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## DYEING PERFORMANCE OF DIRECT AND REACTIVE DYES IN EXHAUST METHOD ON COTTON KNITTED FABRIC

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### ABSTRACT

Bashar MM, Al Mamun MA, Rahman MM, Siddiquee MAB, Hossain T (2011) Dyeing performance of direct and reactive dyes in exhaust method on cotton knitted fabric. *J. Innov. Dev. Strategy* 5(3), 29-34.

Reactive and direct dyes are very popular choice in dyeing cotton fabric. They have wide range of color gamut. This paper represents the comparative dyeing performance of reactive and direct dyed fabric. Two reactive dyes namely Dychufix Red 6B-XF H/C and Dychufix Brilliant Yellow 4GL and two direct dyes Moder Direct Red BWS and Moder Direct Yellow PG were used respectively. Color fastness to water, washing, perspiration, rubbing and light were measured according to ISO norm. The color strength was measured by spectrophotometer. It was found from the study that color strength of reactive dyes was higher than that of direct dyes. The electrolyte used in dyeing reactive dye was higher than that used in direct dyes. All the wet fastness of direct dye is significantly poor whereas reactive dyed fabric showed the better results in this respect. But color fastness to light of direct dyed fabric is considerably higher than reactive dyed fabric.

**Key words:** color strength, direct dye, exhaust method, knitted fabric, reactive dye

### INTRODUCTION

Direct cotton dyes have inherent substantively for cotton fabric. They are available in full range of hue and can be applied onto the fabric with simple equipment. The major drawbacks of direct dye is their poor wet fastness specially fastness to washing but the color fastness to light of this dyes is poor to excellent depending on the dye class. Yet, there are still many applications of direct dyes in the textile industry particularly where a high standard of wet fastness is not required. Resin finishing after dyeing produces a notable improvement of wash fastness especially on regenerated cellulosic fabrics. The development of specialized after treating agents and cross linking reactants for the selected direct dyes of high light fastness has reached the new level of sophistication. This enables the direct dyes to compete more effectively with reactive dyes in meeting severe wet fastness requirements. On the other hand the application of direct dye can be possible with small amount of electrolytes and neutral bath is sufficient for dye adsorption and fixation onto the fibers (Chattopadhyay *et al.* 2006).

Reactive dyes are well known and widely applicable in different materials. They were the improvement over direct dyes especially for good wet fastness. They form stable covalent bond with the cellulose hence the excellent wet fastness can be achieved. But in reactive dyeing huge amount of electrolyte is used which increases the AOX (Adsorbable halogen) in the effluent and is detrimental for environment. Furthermore, the high concentration (20-100 g/l) of electrolyte and alkali (5-20 g/l) required for dyeing may pose additional effluent problem with the ever increasing popularity of reactive dyes. Environmental problems arising from the reactive dyeing have also become increasingly aggravating. The electrolytes play two vital roles in reactive dyeing *viz.* adsorption of dye molecules onto the fabrics and aggregation of dyestuffs. At the same time covalent bond formation need strong alkaline dye bath condition which need effective means for neutralization. Moreover, a large number of unfixed dyes remain in the dye bath that require efficient wastewater treatment process. Most of the reactive dyes lack from good color fastness to light. This present paper deals with the comparative dyeing performance of reactive and direct dyes in exhaust method (Hauser and Tappa, 2001).

The dyeing performance of both of the dyes was evaluated by measuring the color strength and assessing the color fastness to washing, water, perspiration, rubbing and light of the dyed fabric.

### MATERIALS AND METHODS

#### Materials

##### *Fabric*

Scoured and bleached 100% cotton knit single jersey of 180 GSM fabrics was collected from Dysin Chemical Company BD Lt. and used without any further treatment.

##### *Dyestuffs and chemicals*

##### *Reactive dyes*

- a) Dychufix Red 6B-XF H/C
- b) Dychufix Brilliant Yellow 4GL

##### *Direct dyes*

- a) Moder Direct Red BWS
- b) Moder Direct Yellow PG

Gluber salts ( $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ ) was used as the electrolyte and soda ash ( $\text{Na}_2\text{CO}_3$ ) was used as alkali for fixation of reactive dyes. The dyed samples were washed with soaping agent A340ND and for neutralization diluted acetic acid was. All the above chemicals were collected from Dysin as received.

## Method

### Dyeing with Reactive dyes

100% cotton scoured and bleached knit fabric was dyed with reactive dyes in two hues red and brilliant yellow shade % being 1-4 for both hues. The dyeing was carried out in atmospheric shaking bath dyeing machine at liquor to goods ratio 1:10. The pH of the dye bath was 10 and adjusted with 20 g/l soda ash in each case. Gluber salt was used for exhaustion the amount being 40, 50, 60 and 70 g/l for 1, 2, 3 and 4% shade respectively as recommended by the dye manufacturer. The dyeing continued at 60°C for 60 minutes for each case. The recipe is given in the table 1 and dyeing cycle is given in figure 1.

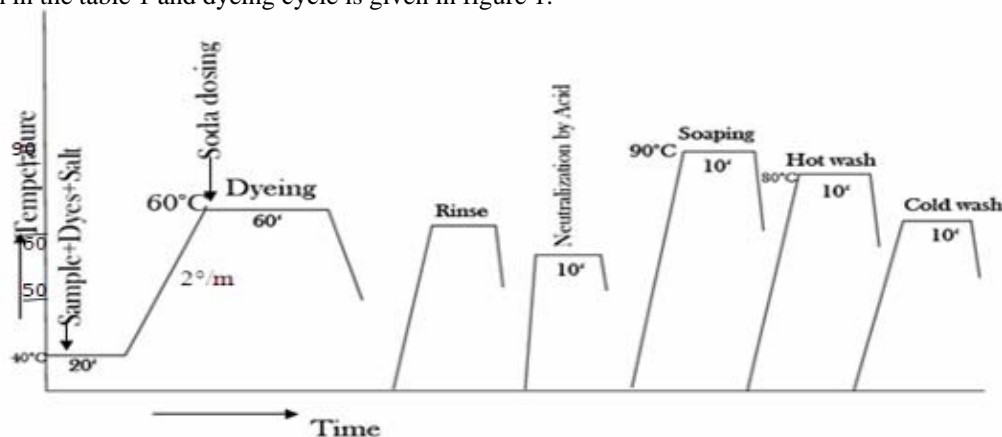


Fig. 1. Dyeing cycle of reactive dye

Table 1. Recipe for dyeing cotton fabric with reactive dyes

Chemicals/Parameters	Amount
100% cotton knit fabric	5 gm
Dychufix Red 6B-XF H/C	1, 2, 3, 4% on the weight of fabric (owf)
Dychufix Brilliant Yellow 4GL	1, 2, 3, 4% on the weight of fabric (owf)
Gluber Salts ( $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ )	40, 50, 60 and 70 g/l
Soda ash ( $\text{Na}_2\text{CO}_3$ )	20g/l
M:L	1:10
Temperature	60°C
Time	60 min
Acetic Acid	1 g/l
Soaping agent	2 g/l

### Dyeing with direct dye

100% cotton scoured and bleached fabric was dyed using direct dyes in an atmospheric shaking water bath dyeing machine keeping material to liquor ratio 1:10. Two hues red and yellow were dyed, the shade% being 1-4. The gluber salt was used as electrolyte at amount 20g/l. The dyeing was continued in neutral pH at 90°C for 60 minutes for each case. The recipe is given in table 2 and dyeing cycle is given in fig. 2.

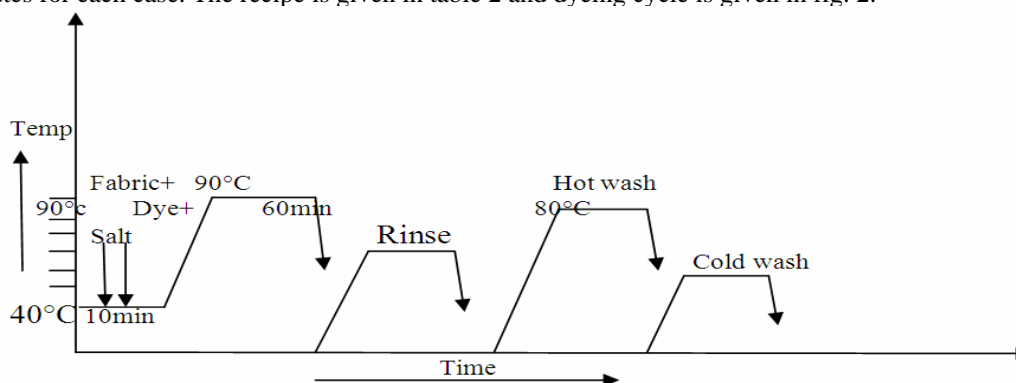


Fig. 2. Dyeing cycle of direct dye

Table 2. Recipe for dyeing cotton fabric with direct dye

Chemicals/Parameters	Amount
100% cotton knit fabric	5 gm
Moder Direct Red BWS	1, 2, 3, 4% on the weight of fabric (owf)
Moder Direct Yellow PG	1, 2, 3, 4% on the weight of fabric (owf)
Gluber Salt ( $\text{Na}_2\text{SO}_4 \cdot 10 \text{H}_2\text{O}$ )	20 g/l
M:L	1:10
pH	7-8
Temperature	90 <sup>0</sup> C
Time	60 minutes
Soaping agent	2 g/l

### Measurement of color strength

The color yield was measured by scanning the dyed sample with spectrophotometer Data color 600 with spectroflash software (www.datacolor.com). All measurements were carried out using D65 illumination, 10<sup>0</sup> standard observers with specular component excluded and UV component included. Each fabric was folded once to give two thicknesses and an average of four readings was taken each time (www.datacolor.com).

### Assessment of color fastness

The color fastness to wash, water, rubbing, perspiration and light were assessed as described in ISO technical manual. Color fastness to wash, water, rubbing, perspiration and light were measured according to ISO 105 C04, ISO 105 E01, and ISO 105 X12, ISO 105 E04 and ISO 105 B02 respectively.

## RESULTS AND DISCUSSION

### Color strength analysis

The color strength of the dyed samples was measured by spectrophotometer. The samples were scanned within the visible wave length and corresponding k/s value was recorded. The spectrum of reactive and direct dyes is shown in fig. 3-6. The color strength increases as the shade% is increased. The color strength of reactive red dye for 1, 2, 3 and 4% shade is 12.22%, 21.40%, 25.93% and 28.04% respectively while the color strength of direct red dye for the same shade is 7.21, 14.90, 18.53 and 21.40% respectively. These data express that color depth of reactive red is greater than the direct red dye for the same shade%.

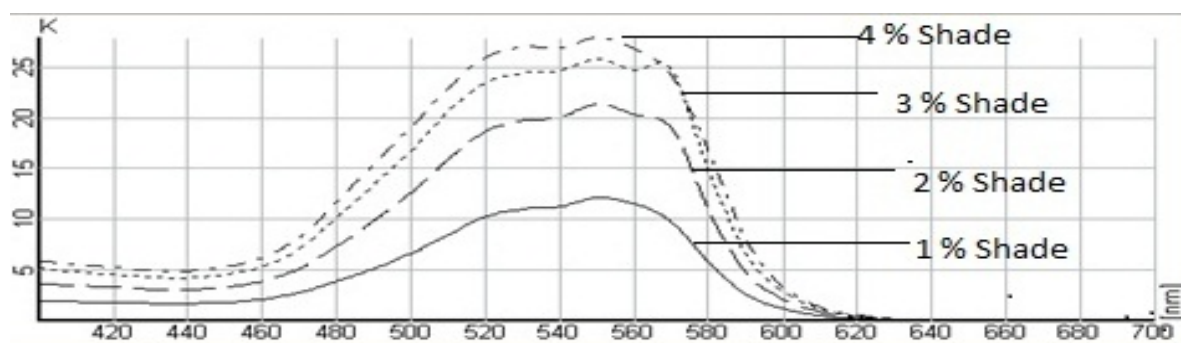


Fig. 3. K/S spectra of Dychufix Red 6B XF-H/C dye

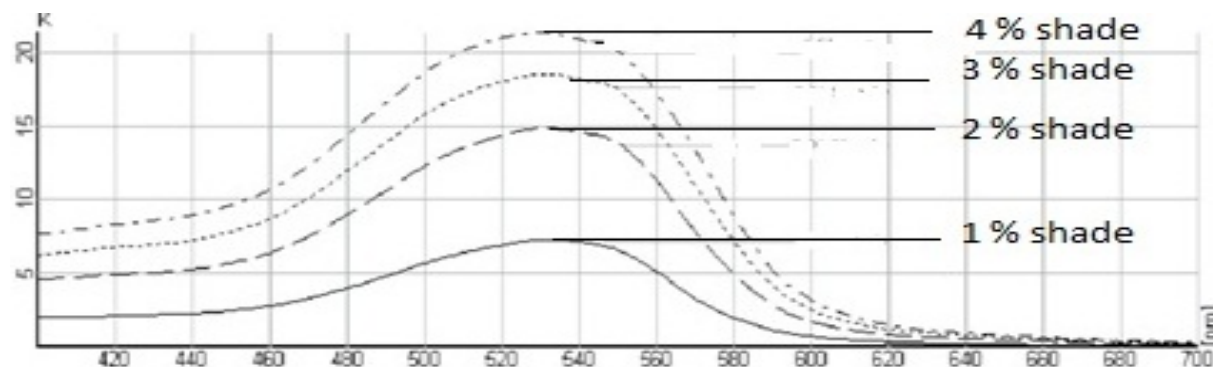


Fig. 4. K/S spectra against wave length of Moder Direct Red BWS

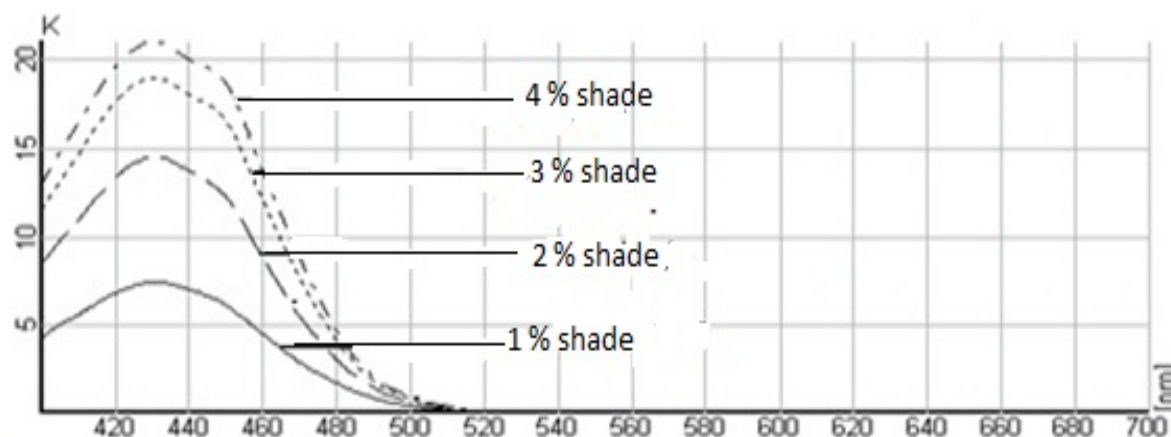


Fig. 5. K/S spectra of Dychufix Brilliant Yellow 4GL

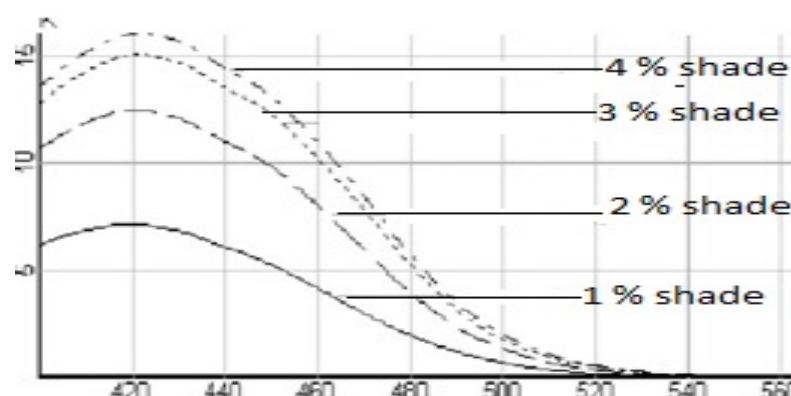


Fig. 6. K/S spectra against wave length of Moder Direct Yellow 4GL

On the other hand the color strength of reactive yellow and direct yellow for 1-4% is 7.39%, 14.49%, 18.96%, 21.03% and 7.14%, 12.48%, 15.13%, 16.14% respectively. So from the above data it is clear that the color depth of reactive yellow is significantly greater than the direct yellow dye in all shade%. From the above data it is obvious that slight less or in some case same color strength can be obtained by direct dyes instead of reactive dyes. The interesting point is that direct dyes require comparatively low electrolytes than the reactive dyes which have great positive effect on effluent management.

### Analysis of fastness properties

#### Color fastness to wash

The color fastness to wash of reactive red dye is 4-5 for color change for all shade% whereas this grading for direct red for color change is 3-4 for 3% and 4% shade. The table 5 and 6 show the fastness grading of reactive red and direct red dye for color change and color staining. The staining on cotton is too poor in direct red dye whose grey scale grading is 1 for 4% shade.

Table 3. Comparative data on color fastness to wash

Shade%	Dychufix Red 6B-XF-H/C		Moder Direct Red BWS		Dychufix Brilliant Yellow 4GL		Moder Direct Yellow PG	
	Color change	Color staining on cotton	Color change	Color staining on cotton	Color change	Color staining on cotton	Color change	Color staining on cotton
1	4-5	3	4-5	1-2	4	4	4	2
2	4-5	2-3	4	1	4	4	4	1-2
3	4-5	2-3	3-4	1	4	3-4	4	1-2
4	4-5	2	3-4	1	4	3-4	4	1-2

But the color change for reactive yellow and direct yellow is same whose value is 4 while the staining on cotton for reactive dye is better than the direct dye. The grading of color change and color staining of reactive yellow and direct yellow is given in table 3.

**Color fastness to water**

The color fastness to water of reactive and direct red dye is same for color change whose value is 4-5 but color staining on cotton for direct red dye is considerably poor (1-2).

Table 4. Comparative data on color fastness to water

Shade%	Dychufix Red 6B-XF-H/C		Moder Direct Red BWS		Dychufix Brilliant Yellow 4GL		Moder Direct Yellow PG	
	Color change	Color staining on cotton	Color change	Color staining on cotton	Color change	Color staining on cotton	Color change	Color staining on cotton
1	4-5	3	4-5	2	4	3-4	4-5	2-3
2	4-5	2-3	4-5	1-2	4	3-4	4-5	2-3
3	4-5	2-3	4-5	1-2	4	3-4	4-5	2
4	4-5	2	4-5	1	4	3-4	4-5	2

Meanwhile the color change of direct yellow is half point greater than the reactive yellow. The grey scale grading of direct yellow for color change is 4-5 while these values for reactive yellow is 4. But color staining on cotton for direct yellow is also poor (2, 2-3) but for reactive yellow it is 3-4, table 5.

**Color fastness to perspiration**

The color change in case perspiration fastness for both reactive and direct red dyes is 4 staining on synthetic fiber is considerably better for both dyes but color staining on cotton is noticeably poor for direct cotton dye for darker shade. The grading is mentioned in table 5.

Table 5. Comparative data on color fastness to perspiration

Shade%	Dychufix Red 6B-XF-H/C		Moder Direct Red BWS		Dychufix Brilliant Yellow 4GL		Moder Direct Yellow PG	
	Color change	Color staining on cotton	Color change	Color staining on cotton	Color change	Color staining on cotton	Color change	Color staining on cotton
1	4	3	4	3	4	4	4	3
2	4	2-3	4	2	4	3-4	4	2-3
3	4	2	4	2	4	3	4	2
4	4	1-2	4	1-2	4	3	4	2

The colour change of the sample is same for both dyes and the rating is 4 but color staining on cotton for direct dyes is poor.

**Color fastness to rubbing**

The color fastness to rubbing of reactive dyed samples is half point greater than the direct dyed samples. The value of dry rubbing of reactive dye is 5 for all shade while the value of that of direct dye is 4-5 for all shades. The wet rubbing of reactive is better than that of direct dyed samples. The lowest value of wet rubbing in case of reactive dye recorded 3-4 for 3% and 4% shade in Dychufix Red 6B-XF H/C. On the other hand the lowest value of wet rubbing for direct dyed samples is recorded 2-3 for 4% shade in Moder Direct Red BWS. The results are tabulated in 6.

Table 6. Comparative data on color fastness to rubbing

Shade%	Dychufix Red 6B-XF-H/C		Moder Direct Red BWS		Dychufix Brilliant Yellow 4GL		Moder Direct Yellow PG	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
1	5	4	4-5	3-4	5	4-5	5	4
2	5	4	4-5	3	5	4-5	4-5	4
3	5	3-4	4-5	3	5	4-5	4-5	4
4	5	3-4	4-5	2-3	5	4	4-5	3-4

**Color fastness to light**

The color fastness to light of reactive dyes and direct dyes is given in figure 7 and 8. Fastness to light is the inherent property of dyes largely depends on the dye chromophoric groups. The light fastness of reactive and direct red dyes was recorded 2-3, 3, 3, 4 and 3-4, 4, 4-5, 4-5 for 1%, 2%, 3%, and 4% shade respectively.

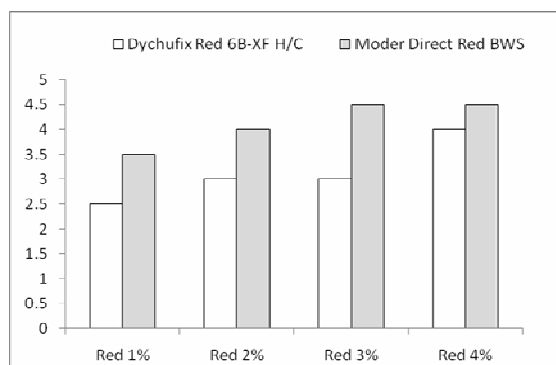


Fig. 7. Color fastness to light of Red hue in Blue wool scale

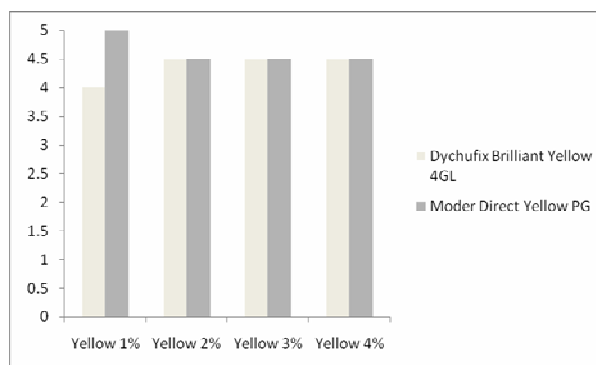


Fig. 8. Color fastness to light of yellow hue in blue wool scale

On the contrary the rating of light fastness yellow hues was recorded higher and better than the red hues both for direct and reactive dyes. The blue wool scale grading of both Dychufix Brilliant Yellow 4GL and Moder Direct Yellow PG is 4 for 1% shade and 4-5 for 2%, 3% and 4% shades.

## CONCLUSION

Comparative analysis of color strength and fastness properties was studied. The color strength of direct dyes was lower in comparison with Dychufix Brilliant Yellow 4GL to Moder Direct Yellow PG. But the color strength of Moder Direct Red BWS was same as the Dychufix Red 6B-XF H/C though direct dyes require fewer electrolytes than the reactive dyes for color adsorption and fixation. The color fastness to light of direct dyed samples was better than that of reactive dyed samples but all other wet fastness is superior for reactive dyes to direct dyes with some fluctuations. So direct dye can be used in such case where no severe wet fastness is not mandatory but require superior light fastness using less amount of electrolyte than the reactive dyes (Burkinshaw *et al.* 2000).

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