One-bath Dyeing Process for Polyester/Cotton Blend using Physical Mixtures of Disperse/Reactive Dyes

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Abstract
Dyeing of fabric blends such as Polyester/Cotton (P/C) is presently done with two chemically different classes of dyes namely disperse for polyester and reactive for cotton, in two bath process. Experimental work was carried out on finding the possibility of making physical mixture of Disperse/Reactive (D/R) dyes to dye the P/C blends (80/20, 67/33) in one bath process. A study was also carried out to understand the stability of the physical mixture of dyes to storage and it was observed that the dyes were stable in terms of particle size, filteration time and flow rate studies. The physical mixture of dyes showed level dyeing having good fastness properties and offers the option of cost effective and eco-friendly one-bath dyeing process.

Keywords: One-bath dyeing, Polyester/Cotton blends, Disperse/Reactive dyes, Physical mixture, Fastness.

1. Introduction

In textile industry polyester / cotton (P/C) blends have dominant market share having share of 58.45% in worldwide - market (Edward Menezes et al., 2008). These blends are famous due to their aesthetic value and user friendly performance. Limitations of both fibers are balanced adequately by blending these two fibers making perfect blend (D.P. Chattopadhyay and T. M. Shaikh et al., 2002). However, the P/C blends posses some challenges to dyer as polyester shows a hydrophobic character while cotton shows a hydrophilic character making it inevitable to dye them with chemically different class of dyes (H. Najafi, R. Assefipour, M. Hajilari and H. R. Movahed et al., 2009).

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. To address the issue of productivity and raising environmental concerns, several attempts have been made in the past to shorten this to one-bath processes, for example Imperial Chemical Industries (ICI) have developed a rapid one-bath method using a mixture of selected disperse and reactive dyes (J J Lee, N K Han, W J Lee, J H Choi and J P Kim et al., 2003).

The key objective in the 'rapid 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 (Joonseok Koh and Jongseung Park et al., 2008).

Various other combinations of dyes like disperse/direct and disperse/vat can be used in single bath dyeing but, the matching of shade is quite difficult (D.P. Chattopadhyay and T. M. Shaikh et al., 2002). Reactive dyes have some significant advantages over other dyes applicable to cotton: viz., color value, reproducibility of color, and fastness properties are usually better, and the dyeing is easier to wash-off (Y.C. Chao, Y.L. Chung, C.C. Lai, S.K. Liao, J.C. Chin et al., 1998).

The one-bath two-step dyeing process uses a separated high-pH and low temperature reactive fixation step after the high temperature, low pH disperse dyeing to avoid a high rate of hydrolysis of both disperse and reactive dyes under high temperature, or high pH dyeing environment (Yiqi Yang and Shiqi Li. et al., 2000). This process is shorter as compared to two-bath dyeing process, but the drawbacks are lower dye ability and poor reproducibility (B. Muralidharan and S. Laya. Et al., 2011).

The one-bath one-step dyeing process of P/C blends with disperse/ reactive (D/R) dyes has the advantages over the conventional dyeing processes on reducing the dyeing cycle as well as energy consumption, and eliminating the use of sodium hydrosulphite, an environmentally questionable chemical in dyeing (Y. Yang and S. Li. et al., 1998).

The present work involves a method of one-bath one-step dyeing process of P/C blend with a physical mixture of D/R commercially available dyes in powder form for ease of shade matching to the dyers.

2. Experimental and Methods

2.1. Materials

Ready for dyeing 67/33 P/C blended fabric (weight 74 gm/m^2, Ends per inch 100 & Picks per inch 82) and 80/20 P/C blended fabric (weight 148 gm/m^2, Ends per inch 56 & Picks per inch 54) were supplied by Piyush Syndicate, Mumbai, India. Sodium carbonate, Glauber's salt, and acetic acid were of analytical grade and purchased from S.D. Fine Chemicals Ltd. Mumbai, India. Non-ionic soap Auxipon NP was provided by Auxichem Ltd. India. CBFIX Reactive and CBENE Disperse dyes with dispersant CBMOL WS were supplied by Colorband Dyestuffs Pvt. Ltd. Mumbai, India. The fabrics were dyed on Flexi dyer dyeing machine (Rossari Labtech, Mumbai, India). Particle size distribution of physical mixture of dyes were evaluated by using CILAS 1064 Particle Size Analyzer, France.

2.2. Selection of dyes

The selection of disperse dyes for physical mixture is based on the chromophore which is either azo or anthraquinone type possessing excellent dispersion and build-up properties with very good wash fastness properties. The reactive dyes selected for physical mixture to obtain same tone with disperse dyes are based on vinyl sulphone due to ease of washing unfixed dyes for good fastness properties and excellent compatibility.

2.2.1. Dyeing of cotton fabric with reactive dye

The dyepot was filled with the predissolved dye, predissolved salt, water and fabric. It is clear from Fig.1, dyeing was started at RT and temperature was allowed to rise to 60^0C. After holding the temperature at 60^0C for 15 min, required amount of glauber salt and soda ash was added and dyeing was continued for 30 min. After the completion of dyeing, dye bath was drained. Soaping was carried out at M:L 1:50 of the dyed fabric at 95 °C for 10 min with 2 gpl of non-ionic soap. The fabric was rinsed and then dried.

2.2.2. Dyeing of polyester fabric with disperse dye

Polyester fabric was dyed in a Flexi dyer dyeing machine at M: L 1:20. As shown in Fig. 2, dyebaths were prepared with the disperse dye. pH was maintained at 4-5 using acetic acid. The dyebath temperature was raised at a rate of 1°C/min to 130°C and maintained at this temperature for 60 min, and rapidly cooled to 60°C. The dyeings were rinsed and then reduction cleared in an aqueous solution of 2 g/l sodium hydroxide and 2 g/l sodium hydrosulphite at 80°C for 30 min.

2.3. Colour strength

The colour properties of the dyed samples were determined with Spectra Scan 5100+ under the illuminant D65 using 10° standard observer. The K/S values were determined using expression;

$$K/S = \frac{(1-R)^2}{2R} \qquad (1)$$

Where, R is the reflectance at complete opacity, K is the Absorption coefficient & S is the Scattering coefficient. In general, the higher the K/S value, the higher the depth of the colour on the fabric. The leveling properties of dyed samples were assessed using the mean of color difference at five arbitrary locations.

2.4. Preparation of physical mixture of dyes

To obtain the same tone of color on fabric, the physical mixture was prepared by calculating the amount of each dye component required which depends on the composition of fibres in fabric as;

Blend ratio of P/C = x/y (2)

Disperse dye required = x * % Stock solution for 100% Polyester fabric

Reactive dye required = y * % Stock solution for 100% Cotton fabric

2.5. Dispersibility of physical mixture of dyes

Dispersibility of physical mixture in terms of filtering time and filter residue were evaluated under standard conditions in aqueous media by using the AATCC Test Method 146-2006.

2.6. Particle size and stability of physical mixture of dyes

Storage stability and particle size of physical mixture of dyes was evaluated by using CILAS 1064 Particle Size Analyzer on various intervals.

2.7. Flow Test of physical mixture of dyes

Prepare 0.5% stock solution of physical mixture of dyes at 40°C and poured 5 drops of dye solution by using the pipette on whatman filter paper at single spot and given rating based on visual analysis of flow pattern.

2.8. Dyeing procedure

P/C blend fabrics were dyed for 1% on weight of fabric (owf) in a Flexi dyer dyeing machine at a material to liquor ratio (M:L) of 1:20. The P/C blend fabric was placed in dye bath with the dye solution at room temperature (RT). Dispersing agent was added to maintain the dispersibility of dye bath during dyeing.

Acetic acid was used to maintain pH 4-4.5.Dyeing was commenced at 70 °C and temperature was raised by 1 °C/min to 130 °C, maintained at this temperature for 60 min and then cooled to 60 °C. 30 gpl of Glauber's salt and 15 gpl of sodium carbonate for exhaustion and fixation respectively of the reactive dye were added to dye bath. The bath was maintained at 60 °C for 60 min as shown in Fig. 3.

After the completion of dyeing, dye bath was drained. Soaping was carried out at M:L 1:50 of the dyed fabric at 95 °C for 10 min with 2 gpl of non-ionic soap. The fabric was rinsed and then dried.

2.9. Fastness properties

Wash fastness testing of the dyed samples was done by the standard method ISO 2-105-C10: 2006(E) on Rota Dyer (Rossari Labtech, Mumbai, India). Rubbing fastness of the dyed samples was determined on automatic Crockmeter (World Traders & Co. Bombay, India) by the standard method ISO 105 X 12. Light fastness of the dyed samples was tested on Q-Sun Xenon Test Chamber (Q-Lab Corporation, Ohio, USA) by the AATCC 16-2004 method. Perspiration fastness of the dyed samples was measured on Perspirometer (James H Heal & Co. Ltd., Halifax, England) by the standard method ISO 105 E04. Sublimation fastness of the dyed samples was tested on Sublimation fastness tester (RBE Electronics Engg. Pvt. Ltd., Mumbai, India) by the standard method ISO 105-F04. The shade change, together with staining of adjacent fabrics, was rated according to appropriate Society of Dyers & Colourists (SDC) grey scales.

3. Results and Discussion

3.1. Selection of dyes

One-bath one-step dyeing involves the use of high temperature for dyeing polyester, and alkaline fixation of reactive dyes. Both disperse and reactive dyes were selected based on their properties from the supplier's manual (Colorband dyestuffs Pvt. Ltd. Dye manual 2009) so as to withstand the adverse condition of high temperature of reactive dyes and alkaline condition for disperse dyes. To obtain the matching strength for desired shade, a reactive dye was taken for dyeing at the particular shade as invariable and disperse dye shade was adjusted on polyester according to reactive dye shade on cotton to arrive at the composition of mixture by dyeing polyester with disperse and cotton with reactive dyes separately. Table 1 elaborates the results in terms of K/S of the dyed fabrics according to which the physical mixtures of D/R dyes were made. It can be observed that for yellow colour, CBENE Yellow SGL 200% of only 0.25% was required to match K/S of 1% shade of CBFIX Lemon Yellow BF H/C. Whereas, in case of orange, 1% shade of CBENE Orange 2RLW 200% and CBFIX Orange BF-2R H/C gave good agreement in terms of K/S values. Overall, in all cases physical mixture of dye was prepared according to the matching % shades of disperse and reactive dyes as mentioned in the Table 1.

3.2. Cross-staining of fabric components by contrary dye

The cross-staining of cotton component by disperse dye and polyester component by reactive dye was investigated to assess the suitability of physical mixture for dyeing P/C blends. Table 2 presents the rating of cross-staining for polyester and cotton respectively. Dyes 1-6 were slightly cross-stained, but dyes 7-8 showed cross-staining to some higher extent on contrary fabric. The cross-staining in the latter case may be due to the deeper shade.

3.3. Preparation of physical mixture of dyes

Preparation of physical mixture of selected disperse and reactive dyes, according to the P/C blend was done by thorough mixing of both the dyes with the help of steel balls in a container to obtain a homogeneous mixture.

3.4. Filter time and residue of physical mixture of dyes

As far as filteration time and filter residue of the physically mixed dyes are concerned, even on storage for a long time i.e. one year there was no significant change in the filteration time or residue which shows that the properties of the dyes do not change even when stored as a mixture for a prolonged time as shown in Table 3 and 4 and thus display acceptable storage stability.

3.5. Particle size and stability of physical mixture of dyes

A study was done to determine any effect on particle size of the physical mixture of dyes. The results of these are mentioned in Table 5. It can be observed that even during storage of a one year, no detrimental effect was observed on the particle size of the dyes, which shows that the mixtures are stable to storage.

3.6. Flow test of physical mixture of dyes

For flow test, the assessment rating was given according to uniformity of the dye spreading on the filter paper. It is clear from Table 6 all dyes mixtures except dyes 6, 7 and 8 showed fairly good ratings which meant the dyes were compatible as such in their available commercial form and required to special procurement precautions. In case of 6, 7 and 8 it is assumed that the electrolyte present in reactive dye and dispersing agent in disperse dyes would have caused non-compatibility in the mixture leading to a lower rating.

3.7. Dyeing levelness of physical mixture of D/R dyes for P/C blends

To measure the levelness of dyeing on 67/33 P/C blend, all dyeings were checked at four scanning points for the same sample and average was calculated for five color difference (dE) values as shown in the Table 7. The color difference values shown by all dyes were under permissible limit. Hence can be said that level dyeing was obtained by the physical mixture of D/R dyes. This may be attributed to the appropriate selection of D/R dyes, homogeneous mixing of dyes and suitable dyeing profile used for dyeing. Similar levelness was observed for 80/20 P/C blend fabric.

3.8. Build up of shade with physical mixture of D/R dyes for P/C blends

The dyeing was carried out from lower to higher concentration of dyes for the saturation of dyes on P/C blend fabrics. Fig. 4 shows the dye uptake of 67/33 P/C blend fabric for all dyes. Upto 3-4% concentration of dye, increase in dye uptake was observed and saturation was obtained at 5% concentration for all dyes. This build up of shade is acceptable though not exceptional can complete the market needs. Similar trends were observed for 80/20 P/C blend fabric.

3.9. Storage stability of physical mixtures of dyes

The physical mixtures of the D/R dye were stored for a period of one month and then subsequent dyeing was done at intervals of 10 days to investigate the stability. The stability of physical mixtures of D/R dye was measured in terms of its dyeability evaluating the color strength (K/S) values. It was observed that K/S values were within acceptable limit for practical dyeing for all the dyes 1-8 in case of 67/33 P/C blend fabric as shown in Fig. 5. Similar outcomes were observed for 80/20 P/C blend fabric.

3.10. Fastness properties

The results of the wash fastness tests for dyes 1-8 on 67/33 P/C blend fabric are summarized in Table 8 and showed good wash fastness. In case of dyes 7-8, the nylon was more stained due to its dyeabililty with both the dyes as nylon can be dyed using reactive as well as disperse dyes.

Table 9 summarizes the results of rubbing, light, sublimation and perspiration fastnesses for 67/33 P/C blend fabrics. The rubbing & light fastness was moderate to good and sublimation & perspiration results were good to excellent. However, for dyes 5-8, the wet rubbing fastness has shown average fastness which is in tune with the results of flow test wherein these dyes have shown inferior results. All the fastness properties were also found similar for 80/20 P/C blend fabric.

4. Conclusion

P/C blend fabrics were successfully dyed with the physical mixture of D/R dyes by one-bath one-step dyeing process. The novelty of undertake study is successful mixing of the commercially available dyes as is to give complete shade gamut, in powder form which will open up new avenues to dyestuff suppliers to cater to the blend dyeing needs of the textile processors. The work is based on the well established process of dyeing however will emerge in readymade dyes as option to dyers to get rid of cumbersome shade matching at their end. Also, this one-bath one-step dyeing process has potential in offering savings in time, energy, water and labour. This research work demonstrates the specific possibility of a commercially acceptable dyeing process for P/C blend using the physical mixture of D/R dyes.

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References

Edward Menezes. 2008. Asian Dyer. 48-50.

D.P. Chattopadhyay and T. M. Shaikh. 2002. Man-made textiles in India. 456-468.

H. Najafi, R. Assefipour, M. Hajilari and H. R. Movahed. 2009. African Journal of Biotechnology. 8 (6).1127-1135.

J J Lee, N K Han, W J Lee, J H Choi and J P Kim. 2003. Color. Technol. 119. 134-139.

Joonseok Koh and Jongseung Park. 2008. Fibers and Polymers. 9(2).128-13.

Y.C. Chao, Y.L. Chung, C.C. Lai, S.K. Liao, J.C. Chin. 1998. Dyes and Pigments. 40. 59-71.

Yiqi Yang and Shiqi Li. 2000. Textile Chemist and Colourist & American dyestuff reporter. 32. 38-45.

B. Muralidharan and S. Laya. 2011. International Scholarly Research Network Materials Science. 1-12.

Y. Yang and S. Li. 1998. International Conference and Exhibition, AATCC. 414-425.

Colorband dyestuffs Pvt. Ltd. 2009. CBFIX Reactive dyes and CBENE Disperse dyes dyeing manual.

Figures

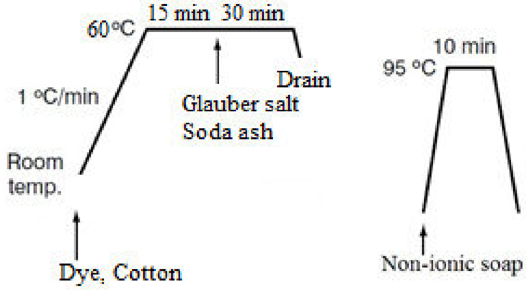

Fig. 1: Dyeing profile of cotton fabrics using reactive dye (M: L 1:20)

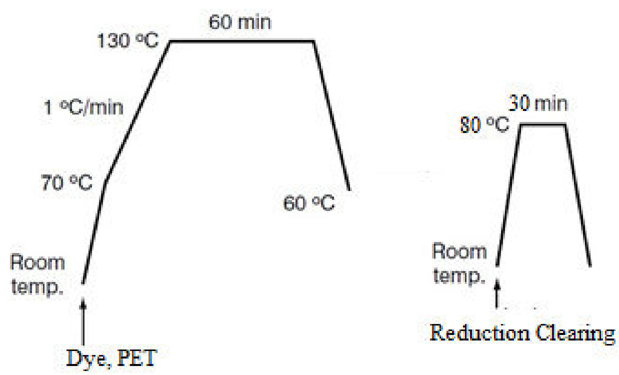

Fig. 2: Dyeing profile of polyester fabrics using disperse dye (M: L 1:20)

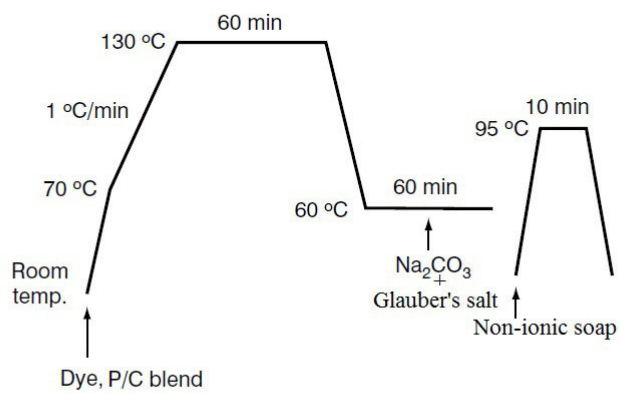

Fig. 3: Dyeing profile for P/C blend fabrics using suitable physical mixture of D/R dye (1% owf, M:L 1:20)

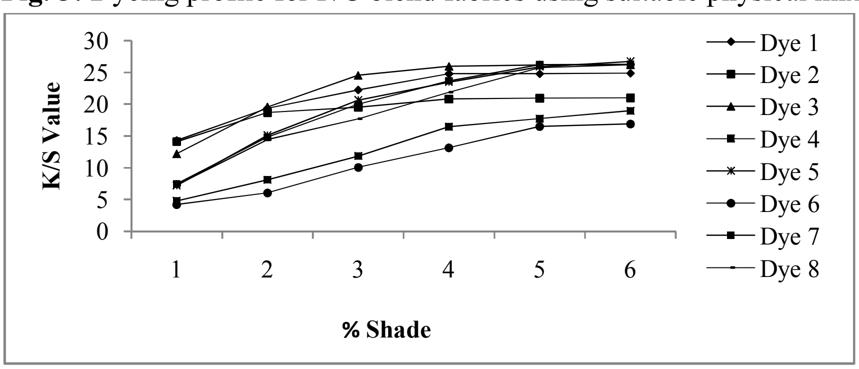

Fig. 4: The build-up of shade of physical mixture of dyes 1-8 on 67/33 P/C blend fabric

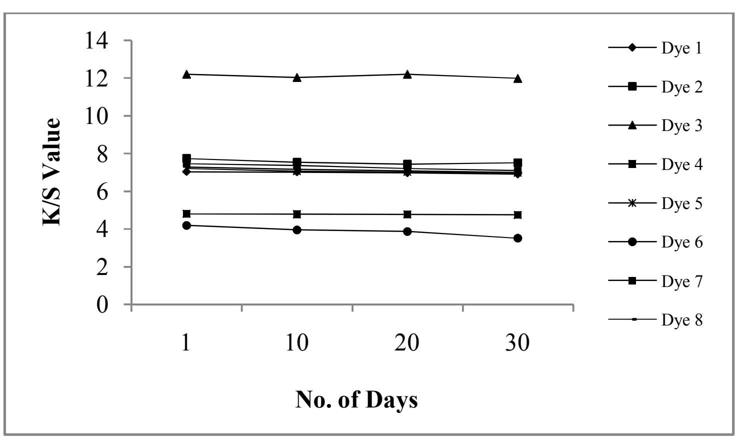

Fig. 5: Stability of physical mixtures of D/R dyes 1-8 on 67/33 P/C blend fabric (1% owf M:L 1:20)

Tables

Table 1: Selection of D/R dyes to obtain a physical mixture for the coloration of P/C blend fabrics

S. N.	Disperse Dyes	% Stock solution for 100% Polyester	K/S	Reactive Dyes	% Stock solution for 100% Cotton	K/S	Color
Dye 1	CBENE Yellow SGL 200%	0.25%	6.41	CBFIX Lemon Yellow BF H/C	1%	6.52	Yellow
Dye 2	CBENE Yellow 2RLSEF 200%	0.6%	3.83	CBFIX Golden Yellow BF-2R H/C	1%	3.89	Golden Yellow
Dye 3	CBENE Orange 2RLW 200%	1%	12.44	CBFIX Orange BF-2R H/C	1%	12.66	Orange
Dye 4	CBENE Red 2BLS	1%	5.50	CBFIX Red BF-3B H/C	1%	5.41	Pink
Dye 5	CBENE Red SRGLR	0.5%	7.45	CBFIX Fire Red BF H/C	1%	7.57	Red
Dye 6	CBENE Blue BGLS	0.75%	20.29	CBFIX Brilliant Blue R-A H/C	1%	20.62	Sky Blue
Dye 7	CBENE Navy Blue 2GLS 200%	3.10%	21.43	CBFIX Navy Blue RGB H/C	4%	21.78	Navy Blue
Dye 8	CBENE Black 3RT 300%	3.25%	17.69	CBFIX Black CNN	5%	17.78	Black

Table 2: Cross-staining by disperse dye on cotton and reactive dye on polyester

S. No.	Disperse Dyes	Cross-staining on Cotton	Reactive Dyes	Cross-staining on Polyester
Dye 1	CBENE Yellow SGL 200%	4-5	CBFIX Lemon Yellow BF H/C	4-5
Dye 2	CBENE Yellow 2RLSEF 200%	4-5	CBFIX Golden Yellow BF-2R H/C	4-5
Dye 3	CBENE Orange 2RLW 200%	4-5	CBFIX Orange BF-2R H/C	4-5
Dye 4	CBENE Red 2BLS	4-5	CBFIX Red BF-3B H/C	4-5
Dye 5	CBENE Red SRGLR	4	CBFIX Fire Red BF H/C	4-5
Dye 6	CBENE Blue BGLS	4	CBFIX Brilliant Blue R-A H/C	4
Dye 7	CBENE Navy Blue 2GLS 200%	3-4	CBFIX Navy Blue RGB H/C	4
Dye 8	CBENE Black 3RT 300%	3	CBFIX Black CNN	3-4

Table 3: Filteration time of physical mixture of dyes

Dye	Filter Rating					
	Filteration Time (sec)					
	0 Days	8 Days	24 Days	60 Days	6 Month	1 Year
Dye 1	54	55	55	56	57	59
Dye 2	57	58	59	61	62	64
Dye 3	66	68	68	70	71	72
Dye 4	57	57	58	58	61	63
Dye 5	64	65	65	65	66	67
Dye 6	70	70	71	71	72	72
Dye 7	62	63	64	67	70	73
Dye 8	59	60	62	63	65	67

Table 4: Filter residue of physical mixture of dyes

Dye	Rating					
	Filter Residue Scale					
	0 Days	8 Days	24 Days	60 Days	6 Month	1 Year
Dye 1	4-5	4-5	4-5	4	3	3
Dye 2	4	4	4	4	3-4	3-4
Dye 3	3-4	3-4	3-4	3-4	3	3
Dye 4	3-4	3-4	3-4	3-4	3	3
Dye 5	4	4	4	4	3-4	3-4
Dye 6	4	4	4	4	3-4	3-4
Dye 7	3	3	3	3	2-3	2-3
Dye 8	3	3	3	3	2-3	2-3

Table 5: Particle size distribution of physical mixture of dyes

Dye	Diameter (µm)	Time					
		0 Days	8 Days	24 Days	60 Days	6 Month	1 year
Dye 1	10 %	0.438	0.443	0.447	0.455	0.457	0.459
	50 %	0.873	0.873	0.874	0.875	0.876	0.877
	90 %	1.547	1.545	1.543	1.537	1.529	1.532
Dye 2	10 %	0.884	0.885	0.878	0.861	0.867	0.868
	50 %	1.439	1.439	1.437	1.431	1.428	1.431
	90 %	2.270	2.270	2.270	2.271	2.272	2.275
Dye 3	10 %	0.169	0.166	0.161	0.155	0.144	0.146
	50 %	1.346	1.348	1.351	1.354	1.361	1.365
	90 %	2.224	2.235	2.257	2.289	2.301	2.310
Dye 4	10 %	0.663	0.661	0.661	0.658	0.656	0.651
	50 %	0.933	0.933	0.934	0.935	0.936	0.940
	90 %	1.446	1.449	1.456	1.464	1.471	1.474

Dye 5	10 %	0.801	0.802	0.808	0.810	0.812	0.816
	50 %	1.279	1.279	1.279	1.279	1.279	1.281
	90 %	2.061	2.053	2.047	2.040	2.030	2.027
Dye 6	10 %	0.117	0.124	0.137	0.411	0.164	0.167
	50 %	0.536	0.552	0.560	0.578	0.587	0.583
	90 %	1.915	1.909	1.900	0.991	0.985	0.986
Dye 7	10 %	0.804	0.805	0.807	0.811	0.815	0.519
	50 %	1.214	1.217	1.222	1.229	1.234	1.239
	90 %	1.914	1.919	1.925	1.937	1.942	1.947
Dye 8	10 %	0.331	0.331	0.332	0.335	0.336	0.339
	50 %	0.689	0.689	0.689	0.700	0.700	0.704
	90 %	1.166	1.169	1.171	1.178	1.181	1.185

Table 6: Flow test of physical mixture of dyes

Dye	**Rating**
Dye 1	5
Dye 2	4-5
Dye 3	3
Dye 4	3
Dye 5	3
Dye 6	1-2
Dye 7	2
Dye 8	2

Table 7: Color differences between four scanning points of 67/33 P/C blend fabric (1% owf, M:L 1:20)

Dye	**Color differences (dE)**					
	1	**2**	**3**	**4**	**5**	**Average**
1	0.514	0.489	0.256	0.607	0.541	0.481
2	0.396	0.331	0.462	0.167	0.372	0.345
3	0.288	0.215	0.297	0.193	0.212	0.241
4	0.411	0.601	0.523	0.317	0.370	0.444
5	0.321	0.461	0.531	0.429	0.391	0.427
6	0.569	0.43	0.513	0.651	0.446	0.444
7	0.213	0.309	0.418	0.236	0.339	0.303
8	0.417	0.561	0.398	0.472	0.556	0.481

Table 8: Wash fastness of 67/33 P/C blend fabric dyed with physical mixture of dye 1-8 (1% owf, M:L 1:20)

Dye	**Change in colour**	**Staining**					
		Acetate	**Cotton**	**Nylon**	**Polyester**	**Acrylic**	**Wool**
1	4-5	4-5	4-5	4-5	5	5	4-5
2	4-5	4	4-5	4-5	5	5	4-5
3	4-5	4-5	5	4-5	5	5	4-5
4	4-5	4-5	5	4-5	5	5	4-5
5	4-5	4-5	4-5	4	5	5	4-5
6	4-5	4-5	4-5	4	4-5	5	4-5
7	4	4	4	3-4	4-5	5	4
8	4	4	4	3-4	4-5	5	4

Table 9: Rubbing, light, sublimation and perspiration fastness of 67/33 P/C blend fabric dyed with physical mixture of dye 1-8 (1% owf, M:L 1:20)

Dye	**Fastness**					
	Rubbing		**Light**	**Sublimation**	**Perspiration**	
	Dry	**Wet**			**Acidic**	**Alkaline**
1	5	4-5	5-6	4-5	5	5
2	5	4-5	5-6	4-5	4-5	4-5
3	5	4-5	5	4-5	4-5	4-5
4	5	4-5	5-6	4-5	4-5	4-5
5	4-5	3-4	5-6	4-5	4-5	4-5
6	4-5	3-4	4-5	5	4-5	4-5
7	4	3	4-5	4	4-5	4-5
8	4	3	5-6	4	4-5	4-5