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ABSTRACT

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Some important properties of reactive dyeing such as rate of exhaustion, rate of fixation, migration, levelness, and wash fastness to color are responsible to provide fault free and right first time dyeing in production. In this experiment, these important properties were studied on 100% cotton knitted fabric with five reactive dyes by exhaust method. Rate of exhaustion was evaluated by measuring optical density following Lambert- Beer's laws and rate of fixation, migration rating were evaluated by measuring K/S values following Kubelka-Munk equation and levelness and wash fastness to color were evaluated by measuring DE CMC values and color staining to multifibre were established by Spectrophotometer (Data color, 650 TM).In this study it was found that all dyed fabrics showed medium to high exhaustion-fixation, good migration, level dyeing, good wash fastness to color. This study showed that these dyes were adequate to provide fault free and right first time dyeing in production and could reduce effluent cost.

Key words: *reactive dyes, exhaustion, fixation, migration, levelness*

INTRODUCTION

Reactive dye is a dye that, under suitable conditions, is capable of reacting chemically with a substrate to form a covalent dye-substrate linkage (Forhad 2009). A dye must be soluble in the application medium, usually water, at some point during the coloration process. It will also usually exhibit some substantivity for the material being dyed and be absorbed from the aqueous solution. Dyeing usually involves contact between an aqueous solution or dispersion of the dyes and the textile material, under conditions that promote substantivity and produce uniform coloration throughout. The objective of dyeing is to color the entire material so that the dye has completely penetrated into the fibers and the visible surface has a completely uniform color. Good penetration of the dyes ensures optimum fastness properties (Broadbent 2011). Cotton is the most important textile fiber in the world and the backbone of the world's textile trade. It is attached to the seeds of plants of the Mallow family and main composition is cellulose (Cook 2012). It is convenient to write as a simple representation of cellulose: cell-OH. In fact, cotton is called king cotton, because of the versatility of its use and certain of its properties. Fibers of cotton is spun into yarn and later woven or knitted into cloth (Shenai 1980). Currently about one-third of the money spent on dyes for cellulose is spent on reactive dyes; ca. 30% more than for any other class of dyes for any fiber. Several factors might account for some of this dominance, including high consumption of cotton, consumer demand for bright colors, high wet fastness and most importantly, the high relative cost per kg of reactive dyes (Aspland 1997). A reactive dye may be represented by R-B-X(irrespective of the chemicals class to which it belongs), where R is the chromogen (color-producing part), X is the reactive system and B is the bridging group, linking the other two. When the dye reacts with a fiber F, it forms R-B-X-F, of which the X-F is the co-valent bond (Shenai 1997). In this case, both atoms(fiber and dyes) donate an electron to the bond and the resulting pair of electrons is shared between them. Such bonds share a large amount of energy and it requires even more energy to tear them apart again (Aspland 1997). The relatively simple procedure for batch dyeing of cotton materials with reactive dyes developed by Rattee and Stephan, is still used for all types of reactive dyes irrespective of their particular reactive group. Dyeing is commenced in neutral solution, often in the presence of salt to promote exhaustion of the dye onto the cotton. During this period, the dye does not react with the fiber and migration from fiber to fiber is possible. Then, an appropriate alkali is added to the dye bath to increase its P^H. This initiates the desired dye-fiber reaction. The hydroxyl groups in cellulose are weakly acidic and absorption of hydroxide ions causes some dissociation, forming cellulosate ions. It is these that react with the fiber by neucleophilic addition or substitution. In general, the lower the reactivity of the reactive group of the dye towards the alkaline cellulose, the higher the final dyeing temperature and the higher the final P^H of the dye bath. Unfortunately, under the alkaline conditions necessary for the dye-fiber reaction, hydroxide ions also react with the reactive group of the dye in much the same manner as the cellulosate ion. This produces the hydrolyzed dye, which is incapable of reaction with the fiber. Hydrolysis of the dye is slower than the fixation process. After dyeing any un-reacted and hydrolyzed dye present in the cotton must be removed by thorough washing (Broadbent 2011). But one of the major problems in exhaust dyeing with many reactive dyes is the rather low level of fixation, particularly when dyeing, using a higher liquor ratio. Often less than 70% of the original dye reacts with the fiber. This results in appreciable dye concentrations in the dye house effluent. This environmental problem is compounded if high salt concentrations are also present. Therefore, in winch dyeing, reactive dyes of higher substantively are preferred. In recent years, there has been a considerable shift to dyeing with reactive dyes on machine with low liquor ratios. This gives more efficient dyeing and reduces the consumption of dyes, salt and alkaline (Broadbent 2011). For many years, the textile dyeing industry was a major source of water pollution. Effluent treatment before discharge will be required, with increasing cost to the textile industry and color is visible pollution, while it may not be toxic, color does reduce light transmission into waters and limit photosynthesis. The dyeing industry discharges about 9% of the dye-stuffs it consumes. This corresponds to a considerable degree of color in dye house effluents. Dyes are not easily biodegraded since, by design; they have good stability towards light and various chemical treatments. Most dyes are not of high toxicity and are eventually removed from water by oxidation or adsorption or sediment, but presence of color in the water from a dye house is undesirable. It is a strong indication of the presence of much higher quantities of dyeing assistants (Broadbent 2011). So proper utilization of reactive dyes it is essential to know the properties of reactive dyes such as exhaustion, fixation, migration, levelness and wash fastness to color so that to provide fault free dyeing and right first time dyeing reduce effluent cost.

EXPERIMENTAL AND MATERIALS

Scoured and bleached cotton knitted single jersey fabric, 160 GSM is supplied by BHB group.

Dyestuffs and chemicals

Five reactive dyes namely C.I. Reactive Yellow 176(Drimaren Yellow CL-2R), C.I. Reactive Orange 16(Drimaren Orange CL-3R), C.I. Reactive Red 241/195(Drimaren Red CL-5B), C.I. Reactive Blue 160(Drimaren Blue CL-BR), C.I. Reactive Blue 256(Drimaren Blue HF-2B), C.I. Reactive Black 5 (Drimaren Navy CL-R). Chemicals, Ladipur SP. Glauber's salt, Sodium Carbonate, Acetic acid (lab. quality).

Dyeing condition

Dye bathes are prepared following dye-stuffs manufacturer's recommendation, 1% and 2% shades for all dyes with liquor ratio 1:10, isothermal 60 degree cent.

Measurements and analysis

Dye exhaustion

For determination of exhaustion percentage of each dyes, dye solutions are collected after 10, 20, 30, 40, 50, 60 and 70 min from dye bath and optical density of each solution is calculated following the formula ex% = a-b/a*100. (a= initial optical density, b=optical density after 10 min)

Dye fixation

For measuring K/S, four dye baths are prepared for each dye stuffs at 2per cent shade and dyeing is continued for 5 min, 15 min, 45 min and 60 min after adding alkali respectively. Then all of the samples are soaped and dried and the K/S values are measured by Spectrophotometer (Datacolor, 650 TM).

Migration

Bathes are prepared with salt and dyes according to 1% shade, the temperature is raised to 60 degree cent. And two samples A and B are allowed to run 30 min in the bath and sample A is taken out and another sample, sample C is run another 30 min. Then sample B and C are taken out. Here A is the first 30 min salt phased sample, B is the 60 min salt phased sample and C is the last 30 min salt phased sample. All samples are dried and K/S are measured by using spectrophotometer.

Levelness

For levelness evaluation fabrics are dyed with five reactive dyes following 2% shade and DE CMC values are measured on four different places of the dyed fabric, where one value was standard, others were batches and calculate mean value of the batches.

Wash fastness to color

The dyed fabrics are tested according to ISOCO6C2S method. The test specimen and multifibre are sewed and immersed into an aqueous solution containing 4 g/l ECE non phosphate detergent, 1 g/l Sodium carbonate, 1 g/l Sodium perborate, 25 steel balls, at 60 degree cent. With liquor ratio 1:50, 30 min., the samples are then removed, rinsed in hot and cold bi-distilled water. Evaluation of the wash fastness is established using Spectrophotometer for the color change in color for dyed samples and staining for multifibre.

RESULTS AND DISCUSSION

Table 1. Exhaustion % of Reactive Dye

Dye name	After 10 min	After 20 min	After 30 min	After 40 min	After 50 min	After 60 min	After 70 min
Drimaren Yellow CL-2R	48.36	54.72	55.88	60.12	66.11	76.10	78.11
Drimaren Orange CL-3R	76.82	86.04	86.39	88.80	89.14	90.00	90.31
Drimaren Red CL-5B	52.80	53.84	57.90	60.32	63.51	64.75	66.43
Drimaren Navy CL-R	16.33	25.35	30.39	35.12	45.66	68.34	71.33
Drimaren Blue CL-BR	51.42	52.91	53.51	56.19	60.32	65.22	77.94
Drimaren Blue HF-2B	58.46	59.87	62.08	67.96	72.33	76.02	79.32

In above table it is understood that exhaustion percentages of Drimaren Yellow CL-2R, Drimaren Red CL-5B, Drimaren Blue CL-BR, Drimaren Blue HF-2B are medium and exhaustion percentage of Drimaren Orange CL-3R is high but exhaustion percentage of Drimaren Navy CL-R initially is low, after 70 min is medium.

Table 2. Evaluation of Fixation by measuring K/S value

Dye name	After 5 min	After 15 min	After 45 min	After 60 min	After 70 min
Drimaren Yellow CL-2R, at 440 nm	5.23	5.80	7.87	8.62	9.00
Drimaren Orange CL-3R, at 500 nm	5.68	6.28	7.13	8.02	11.80
Drimaren Red CL-5B, at 550 nm	4.30	5.21	6.13	7.00	8.48
Drimaren Navy CL-R, at 600 nm	10.0	13.50	16.5	19.10	22.0
Drimaren Blue CL-BR, at 600 nm	1.92	2.05	3.02	4.15	5.10
Drimaren Blue HF-2B, at 620 nm	4.0	4.20	5.18	5.5	6.50

In this table it is seen that fixation behavior of all dyes are good but fixation of Drimaren Blue CL-BR is low. Fixations of Drimaren Navy CL-R and Drimaren Orange CL-3R are high. Higher the value of K/S deeper the color.

Table 3. Levelness evaluation of Reactive Dye

Dye Name	Reading 1	Reading 2	Reading 3	Average DE CMC Value
Drimaren Yellow CL-2R	0.08	0.05	0.07	0.067
Drimaren Orange CL-3R	0.09	0.04	0.06	0.063
Drimaren Red CL-5B	0.12	0.09	0.20	0.18
Drimaren Blue HF-RL	0.08	0.05	0.07	0.067
Drimaren Navy CL-R	0.06	0.08	0.10	0.08
Drimaren Blue CL-BR	0.12	0.10	0.11	0.11
Drimaren Blue HF-2B	0.06	0.04	0.07	0.057

From above table it is clearly seen that all fabrics are dyed evenly with five dyes. For evaluation levelness of the dyed fabrics, four DE CMC values are measured; one value is standard and others three values are batches. Mean values of the batches are recorded.
CMC DE Value (D65 10 deg)
(Measured by Spectrophotometer 650 TM)

Table 4. Evaluation of Migration rating of Reactive Dye

Dye name, wave length in nm	Sample A First 30min	Sample B Total 60min	Sample C Last 30min	Difference between B & C	Migration rating	Comments
Drimaren Yellow CL-2R, at 440	5.55	4.40	3.65	0.45	4.2	Good
Drimaren Orange CL-3R, at 500	7.60	6.85	2.83	4.02	1.5	Poor
Drimaren Red CL-5B,at 550	5.55	4.24	3.18	1.06	4.0	Good
Drimaren Navy CL-R, at 610	8.10	6.10	5.90	0.20	4.3	Good
Drimaren Blue CL-BR, at 600	3.45	2.60	2.50	0.10	4.4	Excellent
Drimaren Blue HF-2B, at 620	3.20	2.45	1.55	0.90	4.1	Good

In this table it is clearly seen that except Drimaren Orange CL-3R all dyed fabric show good to excellent migration rating. Sample B and Sample C should be closed; when B and C equal then migration rating is 4.5. Here rating has been done manually (Aspland 1997).

Measuring K/S by spectrophotometer (Data color, 650 TM)

Table 5. Wash fastness to color of reactive dye

Dye name	Shade change	Staining on multifibre					
		Triacetate	Cotton	Polyamide	Polyester	Acrylic	Viscose
Drimaren Yellow CL-2R	4.01	4.42	4.23	4.22	4.43	4.24	4.40
Drimaren Orange CL-3R	4.33	4.46	3.22	4.34	4.68	4.72	4.10
Drimaren Red CL-5B	3.18	4.54	4.39	4.42	4.79	3.81	4.73
Drimaren Navy CL-R	4.56	4.19	3.62	3.56	4.16	4.16	4.18
Drimaren Blue CL-BR	3.69	3.73	4.65	4.35	4.67	4.62	4.56
Drimaren Bue HF-2B	3.51	4.01	4.43	4.44	4.71	4.65	4.50

In this table it is understood that shade change of Drimaren Yellow CL-2R, Drimaren Orange CL-3R, Drimaren Navy CL-R are good and shade change of Drimaren Red CL-5B, Drimaren Blue CL-BR, Drimaren Blue HF-2B are medium. Staining of multifibre of all dyes is good. Domestic Laundering ISO CO6C2S Method

Shade change and staining on multi fibre are measured by Spectrophotometer (Data color, 650 TM)

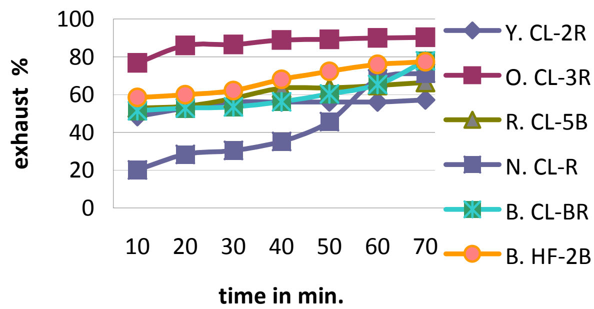

Fig. 1. Rate of exhaustion %

In this figure it is clearly stated that substantivity and exhaustion percentage of Drimaren Yellow CL-2R, Drimaren Red CL-B, Drimaren Blue CL-BR and Drimaren Blue HF-2B are medium but Drimaren Orange CL-3R is high substantive and high exhaustion percentage dyes and Drimaren Navy CL-R is low substantive and medium exhaustion percentage dyes.

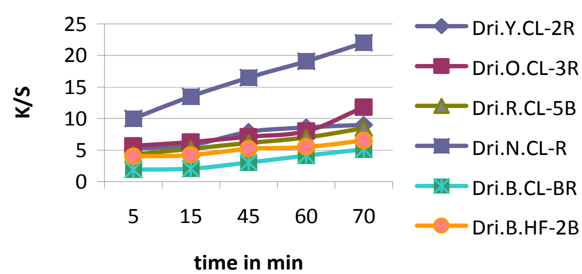

Fig. 2. Rate of fixation

In this figure it is easily described that Drimaren Navy CL-R is dark color than others and rate of fixation is also good. Others are medium to high fixation dyes and rate of fixation are also good.

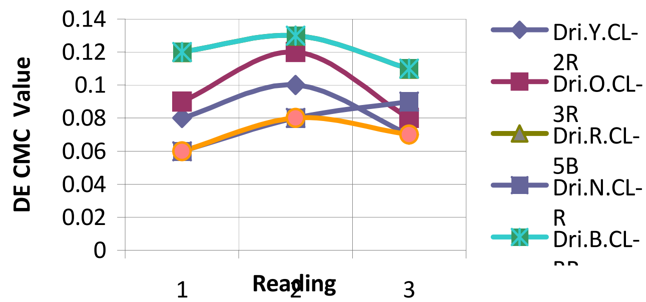

Fig. 3. Levelness evaluation

In above figure it is clearly understood that all dyed fabrics are evenly dyed because variation of DE CMC values of different places are not much.

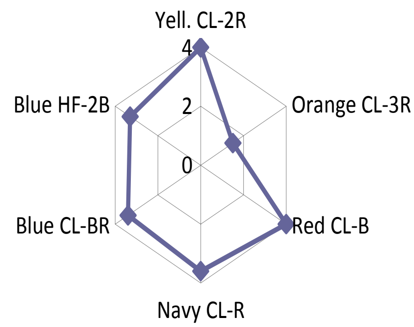

Fig. 4. Migration rating evaluation

In above figure it is clearly understood that migration values of all dyes except Drimaren Orange CL-3R are good.

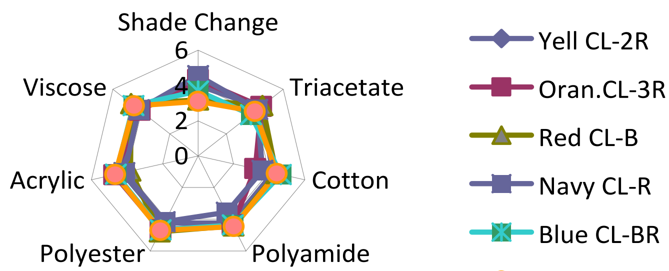

Fig. 5. Wash fastness to color

In above figure it is showed that shade change range of Drimaren Red CL-B, Drimaren Blue HF-2B and Drimaren Blue CL-BR is 3 to 4, other's is 4 to 5. The range of staining on multifibre of all dyes except Drimaren Orange CL-3R and Drimaren Navy CL-R is 4 to 5, so they are good dye-stuff.

CONCLUSION

In order to know dyeing properties such as rate of exhaustion, rate of fixation, migration rating, evenness and wash fastness to colour of five reactive dyes were studied in this research work on 100% cotton knit fabric by exhaust method. Drimaren Yellow CL-2R, Drimaren Red CL-B, Drimaren Blue CL-BR and Drimaren Blue HF -2B showed medium exhaustion and fixation behavior, good migration rating, level dyeing and good wash fastness to color. Drimaren Orange CL-3R showed high exhaustion – fixation behavior, poor migration rating, level dyeing and good wash fastness to colour. Drimaren Navy CL-R showed initially low but later medium exhaustion-fixation behavior, good migration rating, level dyeing and good wash fastness to colour. So before going to bulk dyeing evaluating dyeing properties of reactive dye-stuffs and selecting high exhaustion-fixation dye-stuffs easily we can reduce re dyeing percentage and increase effluent efficiency and minimizes effluent cost.

REFERENCES

Aspland JR (1997) Textile Dyeing and Coloration, Americal Association of Textile Chemists And Colorists, 11-15, 32-33.

Broadbent AD (2011) Basic Principle of Textile Coloration, Society of Dyers and Colorists, 11-15,32-33,147,335-336,342-346.

Cook JJ (2012) Hand Book of Textile Fibres, Volume:1, Natural Fibre, Woodhead Publishing Limited, 35.

Forhad HM (2009) Practice of Textile Coloration, Books Fair Publication, 330.

Shenai VA (1980) Technology of Textile Processing, Volume 1, Textile Fibre, Sevak Publications, 2.

Shenai VA (1997) Technology of Textile Processing, Vlume II, Chemistry of Dyes and Principles of Dyeing, Sevak Publication, 518.