INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2001/03–1–109–112
http://www.ijab.org

Rubbing, Ironing and Dry Cleaning Fastness of Reactive Dyed Cotton Knitted Fabric as Influenced by Salt, Alkali and Dye

MUHAMMAD IFTIKHAR, NISAR AHMAD JAMIL AND BABAR SHAHBAZ
Department of Fibre Technology, University of Agriculture, Faisalabad–38040, Pakistan

ABSTRACT

The study was conducted to investigate the effect of salt, alkali and dye concentrations on the rubbing, ironing and dry cleaning fastness of reactive dyed cotton knitted fabric. The results revealed that excellent results for rubbing, ironing and dry cleaning fastness were achieved at minimum concentrations of salt, alkali and dye.

Key Words: Cotton knitted fabric; Salt; Alkali; Dye

INTRODUCTION

Dyeing of cloth has the economic advantage of avoiding storage of fibers and yarns of varied colors. It makes easier to meet demands of the customer for a wide variety of shades, which are subject to rapid changes dictated by fashion. Reactive dyes are the only textile colorants designed to bond covalently with the substrate on application. These comprise a chromophore and a reactive group, and owe their excellent wet fastness to the formation of covalent bonds with the fiber. Accordingly, they differ fundamentally from other coloration products, which depend on physical adsorption or mechanical retention and in some ways can be regarded as the high tech end of the textile dyeing business. In knitwear industry, dyeing of cotton knitted fabrics is mostly done with reactive dyes, because of their good fastness properties and versatility of applications. The ease of application, wide shade range, high brilliancy and excellent wet fastness properties make the reactive dyes preferred choice for the dyeing of cellulosic fabrics.

In reactive dyeing, the dyeing process can be broadly divided into two phases, namely exhaustion and fixation. The process is lengthy, because much time is spent on the controlled heating of dye bath and portion wise addition of salt and alkali in order to avoid unlevel dyeing and maximizing the exhaustion and fixation. This paper describes the influence of salt, alkali and dye concentration on rubbing, ironing and dry cleaning fastness of reactive dyed cotton knitted fabric.

MATERIALS AND METHODS

The present research work was carried out partially in the Department of Fiber Technology, University of Agriculture, Faisalabad and partially in the Masood Textile Mill (Pvt.) Ltd. Faisalabad (MTM). Single jersey fabric from 24^s combed yarn having knitting construction as 47 courses and 38 wales per inch was selected from the running material at MTM. The fabric was given necessary pre-treatments for further dyeing process in the dye house of MTM. The pre-treatments given to the gray cotton knitted fabric include scouring and bleaching processes, exhaust method was used in this treatment as described by Anonymous (1990) and Iftikhar *et al.* (2001). All the tests of dyed fabric for rubbing, ironing and dry cleaning fastness were performed according to International Standard Organization (ISO) rating.

RESULTS AND DISCUSSION

Rubbing fastness. The gray scale rating for red samples was 4 (very good) for dry rubbing and 3-4 (good to very good) for wet rubbing at A_1 and A_2 and S_1 and S_2, but at increased alkali concentration (A_3), the rubbing fastness increased as 4-5 (very good to excellent) for dry and 4 (very good) for wet for red samples and 4-5 to 5 for blue and yellow samples (Table I). The results confirm the findings of Fujio and Akira (1987) who recommended the use of fixing agent (alkali) for dyed cellulosic materials to improve their wet fastness properties. While, Mifumi and Rumiko (1989) reported that color fastness of reactive dyed cotton fabrics was improved on treatment with fixing agent. Whereas, Warner (1955) concluded that color fastness was complicated and difficult to evaluate, it depends not only upon the nature of coloring matter but also on the fiber composition of textile material and the method used in dyeing. Whereas, by increasing both salt and alkali concentration (S_3, A_3), the gray scale rating was 5 (excellent) for both dry and wet rubbing for yellow and blue samples and 4-5 (very good to excellent) for red samples as described previously (Imada & Harada, 1992). Similarly, Lidyard *et al*. (1992) reported that the substantitivity of reactive dye can be controlled by altering the electrolyte concentration. While, Kamel *et al*. (1992) narrated that sodium carbonate is added for the constant control of pH

value to neutralize the liberated HCl during the reaction.

Table I. Effect of salt alkali and dye concentration on the rubbing fastness of reactive dyed cotton knitted fabric

Variables			Red		Blue		Yellow	
Salt	Alkali	Dye	Dry	Wet	Dry	Wet	Dry	Wet
		D_1	4	3-4	4-5	4	4-5	4
	A_1	D_2	4	3-4	4-5	4	4-5	4
		D_3	4	3-4	4-5	4	4-5	4
		D_1	4	3-4	4-5	4	4-5	4
S_1	A_2	D_2	4	3-4	4-5	4	4-5	4
		D_3	4	3-4	4-5	4	4-5	4
		D_1	4-5	4	5	4-5	5	4-5
	A_3	D_2	4-5	4	5	4-5	5	4-5
		D_3	4-5	4	5	4-5	5	4-5
		D_1	4	3-4	4-5	4	4-5	4
	A_1	D_2	4	3-4	4-5	4	4-5	4
		D_3	4	3-4	4-5	4	4-5	4
		D_1	4	3-4	4-5	4	4-5	4
S_2	A_2	D_2	4	3-4	4-5	4	4-5	4
		D_3	4	3-4	4-5	4	4-5	4
		D_1	4-5	4	5	4-5	5	4-5
	A_3	D_2	4-5	4	5	4-5	5	4-5
		D_3	4-5	4	5	4-5	5	4-5
		D_1	4	3-4	4-5	4	4-5	4
	A_1	D_2	4	3-4	4-5	4	4-5	4
		D_3	4	3-4	4-5	4	4-5	4
		D_1	4	3-4	4-5	4	4-5	4
S_3	A_2	D_2	4	3-4	4-5	4	4-5	4
		D_3	4	3-4	4-5	4	4-5	4
		D_1	4-5	4-5	5	5	5	5
	A_3	D_2	4-5	4-5	5	5	5	5
		D_3	4-5	4-5	5	5	5	5

Standard gray scale rating: 5= Excellent; 4= Very good; 3= Good; 2= Moderate; 1= Poor;
Salt concentrations: S_1= 30%, S_2= 40%, S_3= 50%
Alkali concentrations: A_1= 10%, A_2= 20%, A_3= 30%
Dye concentrations: D_1= 1%, D_2= 2%, D_3= 3%

Table II. Effect of salt alkali and dye concentration on the ironing fastness of reactive dyed cotton knitted fabric

Variables			Red		Blue		Yellow	
Salt	Alkali	Dye	Dry	Wet	Dry	Wet	Dry	Wet
		D_1	5	4-5	4-5	4	5	4-5
	A_1	D_2	5	4-5	4-5	4	5	4-5
		D_3	5	4-5	4-5	4	5	4-5
		D_1	5	4-5	4-5	4	5	4-5
S_1	A_2	D_2	5	4-5	4-5	4	5	4-5
		D_3	5	4-5	4-5	4	5	4-5
		D_1	4-5	4	4	4	4-5	4
	A_3	D_2	4-5	4	4	4	4-5	4
		D_3	4-5	4	4	4	4-5	4
		D_1	4-5	4	4-5	4	4-5	4
	A_1	D_2	4-5	4	4-5	4	4-5	4
		D_3	4-5	4	4-5	4	4-5	4
		D_1	4-5	4	4-5	4	4-5	4
S_2	A_2	D_2	4-5	4	4-5	4	4-5	4
		D_3	4-5	4	4-5	4	4-5	4
		D_1	4	4	4	4	4	4
	A_3	D_2	4	4	3-4	3-4	4	4
		D_3	4	4	3-4	3-4	4	4
		D_1	4-5	4	4-5	4	4-5	4
	A_1	D_2	4-5	4	4-5	4	4-5	4
		D_3	4-5	4	4-5	4	4-5	4
		D_1	4-5	4	4-5	4	4-5	4
S_3	A_2	D_2	4-5	4	4-5	4	4-5	4
		D_3	4-5	4	4-5	4	4-5	4
		D_1	4	4	3-4	3-4	4	4
	A_3	D_2	3-4	3-4	3-4	3-4	3-4	3-4
		D_3	3-4	3-4	3-4	3-4	3-4	3-4

Standard gray scale rating: 5= Excellent; 4= Very good; 3= Good; 2= Moderate; 1= Poor;
Salt concentrations: S_1= 30%, S_2= 40%, S_3= 50%
Alkali concentrations: A_1= 10%, A_2= 20%, A_3= 30%
Dye concentrations: D_1= 1%, D_2= 2%, D_3= 3%

Ironing fastness. The gray scale rating was 4-5 (very good to excellent) for dry and 4 (very good) for wet ironing for blue samples at A_1, A_2, and S_1, S_2, but at increased concentrations (S_3, A_3), the gray scale rating was 4 (very good) for both dry and wet hot pressing for blue samples (Table II). However, at S_3 and A_3, the gray scale rating was 3-4 for both wet and dry ironing for blue samples. Similar trend is observed for red and yellow samples. Therefore, increased concentration of salt resulted in inferior ironing fastness as also reported by Anonymous (1994) due to the aggregation of dye molecules, precipitation of heavy metals sulphate and chlorides. The heavy metal concentration is present in hard water. Furthermore, Eltzer (1979b) reported variable factors that influenced the exhaustion of dyeing including the type and amount of salt, alkali, and dye. By the accumulative effect of suitable salt concentration, temperature and pH value, it was possible to arrive at the same end result. Change in color due to hot pressing of fabric can be either temporary or permanent, and the degree of color change depends on whether the pressing is carried out in dry, damp or wet state (Taylor, 1972).

Under minimum salt concentration (S_1) and at A_1 and A_2 the gray scale rating was 5 for dry and 4-5 for wet ironing for red and yellow samples, while the gray scale rating was 4-5 for dry and 4 for wet pressing. However, at A_3, the gray scale rating remained 4-5 for dry and 4 for wet pressing. Similar trend was observed for S_2 and S_3 i.e. the fastness to ironing deteriorated by increasing the concentration of alkali. The gray scale rating indicates that at A_3 and S_3, the ironing fastness decreased from 4 to 3-4 for red and yellow samples and 3-4 for blue samples. Previously, Beckman and Hoffmann (1977) recorded the parameter controlling the production of level dyeing. Those were amount of dye, pH, levelling agents etc. With the increase of salt and alkali (S_2, A_3) and D_1, D_2, D_3, the gray scale rating was 3-4 (good to very good) for both dry and wet hot pressing for blue samples but for red and yellow

samples the gray scale rating was 4-5 and 4 for dry and wet pressing, dye and alkali concentration. The present result confirms the finding of Lidyard *et al.* (1992) who reported that substantitivity increased as liquor ratio is reduced. The electrolyte concentration could also be reduced in direct proportion while maintaining the same equilibriums substantitivity value. Likewise, Sheikh (2000) stated that reactive dyes have low molecular weight, if large quantities of salt is added unlevelness in dyeing may appear as a result of quick exhaustion of the dye stuff.

Dry cleaning. Overall gray scale rating for both change of shade and staining ranged from 4 (very good) to 4-5 (very good to excellent; Table III). At S_1 and A_1, the best results (gray scale rating 4-5) of dry cleaning fastness were achieved with the minimum concentration of dye D_1. On the other hand, at A_3, the best results are observed at D_3. Similar results are recorded at S_2, S_3. Very good to excellent dry cleaning fastness (gray scale rating 4-5) obtained with D_1 at 10% alkali indicates that the pH level must be kept as low as possible in order to minimize the consumption of dyes and to achieve better dry cleaning fastness. This evidence gets some favor from Anonymous (1999) who mentioned that increasing quantities of alkali would favor maximum reaction between dye and fiber, but in practice an optimum level of alkali rather than the maximum has to be sought. While Shenai (1997) recorded various factors that influence the dyeing of cellulosic fabrics with reactive dyes which included the pH of the dyebath, the temperature of dyeing, concentration of the electrolyte, the time of dyeing, and the liquor ratio. Kamel *et al*. (1992) narrated that sodium carbonate is added for the constant control of pH value to neutralize the liberated HCl during the reaction. While, Warner (1955) reported that whether or not a dyed cotton fabric will bleed or fade in a given treatment depends on the type of dye and its fastness characteristics.

The gray scale rating for both change of shade and staining is 4-5 (very good to excellent) for D_1 (1%), for red, blue and yellow samples. However, at D_2 (2%) and D_3 (3%), the rating was 4 (very good) for all samples. It is obvious from the results that by increasing the concentration of dye (at minimum pH value) the dry cleaning fastness of the reactive dyed cotton samples was reduced. However, it is interesting to note that 2% dye concentration gave very good to excellent results (gray sale rating 4-5) at A_2 and at 3% dye concentration, the excellent result for dry cleaning fastness are achieved at A_3 for red blue and yellow samples. The present results confirm the findings of Eltzer (1979b) who recorded variable factors that influenced the exhaustion of dye including the textile itself; the type and amount of dyes, salt and alkali; the dyeing temperature and time; and the liquor ratio. He described six different dyeing procedures with varying exhaustion and fixing methods. While, it is possible to arrive at the same results by adding suitable amounts of salts and proper control of temperature and pH values during the dyeing process. Defects in dyeing, other than poor color fastness may leads to dissatisfaction (Taylor, 1972).

Table III. Effect of salt alkali and dye concentration on dry cleaning fastness of reactive dyed cotton knitted fabric

Variables			Red		Blue		Yellow	
Salt	Alkali	Dye	CS	ST	CS	ST	CS	ST
		D_1	4-5	4-5	4-5	4-5	4-5	4-5
	A_1	D_2	4	4	4	4	4	4
		D_3	4	4	4	4	4	4
		D_1	4	4	4	4	4	4
S_1	A_2	D_2	4-5	4-5	4-5	4-5	4-5	4-5
		D_3	4	4	4	4	4	4
		D_1	4	4	4	4	4	4
	A_3	D_2	4	4	4	4	4	4
		D_3	4-5	4-5	4-5	4-5	4-5	4-5
		D_1	4-5	4-5	4-5	4-5	4-5	4-5
	A_1	D_2	4	4	4	4	4	4
		D_3	4	4	4	4	4	4
		D_1	4	4	4	4	4	4
S_2	A_2	D_2	4-5	4-5	4-5	4-5	4-5	4-5
		D_3	4	4	4	4	4	4
		D_1	4	4	4	4	4	4
	A_3	D_2	4	4	4	4	4	4
		D_3	4-5	4-5	4-5	4-5	4-5	4-5
		D_1	4-5	4-5	4-5	4-5	4-5	4-5
	A_1	D_2	4	4	4	4	4	4
		D_3	4	4	4	4	4	4
		D_1	4	4	4	4	4	4
S_3	A_2	D_2	4-5	4-5	4-5	4-5	4-5	4-5
		D_3	4	4	4	4	4	4
		D_1	4	4	4	4	4	4
	A_3	D_2	4	4	4	4	4	4
		D_3	4-5	4-5	4-5	4-5	4-5	4-5

Standard gray scale rating: 5= Excellent; 4= Very good; 3= Good; 2= Moderate; 1= Poor;
Salt concentrations: S_1= 30%, S_2= 40%, S_3= 50%
Alkali concentrations: A_1= 10%, A_2= 20%, A_3= 30%
Dye concentrations: D_1= 1%, D_2= 2%, D_3= 3%

CONCLUSIONS

The present study revealed that varying concentrations of alkali, dye and salt influenced the dyeing of cotton fabrics with reactive dyes. Excellent results for rubbing, ironing and dry cleaning fastness were recorded at 30% salt concentration, 10% alkali and 1% dye concentration.

REFERENCES

Anonymous, 1990. *Standard Methods for Determination of Color Fastness of Textiles and Leather.* 5th Ed., The Society of Dyers and Colorists, USA. pp. 619–30.

AATCC, 1974. *AATCC Test Methods for Color Fastness Properties.* American Assoc. Text. Chem. Colorist. N.C. 27709, pp. 680–710.

Anonymous, 1995. *Pretreatment of Viscose Fabrics. Dyeing with Remazol Dyes.* Hoechst Technical Information Manual, F. Hoechst (W. Germany): 7.

Anonymous, 1999. Reactive dyes for warm application. *Textile Asia,* 30: 109.

Anonymous, 1994. *Technical Information on Continuous Dyeing of Cellulosics,* CH-3, Soc. of Dyers and Col.

Baxter, G.C., H. Giles, M.M. Mekee and N. Macaulary, 1979. Influence of physical state of dyes on their light fastness. *Text. Res. J.,* 49: 260.

Beckmann, W. and F. Hoffmann, 1977. Exhaust Dyeing Processes. *J.S.D.C.,* 93 : 11.

Bernard, P.C., 1980. *Fiber to Fabric*. McGraw-Hill, Inc. Library of Congress Catalog Card No. 66-21868, USA.

De-Giorgi, M.R. and A. Cerniani, 1985. Some dyeing properties of dichlorotriazinyl reactive azo dyes for cotton. *Wrld. Text Abst.,* 17: 3851.

Eltzer, P., 1979b. Effect of the variable parameters on the dyeing result when dyeing with reactive dyes from a long liquor. *Wrld. Text. Abst.,* 11: 1370.

Fujio, T. and F. Akira, 1987. Dye fixing agents for cellulosic fibers. *Chem. Abst.,* 95988; 108: 78.

Imada K. and N. Harada, 1992. Recent developments in the optimised dyeing of cellulose using reactive dyes. *J.S.D.C.,* 108: 210–14.

Imada, K., N. Harada and T. Takagishi, 1994. Fading of azo reactive dyes by perspiration and light. *J.S.D.C.,* 110: 231.

Kamel, M.M., M.M. Kamel and M. Kamel, 1992. The addition of reactive compounds to nonreactive dyebaths. Part 5 - procedure for obtaining reactive dyeings on cotton. *J.S.D.C.,* 108: 450–53.

Lidyard, A.M., A. Woodcock and P. Noonet, 1992. Economic considerations from the exhaust application of reactive dyes under ultra-low liquor ratio conditions. *J.S.D.C.,* 108: 501–4.

Mifumi, Y. and U. Rumiko, 1989. Color fastness to light and Perspiration for reactive dyed cotton. *Kenkyo Kiyo-Tokyo Kerei. Daigaku,* 29: 211–5, (*Chem. Abst.,* 112: 218657, 1990.

Shad, M.A., 1987. Printing cotton with reactive dyes. *Textech., Nat. Coll. Text. Engg.,* pp. 57–8.

Sheikh, H.R., 2000. Wet Processing: Technology and Processing. Part II. *Pakistan Text. J.,* 49: 27–31.

Shenai, V.A., 1997a. *Technology of Dyeing.* 8th impression. Dyeing with reactive dyes. Sevak Publications Bombay, India, pp. 260–91.

Taylor, M.A., 1972. *Technology of Textile Properties.* Forbes publication Ltd. London, UK, pp. 172–7.

Trotman, E.R., 1964. *The Chemical Technology of Fibrous Material*. Charles Griffin & Co. Ltd., Landon, UK.

Warner, K.R., 1955. *Chemistry and Chemical Technology of Cotton.* CH. XII: 617.

(Received 15 November 2000; Accepted 15 December 2000)