 50/50% (103gm/m^2). Were kindly supplied by Misr ElMehala Company, Cairo, Egypt.

Corresponding author: Hamada M. Mashaly, Email: hamadammashaly@gmail.com.
(Received 05/01/2022, accepted 10/01/2022)
DOI.10.21608/jtcps.2022.114897.1102

Dyestuff

Brilliant Green FFB: was supplied by Dystar Company.

Molecular Formula: C36H22O4

Brilliant Green

Auxiliaries

Glucose Anhydrous $C_6H_{12}O_6$, Dispersing agent (Sera Sperse MIS), Detergent(CSN01) were kindly supplied by Dystar, Hydrogen peroxide(35%), Sodium Hydroxide(35%).

Methods

Dyeing of Cotton Fabric

A 120 ml dye bath, suitable for 6 gm cotton (liquor ratio1:20) containing vat dye (Brilliant Green FFB) 3%, different concentration of glucose (6,8, 12, 14, 16 gm/l) as the eco friendly reducing agent was used, Sodium Hydroxide (18, 20,22, 26, 30, 36 gm/l), the dyeing temperature ranged from (50-80^{0}C) for (30-90 min). After dyeing, samples were oxidized for 10 min at 60^{0}C and then it were rinsed, soaped at 60^{0}C for 30 min.

Dyeing of Polyester Fabric

Polyester fabrics were dyed at a (liquor ratio1:20). The dye bath were prepared with the dye concentration 3%, dispersing agent 2gm/l at 130^{0}C for different time (30, 60, 90min)

Dyeing of Polyester/Cotton blend fabric with single bath

Polyester/Cotton fabrics were dyed at a (liquor ratio1:20). The dye bath was prepared with the dye concentration 3%, dispersing agent 2gm/l at 130^{0}C for different time (30, 60, 90min) then the temperature is cooled. The reactive dyeing was completed by adding different concentration of glucose (6,8, 12, 14, 16 gm/l) , Sodium Hydroxide (18, 20,22, 26, 30, 36 gm/l), the dyeing temperature ranged from (50-80^{0}C) for (30-90 min). After dyeing, samples were oxidized for 10 min at 60^{0}C and then it were rinsed, soaped at 60^{0}C for 30 min.

Measurements

Color measurements

The colorimetric analysis of the colored fibers was recorded using a spectrophotometer with pulsed xenon lamps as light source (UltraScan Pro, Hunter Lab, USA) 10° observer with D65 illuminant, *d*/2 viewing geometry and measurement area of 2 mm. All measurements were occurred at different λ 630. Values The corresponding color strength value (*K*/*S*) was assessed by applying the Kubelka Munk [5] (Eq. (1)).

$$K/S = \frac{(1-R)}{2R} - \frac{(1-R_0)}{2R_0} \quad (1)$$

R = Decimal fraction of the reflectance of the dyed fabric.

R_0= Decimal fraction of the reflectance of the undyed fabric.

K = Absorption coefficient.

S = Scattering coefficient.

The colorimetric properties of dyed fabrics were obtained with Hunter Lab DP-9000 Color-Spectrophotometer

Fastness properties [6, 7]

Color fastness to washing

The color fastness to washing was determined according to the method ISO 105-C02 (1989). The composite specimens were sewed between two pieces of bleached cotton and wool fabrics, and then immersed into an aqueous solution containing 5 g/l non-ionic detergents at liquor ratio 1:50. The bath was thermostatically adjusted to 60 °C for 30 min. After the desired time, samples were removed, rinsed twice with occasional hand squeezing, and then dried. Evaluation of the wash fastness was established using the grey-scale for color change.

Color fastness to rubbing

Color fastness to rubbing was determined according to the test method ISO 105-X12 (1987). The test is designed for determining the degree of color, which may transfer from the surface of the colored fibers to other surface, by rubbing. The current test can be carried out on dry and wet fibers.

Dry crocking test

The test specimen was placed flat on the base of the crock-meter. A white testing cloth was mounted. The covered finger was lowered on to the test specimen and caused to slide back and forth 20 times by making ten complete turns at a rate of 1 turn/s. The white test sample was then removed for evaluation using the grey-scale for staining.

Wet crocking test

The white test sample was thoroughly wetted out in water to a 65% and then picked up. The procedure was run as before. The white test samples were air dried before evaluation.

Color fastness to perspiration

Two artificial perspiration solutions were prepared as follows according to test method ISO 105-E04 (1989); acidic and alkaline solutions. Acidic solution was prepared by dissolving of L-histidine monohydro-chloride monohydrate (0.5 g), sodium chloride (5 g) and sodium dihydrogen orthophosphate dihydrate (2.2 g) in one liter distilled water. Then the pH was finally adjusted to 5.5 using 0.1N NaOH. To prepare the alkaline solution, L-histidine monohydrochloride monohydrate (0.5 g), sodium chloride (5 g) and disodium hydrogen orthophosphate dihydrate (2.5 g) were all dissolved in 1 l distilled water. The pH was adjusted to 8 using 0.1N NaOH. The fastness test was performed as follows. The colored specimen 5 cm × 4 cm was sewed between two pieces of uncolored specimens to form composite specimen. The composite samples were immersed for 15–30 min in both solutions with a proper agitation and squeezing to insure complete wetting. The test specimens were placed between two plates of glass or plastic under a force of about 4–5 kg. The plates containing the composite specimens were then held vertical in oven at 37 °C (±2 °C) for 4 h. The effect on the color of the tested specimens was expressed and defined by reference to grey-scale for color change.

Color fastness to light

The light fastness test was carried out in accordance with test method ISO 105-B02 (1988) using carbon arc lamp, continuous light, for 35 h. The effect on the color of the tested samples was recorded by reference to blue-scale for color change.

Results and Discussion

Effect of Glucose Conc.

Figure 1 show the Effect of glucose conc. on

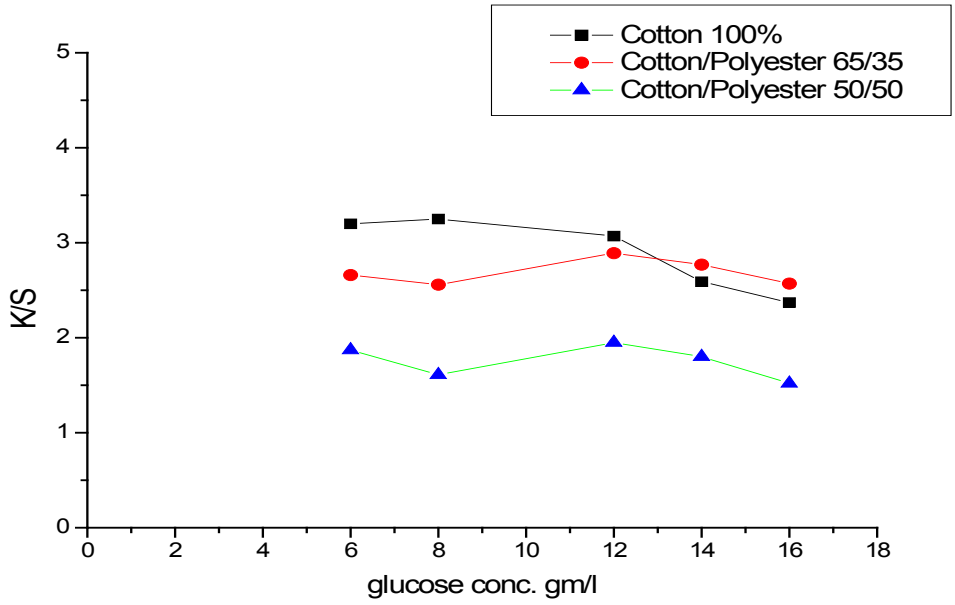

Fig. 1. Effect of glucose on Color strength (K/S) of Cotton – Cotton/ Polyester 65/35– Cotton/Polyester 50/50 fabrics dyed with the vat dye.

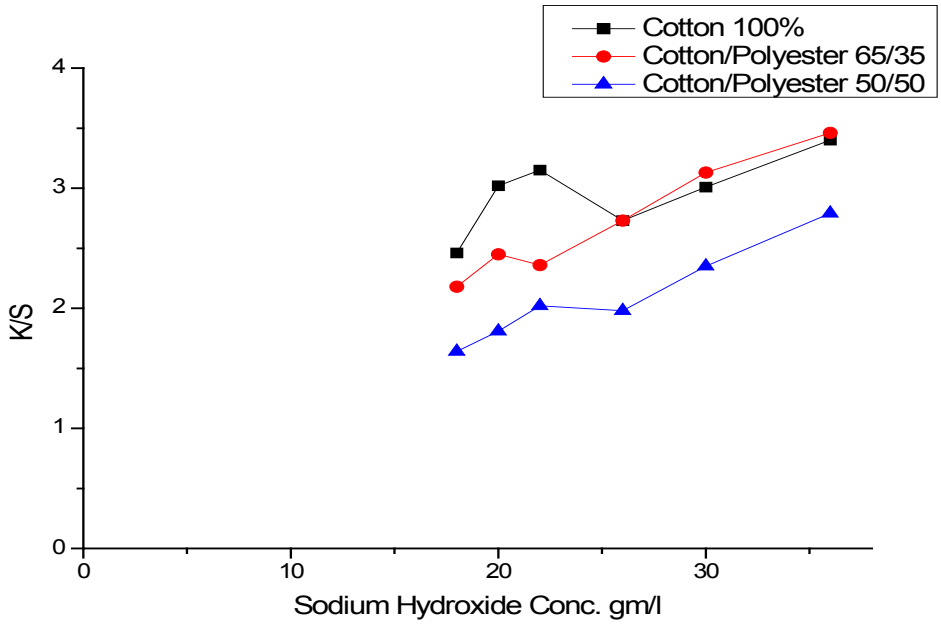

Fig. 2. Effect of Sodium Hydroxide on Color strength (K/S) of Cotton – Cotton/ Polyester 65/35– Cotton/Polyester 50/50 fabrics dyed with the vat dye.

Color strength (K/S) of Cotton – Cotton/ Polyester 65/35– Cotton/Polyester 50/50 fabrics dyed with the vat dye it is clear that cotton fabric show the better k/s value at 8 g/l of glucose conc. while the blend 50/50 cotton to polyester give better results at 12 g/l and this holds trough in case of 65/35 blend of cotton and polyester fabrics.

Effect of Sodium Hydroxide Conc

Figure 2 show Effect of Sodium Hydroxide on Color strength (K/S) of Cotton – Cotton/ Polyester 65/35– Cotton/Polyester 50/50 fabrics dyed with vat dye the results show that better k/s for cotton were obtained at 36 g/l sodium hydroid this holds trough in case of both cotton /polyester blends.

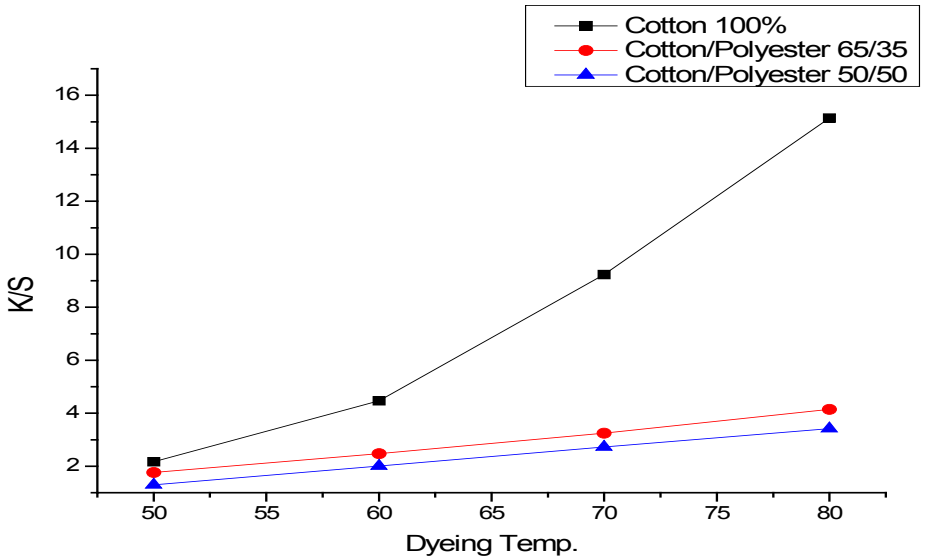

Fig. 3. Effect of dyeing Temp. On Color strength (K/S) of Cotton – Cotton/ Polyester 65/35– Cotton/Polyester 50/50 fabrics dyed with the vat dye

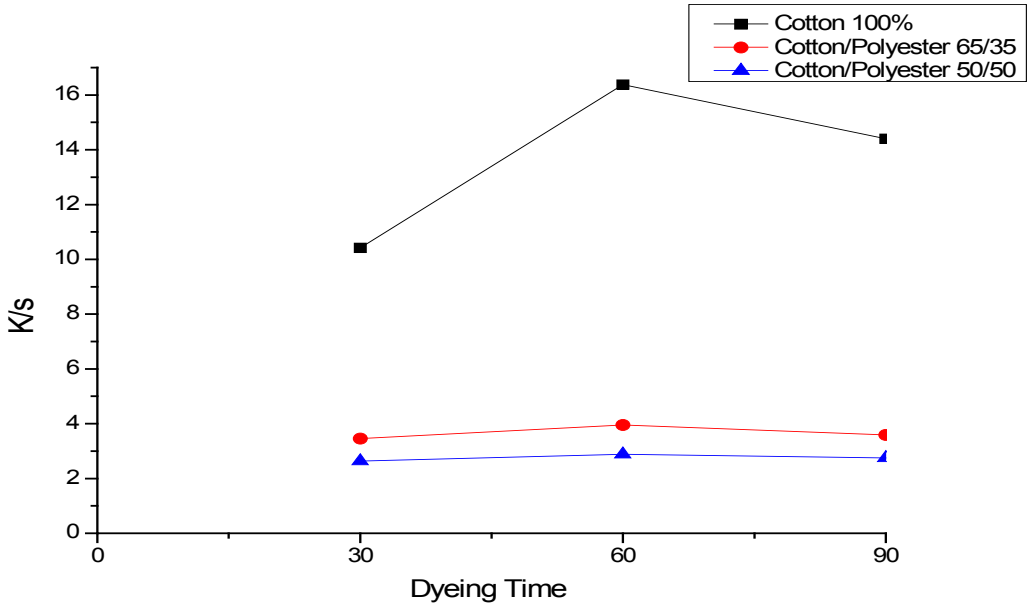

Fig. 4. Effect of dyeing Time. On Color strength (K/S) of Cotton – Cotton/ Polyester 65/35– Cotton/Polyester 50/50 fabrics dyed with the vat dye

TABLE1. K/s and Fastness properties of fabrics sample dyeing with vat dye

Fabrics	K/S	Fastness properties											
		Rubbing		Washing			Perspiration						Light fastness
							Acidic			base			
		Dry	wet	St.*	St.**	Alt.	St.*	St.**	Alt.	St.*	St.**	Alt.	
Cotton	1601	3-4	2	4	4	4	4	4	4	4	4	4	5-6
Polyester	0.52	4	4	4-5	4-5	4	4	4	4	4	4	4	4
Polyester/ cotton (65/35%)	3.96	3-4	3-4	4	4	4	4	4	4	4	3-4	4	5-6
Polyester/ cotton (50/50%)	2.81	3	2	4	4	4	4	4	4	4	3-4	4	5

St.*= staining on cotton St**= staining on wool

Effect of dyeing Temp.

Figure 3 shows the Effect of dyeing Temp. On Color strength (K/S) of Cotton – Cotton/ Polyester 65/35– Cotton/Polyester 50/50 fabrics dyed with the vat dye the results show that better k/s for cotton were obtained at 80 °C this holds trough for the two blends fabrics with large different in the value of k/s.

Effect of dyeing Time

Figure 4 shows the Effect of dyeing Time. On Color strength (K/S) of Cotton – Cotton/ Polyester 65/35–Cotton/Polyester 50/50fabrics dyed with the vat dye best results for the k/s value were obtained at 60 min. this for all fabrics used cotton, polyester and the blends.

Optimum condition

Dyeing of cotton

8gm/l glucose

36 gm/l sodium hydroxide

Dyeing at 80^0C for 60 min.

Dyeing of Polyester/ Cotton (50/50% and 65/35%)

12 gm/l glucose
36 gm/l sodium hydroxide
Dyeing of polyester at 130^{0}C for 60 min

Fastness properties

Fastness properties of the dyed samples were intensively examined against light, washing and perspiration fastness, all dyes shows good results as shown in Table 1. Except the rubbing fastness show moderate results In general, high washing and perspiration fastness was expected.

Conclusions

Dyeing polyester and polyester/cotton blend fabrics with vat dye is successful under certain conditions, which coordinate the rate of glucose and sodium hydroxide. When concentration is 8-12 g/L, the optimum dyeing concentration of sodium hydroxide is 36 g/L in the dyebath solution at 80°C. It seems that the role of the reducing factor formation is important in this dyeing method. The dyeing temperature is effective, and well-dyed polyester fabrics are obtained at 130°C. The maximum wavelength of polyester fabrics dyed with the vat dye is clearly not different from that of cotton fabrics Polyester has a pale color than cotton when they are both dyed with the dye.

References

[1] Meena, C.R., Abhinav Nathany, Adivarekar, R.V. and Sekar, N., One-bath Dyeing Process for Polyester/Cotton Blend using Physical Mixtures of Disperse/Reactive Dyes, European *International Journal of Science and Technology*, **2**(2), 6-16(2013).

[2] Barani Hossein, Peyvandi Shahram, Enhanced Deep Colouring of Micro Polyester Fabric, ISSN 1392–1320 *Materials Science* (Medžiagotyra), **16**(2), pp. 138-143 (2010).

[3]. Najafi1, H., Assefipour, R., Hajilari, M. and Movahed, H.R., One bath method dyeing of polyester/cotton blend fabric with sulphatoethylsulphonyl disperse/ reactive dyes treatment by chitin biopolymer, *African Journal of Biotechnology*, **8**(6), 1127-1135 (2009).

[4]. Malik, G.M., Zadafiya, S.K, Thaizole based disperse dyes and their dyeing application on polyester fibre and their antimicrobial activity*, Pelagia Research Library Der ChemicaSinica*, **1** (3), 15-21 (2010).

[5] Menter, J.M., Hatch, K.L. Clothing as Solar Radiation Protection", *Curr. Probl. Dermatol*., **31**,50-63(2003)

[6] Rehan Mohamed, Mashaly, H.M., Mowaf Salwa, Abou El-Kheir, A., Emam Hossam E. ,Multi-functional textile design using in-situ Ag NPs incorporation into natural fabric matrix, *dyes and pigments*, **118**, 9-17 (2015).

[7] Ahmed, B. Hanan, Emam, H.E., Mashaly, H.M, and Rehan Mohamed, Nanosilver leverage on reactive dyeing of cellulose fibers: Color shading, color fastness and biocidal potentials*,Carbohydrate Polymers*, **186**, 15 April, Pages 310-320 (2018).

تأثير العوامل المختلفة على صبغ البوليستر والقطن والبوليستر/القطن باستخدام صبغات الاحواض

حمادة م. مشالي [١] ونهال إبراهيم الشيخ [٢]
[١]معهد بحوث وتكنولوجيا المنسوجات - المركز القومي للبحوث - الدقي - الجيزة - مصر.
[٢] قسم الطباعة / الاحتضار / التشطيب - كلية الفنون التطبيقية - جامعة بني سويف - مصر

لقد وجد أن القطن هو أكثر المواد التي توفر الراحة في الطبيعة ، ولكن لتحسين التكلفة ومعايير الجودة الأخرى، يلزم أحيانًا مزجه مع بعض المواد الاصطناعية. هنا مرة أخرى للحصول على الراحة والجاذبية الجمالية ، يتم صبغها بصبغة الحوض عن طريق تغيير بعض المعلمات مثل عامل التشتيت ، وتم إجراء صباغة عامل الترطيب ودُرِست أفضل النتائج التي تم تحديدها وهي القيمة المثلى للمواد المساعدة لصبغ هذا p / c يمزج. تم قياس خصائص قوة اللون وثباته للأقمشة المصبوغة. بشكل عام ، تم استكشاف التأثيرات على صباغة البوليستر والقطن والبوليستر / القطن مع صبغ ضريبة القيمة المضافة.