ELSEVIER

Dyes and Pigments, Vol. 33, No. 4, pp. 259–280, 1997

PII: S0143-7208(96)00056-3 0143-7208/97 $17.00+0.00

The Dyeing of Conventional and Microfibre Nylon 6,6 with Reactive Dyes. Part 2. α-Bromoacrylamido Dyes

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(Received 17 May 1996; accepted 18 June 1996)

ABSTRACT

Conventional decitex and microfibre nylon 6,6 fabrics were dyed using three commercial α-bromoacrylamido reactive dyes at pH 4 in the absence of electrolyte and proprietary levelling agent. Only one of the three dyes displayed good build-up on both conventional decitex and microfibre nylon 6,6 fabrics; generally, dye build-up was greater on conventional decitex fabric. It was observed that a large proportion of adsorbed dye was unfixed and removed by wash-off. The fastness of washed-off dyeings to the ISO CO6/C2 wash test, at each of seven depths of shade (0.1%, 0.5%, 1%, 2%, 3%, 4% and 5% omf), was very good although, in the majority of cases, this was expected in view of the very low colour strengths of the dyeings. Treatment of the dyeings before wash-off with a commercial syntan generally reduced the amount of dye removed during wash-off but altered the colour of the dyeings. Generally, syntan treatment did not improve the wash fastness of the dyeings. © *1997 Elsevier Science Ltd*

Keywords: nylon, reactive dyes, α-bromoacrylamido.

INTRODUCTION

Little information exists concerning the application, to nylon, of reactive dyes designed for use on wool. In the first part of this paper[1] the build-up and wash fastness characteristics of three commercial chlorodifluoropyrimidinyl dyes on both conventional decitex and microfibre nylon 6,6 fabrics were examined. It was found that weakly acidic conditions (pH 4) yielded optimum colour strength and that level dyeings were obtained without the need for electrolyte or proprietary levelling agent; also, the three dyes

displayed good build-up on both types of fabric and the wash fastness of the dyes, at each of seven depths of shade used, was very good.[1]

The aim of the present work was to examine the build-up and wash fastness characteristics of α-bromoacrylamido reactive dyes on both conventional decitex and microfibre nylon 6,6.

EXPERIMENTAL

Materials

Fabrics
Two types of scoured, circular knitted nylon 6,6 fabric, namely conventional (78f68; 1.14 dtexpf) and microfibre (60F68; 0.88 dtexpf), were kindly provided by Du Pont (U.K.).

Dyes
Three commercial samples of dye were used, namely *Lanasol Blue 3-G* (CI Reactive Blue 69), *Lanasol Red 6-G* (CI Reactive Red 84) and *Lanasol Yellow 4-G* (CI Reactive Yellow 39). The dyes were generously supplied by Ciba-Geigy and were not purified before use.

Auxiliaries
Sandozin NIE (Sandoz (U.K.)) was used in the scouring of dyeings. *Albegal B* (Ciba-Geigy (U.K.)) was employed as a levelling agent and *Matexil FA-SNX* (ICI Surfactants) was used to aftertreat the dyeings. Each auxiliary was kindly provided by the respective manufacturer.

All other chemicals were of Analar grade purity.

Procedures

Dyeing
The method used was as previously described.[1] At the end of dyeing, the dyed sample was removed and rinsed in cold tap water for 5 min.

Wash-off
This process, to remove any unfixed dye from the dyed sample, was carried out as previously described.[1] At the end of wash-off, the sample was rinsed in tap water for 5 min and allowed to dry in the open air.

Syntan treatment
The rinsed (cold tap water) dyeings were treated with *Matexil FA-SNX* (2% omf) as described earlier.[1] The aftertreated sample was rinsed in cold tap water for 5 min and allowed to dry in the open air.

Colour measurement
The reflectance values of the dry, dyed samples were measured using the instrument and conditions described previously[1] from which the corresponding K/S values and CIE L^*, a^*, b^*, C^* and h° coordinates were calculated at the appropriate λ_{max} of each dye.

Wash fastness
The fastness of the dry, dyed samples to the ISO CO6/C2 wash test was determined using the standard method.[2]

RESULTS AND DISCUSSION

The effect of a proprietary levelling agent on the adsorption of CI Reactive Blue 69

As reactive dyes for wool are not commercially used on nylon 6,6 in the first part of this paper,[1] the effects of pH, liquor ratio, electrolyte and levelling agent on the colour strength achieved, for 2% omf dyeings of CI Reactive Blue 114 carried out at 98°C on conventional decitex nylon 6,6 fibre, were determined. It was found that dyeing was optimal using a pH of 4 and a 20:1 liquor ratio without either electrolyte or levelling agent.[1] In the present work, it was decided to employ these particular application conditions (pH 4, 20:1 liquor ratio and 98°C) for the three α-bromoacrylamido dyes under investigation, although an initial study was made of the effect of a commercial levelling agent on dyeing.

In the dyeing of wool with reactive dyes, such is the propensity of the fibre to dye unevenly that proprietary levelling agents must be added to the dyebath.[3] In the case of the α-bromoacrylamido (*Lanasol*) dyes used in this work, *Albegal B* (Ciba-Geigy) is the levelling agent recommended for the dyeing of wool with the dyes;[3] a study was made of the effect of this particular levelling agent on the adsorption of CI Reactive Blue 69 on conventional decitex nylon 6,6 fibre.

Table 1 shows that when 2% omf dyeings of CI Reactive Blue 69 were carried out in both the presence and absence of *Albegal B*, the levelling agent lowered the colour strength (K/S) of the dyeings to an extent that increased with increasing concentration employed. The colorimetric parameters shown in Table 1 reveal that the levelling agent had a small effect on the colour of the dyeings. Inspection of the dyeings revealed that the levelling agent did not visually enhance or impair the levelness of dyeings and, consequently, its further use was discontinued.

These particular findings concur with those obtained in the first part of this paper, which showed that the proprietary levelling agent *Lyogen TP*

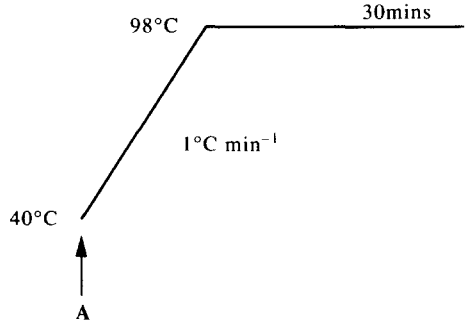
(Sandoz) lowered the colour strength achieved using a difluorochloropyrimidinyl reactive dye (CI Reactive Blue 114) on conventional nylon 6,6 fabric to an extent that increased with increasing concentration employed and did not visually enhance or impair the levelness of the dyeing.[1] In view of the results displayed in Table 1 and those obtained during the dyeing of conventional nylon 6,6 fabric with CI Reactive Blue 114,[1] it appears that although proprietary levelling agents must be used when dyeing wool with reactive dyes, the agents are unnecessary when dyeing nylon 6,6.

In subsequent investigations involving the three α-bromoacrylamido dyes reported herein, the dyeing method employed was that shown in Fig. 1 using a pH of 4 and a 20:1 liquor ratio in the absence of both electrolyte and levelling agent. In these subsequent studies, dyed samples were produced which, at the end of dyeing, had been rinsed in tap water and then either allowed to dry in the open air or washed-off using *Sandozin NIE*/Na_2CO_3 and allowed to dry in the open air; a further set of dyeings was produced that were aftertreated with the commercial syntan *Matexil FA-SNX*. The wash fastness of all dyeings was determined according to the ISO CO6/C2 test method. In all of the cases discussed below, level dyeing was achieved.

TABLE 1

Effect of *Albegal B* on Uptake of CI Reactive Blue 69 (98°C; 20:1 liquor ratio; pH 4; nil electrolyte)

% omf Albegal B	*L**	*a**	*b**	*c**	*h°*	*K/S*
0	36.54	−11.74	−30.63	32.81	249.03	14.93
0.5	37.55	−11.30	−30.98	33.13	249.19	13.34
5	39.69	−12.14	−30.89	33.19	248.54	10.95



A Fabric
Dye
HCOOH to pH 4

Fig. 1.

CI Reactive Blue 69

Conventional decitex fabric

The results shown in Table 2 and Fig. 2 reveal that the dye displayed good build-up on conventional nylon 6,6 fabric. From Table 3 and Fig. 2 it is apparent that wash-off using *Sandozin NIE*/Na_2CO_3 removed unfixed dye from the dyeings. As Table 4 shows, the amount of adsorbed dye that was removed by wash-off varied between 21% and 73% for the 0.1% omf and 5% omf dyeings, respectively. Clearly, this shows that a very large proportion of dye that was adsorbed onto the fabric was unfixed and, therefore, that in order for the dyeings to exhibit reasonable wash fastness, the dyeings must be washed-off to remove unfixed dye. The two values of percentage dye removal (21% and 73%) displayed in Table 4 are twice as large as those

TABLE 2
Colorimetric Data for CI Reactive Blue 69 on Conventional Nylon 6,6 (unwashed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	68.40	−12.51	−22.65	25.89	241.08
0.5	53.75	−12.85	−27.98	30.81	245.33
1.0	44.58	−12.72	−29.88	32.28	246.78
2.0	36.54	−11.74	−30.63	32.81	249.03
3.0	33.34	−10.89	−30.63	32.51	250.43
4.0	32.44	−10.64	−30.41	32.23	250.71
5.0	31.37	−10.43	−29.41	31.59	250.72

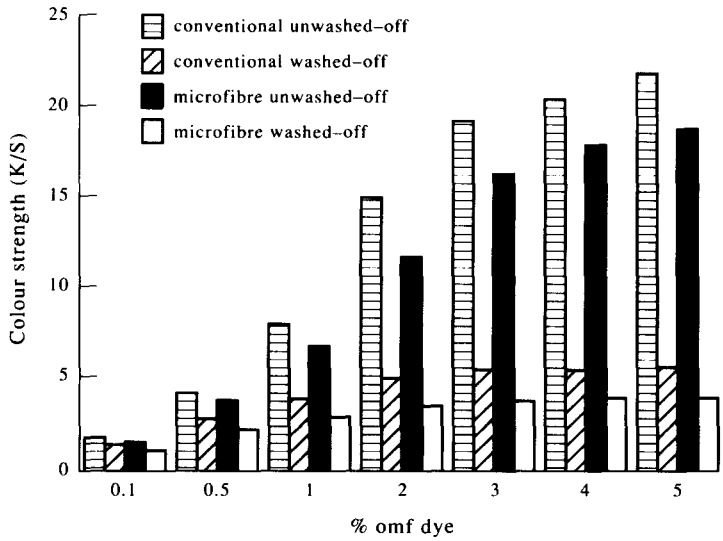


Fig. 2. Colour strength of dyeings of CI Reactive Blue 69.

obtained in the first part of this paper[1] for identical depth dyeings of CI Reactive Blue 114 on conventional nylon 6,6 fabric.

An attempt was made to improve the wash-off of CI Reactive Blue 69 by applying the commercial syntan *Matexil FA-SNX* to the dyed conventional

TABLE 3
Colorimetric Data for CI Reactive Blue 69 on Conventional Nylon 6,6 (washed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	72.52	−12.16	−19.87	23.36	238.52
0.5	60.32	−13.06	−24.65	27.91	242.05
1.0	54.53	−13.22	−25.38	28.62	242.47
2.0	50.45	−13.13	−25.89	29.03	243.09
3.0	49.03	−13.33	−26.07	29.29	242.91
4.0	48.75	−13.17	−25.43	28.64	242.62
5.0	47.85	−12.80	−24.87	27.98	242.76

TABLE 4
Percentage Removal of Dye during Wash-off

Fabric type	*CI Reactive Blue 69*		*CI Reactive Yellow 39*		*CI Reactive Red 84*	
	0.1% omf dye	*5% omf dye*	*0.1% omf dye*	*5% omf dye*	*0.1% omf dye*	*5% omf dye*
Conventional	21.5	73.4	10.4	56.2	14.5	47.7
Microfibre	23.0	78.3	13.7	61.4	13.0	55.3

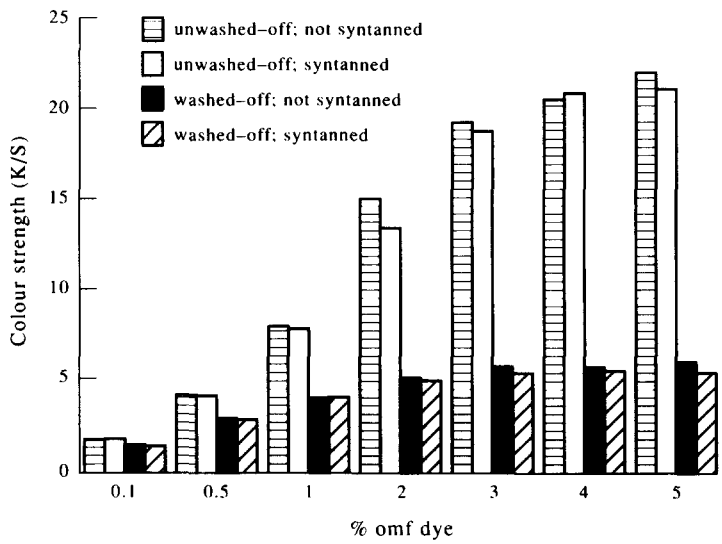


Fig. 3. Colour strength of dyeings of CI Reactive Blue 69 on conventional fabrics.

nylon 6,6 before the dyeing was washed-off, in the hope that this treatment might reduce the amount of unfixed dye removed during wash-off and also improve the fastness of the resulting dyeing to washing. From Fig. 3 and a comparison of the results presented in Tables 2 and 5, treatment with the syntan evidently did not increase the colour strength of the dyeings but did alter the colour of the unwashed-off dyeings. This finding differs from that found for the chlorodifluoropyrimidinyl dyes on nylon,[1] for which it was observed that syntan treatment increased the colour strength and also altered the colour of the unwashed-off dyeings.

From Fig. 3 and by comparing Tables 3 and 6, it is apparent that syntan treatment did not reduce the amount of dye removed during wash-off; indeed, in some cases, the colour strength of the syntanned, washed-off dyeing was lower than that of the corresponding unsyntanned, washed-off dyeing. Thus, one of the aims in applying the syntan to the dyed fabric prior to wash-off, namely that the amount of unfixed reactive dye removed during wash-off would be reduced, was not achieved.

Table 7 reveals that the wash fastness of the dye on the conventional decitex nylon 6,6 fabric used was very good at each of the seven depths of shade employed, and that syntan treatment prior to wash-off neither improved nor

TABLE 5

Colorimetric Data for CI Reactive Blue 69 on Conventional Nylon 6,6 after Syntan After-treatment (unwashed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	68.09	−12.61	−22.10	25.45	240.28
0.5	53.89	−12.97	−27.37	30.29	244.64
1.0	45.00	−12.99	−29.67	32.39	246.36
2.0	37.74	−11.90	−30.50	32.75	248.68
3.0	33.76	−11.11	−30.68	32.64	250.09
4.0	32.05	−10.68	−29.93	31.79	250.36
5.0	31.88	−10.50	−30.03	31.82	250.73

TABLE 6

Colorimetric Data for CI Reactive Blue 69 on Conventional Nylon 6,6 after Syntan After-treatment (washed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	72.86	−12.38	−19.25	22.89	237.26
0.5	60.42	−13.14	−24.09	27.44	241.39
1.0	54.52	−13.53	−25.66	29.01	242.19
2.0	50.82	−13.35	−25.88	29.13	242.70
3.0	49.54	−12.98	−25.96	29.03	243.44
4.0	49.05	−12.87	−25.32	28.42	243.05
5.0	49.20	−12.65	−25.00	28.03	243.17

TABLE 7
Wash Fastness of CI Reactive Blue 69 on Conventional Fabric

% omf Dye	*Colour change*	*Staining of adjacent nylon 6,6*	*Staining of adjacent cotton*
Not syntanned			
0.1	4/5	4/5	4/5
0.5	4/5	4/5	4/5
1.0	4/5	4/5	4/5
2.0	4/5	4/5	4/5
3.0	4/5	4/5	4/5
4.0	4/5	4/5	4/5
5.0	4/5	4/5	4/5
Syntanned			
0.1	4/5	4/5	4/5
0.5	4/5	4/5	4/5
1.0	4/5	4/5	4/5
2.0	4/5	4/5	4/5
3.0	4/5	4/5	4/5
4.0	4/5	4/5	4/5
5.0	4/5	4/5	4/5

diminished wash fastness. Thus, the second of the aims in applying the syntan to the dyed fabric prior to wash-off, namely that the syntan might improve the wash fastness of the dyeing, was also not achieved. However, it must be borne in mind that the colour strengths (K/S values) of the washed-off dyeings, even at an applied concentration of 5% omf dye, were very low and, therefore, it was anticipated that the level of wash fastness achieved for such pale depths of shade (Table 7) would be very good.

Microfibre fabric

From Table 8 and Fig. 2 the dye evidently displayed good build-up on microfibre nylon 6,6 fabric prior to wash-off. Figure 2 and a comparison of

TABLE 8
Colorimetric Data for CI Reactive Blue 69 on Microfibre Nylon 6,6 (unwashed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	71.89	−11.85	−20.53	23.71	240.78
0.5	55.65	−12.99	−27.07	30.03	244.36
1.0	47.39	−13.34	−29.53	32.41	245.69
2.0	40.14	−12.74	−30.68	33.25	247.37
3.0	36.09	−12.09	−31.05	33.32	248.72
4.0	34.61	−11.73	−30.71	32.88	249.08
5.0	33.84	−11.51	−30.53	32.63	249.34

the results presented in Tables 8 and 9 reveal that wash-off using *Sandozin NIE*/Na_2CO_3 removed a large amount of unfixed dye from the dyeings; as Table 4 shows, the amount of this dye removed by wash-off varied between 23% and 78% in the cases of 0.1% omf and 5% omf applied dye, respectively. These findings agree reasonably well with those obtained for the dye on conventional decitex fabric.

Figure 2 shows the difference in build-up of the dye on the two types of fabric used, from which it is apparent that build-up was lower on microfibre at each of the seven depths of shade employed. As the two types of fabric differed in terms of their fineness (1.14 dtexpf in the case of conventional fabric and 0.88 dtexpf for the microfibre), and as it is well known[4] that colour strength decreases with increasing fineness of a textile fibre, the observed lower colour strength achieved on microfibre was expected.

From Fig. 4 and a comparison of the results presented in Tables 8 and 10, treatment with commercial syntan did not increase the colour strength of the unwashed-off dyeings but did change the colour of the dyeings. However, from Fig. 4 and by comparing Tables 9 and 11, syntan treatment evidently reduced the amount of dye removed during wash-off. These latter findings do not agree with those obtained for the dye on conventional decitex fibre

TABLE 9
Colorimetric Data for CI Reactive Blue 69 on Microfibre Nylon 6,6 (washed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	76.12	−11.12	−17.16	20.46	237.07
0.5	64.09	−12.32	−22.63	25.77	241.44
1.0	59.32	−12.52	−23.87	26.96	242.33
2.0	55.69	−12.44	−24.44	27.43	243.02
3.0	54.43	−12.49	−24.11	27.16	242.61
4.0	53.43	−12.29	−23.91	26.89	242.79
5.0	53.02	−11.88	−23.25	26.11	242.92

TABLE 10
Colorimetric Data for CI Reactive Blue 69 on Microfibre Nylon 6,6 with Syntan Aftertreatment (unwashed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	70.92	−11.89	−19.93	23.21	239.18
0.5	55.65	−12.99	−27.07	30.03	244.36
1.0	47.63	−13.35	−29.19	32.05	245.37
2.0	39.28	−12.65	−30.80	33.20	247.66
3.0	36.60	−12.31	−30.94	33.30	248.30
4.0	35.56	−12.18	−30.44	32.19	248.19
5.0	34.58	−11.99	−29.98	32.36	248.21

(Fig. 3), for which it was found that syntan treatment did not reduce the amount of dye removed during wash-off.

Table 12 shows that the wash fastness of the dye on the microfibre nylon 6,6 fabric used was very good at all depths of shade employed, and that syntan treatment prior to wash-off neither improved nor diminished wash fastness.

A comparison of the results presented in Tables 2 and 8 as well as Tables 3 and 9 reveals that the colours of the dyeings on both types of fibre were very similar, as was expected since the two types of fibre were produced from the same polymer.

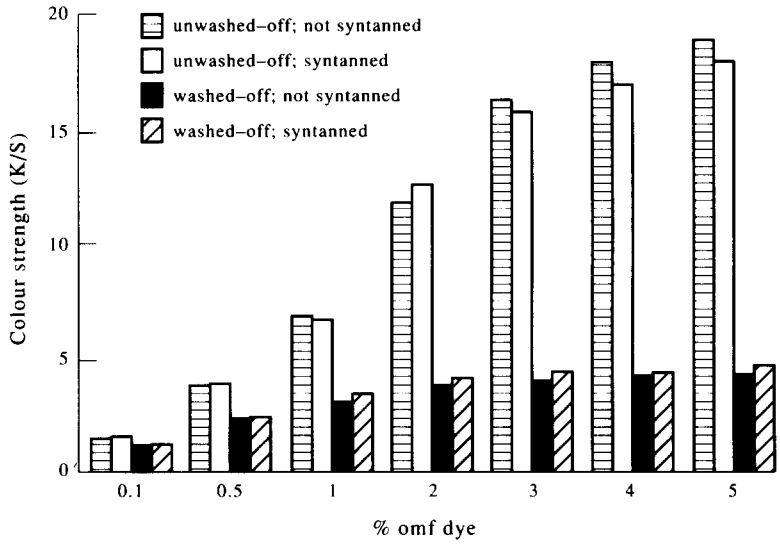


Fig. 4. Colour strength of dyeings of CI Reactive Blue 69 on microfibre fabrics.

TABLE 11
Colorimetric Data for CI Reactive Blue 69 on Microfibre Nylon 6,6 with Syntan Aftertreatment (washed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	74.71	−11.34	−17.48	20.84	237.02
0.5	64.09	−12.32	−22.63	25.77	241.44
1.0	57.44	−13.06	−24.86	28.09	242.28
2.0	54.15	−12.74	−24.85	27.93	242.85
3.0	52.94	−12.70	−24.62	27.71	242.10
4.0	52.73	−12.10	−23.59	26.51	242.84
5.0	51.55	−11.99	−23.56	26.45	243.02

TABLE 12
Wash Fastness of CI Reactive Blue 69 on Microfibre

% omf Dye	*Colour change*	*Staining of adjacent nylon 6,6*	*Staining of adjacent cotton*
Not syntanned			
0.1	4/5	4/5	4/5
0.5	4/5	4/5	4/5
1.0	4/5	4/5	4/5
2.0	4/5	4/5	4/5
3.0	4/5	4/5	4/5
4.0	4/5	4/5	4/5
5.0	4/5	4/5	4/5
Syntanned			
0.1	4/5	4/5	4/5
0.5	4/5	4/5	4/5
1.0	4/5	4/5	4/5
2.0	4/5	4/5	4/5
3.0	4/5	4/5	4/5
4.0	4/5	4/5	4/5
5.0	4/5	4/5	4/5

CI Reactive Yellow 39 and CI Reactive Red 84

The results obtained for the two dyes were very similar to those achieved for CI Reactive Blue 69. Figures 5 and 6 show the build-up of CI Reactive Yellow 39 and CI Reactive Red 84, respectively, on both conventional and microfibre fabrics, before and after wash-off. It is clear that the build-up of CI Reactive Red 84 was much greater, on both conventional and microfibre fabrics, before and after wash-off than that of CI Reactive Yellow 39; furthermore, when Figs 2, 5 and 6 are compared, it is evident that the build-up of CI Reactive Red 84 was much greater than that of CI Reactive Blue 69. Also, the build-up of CI Reactive Red 84 on both types of fibre did not reach a more or less constant value at about 3 to 4% omf applied dye, as was found not only for CI Reactive Yellow 39 (Fig. 5) but also for CI Reactive Blue 69 (Fig. 2).

Figures 5 and 6 further show that the build-up of both the yellow and the red dyes was greater on conventional decitex fabric for each of the seven depths of shade employed. This can be attributed to the lower dtexpf of the microfibre fabric and the well-known fact that colour strength decreases with increasing fineness of a textile fibre, as was discussed earlier for CI Reactive Blue 69.

Figures 5 and 6 also show that wash-off with *Sandozin NIE*/Na_2CO_3 removed unfixed dye from the dyeings of CI Reactive Yellow 39 and CI Reactive Red 84. Table 4 shows the extent of dye removed by wash-off, from

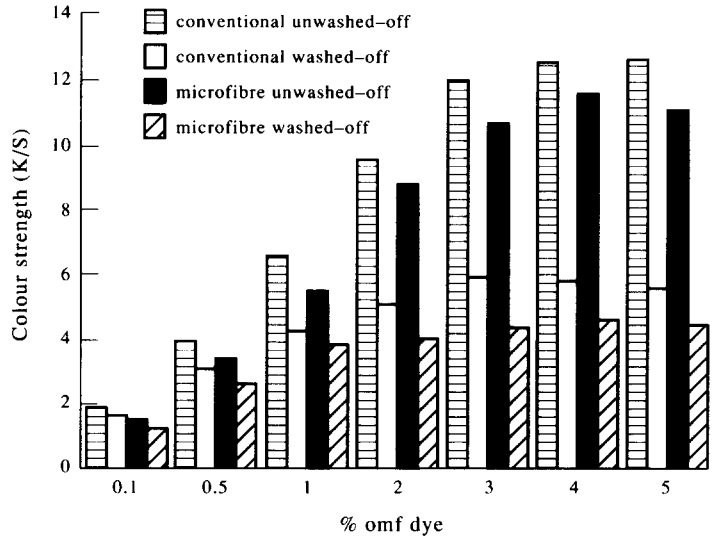


Fig. 5. Colour strength of dyeings of CI Reactive Yellow 39.

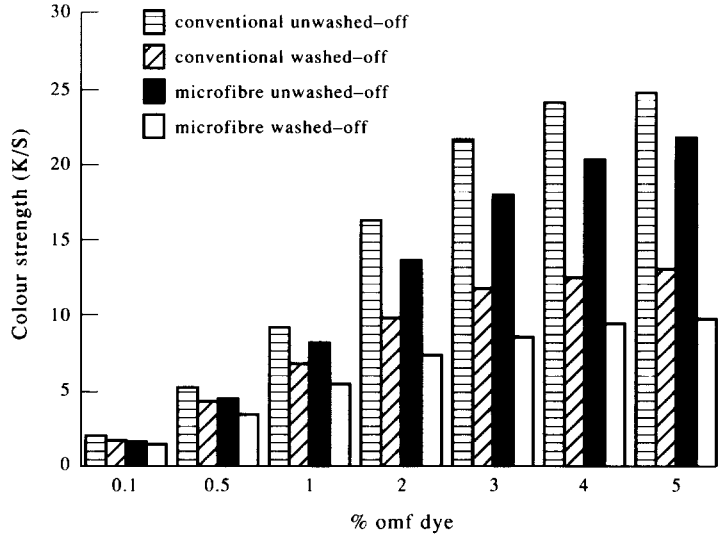


Fig. 6. Colour strength of dyeings of CI Reactive Red 84.

which the proportion of dye evidently removed varied from more than 10% to more than 60%. Table 4 also shows that the proportions of red and yellow dyes removed by wash-off were lower than those for CI Reactive Blue 69.

A comparison of the results presented in Tables 13–18 as well as Tables 19 and 20 reveals that the colours of the dyeings on both types of fibre were

TABLE 13
Colorimetric Data for CI Reactive Yellow 39 on Conventional Nylon 6,6 (unwashed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	91.15	−8.66	40.68	41.60	102.02
0.5	89.92	−7.12	62.73	63.14	96.48
1.0	87.78	−5.27	73.62	73.81	94.10
2.0	86.43	−2.68	81.98	82.03	91.88
3.0	84.35	−0.40	84.89	84.85	89.73
4.0	85.30	−0.72	88.96	88.97	89.53
5.0	84.82	−1.47	89.37	89.39	89.06

TABLE 14
Colorimetric Data for CI Reactive Yellow 39 on Microfibre Nylon 6,6 (unwashed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	92.63	−8.10	36.68	37.57	102.46
0.5	90.60	−7.47	59.29	59.76	97.18
1.0	86.59	−3.62	65.99	66.10	93.14
2.0	87.57	−3.07	80.80	80.87	92.18
3.0	86.55	−1.51	84.99	85.01	91.02
4.0	83.96	−0.24	82.99	83.00	90.17
5.0	86.38	−2.60	86.01	86.01	90.02

TABLE 15
Colorimetric Data for CI Reactive Yellow 39 on Conventional Nylon 6,6 (washed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	91.69	−8.24	37.71	38.59	102.34
0.5	90.12	−6.40	55.83	56.20	96.54
1.0	88.50	−5.59	62.25	62.51	95.14
2.0	87.38	−3.89	65.80	65.92	93.39
3.0	84.89	−0.78	64.79	64.80	90.70
4.0	86.03	−2.59	66.53	66.59	92.23
5.0	85.77	−1.94	65.79	65.82	91.70

TABLE 16
Colorimetric Data for CI Reactive Yellow 39 on Microfibre Nylon 6,6 (washed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	93.06	−7.69	31.45	32.38	103.75
0.5	91.01	−8.13	49.76	50.42	99.29
1.0	89.65	−7.24	58.42	58.87	97.07
2.0	89.57	−6.14	59.74	60.06	95.87
3.0	88.29	−5.05	60.15	60.37	94.81
4.0	85.78	−2.54	57.80	57.87	92.52
5.0	87.87	−4.35	59.88	60.05	94.16

TABLE 17
Colorimetric Data for CI Reactive Red 84 on Conventional Nylon 6,6 (unwashed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	70.77	38.04	8.05	38.89	11.95
0.5	57.76	49.11	15.31	51.45	17.32
1.0	51.55	53.70	19.51	57.14	19.97
2.0	45.26	55.37	23.32	60.09	22.84
3.0	41.92	55.72	25.90	61.45	24.93
4.0	40.42	55.34	26.57	61.39	25.65
5.0	39.66	55.22	26.78	61.38	25.88

TABLE 18
Colorimetric Data for CI Reactive Red 84 on Microfibre Nylon 6,6 (unwashed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	73.09	35.22	7.21	35.96	11.58
0.5	60.09	48.24	14.78	50.46	17.03
1.0	53.02	53.40	19.37	56.81	19.94
2.0	47.56	55.35	23.05	59.96	22.61
3.0	44.62	56.40	25.64	61.96	24.45
4.0	43.13	56.35	26.72	62.37	25.37
5.0	42.17	56.46	27.51	62.81	25.98

TABLE 19
Colorimetric Data for CI Reactive Red 84 on Conventional Nylon 6,6 (washed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	73.52	34.63	9.45	35.90	15.27
0.5	61.03	46.86	17.27	49.94	20.23
1.0	55.83	51.40	20.98	55.52	22.20
2.0	51.57	53.36	23.38	58.27	23.66
3.0	49.94	54.30	24.99	59.78	24.72
4.0	49.12	54.28	25.09	59.80	24.81
5.0	48.91	54.84	25.64	60.55	25.06

TABLE 20
Colorimetric Data for CI Reactive Red 84 on Microfibre Nylon 6,6 (washed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	75.66	32.05	8.57	33.19	14.98
0.5	64.11	44.51	15.74	47.22	19.47
1.0	58.57	49.55	19.60	53.30	21.58
2.0	54.97	51.50	21.62	55.86	22.78
3.0	53.60	53.00	22.87	57.73	23.34
4.0	52.59	53.45	23.62	58.44	23.85
5.0	52.34	53.65	23.79	58.70	23.92

very similar, as expected since the two types of fibre were produced from the same polymer. This finding agrees with that secured for CI Reactive Blue 69.

From Figs 7 and 8 and a comparison of the appropriate colorimetric parameters presented for CI Reactive Yellow 39 and CI Reactive Red 84 (Tables 13–28), it is apparent that in the case of the conventional decitex

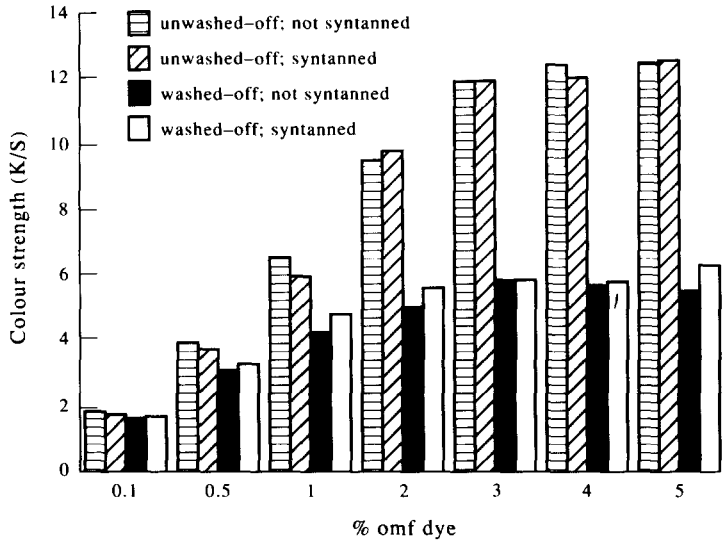


Fig. 7. Colour strength of dyeings of CI Reactive Yellow 39 on conventional fabrics.

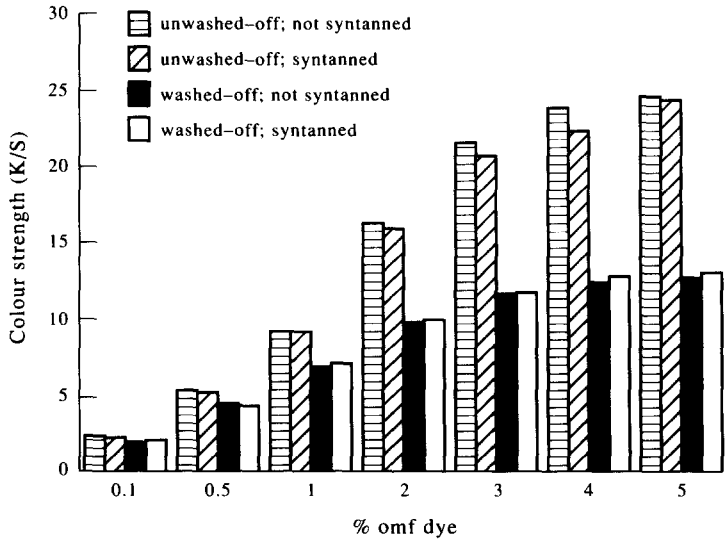


Fig. 8. Colour strength of dyeings of CI Reactive Red 84 on conventional fabrics.

fabric, treatment with the commercial syntan did not increase the colour strength of the unwashed-off dyeings but did alter the colour of the dyeings. Furthermore, Figs 7 and 8 and the appropriate colorimetric data presented in Tables 13–28 show that syntan treatment reduced the amount of each dye removed during wash-off. This latter finding contrasts with that observed for CI Reactive Blue 69, for which syntan treatment did not reduce the amount of dye removed during wash-off in the case of the conventional decitex fabric.

TABLE 21
Colorimetric Data for CI Reactive Yellow 39 on Conventional Nylon 6,6 after Syntan Treatment (unwashed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	91.31	−7.14	40.55	41.18	99.99
0.5	88.94	−6.59	60.09	60.45	96.20
1.0	88.11	−4.45	71.91	72.05	93.54
2.0	86.63	−1.49	83.21	83.23	91.03
3.0	84.35	−0.40	84.84	84.85	89.73
4.0	85.33	−0.89	87.73	87.74	89.42
5.0	82.51	2.20	84.27	84.30	88.50

TABLE 22
Colorimetric Data for CI Reactive Yellow 39 on Conventional Nylon 6,6 after Syntan Treatment (washed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	91.80	−7.83	37.03	37.86	101.95
0.5	89.50	−7.73	54.75	55.30	98.04
1.0	89.11	−6.17	64.16	64.46	95.50
2.0	88.07	−4.70	66.99	67.16	94.02
3.0	84.89	−0.78	64.79	64.80	90.70
4.0	86.22	−2.02	66.97	67.01	91.73
5.0	82.84	−0.41	62.01	62.02	89.62

TABLE 23
Colorimetric Data for CI Reactive Yellow 39 on Microfibre Nylon 6,6 after Syntan Treatment (unwashed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	92.63	−8.10	36.68	37.57	102.46
0.5	90.60	−7.47	59.29	59.76	97.18
1.0	86.59	−3.62	65.99	66.10	93.14
2.0	87.09	−2.77	79.85	79.90	91.99
3.0	86.36	−1.48	83.99	84.01	91.09
4.0	84.49	−0.38	82.27	82.28	90.27
5.0	85.12	−0.74	83.80	83.80	90.51

Figures 9 and 10 and a comparison of the appropriate colorimetric parameters presented for CI Reactive Yellow 39 and CI Reactive Red 84 (Tables 13–28) show that, in the case of microfibre fabric, treatment with the commercial syntan generally increased the colour strength of the unwashed-off dyeings and also altered the colour of the dyeings. Furthermore, Figs 9 and 10 and the appropriate colorimetric data presented in Tables 13–28 reveal that syntan treatment reduced the amount of each dye removed during

TABLE 24
Colorimetric Data for CI Reactive Yellow 39 on Microfibre Nylon 6,6 after Syntan Treatment (washed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	93.06	−7.69	31.45	32.38	103.75
0.5	91.05	−8.13	49.76	50.42	99.29
1.0	89.65	−7.24	58.42	58.87	97.07
2.0	88.56	−5.54	62.36	62.61	95.08
3.0	88.42	−5.48	62.86	63.10	94.99
4.0	85.85	−2.36	59.87	59.92	92.27
5.0	87.49	−4.35	63.81	63.97	93.91

TABLE 25
Colorimetric Data for CI Reactive Red 84 on Conventional Nylon 6,6 after Syntan Treatment (unwashed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	70.83	37.18	8.93	38.24	13.51
0.5	58.24	49.05	15.95	51.59	18.02
1.0	51.58	53.51	20.06	57.16	20.56
2.0	45.49	55.50	23.56	60.30	23.01
3.0	42.02	55.15	25.31	60.69	24.66
4.0	41.15	55.76	26.48	61.73	25.60
5.0	39.73	54.81	26.64	60.95	25.92

TABLE 26
Colorimetric Data for CI Reactive Red 84 on Conventional Nylon 6,6 after Syntan Treatment (washed-off)

% omf Dye	*L**	*a**	*b**	*c**	*h°*
0.1	72.48	35.24	10.13	36.68	16.05
0.5	61.25	46.73	17.31	49.83	20.33
1.0	55.44	51.47	21.29	55.70	22.47
2.0	51.61	53.47	23.71	58.49	23.92
3.0	49.85	54.34	24.84	59.75	24.57
4.0	48.93	54.80	25.63	60.51	25.06
5.0	48.72	54.65	25.74	60.41	25.23

TABLE 27
Colorimetric Data for CI Reactive Red 84 on Microfibre Nylon 6,6 after Syntan Treatment (unwashed-off)

% omf Dye	L*	a*	b*	c*	h°
0.1	71.05	37.09	9.64	38.33	14.57
0.5	60.06	47.82	15.71	50.34	18.19
1.0	53.02	53.40	19.37	56.81	19.94
2.0	46.90	56.22	24.29	61.25	23.37
3.0	44.24	56.85	26.38	62.68	24.89
4.0	42.66	56.40	27.15	62.60	25.71
5.0	42.04	56.35	27.31	62.62	25.86

TABLE 28
Colorimetric Data for CI Reactive Red 84 on Microfibre Nylon 6,6 after Syntan Treatment (washed-off)

% omf Dye	L*	a*	b*	c*	h°
0.1	73.19	34.84	9.90	36.22	15.86
0.5	62.96	45.31	16.25	48.14	19.73
1.0	58.57	51.50	21.62	53.30	21.58
2.0	53.41	53.06	23.05	57.85	23.49
3.0	52.08	53.76	23.82	58.81	23.90
4.0	51.64	53.80	23.98	58.91	24.02
5.0	51.03	53.86	24.92	59.09	24.28

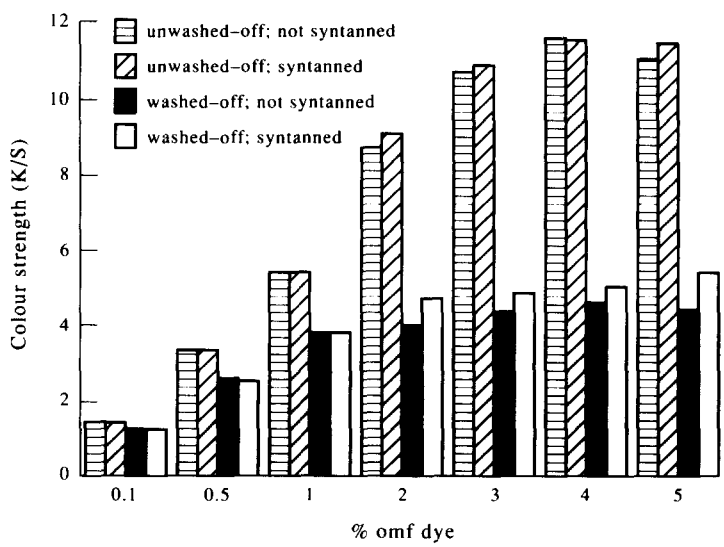


Fig. 9. Colour strength of dyeings of CI Reactive Yellow 39 on microfibre fabrics.

wash-off. This latter finding contrasts with that observed for CI Reactive Blue 69, for which syntan treatment did not reduce the amount of dye removed during wash-off for microfibre fabric.

Tables 29 and 30 reveal that the wash fastness of the yellow dye on both conventional decitex and microfibre nylon 6,6 fabrics was very good at all

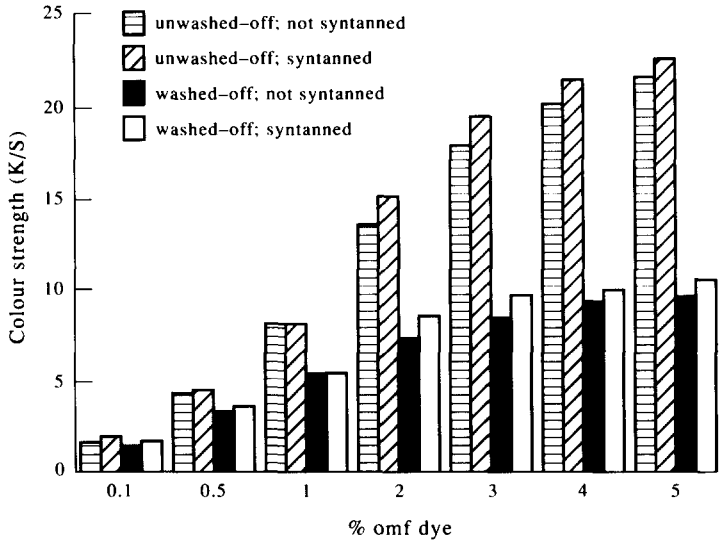


Fig. 10. Colour strength of dyeings of CI Reactive Red 84 on microfibre fabrics.

TABLE 29
Wash Fastness of CI Reactive Yellow 39 on Conventional Nylon 6,6

% omf Dye	*Colour change*	*Staining of adjacent nylon 6,6*	*Staining of adjacent cotton*
Not syntanned			
0.1	4/5	4/5	4/5
0.5	4/5	4/5	4/5
1.0	4/5	4/5	4/4
2.0	4/5	4/5	4/5
3.0	4/5	4/5	4/5
4.0	4/5	4/5	4/5
5.0	4/5	4/5	4/5
Syntanned			
0.1	4/5	4/5	4/5
0.5	4/5	4/5	4/5
1.0	4/5	4/5	4/5
2.0	4/5	4/5	4/5
3.0	4/5	4/5	4/5
4.0	4/5	4/5	4/5
5.0	4/5	4/5	4/5

seven depths of shade employed and that syntan treatment prior to wash-off neither improved nor diminished wash fastness. However, owing to the very low colour strengths (K/S values) of the washed-off dyeings, even at an applied concentration of 5% omf dye it was anticipated that the level of wash fastness achieved for such pale depths of shade (Tables 29 and 30) would be very good.

TABLE 30
Wash Fastness of CI Reactive Yellow 39 on Microfibre Nylon 6,6

% omf Dye	*Colour change*	*Staining of adjacent nylon 6,6*	*Staining of adjacent cotton*
Not syntanned			
0.1	4/5	4/5	4/5
0.5	4/5	4/5	4/5
1.0	4/5	4/5	4/5
2.0	4/5	4/5	4/5
3.0	4/5	4/5	4/5
4.0	4/5	4/5	4/5
5.0	4/5	4/5	4/5
Syntanned			
0.1	4/5	4/5	4/5
0.5	4/5	4/5	4/5
1.0	4/5	4/5	4/5
2.0	4/5	4/5	4/5
3.0	4/5	4/5	4/5
4.0	4/5	4/5	4/5
5.0	4/5	4/5	4/5

TABLE 31
Wash Fastness of CI Reactive Red 84 on Conventional Nylon 6,6

% omf Dye	*Colour change*	*Staining of adjacent nylon 6,6*	*Staining of adjacent cotton*
Not syntanned			
0.1	4/5	4/5	4/5
0.5	4/5	4/5	4/5
1.0	4/5	4/5	4/5
2.0	4/5	4/5	4/5
3.0	4/5	4/5	4/5
4.0	4/5	4/5	4/5
5.0	4/5	4/5	4/5
Syntanned			
0.1	4/5	4/5	4/5
0.5	4/5	4/5	4/5
1.0	4/5	4/5	4/5
2.0	4/5	4/5	4/5
3.0	4/5	4/5	4/5
4.0	4/5	4/5	4/5
5.0	4/5	4/5	4/5

TABLE 32
Wash Fastness of CI Reactive Red 84 on Microfibre Nylon 6,6

% omf Dye	*Colour change*	*Staining of adjacent nylon 6,6*	*Staining of adjacent cotton*
Not syntanned			
0.1	4/5	4/5	4/5
0.5	4/5	4/5	4/5
1.0	4/5	4/5	4/5
2.0	4/5	4/5	4/5
3.0	4/5	4/5	4/5
4.0	4/5	4/5	4/5
5.0	4/5	4/5	4/5
Syntanned			
0.1	4/5	4/5	4/5
0.5	4/5	4/5	4/5
1.0	4/5	4/5	4/5
2.0	4/5	4/5	4/5
3.0	4/5	4/5	4/5
4.0	4/5	4/5	4/5
5.0	4/5	4/5	4/5

Tables 31 and 32 show that the wash fastness of CI Reactive Red 84 on both types of fabric was very good at all depths of shade employed and that syntan treatment prior to wash-off neither improved nor diminished wash fastness. As the colour strengths (K/S values) of the washed-off dyeings of CI Reactive Red 84 were much higher than those of identical depth dyeings of CI Reactive Yellow 39, it can be proposed that the levels of wash fastness achieved for the red dye (Tables 31 and 32) were much greater than those secured for the yellow dyeings.

CONCLUSIONS

Only one of the three α-bromoacrylamido reactive dyes, namely CI Reactive Red 84, displayed good build-up on both conventional decitex and microfibre nylon 6,6 fabrics; the other two dyes yielded only pale dyeings on both fabric types. For each of the three dyes, build-up was greater on conventional decitex fabric at each of the seven depths of shade used. A large proportion of adsorbed dye was unfixed and removed by wash-off. The wash fastness of the washed-off dyeings, at each of the seven depths of shade used, was very good although this was expected in the cases of CI Reactive Blue 69 and CI Reactive Yellow 39 owing to the very low colour strength of the dyeings. Syntan treatment prior to wash-off reduced the amount of dye removed during wash-off in the cases of the red and yellow dyes; generally, syntan treatment did not improve the wash fastness of the dyeings.

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