DYEING OF WOOL/POLYESTER BLENDED FABRICS USING BASIC DYES.

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Abstract

The main task of this study is to establish a one step dyeing of wool/polyester blended fabric using basic dyes. Wide range of parameters has been studied such as pH values, PEG-600 concentration, dyeing technique, fixation time and temperature.

The best dyeing conditions were achieved, using different colors of basic dyes at pH 9. The color strength (K/S) values of the dyed blend with temperature increased rapidly the fixation time and temperature until 30 min. at 130˚C.This was followed by a relatively increase in the k/s values by using different amounts of PEG-600. The dyeing technique has an important effect on the k/s values and the improvement can follow the decreasing order of exhaustion under pressure< exhaustion< pad-dry cure method.

Keywords: wool / polyester, basic dyes.

1. Introduction

Blending of wool and polyester, results in a significant improvement in the physic-mechanical properties of the obtained textile materials taking into consideration both economical and aesthetical aspects. This combination is used to make textiles that possess good elastic recovery, excellent crease retention and wrinkle-proof properties, suitable moisture regain, easy care performance, together with good handle and comfort [1, 2].

Basic dyes are known to have no affinity toward polyester fabrics. Wool/polyester blends are dyed batchwise with reactive/disperse dyes using several sequences. [4, 5] The main task of this study is to establish a single step dyeing of polyester / wool blended fabrics using basic dyes in alkaline medium. Increasing the hydrophilicity character of polyester by using alkali that can create hydrophilic groups,e.g. –COOH,-OH groups, gives PET fiber more affinity to basic dyes.

This innovative study examines a novel approach for single dyeing step of polyester/wool blended fabrics using basic dyes as well as to search for the best dyeing conditions for attaining high performance properties.

Experiments

2-1 Materials

Polyester /wool (70/30,230glm^2) woven fabric was used. The commercial dyestuffs used were: Astrazone Blue BG, Astrazone red F3BL (BBL), Astrazone G. yellow GSL (Gin well Enterprise, Taiwan).All chemicals used were laboratory grade sodium carbonates and Polyethylene glycol-600.

2-2 Methods

Polyester /wool blended fabrics were dyed with 2% (owf) basic dye at pH 9 using sodium carbonate and at 1:30 material to liquor ratio in launder Ometer at 130°C under pressure for 30 minutes.

The dyed fabric samples were rinsed thoroughly until the rinse became clear, washed at 60° for 15 min in the presence of 2 g/l Leomin®W(nonionic wetting agent and detergent-BASF), then rinsed well and finally dried at 85°C for 5 min.

2-3 Testing

Color strength of dyed fabric samples, expressed as K/S, was measured at the wave length of the maximum absorbance using an automatic spectrophotometer, and calculated by the Kubelka Murnk equation:

$K/s= (1-R)^2/2R$, where K is the absorption coefficient; S is the scattering coefficient; and R is the reflectance value of the fabric at peak wavelength.

Fastness properties to washing, perspiration, rubbing, handle, light and tensile strength of the dyed samples were evaluated to AATCC tests methods: (61-1972), (15-1973), (8-1972), (5-1993) ,(16-1998) and (92-2009); respectively.

3. Results & Discussions

3.1 Effect of Alkali (pH value)

Table (1) shows that the color strength values as well as the fastness properties, improved by raising the pH values from 7 to 9. These results can be discussed in terms of enhancing the extent of new active sites on the polyester / wool blend due to the partial alkali hydrolysis of the polyester component, and breaking some of the cystin bonds of the wool component.

Improving the extent of picking up the used basic dye molecules under the proper alkaline dyeing conditions, i.e. pH 9, thereby getting darker shade along with affording better degree of fastness properties. On the other hand, further increase in

the pH value up to 10 resulted in a slight decrease in the K/S values which can be explained as a lower stability of the used basic dye at higher pH.

Table (1): Effect of pH value on dyeing and some performance properties of w/p blended fabric.

pH	K/S	Washing at 95°C± 70°C			Rubbing*		Perspiration						Light Fastness	Handle	T.S kg	
							Acidic			Alkaline						
		Alt	SC	SW	wet	dry	Alt	SC	SW	Alt	SC	SW			W kg	F kg
7	17.21	2-3	3	2-3	2-3	3	2-3	2-3	2-3	3	2	2	4-5	H*	86	77
8	23.90	3-4	3-4	3	3	3-4	3-4	3-4	3	3-4	3	2-3	6	H	83	74
9	27.8	4-5	4-5	4	4	4-5	4-5	4-5	4	4-5	4-5	4	6	S	81	73
10	24.95	4	4	3-4	3-4	4	4	4	3-4	4	4	3-4	6	S	77	69

pH x, PEG-600 15 g/l ,for 30 min.,at 130°C under pressure, 2% dye basic (w.o.s).

From this table, it is clear that dyeing at pH 9 results in a washing fastness of good to very good (4-5), a light of good (6), rubbing of 4-5 and wet of 4 and soft handle,along with a higher K/S value.

3.2 Effect of PEG-600 concentration

In order to find the optimal PEG-600 concentration, the blended fabric samples were dyed in a solution containing basic dye 2% (W.O.S.), PEG-600 (0, 5, 10, 15, 20)g/l, pH 9 for 30 min., at 130°C under pressure.

The variation in color strength values and fastness properties of the obtained basic dyeing as a function of PEG-600 concentration is shown in table 2. The obtained results disclose the following: i) incorporation of PEG-600 into the "all-in" bath to 20 g/l is accompanied by a remarkable improvement in the K/S values of the obtained dyeing, ii) enhancement in both the K/S values and the fastness properties reflects the positive impact of PEG-600 on enhancing the swelling of the substrates as well as dye solubility thereby opening the blend structure for dye solution i.e better extent of penetration and diffusion of the basic dye molecules in/on to the fabrics using. It is clear that PEG-600 at 15g/l gives a very good washing, a good light and rubbing fastness properties and a soft handle.

Table (2): Effect of PEG—600 concentration on dyeing and some performance properties of W/P blended fabric.

PEG—600 concentration g/l	K/S	Washing at 95°C± 70°C			Rubbing*		Perspiration						Light Fastness	Handle	T.S kg	
							Acidic			Alkaline					W kg	F kg
		Alt	SC	SW	wet	dry	Alt	SC	SW	Alt	SC	SW				
0	25.98	2-3	2-3	2	2	2-3	2-3	2-3	2	2-3	2-3	2	4-5	H	74	68
5	26.11	3	3-4	3	2-3	2-3	3	3	2-3	3	2-3	2	5	H*	75	68
10	26.49	3-4	4	3-4	3-4	3	3-4	3-4	3	3-4	3-4	3	6	H	77	71
15	27.82	4-5	4-5	4	3	3-4	4-5	4	3-4	4-5	4	3-4	6	S	82	74
20	28.43	4	4-5	4	4	4-5	4	4	4	4-5	4	4	6	S	84	75

pH 9, PEG-600 x g/l ,time 30 min at 130°C under pressure, 2% dye basic (w.o.s).

It is clear from the previos table that increasing the PEG—600 up to 20 g/l results in a slight improvement in the k/s values as a direct consequence of presence of glycol residues in the dyeing reaction thereby preventing complete deswelling of the fiber during the reaction and enhancing the extent of dye penetration into the blended fabric.

3.3 Effect of dyeing time

Effect of dyeing time on dyeing and dyeing and some mechanical properties is given in table 3. Fabrics were dyed in a bath containing 2% basic dye(w.o.s), PEG-600 15 g/l, pH 9 by using Na_2CO_3 at 130°C under pressure for different periods of time ranging from 10 to 40 min.

Table (3) shows that prolonging fixation time up to 30 min at 130°C gives rise to a gradual increase in K/S values and fastness properties which can be discussed in terms of the positive impact on the extent of the dye adsorption and fixation, further increase in fixation time beyond 30 min has practically a little negative impact on the k/s values (5,6) of the obtained dyeings and also gives harsh handle[5,6] . Within the range studied, it is expected that there will be an enhancement in all fastness properties as the duration of fixation increases.

Table (3): Effect of dyeing time on dyeing properties of w/p blended fabric.

Dyeing Time Min.	K/S	Washing at 95°C± 70°C			Rubbing*		Perspiration						Light Fastness	Handle	T.S kg	
							Acidic			Alkaline						
		Alt	SC	SW	wet	dry	Alt	SC	SW	Alt	SC	SW			W kg	F kg
10	19.95	2-3	2-3	2	2	2-3	3-4	3	2-3	3	2-3	3	5	S*	78	70
20	24.81	3	3	2-3	3	3	4	3-4	3	4	3-4	3-4	6	S	80	72
30	27.96	4-5	4-5	4	4	4-5	4-5	4-5	4	4-5	4	4	6-7	S	82	73
40	27.42	4-5	4-5	4	3-4	4	4	4-5	4	4	4	4	6-7	H	71	68

pH9, PEG-600 15 g/l ,time x min., at 130°C under pressure , 2% dye basic dye (w.o.s).

3.4 Effect of dyeing temperature

The fixation temperature is regarded as one of the most important factors in concurrent basic dyeing. This due to the fact that reactions of basic dye and fabric are temperature-dependent. The blended fabric samples were dyed in a solution containing basic dye 2% (w.o.s), PEG-600 15 g/l, pH, for 30 min. at different temp. viz. 100°C, 120°C, 130°C and 140°C under pressure.

Table (4): Effect of dyeing temperature on the dyeing and some performance properties on W/P blended fabric.

Dyeing Temp. °C	K/S	Washing at 95°C± 70°C			Rubbing*		Perspiration						Light Fastness	Handle	T.S kg	
							Acidic			Alkaline						
		Alt	SC	SW	wet	dry	Alt	SC	SW	Alt	SC	SW			W kg	F kg
100	24.13	3	2-3	2	2	2-3	3	3	2-3	2-3	3	3	5	S	85	78
120	26.28	3	3	2-3	3	3-4	4	3-4	3	4	3-4	4-5	6	S	83	77
130	27.98	4-5	4-5	4	4	4-5	4-5	4-5	4	4-5	4	4-5	6-7	S	82	74
140	26.97	4	4-5	4	4	4	4-5	4	4	4-5	4	4	6-7	H	78	70

pH 9, PEG-600 15 g/l ,time 30 min., 2% basic dye(w.o.s).

Table (4) shows that raising the dyeing temperature up to 130°C for 3 min. results in a gradual increase in the k/s values and the fastness properties of the obtained dyeings as a direct consequence of swellability of the substrates and high extent of basic dye adsorption followed by subsequent diffusion and fixation onto/within the modified structure [5,6].

Obviously, the K/S and all fastness properties values follows the descending order 130°C < 120°C <100°C. This order is in full agreement with the statement made above.

3.5 Effect of dyeing technique

In this section, the blended fabric samples were dyed in a solution containing 2% basic dye (w.o.s), PH 9 by using Na_2CO_3, PEG – 600 15 g/l for 30 min at 130ºC at different dying techniques to find the most suitable one, which gives the highest results of K/S values and all fastness properties.

Table (5): Comparison between the K/S and some performance properties of w/p blended fabric.

Dyeing technique	K/S	Washing at 95°C± 70°C			Rubbing*		Perspiration						Light Fastness	Handle	T.S kg	
							Acidic			Alkaline					W kg	F kg
		Alt	SC	SW	wet	dry	Alt	SC	SW	Alt	SC	SW				
PDC	25.45	3	2-3	2	2	2-3	3	3	2-3	2-3	3-4	3	6	H	79	70
Exh	27.11	3-4	3	2-3	2-3	3	3-4	3-4	3	3	4	3-4	6	S	81	74
EUP	28.35	4-5	4-5	4	4	4-5	4-5	4-5	4	4-5	4-5	4	6-7	S	81	75

pH 9, PEG-600 15 g/l ,time 30 min at 130°C , 2% basic dye(w.o.s)

- P D C = PAD- DRY-CURE
- EXH = Exhaustion
- EUP = Exhaustion under pressure

Table 5 shows that the exhaustion under pressure gives the highest K/S values and highest fastness properties values ;The results follows the descending order exhaustion under pressure > exhaustion > pad – dry – cure .

3.6 Effect of dye type

Table 6 shows data regarding the fastness properties of the dyed fabrics with different basic dyes at the optimum identical conditions.

In general, data for current work indicate that the difference of dye type presents relatively different K/s values depending on the type of dye. Table (6) also shows good to very good values of the physical mechanical properties and gives a washing of good to very good (4-5) for the three basic dyes and light of moderate to fairly

good (6-7) and rubbing dry of (4-5) and wet of 4. It can be said that the fastness properties show fairly good to very good for the three colors.

Table (6): Effect of using different basic dye.

Basic Dye	K/S	Washing at 95°C± 70°C			Rubbing*		Perspiration						Light Fastness	Handle	T.S kg	
							Acidic			Alkaline					W kg	F kg
		Alt	SC	SW	wet	dry	Alt	SC	SW	Alt	SC	SW				
Astrazone Blue BG	28.37	4-5	4-5	4	4	4-5	4-5	4-5	4-5	4-5	4-5	4-5	6-7	S	82	74
Astrazone red F3BL(BBL)	24.76	4-5	4-5	4	4	4-5	4-5	4-5	4	4-5	4-5	4	6-7	S	81	73
Astrazone G. Yellow GSL	16.28	5	5	4-5	4-5	5	5	5	4-5	5	4-5	4-5	6-7	S	82	74

pH 9, PEG-600 15 g/l ,time 30 min at 130°C, 2% basic dye(w.o.s).

4– Conclusion

It is possible to get union basic dyeing of wool /polyester blended fabrics under alkaline conditions. The dyeing process was carried out using exhausion under pressure under different technique. The variables studied cover concentration of PEG – 600, fixation time and temperature, dyeing technique type, at different PH values. The results obtained indicate that for optimization it is advantageous to carry out concurrent dyeing under the following condition s: 2 % basic dye (w.o.s) , PEG-600 15 g/l PH9 at 130˚ for 30 min .[7,8]

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