

The Dyeing of Tencel. Part 2: Sulphur Dyes

S. M. Burkinshaw & C. J. Leonard

Department of Colour Chemistry and Dyeing,
The University, Leeds LS2 9JT, UK

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ABSTRACT

Four CI Solubilised Sulphur dyes were applied to cotton, regular viscose and Tencel at 2%, 6% and 10% o.m.f. and the colour strength and colorimetric parameters of the dyeings determined. It was found that the colorimetric parameters of all the dyes on the three types of fibre reflected those of the undyed substrates and, in general, that there was relatively little difference in colour between the dyeings on the three fibre types. The colour strength of the dyeings was lowest on cotton, the dyeings on Tencel being of slightly lower colour strength than those on viscose. From the results, it appears that Tencel exhibits similar dyeability to cotton with such solubilised sulphur dyes.

INTRODUCTION

In the previous part of this paper,¹ which examined the dyeability of Tencel, cotton and regular viscose with three different types of reactive dye, the findings that there was little difference in colour between dyeings on the three fibre types and also that the colour strength of the dyeings was lowest on cotton whilst the dyeings on Tencel were of only slightly lower colour strength than those on regular viscose, led to the conclusion that Tencel exhibited similar dyeability to regular viscose with reactive dyes. This part of the paper examines the dyeability of Tencel with CI Solubilised Sulphur dyes and compares the dyeing behaviour of the fibre with that of both cotton and viscose.

TABLE 1
Dyes Used

Commercial name	CI generic name	Dyeing temp. (°C)	Salt addition (cm ³ of 300 g litre ⁻¹)	Luecad 71 (5% aq. solution) (cm ³)		
				2%	6%	10%
Sulphosol Black SG	CI Solubilised Sulphur Black 1	85	3.5	3	9	15
Sulphosol Blue SL	CI Solubilised Sulphur Blue 5	85	2.5	2.1	4.5	7.5
Sulphosol Yellow SR	CI Solubilised Sulphur Yellow 23	85	3.5	7	12	20
Sulphosol Bordeaux SB	CI Solubilised Sulphur Red 6	75	3.5	2	6	10

EXPERIMENTAL

Materials

Fabric

Scoured and bleached woven Tencel (123.5 g m⁻²), cotton (186.5 g m⁻²) and viscose (187.5 g m⁻²) were generously supplied by Courtaulds Research.

Dyes

Commercial samples of four CI Solubilised Sulphur dyes (Table 1) were used, each generously supplied by J. Robinson Ltd.

Auxiliaries

A commercial sample of Leucad 71 was kindly supplied by J. Robinson Ltd. All other reagents were of general purpose grade.

Procedures

Dyeing

All dyeings (2%, 6% and 10% o.m.f.) were carried out in sealed, 100 cm³ capacity PTFE dyeing tubes housed in a John Jeffries Rota Dyer (J. Jeffries, UK) laboratory-scale dyeing machine, using a 7 : 1 liquor ratio. The dyeing method used is shown in Fig. 1 and the additions made to the dyebaths are displayed in Table 1.

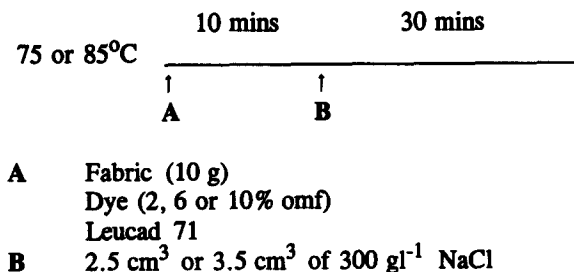


Fig. 1. Dyeing method used.

Oxidation

At the end of dyeing, the dyed sample was removed, rinsed thoroughly in cold water and then in hot water and treated in a stirred, aqueous (distilled water) solution (50 : 1 liquor ratio) containing 1 g litre⁻¹ hydrogen peroxide (30% w/v) and 1 g litre⁻¹ glacial acetic acid at 60°C for 15 min; at the end of this time, the oxidised sample was removed, rinsed thoroughly in cold water and allowed to dry in the open air.

Colour measurement

The reflectance values of the dyed samples of Tencel, cotton and viscose were measured using the equipment and viewing conditions described previously¹ and the corresponding CIE L^* , a^* , b^* , C^* and h^0 coordinates and K/S values (at the appropriate λ_{\max} for each dye) calculated. Each fabric sample was folded so as to realise a total of eight thicknesses of fabric; a total of four measurements was made of each sample, from which the average value was calculated.

Fastness determination

The fastness of 1/1 standard depth dyeings of CI Solubilised Sulphur Black 1 and also CI Solubilised Sulphur Red 6 on Tencel, cotton and viscose fabrics to washing and to light was determined using the ISO C06/C2 and ISO BO2 test methods.²

RESULTS AND DISCUSSION

The colorimetric data obtained for the four CI Solubilised Sulphur dyes on each of the three types of fibre are shown in Table 2. A comparison of the colorimetric parameters (lightness [L^*], chromaticity [a^* , b^* and h^0] and chroma [C^*]) secured for the four dyes on the three types of fibre (Table 2) with those of the three undyed fabric samples (Table 3) shows that the lightness, chromaticity and chroma of the dyed samples generally

TABLE 2
Colorimetric Data for Dyeings

<i>CI Sol. Sulphur</i>	<i>Dye applied (o.m.f.)</i>	<i>Fibre</i>	<i>L*</i>	<i>a*</i>	<i>b*</i>	<i>c*</i>	<i>h°</i>
Yellow 23	2	Viscose	75.5	7.4	47.4	47.9	81.1
		Tencel	70.9	7.8	49.4	50.1	80.9
		Cotton	74.5	6.1	50.7	51.0	83.1
	6	Viscose	62.5	14.4	56.1	57.9	75.6
		Tencel	61.9	13.4	54.9	56.6	76.6
		Cotton	63.1	14.4	58.3	60.1	76.1
	10	Viscose	57.3	17.1	55.3	57.9	72.9
		Tencel	58.9	14.4	55.7	57.5	75.5
		Cotton	59.3	16.3	58.2	60.4	74.3
Blue 5	2	Viscose	36.2	2.9	-17.8	18.0	279.4
		Tencel	36.7	1.9	-16.5	16.6	276.6
		Cotton	38.5	1.5	-17.9	17.9	274.9
	6	Viscose	22.4	3.0	-15.3	15.6	281.3
		Tencel	24.8	2.3	-15.0	15.2	278.7
		Cotton	25.7	2.3	-15.4	15.5	278.6
	10	Viscose	16.9	2.6	-11.4	11.8	283.1
		Tencel	18.9	2.2	-10.8	11.1	281.6
		Cotton	21.2	2.3	-12.5	11.8	283.1
Red 6	2	Viscose	35.1	18.5	3.4	18.8	10.5
		Tencel	34.2	17.3	2.9	17.6	9.6
		Cotton	34.5	18.5	3.4	18.8	10.5
	6	Viscose	21.3	16.1	3.1	16.4	11.0
		Tencel	21.0	14.1	2.5	14.3	9.9
		Cotton	22.3	13.7	1.9	13.8	8.3
	10	Viscose	16.2	12.4	-5.2	13.4	337.4
		Tencel	18.2	13.1	-3.6	13.6	344.8
		Cotton	19.3	12.9	-3.4	13.4	345.3
Black 1	2	Viscose	30.0	0.1	-2.4	2.4	274.0
		Tencel	32.4	0.2	-2.0	2.0	278.2
		Cotton	36.6	0.4	-3.4	3.5	276.2
	6	Viscose	17.5	0.1	-1.6	1.6	282.8
		Tencel	18.9	0.2	-1.5	1.5	279.3
		Cotton	19.3	0.3	-1.6	1.6	282.7
	10	Viscose	14.8	0.2	-0.8	0.8	285.4
		Tencel	16.2	0.3	-0.8	0.9	294.2
		Cotton	16.8	0.4	-0.9	1.05	297.3

TABLE 3
Colorimetric Data for Undyed Fabrics¹

<i>Fabric</i>	<i>L*</i>	<i>a*</i>	<i>b*</i>	<i>c*</i>	<i>h°</i>	<i>K/S</i>
Viscose	92.48	-0.39	4.75	4.77	94.7	0.05
Tencel	91.35	-0.32	1.72	1.75	100.5	0.04
Cotton	93.89	-0.29	3.07	3.08	95.4	0.03

reflected those of the undyed samples as was previously observed in the case of reactive dyes on the three substrates.¹ Table 2 and Figs 2-5 show that, as expected, the colour strength of the dyeings increased with increasing concentration of dye applied (as evidenced by the decrease in *L** values and the increase in *K/S* values that accompanied an increase in the concentration of each dye applied). It is also evident from Figs 2-5 that, with the exception of CI Solubilised Sulphur Yellow 23, the colour strengths (*K/S*) of the dyeings, at each of the three dye concentrations employed, decrease in the order viscose > Tencel > cotton; in the case of CI Solubilised Sulphur Yellow 23, the dyeings on Tencel were of slightly greater colour strength than those on the two other types of fibre. The

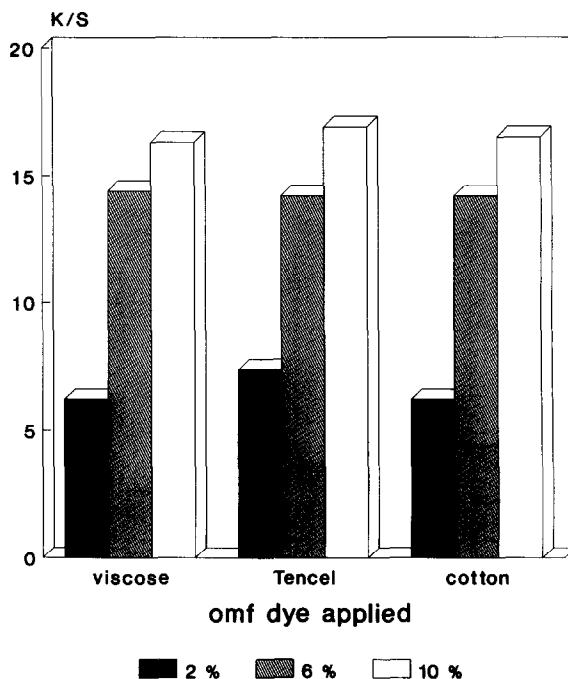


Fig. 2. Colour strength obtained using CI Solubilised Sulphur Yellow 23.

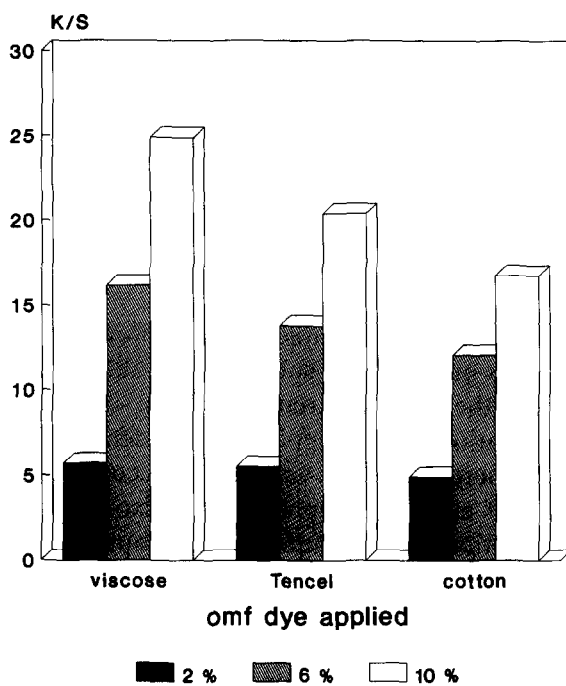


Fig. 3. Colour strength obtained using CI Solubilised Sulphur Blue 5.

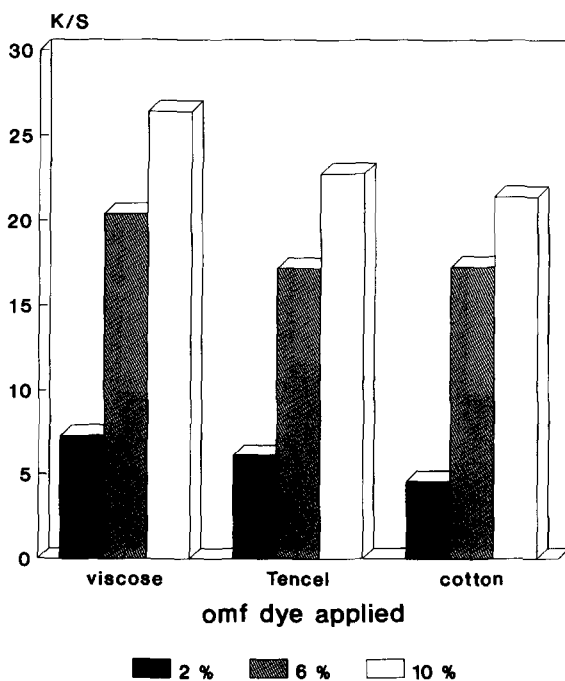


Fig. 4. Colour strength obtained using CI Solubilised Sulphur Black 1.

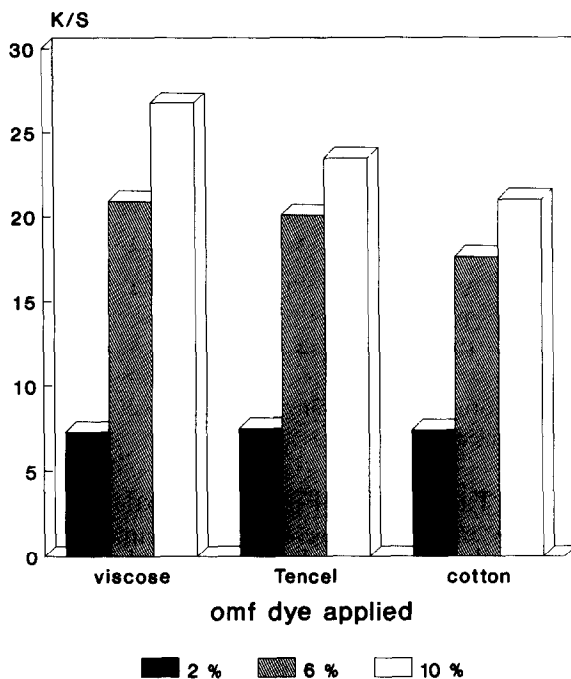


Fig. 5. Colour strength obtained using CI Solubilised Sulphur Red 6.

TABLE 4
Difference in Colour Strength ($\Delta K/S$) for Dyeings

Dye	<i>o.m.f.</i> (%)	<i>V-C</i>	<i>T-C</i>	<i>V-T</i>
CI Solubilised Sulphur Yellow 23	2	0.0	1.25	-1.25
	6	0.2	0.0	0.2
	10	-0.2	0.4	-0.6
CI Solubilised Sulphur Blue 5	2	0.8	0.6	0.2
	6	4.1	1.7	2.4
	10	7.9	3.6	4.5
CI Solubilised Sulphur Red 6	2	-0.06	0.1	-0.19
	6	3.3	2.4	3.3
	10	5.8	2.5	3.3
CI Solubilised Sulphur Black 1	2	2.7	1.5	1.3
	6	3.1	-0.1	3.2
	10	5.0	1.4	3.6

V, viscose; T, Tencel; C, cotton.

TABLE 5
Fastness of 1/1 Standard Depth Dyeings to ISO CO6/C2 Wash Test

<i>CI Solubilised Sulphur</i>	<i>Fibre</i>	<i>Ch.</i>	<i>C</i>	<i>V</i>	<i>T</i>
Red 6	Viscose	4	3-4	4-5	—
	Tencel	4	—	5	4-5
	Cotton	3-4	3-4	4-5	—
Black 1	Viscose	4	3-4	4-5	—
	Tencel	5	—	4-5	4-5
	Cotton	4-5	4-5	4-5	—

Ch., change in shade of original; C, staining of adjacent cotton; V, staining of adjacent viscose; T, staining of adjacent Tencel.

results presented in Table 2 and Figs 2-5 reveal that for the four dyes under consideration, the dyeings obtained on Tencel more closely resembled those secured on cotton rather than on viscose. Support for this proposal accrues from the magnitude of the difference in colour strength ($\Delta K/S$) obtained for the dyeings on the three types of fibre (Table 4), insofar as, for the four dyes used, the difference in colour strength between dyeings on Tencel and cotton was generally lower than that between viscose and Tencel and between viscose and cotton. Thus, in terms of colour strength, the dyeings on Tencel were similar to those on cotton and, therefore, the dyeability of Tencel was more similar to that of cotton than regular viscose. This particular finding differs to that observed for dyeing with reactive dyes.¹

Table 5 shows that the fastness to washing of 1/1 standard depth dyeings of both CI Solubilised Sulphur Red 6 and CI Solubilised Sulphur Black 1 on Tencel was slightly higher than that of comparable depth dyeings on cotton and viscose. Table 6 reveals that whilst the light fastness of the 1/1 standard depth dyeing of CI Solubilised Sulphur Red 6 on Tencel was

TABLE 6
Fastness of 1/1 Standard Depth Dyeings to ISO BO2 Light Test

<i>CI Solubilised Sulphur</i>	<i>Fibre</i>	
Red 6	Viscose	3-4
	Tencel	3-4
	Cotton	3
Black 1	Viscose	6-7
	Tencel	5-6
	Cotton	6-7

virtually identical to that of the dye on the other two types of fibre, the light fastness of CI Solubilised Sulphur Black 1 on Tencel was slightly lower than on cotton and viscose. The findings displayed in Tables 5 and 6 indicate that, as might be expected, the fastness to both washing and light of the two dyes used was very similar on each of the three types of cellulosic substrate.

CONCLUSIONS

The colorimetric parameters of the dyeings of the four dyes employed on the three types of fibre reflected those of the undyed substrates and, in general, there was relatively little difference in colour between the dyeings on the three fibre types. The colour strength of the dyeings was lowest on cotton, the dyeings on Tencel being of slightly lower colour strength than those on viscose. The results obtained suggest that the dyeability of Tencel with the three types of reactive dye more closely resembles that of cotton than regular viscose.

REFERENCES

1. Burkinshaw, S. M. & Willmott, N. J., *Dyes and Pigments*, **26** (1994) 129.
2. *Methods of Test for Colour Fastness of Textiles and Leather*, 4th edn. Society of Dyers and Colourists, Bradford, 1978.