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QUALITY ASSESSMENT OF LARGE BLOTCH PRINTED POLYESTER/COTTON BLEND FABRIC WITH DISPERSE/REACTIVE DYE OVER PIGMENT DYE

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ABSTRACT

Akter N, Islam S, Moin CJ (2012) Quality assessment of large blotch printed polyester/cotton blend fabric with disperse/reactive dye over pigment dye. *Ins. Engg. Tech.* 2(2), 1-7.

Widely uses of blended fabrics were subjected to dyeing and printing as well. However the dyeing quality stood as satisfactory quality comparing with non-blended fabric but not the printed blended fabrics. Nowadays the blended fabric was printed by pigment color which incapable to offer the superlative quality of printed fabrics in respect to fastness properties, the luster and fabric bending. Looking for a better and technically feasible option disperse/reactive dyes were applied for printing a polyester/cotton blend and were examined for the yield printing quality. Investigation for fabric quality of three shades on three categories, light, medium and dark for both colorants were printed with appropriate process and then testing were done as per relevant standard methods. In case of fastness properties except light fastness disperse/reactive printed fabrics yield upto 20% better result with appreciable luster and around 15% better bending properties. But in case of wash fastness properties disperse/reactive printed fabrics shows approximately similar result in compare with pigment printed samples. The study revealed that there were some encouraging properties over each other which indicate the selection of the colorants and their appropriate process depends on the end uses of the fabrics. The study also showed that for printing the disperse/reactive dyes for polyester/cotton blend fabric was better than pigment in technical and qualitative aspects.

Key words: *blend fabric, pigment printing, disperse/reactive printing, color fastness etc*

INTRODUCTION

When two or more staple fibres are mixed intimately to produce a yarn and that yarn is used to make a fabric, the resulting mixture is referred to as a blend (www.ifc.net.au). In the early 1960 polyester/cotton blend was introduced and after that their popularity has increased remarkably due to aesthetic qualities of cotton and the strength of polyester fibre (Jenkinson 1979). On the other hand the most significant and handy method for introducing color and design to textile fabrics is printing. Every year 1-2 billion meters of polyester/cotton fabric are printed throughout the world and a large amount of this fabric is printed with pigments, as printing is very easy process for producing multi colored and sharp edge design on textile substrate, using with different printing techniques with some precisions (Chiou and Schoen, 2006). Again printing with pigment is not only the ancient process but also more than 80% of the total printed goods are printed with pigment (Najafi and Aghaee, 2011). But pigment printing consigns much of the product to lower quality fabrics. The insoluble pigment colorants are not react with cotton or polyester and only impart color when incorporated with an adequate binder system (Miles 1994). Due to absence of any chemical bonding it yields poor quality. Film-forming binders are used to fix pigment colors to the substrate by adhesion and fixation at elevated temperature is practiced to improve the quality considerably (Giesen and Eisenlohr, 1994). Generally wet after-treatment like washing is not required after pigment printing (Shenai 1990). Pigment printing is largely used to print small motifs on white or colored grounds (Miles 1994). Usually to meet the higher demand of printed blend fabric the industries are usually depends on pigment i.e. one class dye process (Miksovsky 1980). But it does not execute all the requirements of which are desirable, like rubbing fastness particularly in wet rubbing fastness as well as abrasion resistance, handle of the fabric and also impedes the luster of the ground fabric and these problems will be appeared more, where a large blotch prints are produced by pigment (Jenkinson 1979). Again fibre reactive dyes are water-soluble colored organic substances; react with the cotton fibre through covalent bonds under certain conditions of pH, temperature, solution, and time (Choudhury 2006). Beside this the disperse dyes are organic compounds which are trapped inside the polyester fibre in association with heat and dispersing compounds (Shenai 1980). But these two dyes can be applied together for printing on polyester/cotton fabric by two dyes-one stage fixation method where both dyes are fixed at a time on the fabric. Now a days to print the blend fabric there is another process using mixtures of two classes of dye (disperse for polyester part and reactive for cotton part) to overcome the problem regarding appearance, fastness issues and fabric handle which are associated by pigment (Miksovsky 1980). But practically it is difficult to apply two different dyes, one is water soluble and another is partially soluble in water (Broadbent 2001), on two chemically dissimilar fiber containing fabric (blend) and ensures that the color should be uniform. In this paper a comparative analysis was done between pigment printings, one dye-one stage fixation and disperse/reactive printing, two dye-one stage fixation technique. Yet again precaution should be taken to choose the dyestuffs because some of the disperse dye stain on cellulosic fibres quite heavily even at higher temperature sublimation of dyes stain the white ground of the fabric on the contrary reactive dyes never stain the polyester component of the blend (Shenai 1990).

METHODOLOGY

In this paper direct printing style was used to compare for a large blotch designed printed sample with two different processes named one dye one stage fixation (pigment printing) and two dye one stage fixation (disperse/reactive printing) on polyester/cotton blend fabric.

Materials selection

A blend fabric named 60:40 PC ready for printed 3/1 twill woven fabric, containing warp and weft count respectively 28 Ne and 20 Ne, was taken for this experiment. The EPI and PPI of the selected fabric are 128 and 74 respectively. The fabric sample was singed, desized, scoured and bleached with a standard method. After pretreatment the fabric GSM was 210 and it was measured by BSEN-12127 method.

Color selection

In case of pigment printing the Helizarin group of dyes from BASF was selected. For cotton fiber Procion dyes were used, suggested by many researchers, for printing. The reaction of Procion PX dyes as a monochlorotriazine (MCT) dyes with cotton fiber as below:

MCT–Dye + **Cotton** ⟶ **Cotton – MCT**–Dye

In covalent bond the link between the cotton and the MCT-dye (Procion PX) is an ESTER linkage, which is not stable to acid hence for the mixed dyes process alkaline medium was selected with pH 9-9.5. The Dianix group of DyStar dyes was selected for polyester fiber/part which is stable in alkaline medium. Procion PX dyes also provide an advantage in case of white fabric printing on cellulose portion in blend fabric because of it is low substantivity & low reactivity.

Auxiliaries & chemicals selection

Always care also should be taken to choose the thickener for printing. In this paper work in case of applied mixed dyes on blend fabric sodium alginate and guar gum both thickener were selected.

Table 1. Function of chemicals given in Table 1

Sl No.	Type of printing	Dyes & chemicals	Function
01	Pigment	Helizarin Binder ET ECO	Cross-linking agent
02		Luprintol MCL	Softener & leveling agent
03		Lutexal HIT	Synthetic thickening agent
01	Disperse/ Reactive	Urea	Humectants
02		Soda ash (Na_2CO_3)	To maintain p^H
03		Resist salt	Oxidative compound
04		Sodium alginate (3-12%) + Guar gum (6-8%)	Natural & Synthetic thickening agent

Printing recipe selection

The printing recipe generally divided into two parts first stock thickening then print paste preparation. Stock thickening & print paste recipe of light, medium & dark shades for both pigment printing & disperse/reactive printing are given respectively.

Stock thickening paste recipe for pigment printing:

Heli. Binder ET ECO	:	180 g/kg
Luprintol MCL	:	25 g/kg
Lutexal HIT	:	21 g/kg
Water	:	774 g/kg

Table 2. Print paste recipe for pigment printing

Dyes & chemicals	Light shade (8.2 g/kg)	Medium shade (15.92 g/kg)	Dark shade (30.87 g/kg)
Heli. Red BT	5.8	11	22.4
Heli. Yellow FFGR	1.7	2.91	5.13
Heli. Royal Blue	0.7	2.01	3.34
Stock paste	Rest of amount		
pH	7.85		
Viscosity	77 Daps		

Stock thickening paste recipe for disperse/reactive (one stage) printing:

Urea	:	30 g/kg
Soda Ash (Na_2CO_3)	:	30 g/kg
Resist salt	:	15 g/kg
Sodium alginate (3-12%) + Guar gum (6-8%)	:	Rest of amount
Water	:	145 g/kg

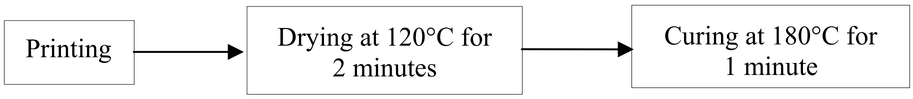
Table 3. Print paste recipe for disperse/reactive (one stage) printing

Dyes & chemicals	Light shade (5.5 g/l)	Medium shade (11.2 g/l)	Dark shade (22.4 g/l)
Dianix Rubine S2G	0.8	1.6	3.2
Dianix Yellow Brown S2R	0.7	1.4	2.8
Dianix Blue SBG	0.6	1.3	2.6
Procion Red PX4B	1.7	3.5	7.0
Procion Golden Yellow PXGR	1.0	2.0	4.0
Procion Brilliant Blue PX3R	0.7	1.4	2.8
Stock paste	Rest of amount		
pH	9-9.5		
Viscosity	77 Daps		

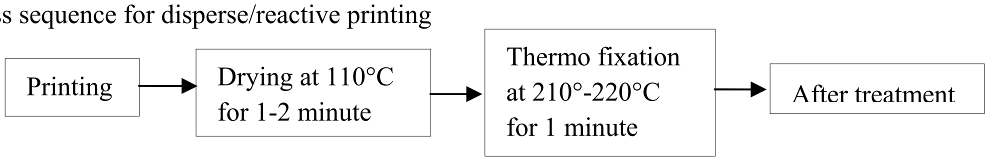
Printing procedure

Printing was carried out using the flat screen as direct style. The Process sequence for both as below:

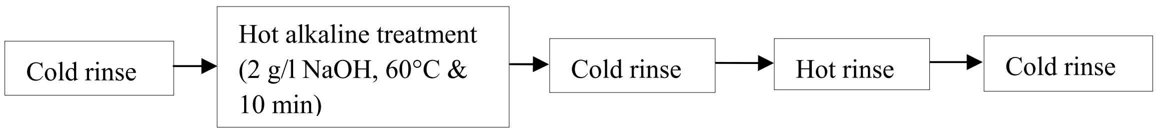
Process sequence for disperse/reactive printing



Process sequence for disperse/reactive printing



Process sequence of after treatment



The pigment printed shades were matched with disperse/reactive printed shades with the help of the correction recipes from Datacolor 650. The accepted ΔE values of pigment printed light, medium and dark shades against the disperse/reactive printed shades were 0.74, 0.69 and 0.73 respectively.

Testing method selection

The test methods were as per standard, suggested by different professional organization and the relevant information is as below.

Table 4. The chemical & physical test conducted on the fabric

Sl No.	Checking parameter	Standard method	Instrument used
1	Color fastness to wash	ISO 105 CO6(C2S)	Gyrowash
2	Color fastness to rubbing	ISO 105 X 12:1994	Crockmeter
3	Color fastness to light	ISO105 B02	Microsol
4	Color fastness to dry cleaning	ISO 105 D01	Launder-Ometer
5	Bending length	BS 3356	Shirley stiffness tester
6	Aerial density	BSEN-12127	GSM cutter

DATA ANALYSIS

Table 5. Color fastness to wash [ISO 105 CO6 (C2S)] results for disperse/reactive and pigment printed sample

Samples / Wash fastness		Disperse/ Reactive printed sample			Pigment printed sample		
		Light shade	Medium shade	Dark shade	Light shade	Medium shade	Dark shade
Rating for staining on the components of multifibre	Di-acetate	5	5	4-5	5	5	5
	Bleached cotton	4-5	4-5	4-5	5	4-5	4-5
	Polyamide	4-5	4-5	4	4-5	4-5	4-5
	Polyester	5	5	5	5	5	5
	Acrylic	5	5	5	5	5	5
	Wool	5	5	5	5	5	5
Rating for color change of the samples		4-5	4-5	4-5	4-5	4-5	4-5

Table 6. Color fastness to rubbing [ISO 105 X 12:1994] results in for disperse/reactive and pigment printed sample

Fabric directions	Samples / Rubbing fastness	Disperse/ Reactive printed sample			Pigment printed sample		
		Light shade	Medium shade	Dark shade	Light shade	Medium shade	Dark shade
Warp way	Rating for dry rub	5	5	5	4-5	4-5	4
	Rating for wet rub	4-5	4-5	4-5	4-5	4	3-4
Weft way	Rating for dry rub	5	5	5	4-5	4-5	4
	Rating for wet rub	4-5	4-5	4-5	4-5	4	4

Table 7. Color fastness to light [ISO105 B02] results for disperse/reactive and pigment printed sample

Samples / Light fastness	Disperse/ Reactive printed sample			Pigment printed sample		
	Light shade	Medium shade	Dark shade	Light shade	Medium shade	Dark shade
Rating	3	4	4	4-5	5	5

Table 8. Dry Cleaning fastness [ISO 105 D01] results (color change) for disperse/reactive and pigment printed Sample

Samples / Dry Cleaning fastness	Disperse/ Reactive printed sample			Pigment printed sample		
	Light shade	Medium shade	Dark shade	Light shade	Medium shade	Dark shade
Rating	5	5	4-5	4	3-4	3-4

Table 9. Bending length [BS 3356] results for disperse/reactive and pigment printed sample

Fabric directions	Samples / Bending length (cm)	Disperse/Reactive printed sample			Pigment dyed sample		
		Light shade	Medium shade	Dark shade	Light shade	Medium shade	Dark shade
Warp way	Face up	2.82	2.88	3	3.48	3.5	3.65
	Face down	2.35	2.35	2.5	3.0	3.18	3.2
	Average	2.585	2.615	2.75	3.24	3.34	3.425
Weft way	Face up	2.3	2.22	2.3	2.48	2.65	2.8
	Face down	2.05	2.15	2.15	2.25	2.48	2.55
	Average	2.175	2.185	2.225	2.365	2.565	2.675

RESULT AND DISCUSSION

From Table 5, a comparison between, color fastness to wash between pigment dyed samples and disperse/reactive dyed samples can be observed in the following figures:

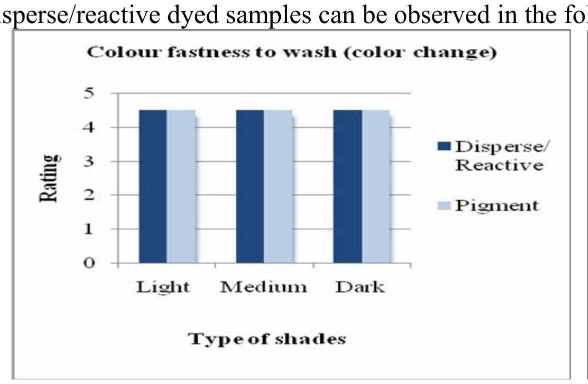


Fig. 1. Color fastness to wash (color change)

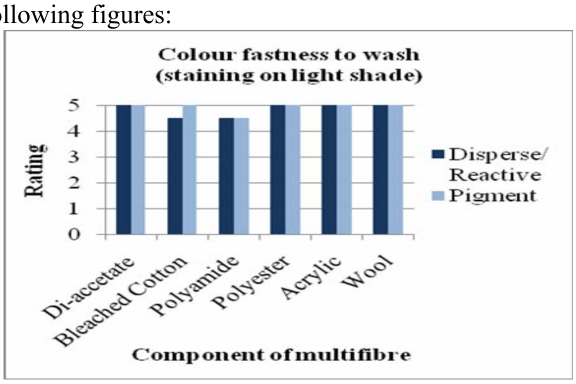


Fig. 2. Color fastness to wash for light shade (staining)

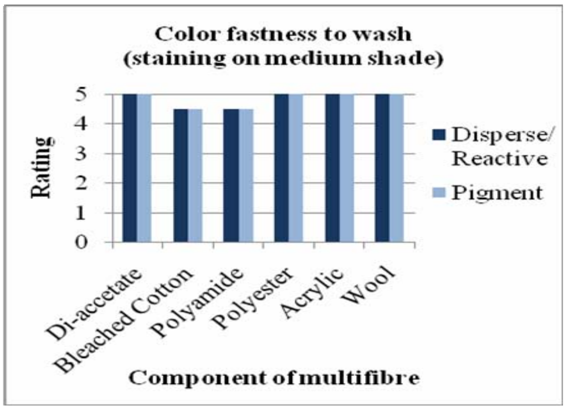


Fig. 3. Color fastness to wash for medium shade (staining)

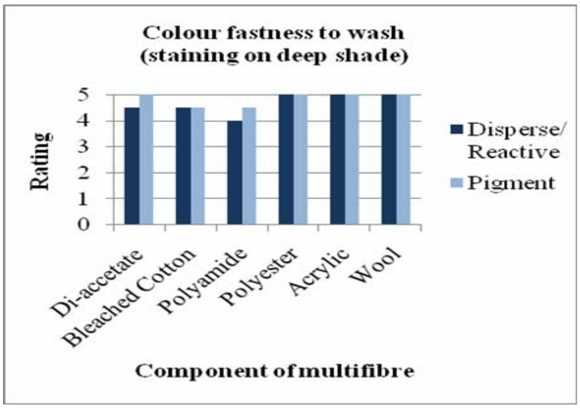


Fig. 4. Color fastness to wash for dark shade (staining)

As can be seen in figure-1, 2, 3 and 4 clearly shows that most of the cases disperse/reactive printed sample and pigment printed samples show the same ratings. However in some cases disperse/reactive shows satisfactory result where as pigment printed sample always excellent. The reasons regarding these phenomenons are pigment is insoluble in water and reactive dyes make covalent bond with fiber and disperse dyes trapped into fiber.

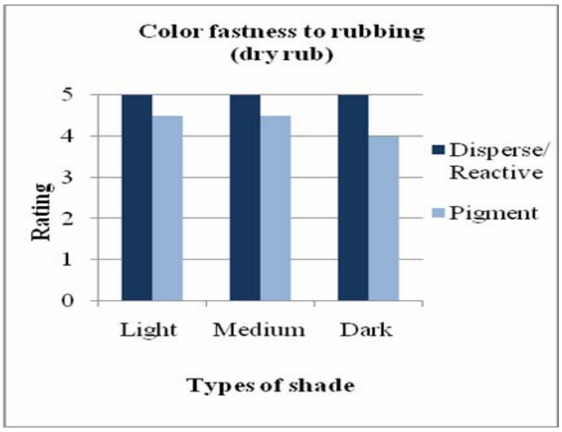


Fig. 5. Color fastness to rubbing (warp way)

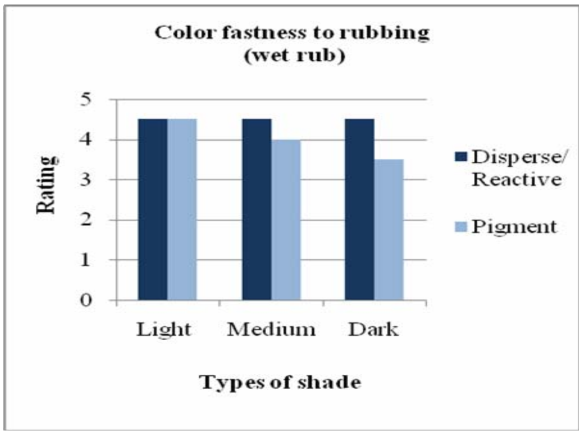


Fig. 6. Color fastness to rubbing (warp way)

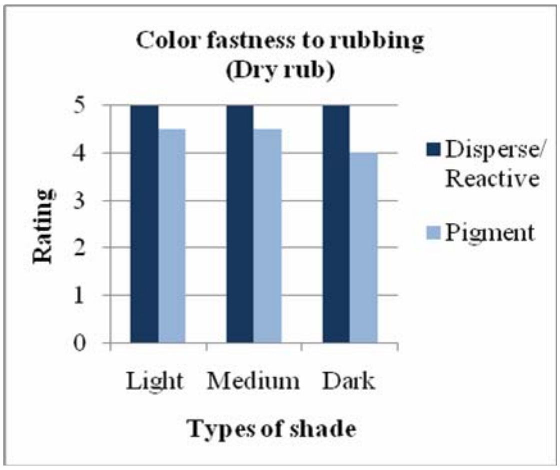


Fig. 7. Color fastness to rubbing (weft way)

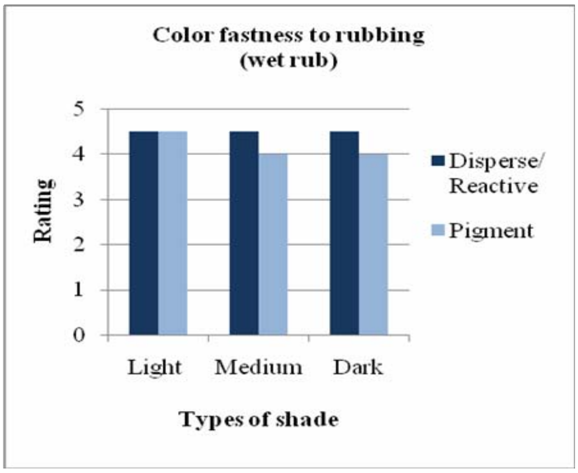


Fig. 8. Color fastness to rubbing (weft way)

But in case of color fastness to rubbing for both dry and wet rub disperse/reactive printed samples show better result than pigment printed samples. Approximately for dry rub 10 to 20% and wet rub 0 to 10% better result were found in disperse/reactive printed samples. Figure-5, 6, 7, 8 and 9 shows the comparative result between disperse/reactive printed samples and pigment printed samples. Especially medium to dark shades of pigment printed sample shows inferior result than the others in all cases as pigment makes a coating on the fabric rather than any chemical bonding and consume enough pigment to hold on the surface (www.specialchem4coatings.com).

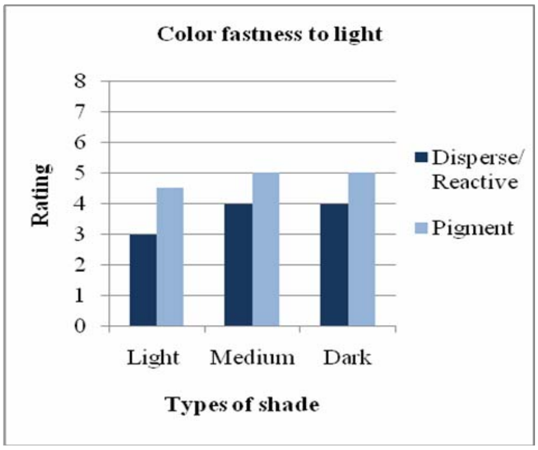


Fig. 9. Color fastness to light

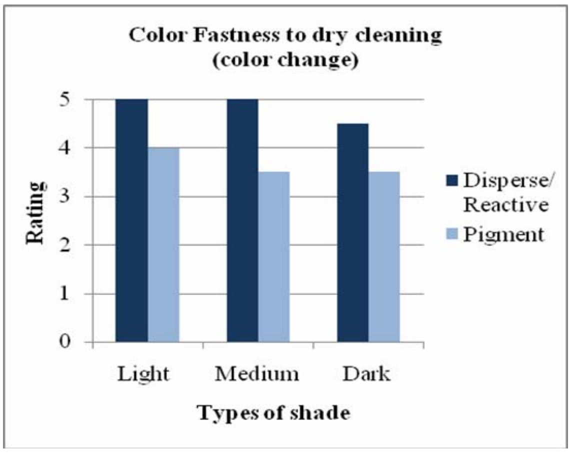


Fig. 10. Color fastness to dry cleaning (color change)

For pigment printed sample around 20% better result was found only in light fastness. As the evidence of this scenario is found in figure-9, light fastness of a pigment printed sample is not only depending on the pigment color but also binder is accountable for this type of result. Binder imparts a varying degree of protection to the pigment.

Again in figure-10, color fastness to dry cleaning be found that disperse/reactive printed samples show better result than pigment printed samples on an average 20 to 30% because the chlorinated hydrocarbons swell binders and hence the cross-linkage between fiber and pigment are decayed.

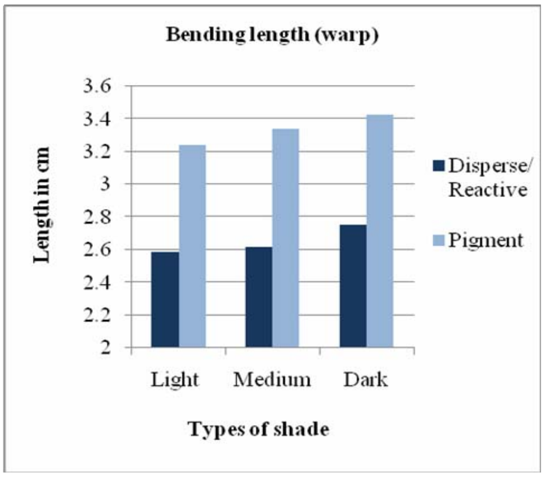


Fig. 11. Color fastness to rubbing (weft way)

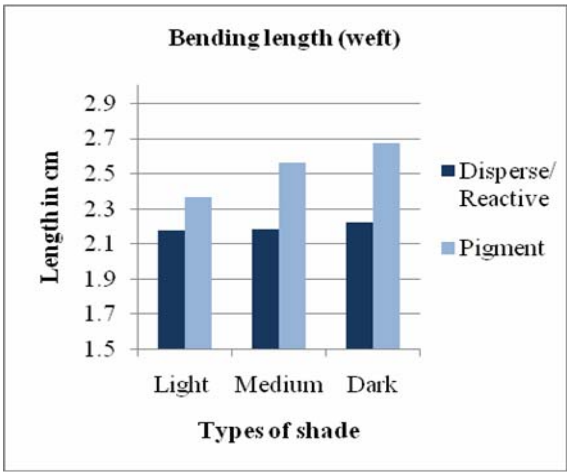


Fig. 12. Color fastness to rubbing (weft way)

From figure-11 and 12, in case of pliability between disperse/reactive and pigment printed samples first one shows lower bending length than the later which indicates that first one is good in pliability and handle as well. The improvement in bending length was found 15.58% as average. Binders which makes external cross-linking, is responsible for that type of result and the fabric become stiffer gradually increase with the amount of binder.

CONCLUSION

In this paper direct printing style was used to compare for a large blotch designed printed sample with two different processes named one dye one stage fixation (pigment printing) and two dye one stage fixation (disperse/reactive printing) on polyester/cotton blend fabric. The analytical result reveals that the later method is a suitable process in respect of all fastness properties, fabric handle and luster. Whereas one dye one stage fixation (pigment printing) process is not possible to print the fabric without sacrificing some properties such as color fastness to rubbing, stiffness (handle) and luster. Again in case of wash fastness there is no significant difference between disperse/reactive printed sample and pigment printed sample where as light fastness for pigment printed sample showed better result than disperse/reactive printed sample. Regarding the rubbing fastness and dry cleaning fastness pigment printing showed lower rating and decrease accordingly for light to darker shade where as disperse/reactive printing possessed better performance. The more bending length depict that the fabric is stiffer which is related to comfort and hand fell properties which was found inferior to pigment printed sample over disperse/reactive printed sample and become more inferior for darker shade. The study also recommends further research on other printing style like discharge and resist printing style for large blotch and small motif. Again it will be a problem if any polyamide material or fabric used with cotton/polyester blend fabric on the way to make it a value added product. Hence more research also needs to be done to resolve this problem.

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