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Single and double bath dyeing of polyester/cotton blended fabric using disperse and reactive dye

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Abstract

Normally dyeing of polyester/cotton blended fabric is dyed in two steps. The cost of double bath dyeing is quite higher than the one step or single bath dyeing. The continuous dyeing technique of polyester/cotton blended fabric providing advantages of improvement in productivity with reduced dyes and auxiliary cost and reduce material handling with minimum process time. However, double bath dyeing of polyester/cotton blend fabric gives far better results in terms uniformity of shades in both light and dark shades, while in single bath dyeing shown poor fastness property for dark shades but good fastness property for light shades.

Introduction

The continuous dyeing of woven polyester/cotton blend fabrics is a most important sector of the textile dyeing industry. Statistics for the USA have shown that more than half of the polyester fiber processed is destined for dyed polyester/cotton fabrics, more than half of which are dyed continuously by pad–thermofix processes. Continuous processing of long runs to a given colour ensures consistently high yields and reproducible uniformity at a much more economical price per meter than batch wise methods[1]. The conventional method of exhaust dyeing for P/C blends is to dye each component separately under its optimum conditions, i.e. in a two-bath process. This two bath process is continuously carried out in continuous dyeing process[2]. In this technique the dyeing of polyester/cotton blended fabric with advantages to improve the productivity and reduce the cost of dyes and chemicals and also reduction in process time. This dyeing method of P/C blend fabric is dyed at two stages first is dyeing the polyester portion and then reduction clearing of fabric to remove the disperse dyes particle on the cotton portion. After this process cotton portion is dyed[3]. But, as compare to double bath dyeing, address the issue of productivity and raising environmental concerns, several attempts have been made in the past to shorten this to one-bath process[4]. The key objective in the 'single bath dyeing' approach is to avoid the need for reduction clearing of polyester dyed sample, so that; significant productivity improvements can be made. Also it offers lower usage of water and chemicals and a reduction in effluent volume[5].

Materials and methods

Material

Polyester/cotton blended fabric was used for the experiments. The details are as below.
Polyester/cotton: 60/40
GSM- 129
GLM- 367.440
TC- 250
Construction- CVC PERCALE- 45CVCX60CVC/ 176X70-112"

RFD parameters of the fabric

1. Absorbency: 3 sec
2. Whiteness: 81.76
3. Tegawa Rating: 8
4. pH of fabric: 5.0

Dyes and chemicals

Dyes:

Reactive Dyes: (Manufactured by Colourtex Pvt. Ltd., India)
Corazol Yellow RFT, Corafix Rubine GDN, Corazol Navy RFT, Novacron Yellow CRG, Coractive T. blue H2GP, Novacron Yellow S3R, Novacron Rubby S3B, Novacron Blue CR, Novacron Yellow CRG, Novacron Yellow GL, Novacron Red C2BL and Novacron Blue CR,

Disperse Dyes: (Manufactured by Colourtex Pvt. Ltd., India)
Coralene Yellow XF, Coralene Rubine XF2G, Coralene Blue XF, Coralene Dark Blue XF, Coralene Red XF and Coralene Yellow BXF,

Chemicals and auxiliary

Sodium hydroxide, Sodium carbonate, Sodium sulphate (Gluaber's salt), Sodium hydro Sulphite, Premasol AMK (Anti-migrating agent), Salson NF (Wetting agent), Dekol FBSN (Non-ionic soap, BASF) and Acetic acid

Machines and the Laboratory Instruments

1) Mathis padder – Manufacture: Werner Mathis AG, Switzerland
2) Rota dyer machine – Manufacture: R.B. Electronics and Engineering Pvt. Ltd., India
3) Mathis Pad steam range - Manufacture: Werner Mathis AG, Switzerland
4) Mathis dryer - Manufacture: Werner Mathis AG, Switzerland
5) Spectrophotometer – Manufacture: Data color, USA

Methods

Dyeing of polyester/cotton with single bath

In the laboratory, as per the dyeing recipe, the 100 ml of dye baths were prepared by adding the required amount of dye solution of disperse and reactive dyes, 2 % anti-migrating agent, 2 g/l wetting agent and acidic acid to adjust pH of 4-5. The fabric samples dyed was padded through dye bath at room temperature and then dried at 130ºC. After drying the samples were thermo-fixed at temperature of 180-220ºC for one min. Then the reactive dyeing was completed by adding 50 g/l glauber's salt, 2 g/l caustic, 20 g/l soda ash and 2 g/l resist salt at temperature of 100ºC. Finally samples were soaped with 2 g/l soap and then washed and neutralized.

Dyeing of polyester/cotton with double bath

Here dyeing of polyester and cotton was carried out in separate bath. As per the dyeing recipe, the 100 ml of dye baths were prepared by adding the required amount of disperse dye solution, 2 % anti-migrating agent, 2 g/l wetting agent and acidic acid to adjust pH of 4-5. The fabric samples to be dyed was padded through dye bath at room temperature and then dried at 130ºC. After drying the samples were thermo-fixed at temperature of 180-220ºC for one min. The reduction clearing was carried out with 2 g/l sodium hydrosulphite and 2 g/l sodium hydroxide at 70ºC for 15-20 min. After reduction clearing, the samples were washed and neutralized. Then the reactive dyeing was carried out. The polyester dyed samples were padded through required amount of reactive dye, 50 g/l glauber's salt, 2 g/l caustic, 20 g/l soda ash and 2 g/l resist salt at room temperature. After padding samples were covered with plastic paper and kept for fixation in pot of Rota dyeing machine at 100ºC for 30 min. Finally samples were soaped with 2 g/l soap and then washed and neutralized. The following recipes were selected for the single and double bath dyeing.

Dyeing recipes:

Recipe	**Disperse Dye**	**Reactive dye**
Recipe A	Coralene Yellow XF 7.5 g/l Coralene Rubine XF2G 7.1 g/l Coralene Blue XF 8.1 g/l	Corazol Yellow RFT 13.6 g/l Corafix Rubine GDN 3.6 g/l Corazol Navy RFT 3.9 g/l
Recipe B	Coralene Yellow XF 1.5 g/l Coralene Red XF 4.5 g/l Coralene Blue XF 1.7 g/l	Novacron Yellow S3R 4.5 g/l Novacron Rubby S3B 4.3 g/l Novacron Blue CR 1.5 g/l
Recipe C	Coralene Yellow XF 0.9 g/l Coralene Dark blue XF 1.0 g/l	Novacron Yellow CRG 1.6 g/l Corazol Navy RFT 7.2 g/l Coractive T. blue H2GP 1.3 g/l
Recipe D	Coralene Yellow XF 1.07 g/l Coralene Yellow BXF 0.6 g/l Coralene Blue XF 1.0 g/l	Novacron Yellow GL 3.9 g/l Novacron Red C2BL 0.6 g/l Novacron Blue CR 1.1 g/l

Dyeing parameters

Parameters	Single bath	Double bath
Padding	Trough temp- room temp. Mangle pressure- 3 bar Speed of mangle- 3 mtr/min	Trough temp- room temp. Mangle pressure- 3 bar Speed of mangle- 3 mtr/min
Drying and curing	Drying temp- 130ºC Drying speed- 1 mtr/min Curing temp- 220ºC Curing speed- 0.7 mtr/min	Drying temp- 130ºC Drying speed- 1 mtr/min Curing temp- 220ºC Curing speed- 0.7 mtr/min
Development of reactive dye in cotton portion	Trough temp- room temp Mangle pressure- 2.0 bar Speed of machine- 2 mtr/min Steamer temp- 101ºC-102ºC Dwell time- 1 min, 30 sec.	This process is not carried out for double bath method

Reduction clearing	This process is not carried out in single bath method	Time- 15-20 min Temp- 70°C
Cotton portion dyeing	This process is not carried out in single bath method	Trough temp- room temp. Mangle pressure- 3 bar Speed of mangle- 3 mtr/min
Washing	Washer temp- 1st washer- cold wash, 2nd washer- hot wash, 95°C, 3rd washer- soaping with 2 g/l Dekol FBSN, 5°C, 4th washer- soaping with 2g/l Dekol FBSN, 5°C, 5th washer- hot wash, 95°C, 6th washer- neutralization with 0.5 g/l acidic acid	Washer temp- 1st washer- cold wash, 2nd washer- hot wash, 95°C, 3rd washer- soaping with 2 g/l Dekol FBSN, 95°C, 4th washer- soaping with 2 g/l Dekol FBSN, 95°C, 5th washer- hot wash, 95°C, 6th washer- neutralization with 0.5 g/l acidic acid

Results and discussion

Polyester-cotton blended fabrics were dyed using single bath and double bath techniques. After dyeing the dyed samples were evaluated for fastness properties.

1. **Washing fastness-** (AATCC 61-2A/ISO 105 C06)

Table 1: Results of washing fastness of single bath and double bath dyed fabric.

Note: CC: color change; Ac: Acetate; C: cotton; N: nylon; P: polyester; Ar: acrylic; W: wool

Recipe	Single bath							Double bath						
		Staining on						CC	Staining on					
	CC	Ac	C	N	P	Ar	W		Ac	C	N	P	Ar	W
Recipe A	4	3/4	3/4	3/4	4	4/5	4	4	4/5	4	4/5	4/5	4/5	4/5
Recipe B	4	3/4	3/4	3/4	4/5	4/5	4	4	4/5	4	4/5	4/5	4/5	4/5
Recipe C	4	4/5	4	4/5	4/5	4/5	4/5	4	4/5	4/5	4/5	4/5	4/5	4/5
Recipe D	4	4/5	4	4/5	4/5	4/5	4/5	4	4/5	4/5	4/5	4/5	4/5	4/5

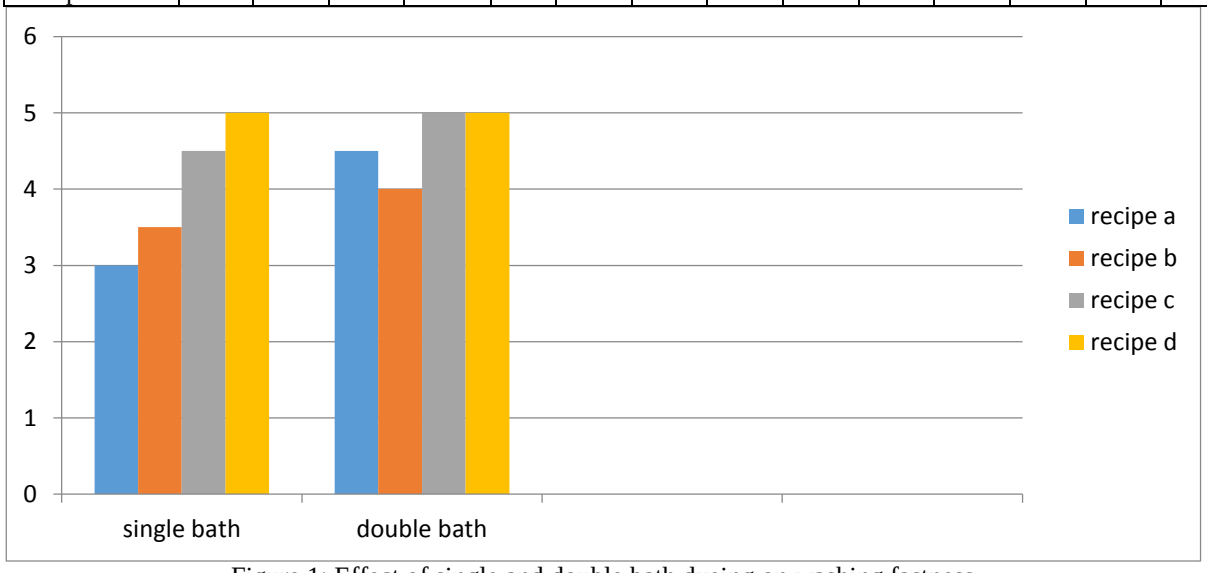

Figure 1: Effect of single and double bath dyeing on washing fastness

The results of washing fastness properties of single bath and double dyeing of p/c blended fabrics using recipe A, recipe B, recipe C, recipe D. are given in Table 1. Recipe A and recipe B are darker in shade. From Table I and figure 1, it was observed that recipe A and B has good washing fatness range 4 to 5 in double bath in compared to poor fastness range 3-4 in single bath this may be due to in single bath process the reaction time is less and dye fixation time was also less. Recipe C and recipe D are lighter in shade. From Table I and figure 1, it was observed that recipe C and D has good washing fatness 4-5 in double bath and single bath.

2. **Rubbing fastness-** (AATCC 8/ISO 105 X 12)

Table 2: Results of rubbing fastness of single bath and double bath dyed fabric

Recipe	Single bath		Double bath	
	wet	dry	wet	dry
Recipe A	3/4	4	4	4/5
Recipe B	3/4	4/5	4	4/5
Recipe C	4/5	4/5	4/5	4/5
Recipe D	4/5	4/5	4/5	4/5

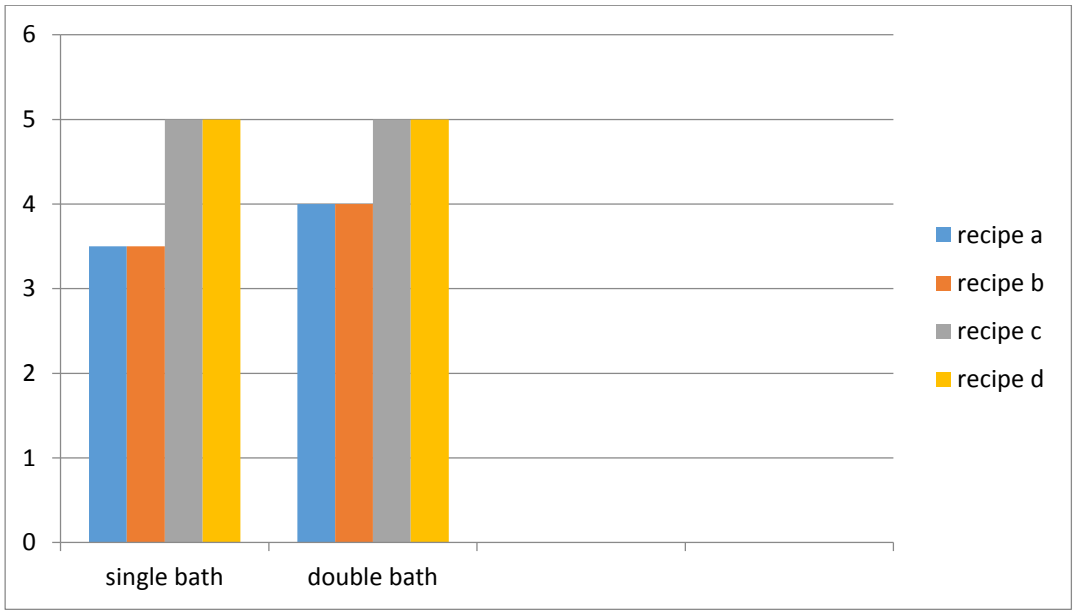

Figure 2: Effect of single and double bath dyeing on rubbing fastness.

The results of rubbing fastness properties of single bath and double dyeing of p/c blended fabrics using recipe A, recipe B, recipe C, recipe D. are given in Table 2. Recipe A and recipe b are darker in shade. From Table 2 and figure 2, it was observed that recipe A and B has good rubbing fatness range 4 to 5 in double bath but poor fastness range 3-4 in single bath this may be due to less reaction and dye fixation time. Recipe C and recipe D are lighter in shade. From Table 2 and figure 2, it was observed that recipe C and D has good washing fatness 4-5 in both methods. Not more change in dry rubbing but in wet rubbing of darker shade of single bath rubbing fastness is reduce

Conclusion

As far as dyeing of polyester/cotton is concerned the cost of production is very important for the overall profitability of the industry. One can develop the process in order to reduce the cost of production. In this study, polyester /cotton fabrics were dyed with single bath and double bath dyeing methods using various recipes. In double bath dyeing gave better results compared to single bath dyeing. However, the cost of double bath dyeing is higher than that of single bath dyeing. The darker shades obtained in double bath dyeing may be due to dyeing carried out at suitable individual dyeing conditions. Here polyester part is first dyed with disperse dyes and then another bath dyeing of cotton was carried out using reactive dye. The single bath dyeing is not better for darker shade. The fastness properties are poor in darker shade dyeing. This effect is occurring due to not giving the proper reaction time for dark shade. The single bath dyeing is better for light shade of dyeing. The light shade gives better result in single-bath as fixation time is sufficient.

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