Alkaline Dyeing of Polyester and Polyester/Cotton Blend Fabrics Using Sodium Edetate

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ABSTRACT: An alkaline dyeing of polyester with an alkali-stable disperse dye, Dianix® Scarlet AD-RG, was developed using sodium edetate as an alkaline buffering agent. The results obtained indicate the suitability of using sodium edetate for alkaline dyeing of polyester when compared with the control alkaline dyeing using Dianix AD system. Selected mono and bifunctional reactive dyes were used in combination with the alkali-stable disperse dye for dyeing of polyester/cotton blend. Different dyeing methods for cotton and polyester/cotton blend fabrics using sodium edetate were evaluated in comparison with their respective control alkaline dyeing methods. The results of using sodium edetate in one-bath two-stage and two-bath dyeing of polyester/cotton blend were comparable with that of the control dyeing method. Particularly, no change in the leveling and fastness properties was evaluated for all samples irrespective of the dyeing method. © 2007 Wiley Periodicals, Inc. J Appl Polym Sci 108: 342–350, 2008

Key words: sodium edetate; alkaline dyeing; polyester/cotton blend; disperse dyes; reactive dyes

INTRODUCTION

Polyester fiber consumption is growing and represents the largest percentage among synthetic fibers in the market and is used as pure material or mixed with cellulose. Polyester/cotton blend has the advantage of polyester's tensile strength, abrasion resistance, and dimensional stability as well as cotton's reduced pilling, ability to absorb water, and comfort in wear.

Although preparation and aftertreatment of polyester is conducted in an alkaline medium, the dyeing process has been and is still carried out in acid conditions with pH value 4–5. For alkaline dyeing, however, DyStar has introduced Dianix AD system, including an alkali-stable Dianix AD disperse dyes and Diaserver AD-95 plus Borax/alkali to act as dye stabilizer, sequestering agent, and stable buffer system along with dispersing/leveling agent.[1–4] Therefore, alkaline dyeing of polyester is of increasing interest as it additionally offers the possibility of dyeing polyester/cellulosic blends using disperse and reactive dyes.[5–7]

Recently, we have explored the viability of using a commercially available sodium edetate (SE) as an exhausting and fixing agent in the dyeing of cotton and its wool blend with reactive dyes.[8,9] Additionally, urea/alkali free printing of cotton with reactive dyes has been properly achieved using SE.[10] As a part of our ongoing interest of process optimization in textile coloration, we present here the viability of using SE as an auxiliary for alkaline dyeing of polyester and its cotton blend. For this purpose, alkaline dyeing of polyester was initially investigated using SE in comparison with the control alkaline Dianix AD system. For cotton fabric, however, simulated alkaline dyeing procedures using SE were merely to be examined so as to get a clear vision for the dyeability of cotton component in the polyester/cotton blend. The effect of SE concentrations on the dyeability of polyester and its cotton blend was thoroughly investigated. Color assessment and fastness properties for all dyed fabrics were determined.

EXPERIMENTAL

Materials

Mill-scoured and bleached cotton fabric (130 g/m^2), 100% polyester woven fabric (195 g/m^2), and scoured woven polyester/cotton blend fabric 50/50 (235 g/m^2) kindly supplied by Misr El-Mehalla Co., Egypt were used throughout this study. The commercial dyes used in this study were, one alkali-stable disperse dye, Dianix® Scarlet AD-RG (DyStar, Egypt), two bifunctional reactive dyes, Procion Red H-E7B (CI Reactive Red 141, ICI, Egypt) and Sumifix Supra Yellow 3RF (CI Reactive Yellow 145, Sumitomo, Japan) and two monofunctional reactive dyes,

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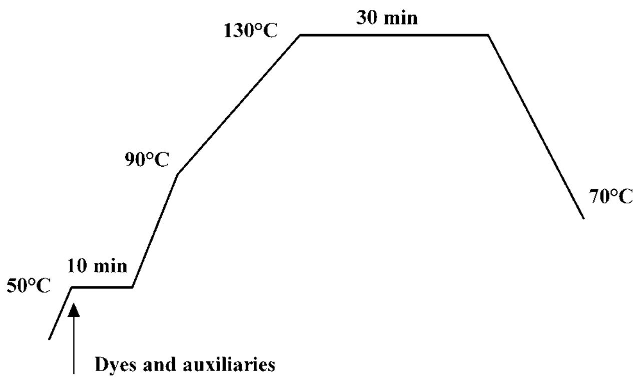

Figure 1 Dyeing profile of polyester, cotton, and blend fabrics.

Cibacron Red B (CI Reactive Red 24, ICI, CGY) and Remazol Brilliant Orange 3R (CI Reactive Orange 16, DyStar, Egypt). These dyes were used as received. Sodium edetate (SE) was purchased from Fluka (Germany). Diaserver AD-95 (stabilizing, sequestering, buffering, and oilgomer dissolving agent; DyStar, Egypt) and Sera Gal P-LP (anionic dispersing agent for disperse dyes; DyStar, Egypt) were used as auxiliaries for dyeing polyester. Hostapal CV (Clariant, Egypt) was used as a nonionic soaping agent. All other chemical reagents were of laboratory grade.

Alkaline dyeing procedures

All dyeings were carried out in a laboratory dyeing machine using 3% of dye concentration in distilled water with a liquor ratio 40 : 1. Dyeing of polyester with an alkali-stable disperse dye, Dianix® Scarlet AD-RG, cotton fabric with reactive dyes and polyester/cotton blend fabric with Dianix® Scarlet AD-RG/reactive dyes was conducted as follows.

Control dyeing of polyester using Dianix AD system (Ct-PET)

The control alkaline dyeing of polyester fabric Ct-PET (Fig. 1) was carried out using Dianix AD system,[1,2,4] in which an alkali-stable Dianix® Scarlet AD-RG was applied at 3% of, 2 g/L Sera Gal P-LP, 2% of Diaserver AD-95, and 2 g/L Borax while adjusting the pH of the dyebath at 9.5 using aqueous sodium hydroxide solution. The polyester fabric was introduced into the dyebath at 50°C and the temperature was raised at a rate of 2.5°C/min to 90°C, then at a rate of 1.5°C/min to 130°C, and the dyeing continued for 30 min, after which time, the dyebath temperature was reduced to 70°C, and then the samples were removed from the dye pots, rinsed thoroughly with water and dried.

Dyeing of polyester using SE (SE-PET)

Following the dyeing profile shown in Figure 1, SE-PET dyeing method was similarly performed using various concentrations of SE (5–25 g/L), 3% of alkali-stable Dianix® Scarlet AD-RG and 2 g/L Sera Gal P-LP.

Dyeing of cotton and polyester/cotton blend using SE

To find out the appropriate alkaline dyeing method of polyester/cotton blend under exhaust dyeing conditions using SE, dyeing of cotton and polyester/cotton blend fabrics was independently performed as follows.

One-bath dyeing of cotton (SE-C1) and polyester/cotton blend (SE-B1). Following the dyeing profile shown in Figure 1, SE-C1 and SE-B1 were carried out at 3% of dye concentration at a liquor ratio of 40 : 1. The cotton fabric was dyed using reactive dye in a dyebath containing different concentrations of SE (5–25 g/L) and 50 g/L sodium sulfate. The dyed cotton samples were thoroughly rinsed with water and dried at room temperature. For polyester/cotton blend dyeing (SE-B1), the mixed dyes of Dianix® Scarlet AD-RG and reactive dyes were introduced together at the start of dyeing in the presence of SE, sodium sulfate and dispersing agent concentrations of 25, 50, 2 g/L, respectively.

One bath two-stage dyeing of cotton and ployester/cotton blend: SE-C2 and SE-B2 dyeing methods. In one-bath two-stage dyeing method for cotton (SE-C2) and polyester/cotton (SE-B2), the dyeing was conducted using 3% of dye concentration at a liquor ratio of 40 : 1 as shown in Figure 2. The cotton fabric was dyed with reactive dyes in a dyebath containing 50 g/L sodium sulfate and different concentrations of SE (5–25 g/L) for 60 min at 60 and 80°C for both CI Reactive Yellow 145 and CI Reactive Orange 16 and for both CI Reactive Red 141 and CI Reactive Red 24, respectively. The dyebath temperature was then raised to 130°C and continued for a further 30 min, after which time,

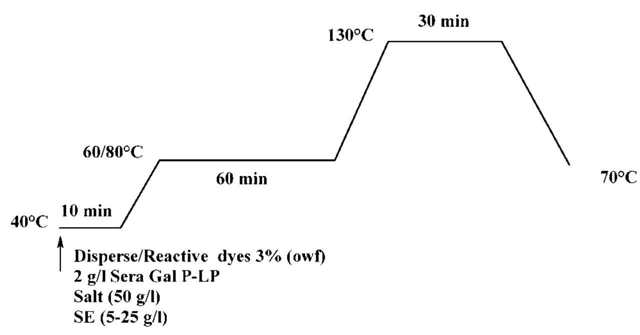

Figure 2 One-bath two-stage dyeing methods (SE-C2, SE-B2).

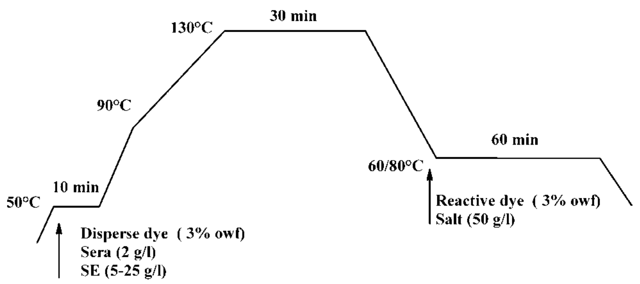

Figure 3 Alternative one-bath two-stage dyeing methods (SE-C3, SE-B3).

the dyed cotton samples were rinsed and dried. Similarly, the blend fabric was dyed using this dyeing method (SE-B2) by introducing 3% of dye of both Dianix® Scarlet AD-RG and reactive dyes along with SE (25 g/L), sodium sulfate and dispersing agent at the start of dyeing, then the dyed blend samples were rinsed and dried at room temperature.

SE-C3 and SE-B3 dyeing methods: A further concern for dyeing cotton and polyester/cotton blend was carried out using an alternative one-bath two-stage dyeing profile (SE-B3), shown in Figure 3, in which the polyester component was first dyed with 3% of alkali-stable Dianix® Scarlet AD-RG in the presence of 2 g/L dispersing agent and the required amount of SE (25 g/L) at 130°C, then after reducing the dyebath temperature to 60 or 80°C, reactive dye and salt were added directly to the polyester dyebath to dye cotton component for 60 min, then the dyed blend samples were rinsed and dried at room temperature. For dyeing cotton fabric, the extent of exhaustion and total fixation yield of reactive dyes were estimated following SE-C3 method (Fig. 3) in which the cotton fabric was introduced into a dyebath containing 3% of reactive dye concentration, sodium sulfate (50 g/L) and SE (5–25 g/L) at the start of the second stage dyeing temperature (60 or 80°C) and then dyeing continued for 60 min and worked-up as above.

Two-bath dyeing of polyester/cotton blend (SE-B4). Initially, cotton fabric was dyed using SE (5–25 g/L), expressed as SE-C4 dyeing method (Fig. 4).

In the two-bath dyeing of polyester/cotton blend fabric (SE-B4), the polyester component of the blend was dyed in the first bath for 30 min at 130°C using 25 g/L SE (Fig. 1), followed by rinsing with water. The cotton component of the blend was dyed with reactive dyes in a fresh dyebath at 60 or 80°C for 60 min using 25 g/L SE and 50 g/L sodium sulfate in a similar manner to SE-C4.

Control dyeing of polyester/cotton blend using Dianix AD/reactive dyeing system

To further confirm the findings obtained above, the following dyeing methods (control methods) were undertaken in the absence of SE to compare the dyeability of cotton and polyester/cotton blend fabrics with those obtained above using SE.

Reactive dyeing of cotton (Ct-C). CI Reactive Red 141 and CI Reactive Red 24 dyes were applied at 80°C, and CI Reactive Yellow 145 and CI Reactive Orange 16 at 60°C using 50 g/L sodium sulfate and 20 g/L sodium carbonate. Each dyeing was conducted with sodium sulfate at 40°C for 30 min and then allowing fixation in sodium carbonate for a further 60 min at 80 and 60°C, respectively. After a thorough rinsing, the dyed samples were dried and color measurements and testing were carried out as described latter.

Two-bath dyeing of polyester/cotton blend (Ct-B). Control two-bath dyeing (Ct-B) for polyester/cotton blend, in which the polyester component of the blend was dyed using Dianix AD system as indicated in Figure 1. The blend samples were rinsed and then the cotton component was dyed with reactive dyes in a freshly prepared second dyebath at the typical dyeing procedure described in Ct-C method.

Measurements and analyses

Dye exhaustion

The uptake of the reactive dye by cotton fabric was measured by sampling the dyebath before and after the dyeing. The concentration (g/L) of the dyebath was measured on Shimadzu UV-2401PC UV/Visible spectrophotometer at λ_{max} of the dye. The percentage of the dye exhaustion on cotton (%E) was calculated using eq. (1):

$$\%E = \left(1 - \frac{C_2}{C_1}\right) \times 100 \quad (1)$$

where C_1 and C_2 are the concentrations of dye in the dyebath before and after dyeing cotton, respectively.

Dye fixation

The dye fixation ratio (%F), the percentage of the exhausted dye chemically bound on the cotton fabric,

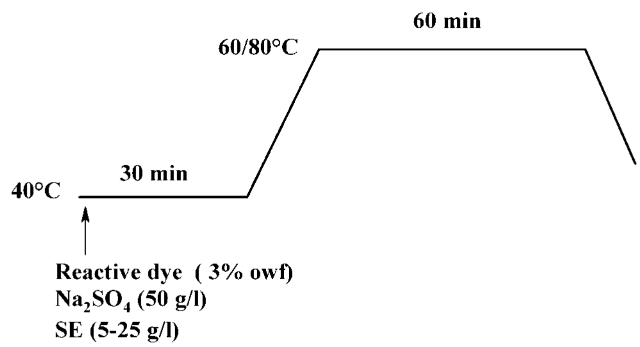

Figure 4 Dyeing of cotton (SE-C4).

was measured by refluxing the dyed cotton samples in 50% DMF (liquor ratio 20 : 1) for 15 min to extract the unfixed dye. This procedure was repeated until the extract was clear. The concentration of the extract was then measured spectrophotometrically at λ_{max} and the percentage dye fixation ratio (%F) on cotton was calculated using eq. (2):

$$\%F = \frac{C_1 - C_2 - C_3}{C_1 - C_2} \times 100 \tag{2}$$

where C_3 is the concentration of the extracted dye after dyeing cotton.

From the dyebath exhaustion (E) and dye fixation ratio (F), the total dye fixation (T), which is the percentage of dye chemically bound relative to the total amount of dye used, was calculated for dyeing cotton (%T) using eq. (3):

$$\%T = (\%E \times \%F)/100 \tag{3}$$

Color measurements

The color data were evaluated on a spectrophotometer (Datacolor International SF 600 plus, D65) interfaced with a personal computer. The color strength (K/S) and CIELAB values of dyed cotton and polyester samples were measured at the respective wavelength of maximum absorption for each dye and those data of the polyester/cotton blend were taken as cumulative values at the wavelength of maximum absorption for the combined dyes. The color difference (ΔE) of the dyed fabrics using sodium edetate methods were assessed compared to the control dyed samples.

Leveling properties

The leveling of the dyed polyester, cotton, and polyester/cotton blend samples was assessed using a Datacolor International SF 600 Plus spectrophotometer by measuring the color differences within each sample at five separate points and the average color difference (ΔE) between these points was determined.[11,12]

Fastness testing

The dyed samples were tested, after washing-off using 2 g/L nonionic detergent (Hostapal CV) at 85°C for 15 min, according to ISO standard methods.[13] The specific tests were ISO 105-C02 (1989), color fastness to washing and ISO 105-E04 (1989), color fastness to perspiration.

RESULTS AND DISCUSSION

It is of interest to explore the viability of using SE as a propitiate auxiliary for alkaline dyeing of polyester and its cotton blend fabrics. SE has been conventionally used in textile coloration as a sequestering agent to prevent precipitation of dyes by calcium and magnesium salts present in hard water and thus producing brilliant dyed goods.[14] Since, SE is a mild organic base, it would be anticipated that its compounding with disperse/reactive dyes in alkaline dyeing of polyester/cotton blend would be favorable. In this regard, the purpose of this work was to examine the dyeability of polyester, cotton, and polyester/cotton blend fabrics using SE.

Application of disperse and reactive dyes

In the case of control alkaline dyeing methods using reactive dyes and an alkali-stable Dianix® Scarlet AD-RG disperse dye, the color strength values of the dyed polyester (Ct-PET), cotton (Ct-C) and polyester/cotton blend fabrics (Ct-B) were investigated as control samples to compare with those of SE dyeing methods of polyester (SE-PET), cotton (SE-C1-4), and polyester/cotton blend fabrics (SE-B1-4).

Effect of SE concentration on the color yield of polyester fabrics

In SE-PET, the effect of SE on the dyeability of polyester fabrics was conducted at different concentrations (5–25 g/L). It is indicated in Table I that, within the range of SE examined, the disperse dye showed approximately the same color strength values compared to that obtained using Dianix AD system (Ct-PET), even at low SE concentrations. Increasing SE concentration has practically no effect on the color strength values which reflects high dye stability under SE conditions, leading to good dye-uptake. Additionally, the pH of the dye bath was in the range of 10.8 initial to 10.2 final, indicating its buffering effect, which would be in favor for better dyeings.

As the color yield of polyester dyed using SE (SE-PET) goes similar to that of the sample dyed using Dianix AD system (Ct-PET), this could be attributed to the moderate basicity of SE and its capacity of buffering action in polyester dyeing owing to its content of tetra-sodium acetate derivatives. Accordingly, one would expect the suitability of using SE for the alkaline dyeing of polyester when compared with the control dyeing method using Dianix AD system (Ct-PET).

TABLE I
Effect of SE Concentration on the Exhaustion, Color Strength, and Color Difference of Dyed Polyester Fabrics with an Alkali-Stable Dianix® Scarlet AD-RG Disperse Dye

SE concentration (g/L)	E (%)	K/S	ΔE
Control*	89.50	29.83	–
5	88.85	29.76	0.47
10	89.91	29.89	0.44
15	90.12	29.96	0.51
20	89.78	29.79	0.38
25	89.85	29.92	0.42

* Dianix AD system (Ct-PET).

Effect of SE and dyeing method on the dyeability of cotton fabric

The exhaustion and total fixation values of the reactive dyes, when applied to cotton using different dyeing methods at different SE concentrations compared to the control reactive dyeings (Ct-C), are given in Table II. The results for all reactive dyes showed higher exhaustion and fixation values when applied using dyeing method SE-C4 than those obtained using SE-C1, SE-C2, and SE-C3.

On the other hand, comparable values of exhaustion and fixation were obtained using SE-C4 and Ct-C methods. The high dyeing temperature and the prolonged dyeing time involved in SE-C1 and SE-C2 dyeing methods would account for the lower exhaustion values relative to the control Ct-C method. This observation is clearly obvious in the case of monofunctional dyes, CI Reactive Orange 16 and CI Reactive Red 24, as a consequence of their hydrolysis at these conditions when compared with the bifunctional reactive dyes used.

It is known that the dyeing being an exothermic process, the exhaustion of the given reactive dye is lower at higher temperature. Furthermore, the problems associated with low dye uptake would be less pronounced if the reactive dye used is being more stable against hydrolysis and more robust for variation in the dyeing conditions. Since the hydrolysis would be expected to decrease with bifunctional reactive dyes, therefore, it is anticipated that CI Reactive Red 141 and CI Reactive Yellow 145 should be more convenient for the dyeing of polyester/cotton blend fabric than the monofunctional reactive dyes. These findings can be explained further by examining the K/S and ΔE values obtained for all dyeing methods (SE-C1-4) relative to the control dyeing method Ct-C, as shown in Figures 5–8. As expected, the bifunctional reactive dyes showed higher K/S and better ΔE values than the monofunctional reactive dyes using all dyeing methods. It is also clear that the dyeing results are more satisfactory with SE-C4 dyeing method for all dyes used and almost comparable to those of the control Ct-C method. Moreover, SE-C3 and SE-C4 methods showed comparable results with those of Ct-C method in the case of bifunctional reactive dyes. Therefore, it is anticipated that SE-C3 method (Fig. 3) using the bifunctional reactive dyes would be convenient for dyeing the cotton component of polyester/cotton blend fabrics throughout the dyeing cycle. This meaning is further

TABLE II
Effect of SE Concentration on the Exhaustion and Total Fixation Yield on Cotton Fabrics Dyed with Different Reactive Dyes Using Different Dyeing Methods

Dyeing method	SE concentration (g/L)	R Red 141		R Yellow 145		R Red 24		R Orange 16	
		E (%)	T (%)	E (%)	T (%)	E (%)	T (%)	E (%)	T (%)
Ct-C	Control	83.4	72.22	79.51	70.52	56.76	53.75	61.40	56.88
SE-C1	5	68.90	60.63	61.65	56.14	38.03	37.50	31.80	28.56
	10	70.98	62.17	62.65	57.66	39.52	37.93	32.85	29.80
	15	71.68	63.00	63.00	57.86	39.89	38.49	33.71	30.35
	20	71.71	63.45	64.50	58.00	40.21	39.02	32.81	29.85
	25	71.76	63.60	64.85	58.26	40.24	39.66	32.75	29.40
SE-C2	5	66.6	61.46	67.46	56.83	44.95	43.06	35.55	34.69
	10	69.27	64.42	68.65	58.05	45.20	43.21	36.15	35.21
	15	69.72	65.14	68.70	58.18	46.85	44.60	37.45	36.43
	20	70.40	68.14	68.86	58.69	46.75	44.64	36.35	35.22
	25	73.10	70.16	68.90	59.43	46.00	43.60	33.00	32.10
SE-C3	5	74.16	67.64	66.60	61.27	52.24	51.40	43.95	40.35
	10	75.98	68.88	70.15	64.58	53.43	52.13	46.89	42.60
	15	77.42	69.52	73.85	66.20	53.87	52.85	49.78	46.05
	20	79.50	71.80	75.80	68.98	54.21	52.96	51.90	48.55
	25	81.11	71.85	76.0	69.24	54.75	52.97	55.82	49.45
SE-C4	5	82.00	66.05	74.00	64.38	52.40	49.43	46.20	43.16
	10	82.75	67.35	75.80	66.47	54.90	51.77	52.72	49.85
	15	83.20	69.11	76.25	66.90	56.75	52.58	58.80	55.45
	20	83.90	72.30	78.00	69.10	58.20	55.29	61.60	57.47
	25	84.25	73.94	78.15	70.20	58.25	55.62	62.50	57.90

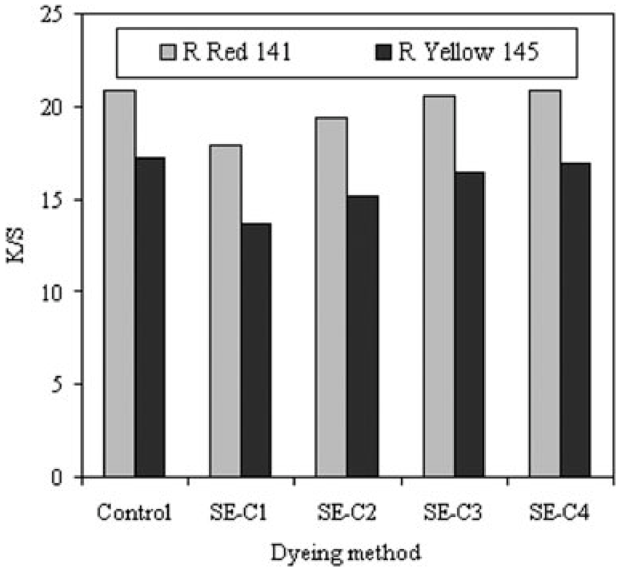

Figure 5 K/S values of cotton fabric dyed with bifunctional reactive dyes, CI Reactive Red 141, and CI Reactive Yellow 145, using different SE dyeing methods relative to the control method (Ct-C).

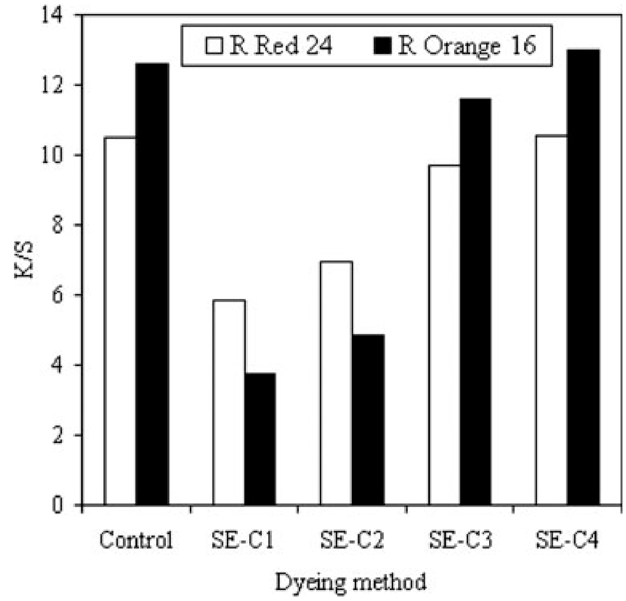

Figure 7 K/S values of cotton fabric dyed with monofunctional reactive dyes, CI Reactive Red 24 and CI Reactive Orange 16, using different SE dyeing methods relative to the control method (Ct-C).

elaborated below. Moreover, the results shown in Table I would lead to select 25 g/L of SE concentration for the subsequent study for blend dyeing.

Effect of dyeing methods on dyeing polyester/cotton blend fabrics

The present study was conducted in a comparative manner between SE dyeing methods (SE-B1-4) and control Dianix AD/reactive dyeing system (Ct-B) in the dyeing polyester/cotton blend. Figures 9–12 show the effect of applying the four dyeing methods using SE on the K/S and ΔE values of polyester/cotton blend fabrics dyed with disperse and reactive dyes. A look to these Figures 9–12 and Figures 5–8 for cotton dyeing, the correlation for the dyeability manner of mono- and bifunctional reactive dyes on cotton reveals the success of SE application for polyester/cotton blend dyeing. It indicates that the dye uptake of the alkali-stable Dianix® Scarlet AD-RG

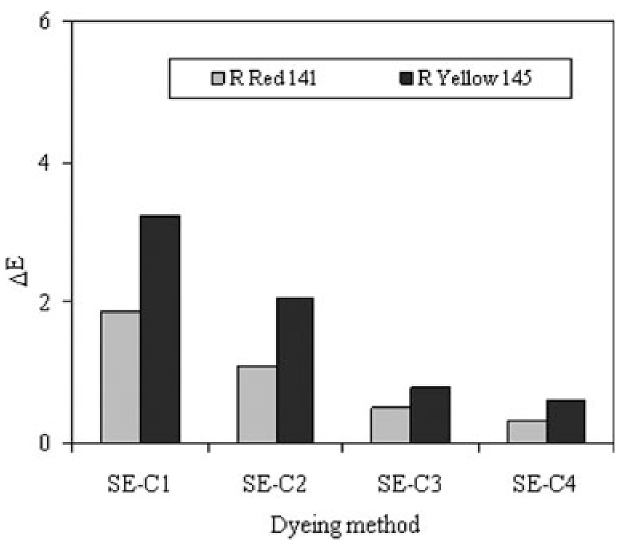

Figure 6 Color difference values of dyed cotton fabric with bifunctional reactive dyes applied using different SE dyeing methods relative to the control dyed cotton samples.

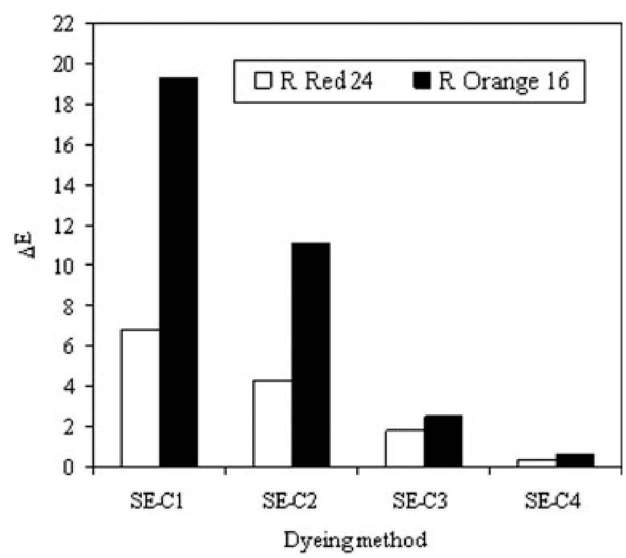

Figure 8 Color difference values of dyed cotton fabric with monofunctional reactive dyes applied using different SE dyeing methods relative to the control dyed cotton samples.

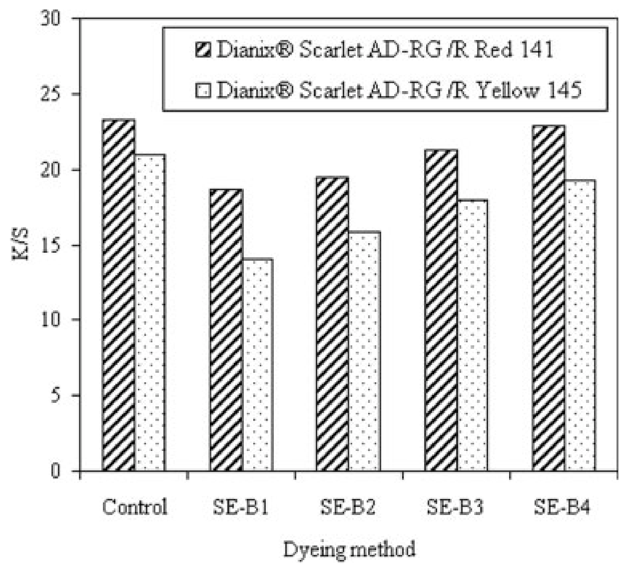

Figure 9 *K/S* values of dyed polyester/cotton blend fabrics with Dianix® Scarlet AD-RG/bifunctional reactive dyes using different SE dyeing methods relative to the control dyeing method (Ct-B).

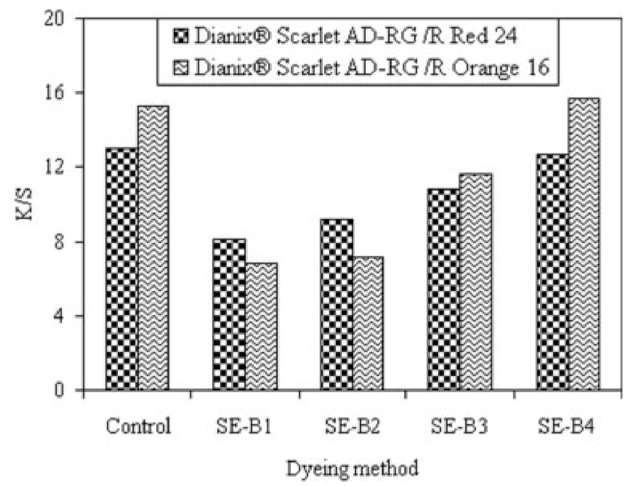

Figure 11 *K/S* values of dyed polyester/cotton blend fabrics with Dianix® Scarlet AD-RG/monofunctional reactive dyes using different SE dyeing methods relative to the control dyeing method (Ct-B).

disperse dye and reactive dye is affected by the SE dyeing method used, resulting in varying *K/S* values of the dyed blend fabrics and the combined shade obtained will be different as confirmed by the results of ΔE values of the dyed samples.

The results show that the samples dyed using two-bath dyeing SE-B4 method reveals the best *K/S* and ΔE values among SE-B1-4 methods with comparable results of those of Ct-B method. Also, samples dyed using one-bath two-stage SE-B3 dyeing method show good results relative to those of Ct-B method. Interestingly, the combination of alkali-stable Dianix® Scarlet AD-RG disperse dye with the bifunctional reactive dyes using SE-B3 method operated in a similar manner with SE-C3 method of cotton dyeing, which confirms the suitability of applying SE-B3 method for the blend dyeing owing to its short dyeing cycle as well as avoidance of polyester dyebath drainage prior to cotton dyeing. In other words, while in Ct-B method it is necessary to drain the alkaline dyebath with Dianix AD system after dyeing the polyester component so as to conduct the proper alkaline dyeing condition for the cotton component using reactive dyes, this step is omitted in the case of SE-B3 method.

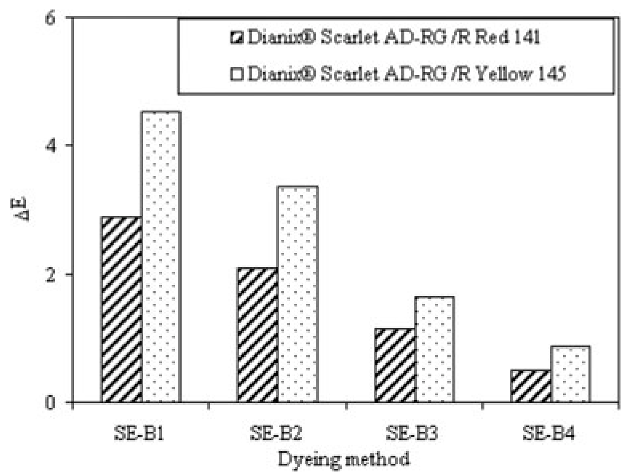

Figure 10 Color difference values of dyed polyester/cotton blend fabrics using different SE dyeing methods relative to the control dyed blend samples.

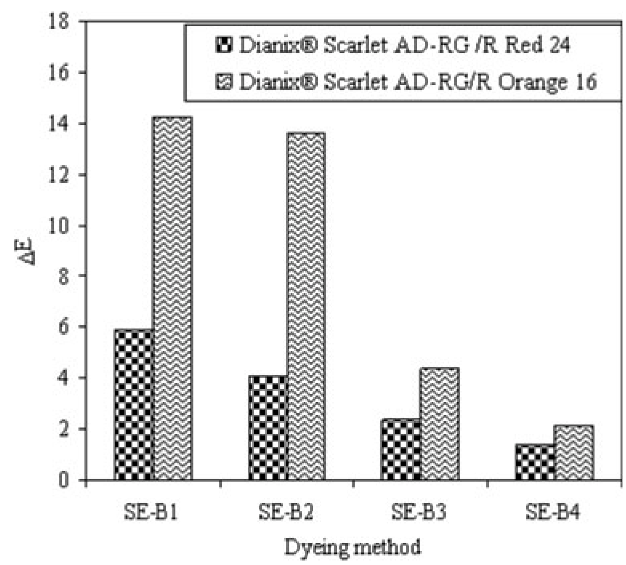

Figure 12 Color difference values of dyed polyester/cotton blend fabrics using different SE dyeing methods relative to the control dyed blend samples.

TABLE III
Leveling and Fastness Properties of Dyed Polyester, Cotton, and Polyester/Cotton Blend Using Different SE Dyeing Methods Compared to Those of the Control Dyed Fabrics

Dyeing method (sample)	Dye	Leveling[a] (ΔE)	Washfastness[b,c]			Fastness to perspiration[c]					
						Alkaline			Acidic		
			Alt	SC	SW	Alt	SC	SW	Alt	SC	SW
Ct-PET, polyester	Disperse (Dianix Scarlet AD-RG)	0.43	5	5	5	5	5	5	5	5	5
SE-PET, polyester	Disperse (Dianix Scarlet AD-RG)	0.46	5	5	5	5	5	5	5	5	5
Ct-C, Cotton	R Red 141	0.32	5	4–5	5	5	5	5	5	5	5
	R Yellow 145	0.40	5	5	5	5	5	5	5	5	5
	R Red 24	0.33	5	5	5	5	5	5	5	5	5
	R Orange 16	0.32	5	4–5	5	5	4–5	5	5	5	5
SE-C1, Cotton	R Red 141	0.31	5	4–5	5	5	5	5	5	5	5
	R Yellow 145	0.34	5	5	5	5	5	5	5	4–5	5
	R Red 24	0.32	5	5	5	5	5	5	5	5	5
	R Orange 16	0.43	5	5	5	5	4–5	5	5	5	5
SE-C2, Cotton	R Red 141	0.30	5	5	5	5	5	5	5	5	5
	R Yellow 145	0.33	5	5	5	5	5	5	5	4–5	5
	R Red 24	0.27	5	5	5	5	5	5	5	5	5
	R Orange 16	0.35	5	4–5	5	5	5	5	5	5	5
SE-C3, Cotton	R Red 141	0.24	5	5	5	5	4–5	5	5	5	5
	R Yellow 145	0.29	5	4–5	5	5	5	5	5	5	5
	R Red 24	0.25	5	5	5	5	5	5	5	5	5
	R Orange 16	0.33	5	4–5	5	5	5	5	5	5	5
SE-C4, Cotton	R Red 141	0.21	5	4–5	5	5	5	5	5	5	5
	R Yellow 145	0.27	5	5	5	5	5	5	5	5	5
	R Red 24	0.25	5	5	5	5	5	5	5	5	5
	R Orange 16	0.30	5	4–5	5	5	5	5	5	5	5
Ct-B. Blend	Disperse/R R141	0.37	5	4–5	5	5	5	5	5	4–5	5
	Disperse/R Y145	0.41	5	4–5	5	5	5	5	5	5	5
	Disperse/R R 24	0.37	5	5	5	5	5	5	5	5	5
	Disperse/R O 16	0.46	5	5	5	5	5	5	5	5	5
SE-B1, Blend	Disperse/R R141	0.38	5	4–5	5	5	5	5	5	5	5
	Disperse/R Y145	0.41	5	5	5	5	5	5	5	5	5
	Disperse/R R 24	0.40	5	5	5	5	5	5	5	5	5
	Disperse/R O 16	0.41	5	4–5	5	5	5	5	5	4–5	5
SE-B2, Blend	Disperse/R R141	0.34	5	4–5	5	5	5	5	5	5	5
	Disperse/R Y145	0.43	5	5	5	5	5	5	5	5	5
	Disperse/R R 24	0.38	5	5	5	5	5	5	5	5	5
	Disperse/R O 16	0.41	5	4	5	5	5	5	5	5	5
SE-B3, Blend	Disperse/R R141	0.31	5	4–5	5	5	5	5	5	5	5
	Disperse/R Y145	0.38	5	5	5	5	5	5	5	5	5
	Disperse/R R 24	0.35	5	4–5	5	5	5	5	5	5	5
	Disperse/R O 16	0.36	5	4–5	5	5	5	5	5	5	5
SE-B4, Blend	Disperse/R R141	0.30	5	4–5	5	5	4–5	5	5	5	5
	Disperse/R Y145	0.37	5	5	5	5	5	5	5	5	5
	Disperse/R R 24	0.36	5	5	5	5	5	5	5	5	5
	Disperse/R O 16	0.34	5	4	5	5	5	5	5	4–5	5

[a] Section 2.3.4: Leveling properties.
[b] ISO CO2.
[c] Alt = alteration; SC = staining on cotton; SW = staining on wool.

Leveling and fastness properties

The leveling of cotton, polyester and blend samples dyed using SE and the control dyeing methods are illustrated in Table III, from which it is clear that the average color differences (ΔE) indicate very good leveling properties for all dyed samples. However, the leveling of the dyed samples using of SE-C3-4 and SE-B3-4 are slightly better than those of SE-C1-2 and SE-B1-2, respectively. As shown in Table III, the fastness to washing and perspiration of cotton, polyester and blend samples dyed using SE and the control dyeing methods are excellent to very good. The fastness properties obtained are also similar irrespective of the dyeing method used and depend on the proportion of dye-fiber interactions.

CONCLUSIONS

The viability of using SE as an alkaline buffering and fixing agent for dyeing polyester/cotton blend is explored. The result indicates the effectiveness of SE as an auxiliary for alkaline dyeing of polyester and its cotton blend and it shows a nearly stable pH throughout the dyeing cycle (10.8–10.2), which is crucial for successful alkaline dyeing of polyester. This success in process optimization would further suggest future work for the use of sodium edetate in textile coloration.

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