

**SAWTRI
TECHNICAL REPORT**



NO 313

**A Laboratory Process for Dyeing
Wool-Orlon 42 Blends from
a Charged Solvent system**

by

M.B. Roberts

**SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH
INSTITUTE OF THE CSIR**

**P.O. BOX 1124
PORT ELIZABETH
REPUBLIC OF SOUTH AFRICA**

ISBN 0 7988 0863 2

A LABORATORY PROCESS FOR DYEING WOOL-ORLON 42 BLENDS FROM A CHARGED SOLVENT SYSTEM

by M. B. ROBERTS

ABSTRACT

An aqueous charged solvent system has been used to dye a 50/50 blend of Wool-Orlon 42. Reactive dyes were used for the wool component and cationic dyes for the acrylic.

The build-up characteristics were satisfactory. Wet fastness properties were similar to those obtained in conventional aqueous dyeing techniques except in the case of the heaviest depth when solvent dyeings gave slightly inferior results.

Control of the rate of dyeing could be exercised through the use of an anionic auxiliary and a temperature arrest period.

INTRODUCTION

Blends of acrylic fibres and wool have now assumed a position of some importance in the textile industry. The most common blend consists of 55 *per cent* acrylic fibre but others of increasing richness in acrylic fibre, notably 70 *per cent* and 80 *per cent* respectively, are also popular. The attractive features inherent in such blends are the well-known wearing properties of wool, together with the high bulk and easy care properties associated with the acrylics.

The dyeing of these blends is normally achieved by means of anionics, notably reactive, acid milling or 1 : 2 premetallised dyes, for the wool component and cationic dyes for the acrylic. Whilst disperse dyes may be useful for pale shades on 100 *per cent* acrylics they are not recommended for wool-acrylic blends. Both two bath and one and two stage single bath methods have been proposed for dyeing but single bath methods are to be preferred for economic considerations. The two-stage single bath technique seems capable of producing deep shades of adequate fastness for most requirements.

Important factors to be borne in mind when dyeing wool-acrylic blends are that the cationic dye is initially absorbed by the wool and subsequent transfer to the acrylic fibre occurs only at temperatures in excess of the second order transition when exhaustion is very rapid with little subsequent levelling action. An excellent review of the subject is that of Lemin¹.

The object of this work was to establish whether wool-Orlon 42 blends could be dyed successfully from an aqueous charged solvent system bearing in mind the factors of importance indicated above and the additional potential problem of coprecipitation of anionic and cationic dyes in the small amount of water present and the possible solubility of the complex in the non-polar solvent. Solvent dyeing systems, particularly those for wool, have long engaged the attention of workers

at SAWTRI and several publications have appeared on the subject²⁻⁵. The aqueous charge system described by Roberts and Botha⁶ was shown to give satisfactory dyeings on wool with reactive dyes. Unpublished pilot scale work has confirmed that the process is capable of giving good results. Thus the application of this technique to blends of wool and acrylic fibres is a natural extension of previous work.

EXPERIMENTAL

Three double jersey fabrics, each of similar construction, were used for this work. One was 100 per cent wool, another 100 per cent [®]Orlon 42, and the third a 50/50 blend of wool and Orlon 42. 10 g samples (5 g of each fibre or 10 g of the blend) were dyed in stainless steel capsules of a Linitest apparatus.

The dyes used were reactive dyes for wool selected from the [®]Lanasol range and cationic dyes from the [®]Maxilon range. The general dyeing procedure was as follows: In order to facilitate the handling of small quantities, a multiple charge of the reactive dye dissolved in water, previously adjusted to pH 5 with acetic acid, 1 per cent (o.m.f.) ammonium sulphate, 1 per cent (o.m.f.) [®]Albegal A and 0,25 per cent [®]Albegal B was prepared. An aliquot of this aqueous phase was added to 100 ml perchloroethylene containing 0,2 per cent (m/v) emulsifying agent, Emulgator 20FB1002, a former experimental product of Ciba-Geigy. The composition of the aqueous phase was adjusted so that the requisite amount of dye and assistants was contained in a quantity of water equivalent to 25 per cent (o.m.f.).

After agitating for 10 min using a magnetic stirrer, the emulsion was tumbled in the Linitest for 5 min at 50°C prior to the addition of the fabric. The temperature was raised to 70°C over 20 min and maintained for 20 min at this temperature after which an aliquot of the cationic dye dissolved in water, such that the combined aqueous charge totalled 50 per cent (o.m.f.), was added to the system. The temperature was maintained at 70°C for a further 10 min prior to heating to the boil over 30 min. The boiling period was maintained for 60 min before the system was allowed to cool to 60°C over 15 min.

Rates of dyeing for members of each class of dye were determined by carrying out dyeings for specific times. The dyed samples were removed from the liquor and rinsed in 2 x 25 ml portions of ethanol to remove entrained liquor. The alcoholic extracts were added to the residual liquor and the whole made up to volume with ethanol. Exhaustion values were determined by spectrophotometric analysis of the residual dye liquors after centrifuging at 12 000 r.p.m. for 30 min. Preliminary checking was undertaken to ensure that the cationic and reactive dyes did not interfere with each other and that Beer's Law was obeyed.

The staining of the wool by the cationic dye was determined by dyeing according to the previously described method in the presence of the cationic dye only and assessing the staining by reference to the S.D.C. Grey Scale. Two different depths were employed.

The build up characteristics of this method of dyeing were examined by carrying out dyeings of various strengths and determining the reflectance values of the dyed samples by means of a Zeiss Elrepho reflection photometer. K/S values were then calculated from the Kubelka-Munk equation.

Aqueous dyeings were carried out in an Ahiba laboratory dyeing machine for purposes of comparison. The use of different machines for solvent and aqueous dyeing was considered to be of little significance. Dyebaths were prepared according to the appropriate pattern card instructions.

The dyeings were tested for fastness to washing⁷ and alkaline perspiration⁸.

TABLE I

RATES OF DYEING OF MIXTURES OF REACTIVE AND CATIONIC DYES ON 50/50 WOOL-ORLON 42 BLENDS APPLIED FROM SOLVENT AND AQUEOUS SYSTEMS

Time (min)	Temp (°C)	Exhaustion (%)			
		Solvent		Aqueous	
		Reactive	Cationic	Reactive	Cationic
0,36% Maxilon Yellow GL and 0,4% Lanazol Blue 3G					
10	60	61	—	28	—
20	70	95	—	62	—
50	70	97	41	95	24
65	85	—	59	—	42
80	100	98	86	98	67
110	100	—	93	—	96
140	100	99	96	99	98
0,44% Maxilon Blue GRL and 0,6% Lanazol Yellow 4G					
10	60	57	—	34	—
20	70	94	—	71	—
50	70	96	50	91	33
65	85	—	69	—	50
80	100	97	90	98	70
110	100	—	95	—	95
140	100	98	98	98	97

RESULTS AND DISCUSSION

The results of this work have shown that while the aqueous charged solvent dyeing system is capable of dyeing wool-Orlon 42 blends, certain characteristics of the resultant dyeings are inferior to those obtained from conventional aqueous systems. It would appear that these deficiencies are caused primarily by the very rapid uptake of dye and the failure of the cationic dye to migrate sufficiently to the acrylic fibre within a reasonable time. The former problem has been improved by the use of dyeing auxiliaries and an arrest period but the migration problem remains.

Table I shows the very rapid rate of exhaustion of both reactive and cationic dye when applied by the solvent technique compared to the normal aqueous method. In both examples quoted, about 60 *per cent* of the anionic dye was exhausted after only 10 min, the corresponding figure for aqueous dyeing being of the order of only 30 *per cent*. Reactive dye exhaustions of 95 *per cent* were recorded after only 20 min, a rate of dyeing too fast to lend itself to level dyeing.

It should be remembered that these dyeings were carried out in the presence of 1 *per cent* (o.m.f.) Albegal A, this auxiliary being a levelling agent for anionic dyes and, under the conditions of application, exhibiting anionic characteristics and promoting levelling and a slowing of the rate of dye uptake by providing competition for dye sites.

The rates of exhaustion of the cationic dyes are also much higher in the charged solvent dyeing system than in water but exhaustion in this context is liable to be misleading since much of the dye goes to the non-target fibre from which it subsequently migrates to the acrylic. Careful inspection of the dyeings carried out with separate wool and acrylic samples showed that in all cases the wool was much more heavily stained with the cationic dye immediately following its addition in the

TABLE II
GREY SCALE RATINGS OF THE
STAINING OF THE WOOL COMPONENT OF A 50/50
WOOL-ORLON 42 BLEND BY CATIONIC DYES WHEN DYED FROM
SOLVENT AND AQUEOUS SYSTEMS

Dye	Std. Depth	Solvent	Aqueous
Maxilon Yellow GL	1/1	4-5	5
	2/1	4	4-5
Maxilon Red GRL	1/1	4	4-5
	2/1	3	4
Maxilon Blue GRL	1/1	4-5	5
	2/1	3-4	4

TABLE III

**INFLUENCE OF DEPTH OF SHADE UPON ALKALINE PERSPIRATION
FASTNESS OF 50/50 BLENDS OF WOOL-ORLON 42 DYED IN
SOLVENT AND AQUEOUS SYSTEMS**

Depth of Shade (% o.m.f.)	Fastness to Alkaline Perspiration			
	Solvent		Aqueous	
	Staining on		Staining on	
	Wool	Cotton	Wool	Cotton
Lanasol RedG/Maxilon Red GRL				
0,12/0,05	5	5	5	5
0,24/0,1	5	5	5	5
0,48/0,2	4	5	5	5
0,72/0,3	4	4-5	5	5
1,08/0,45	3-4	4-5	4-5	5
1,65/0,68	3-4	4-5	4-5	5
Lanasol Blue 3G/Maxilon Blue GRL				
0,1/0,11	5	5	5	5
0,2/0,22	5	5	5	5
0,4/0,44	5	5	5	5
0,6/0,66	4	5	4-5	5
0,9/0,99	4	4-5	4	5
1,35/1,5	3	4-5	4	4-5
Lanasol Yellow 4G/Maxilon Yellow GL				
0,1/0,06	5	5	5	5
0,2/0,12	5	5	5	5
0,4/0,24	4-5	5	5	5
0,6/0,36	4	5	5	5
0,9/0,54	4	5	5	5
1,35/0,86	3-4	5	5	5

solvent dyeing trials than in the aqueous dyeings. It is not difficult to account for this occurrence. The small quantity of water used in this system is being continuously extracted from the perchloroethylene by the fibre, preferentially by the wool on account of the lower affinity of the acrylic for water.

Subsequent migration of the cationic dye to the acrylic fibre is less efficient in the charged solvent dyeing than in the aqueous system. This is shown in Table II by the staining of the wool component by the cationic dyes at 1/1 and 2/1 standard depths respectively. In every case the staining of wool dye from the solvent system is greater than that from aqueous dyeing.

Further evidence of incomplete migration of the cationic dye to the acrylic is provided by the figures for fastness to alkaline perspiration in Table III from which it may be seen that with increasing depth of shade the staining of the adjacent fabrics increases at a greater rate for the solvent dyed samples.

The aqueous charged solvent system has proved capable of satisfactory build-up properties. The relationship between reflectance of dyed patterns and applied dyestuff concentration is shown in Figs 1-3. The graphs show excellent agreement between solvent and aqueous dyed systems.

The ISO 2 wash fastness ratings for the solvent dyed samples were good, in most cases identical to those of the corresponding aqueous dyed samples, with the exception of the heaviest depths when the degree of staining of adjacent fabrics exhibited by the solvent dyeings was slightly greater than that of the aqueous dyeings.

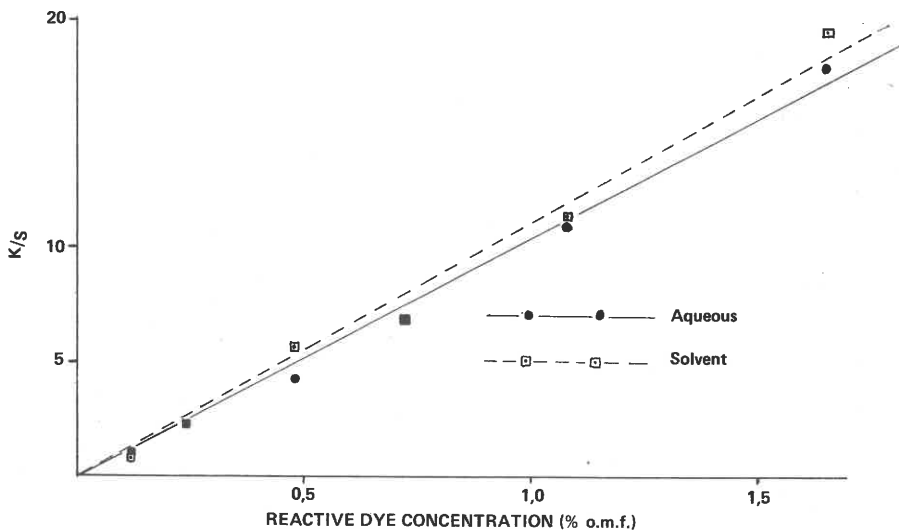


FIGURE 1

Relationship between reflectance of dyed fabric and dye concentration –
Lanazol Red G : Maxilon Red GRL

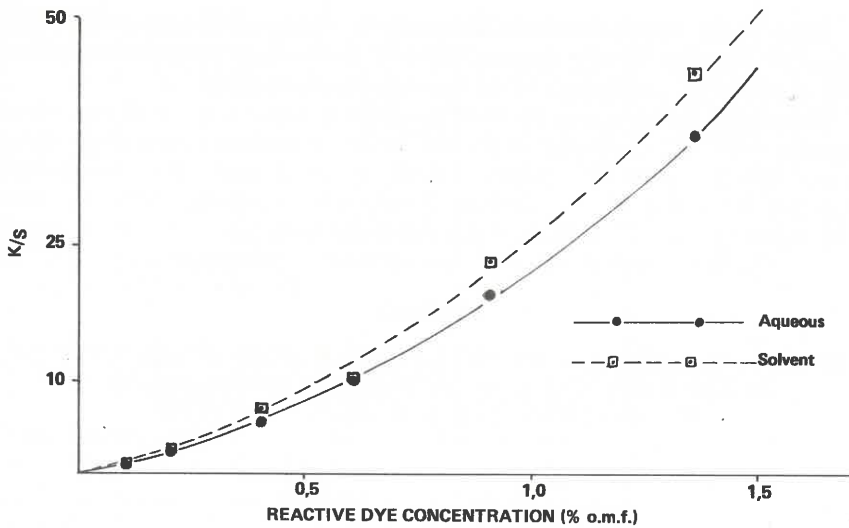


FIGURE 2

Relationship between reflectance of dyed fabric and dye concentration -
Lanazol Blue 3G : Maxilon Blue GRL

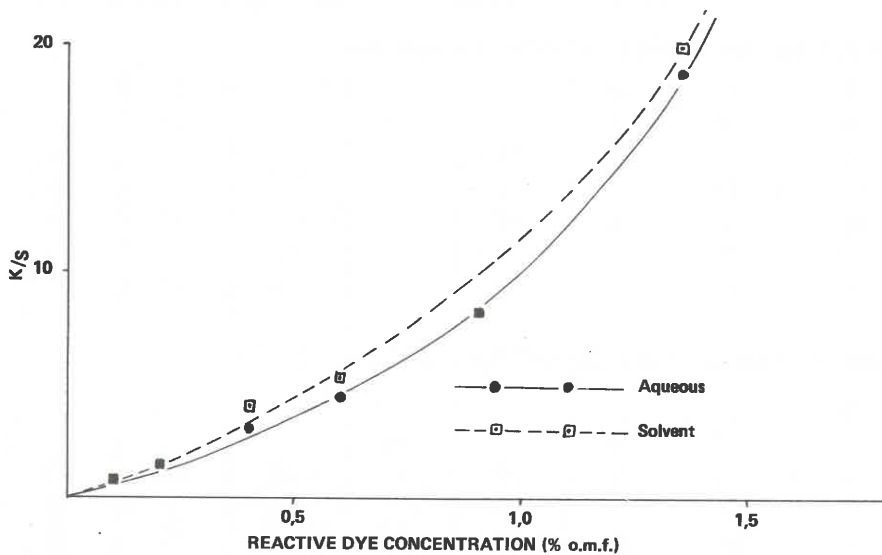


FIGURE 3

Relationship between reflectance of dyed fabric and dye concentration -
Lanazol Yellow 4G : Maxilon Yellow GL

Experiments directed towards the reduction of the rate of dyeing in an effort to improve the level dyeing characteristics of the method were centred around modifications of the auxiliaries and the time-temperature profile.

Many level dyeing agents for wool are cationic but it was felt that problems might arise with the introduction of further cationic substances into a small volume of water already containing a variety of ionic species. Accordingly it was decided to examine the effect of the auxiliary already present, namely Albegal A. The results shown in Table IV indicate that a significant reduction in the rate of dyeing in the reactive dye occurred only after the addition of 3% Albegal A (o.m.f.). This

TABLE IV
EFFECT OF ALBEGAL A ON THE RATE OF DYEING OF MIXTURES OF REACTIVE AND CATIONIC DYES ON 50/50 WOOL-ORLON 42 BLENDS APPLIED FROM A SOLVENT SYSTEM

Time (min)	Temp (°C)	Exhaustion (%)					
		0,5% Albegal A		1,0% Albegal A		3,0% Albegal A	
		Reactive	Cationic	Reactive	Cationic	Reactive	Cationic
0,36% Maxilon Yellow GL and 0,4% Lanazol Blue 3G							
10	60	63	—	61	—	28	—
20	70	93	—	95	—	52	—
50	70	97	53	97	41	75	35
65	85	—	68	—	59	—	50
80	100	98	90	98	86	85	69
110	100	—	95	—	93	—	79
140	100	99	98	99	96	87	87
0,44% Maxilon Blue GRL and 0,6% Lanazol Yellow 4G							
10	60	64	—	57	—	33	—
20	70	95	—	94	—	53	—
50	70	95	60	96	50	71	42
65	85	—	76	—	69	—	53
80	100	97	92	97	90	82	70
110	100	—	96	—	95	—	76
140	100	99	98	98	98	84	84

quantity is much greater than would normally be employed in conventional aqueous dyeing but the dyeing environment is totally different.

There is also an accompanying reduction in the rate of exhaustion of the cationic dye but there remains a period of fairly rapid exhaustion immediately after the second order transition temperature of the acrylic is reached. Since accurate

TABLE V

EFFECT OF AN ARREST PERIOD AT 85°C ON THE RATE OF DYEING OF MIXTURES OF REACTIVE AND CATIONIC DYES ON 50/50 WOOL-ORLON 42 BLENDS APPLIED FROM A SOLVENT SYSTEM

N.B. 3% Albegal A (o.m.f.) used in this series of experiments

No Arrest at 85°C				With Arrest at 85°C			
Time (min)	Temp (°C)	Exhaustion (%)		Time (min)	Temp (°C)	Exhaustion (%)	
		Reactive	Cationic			Reactive	Cationic

0,36% Maxilon Yellow GL and 0,4% Lanazol Blue 3G

10	60	26	—	10	60	28	—
20	70	51	—	20	70	52	—
50	70	76	36	50	70	75	35
65	85	—	50	65	85	80	50
80	100	84	68	80	85	83	61
110	100	—	79	95	100	86	70
140	100	88	86	125	100	88	79
				155	100	90	87

0,44% Maxilon Blue GRL and 0,6% Lanazol Yellow 4G

10	60	34	—	10	60	33	—
20	70	52	—	20	70	51	—
50	70	70	40	50	70	69	39
65	85	—	52	65	85	73	51
80	100	82	71	80	85	77	64
110	100	—	78	95	100	83	73
140	100	85	85	125	100	87	80
				155	100	89	86

temperature control is an accepted means of overcoming this problem in aqueous dyeing techniques, its potential usefulness was explored in this context.

Results shown in Table V indicate that temperature control exerts a similar influence in the charged solvent dyeing system to the aqueous methods. It has been shown that an arrest period of 15 min at 85°C is adequate for the purpose of slowing down the rate of exhaustion of the cationic dye to an acceptable level. Such control is essential if this type of process is to be employed in the production of pale shades.

The experiments described above have merely sought to establish the applicability of the charged solvent system to fibre blends. Previously, the technique had been applied only to single fibre systems. That reasonably satisfactory dyeings can be obtained has been established. Some degree of control has also been shown possible but the complexities of the dyeing system suggest that the degree of control necessary for practical application may be difficult to achieve.

SUMMARY AND CONCLUSIONS

The aqueous charged solvent dyeing technique has been applied to a 50/50 wool-Orlon 42 blend with a fair degree of success. It has been shown possible to control the rate of dyeing of the reactive dye by means of an anionic levelling agent and that of the cationic dye by the combined use of the levelling agent and an arrest period.

The migration of the cationic dye from the wool to the acrylic has been found less efficient in the solvent dyeing system with the result that at heavy depths, the wet fastness is slightly inferior to corresponding aqueous dyeings.

ACKNOWLEDGEMENTS

The author wishes to thank Miss C. Botha for assistance with the laboratory work.

Permission to publish from the South African Wool Board is gratefully acknowledged.

USE OF PROPRIETARY NAMES

®Lanasol, ®Maxilon and ®Albegal are registered trade marks of Ciba-Geigy Ltd. ®Orlon is a registered trade mark of the Du Pont Company.

The fact that products with proprietary names have been used in this investigation in no way implies that there are not others of equal or greater merit.

REFERENCES

1. Leimin, D. R., Some Observations on the Dyeing of Wool-Acrylic Blends, *J. Soc. Dyers & Col.* 91, 168 (1975).

2. Swanepoel, O. A. and Roesstorff, L., Dyeing of Wool from a Charged Solvent System, *S. African Wool & Text. Res. Inst. Tech. Rep. No. 137* (July, 1970).
3. Van der Merwe, J. P. and Van Rooyen, A., Dyeing of Wool with Reactive Dyes from a Charged Solvent System, *S. African Wool & Text. Res. Inst. Tech. Rep. No. 152* (September, 1971).
4. Van der Merwe, J. P. and Van Rooyen, A., The Laboratory Dyeing of Wool from a Non-Aqueous Medium Using Reactive Dyes, *S. African Wool & Text. Res. Inst. Tech. Rep. No. 206*, (November, 1973).
5. Meissner, H. D. and Mclver, B. A., Solvent Dyeing of Wool with a Reactive Dye/Surfactant Complex, *S. African Wool & Text. Res. Inst. Tech. Rep. No. 231* (August, 1974).
6. Roberts, M. B. and Botha, C., A Laboratory Process for Dyeing Wool with Reactive Dyes from a Charged Solvent System Using a Single Emulsifier, *S. African Wool & Text. Res. Inst. Tech. Rep. No. 265*, (August, 1975).
7. Standard Methods for the Determination of Colour Fastness of Textiles, 3d ed. p. 104, Bradford, Soc. Dyers & Colorists, 1962.
8. *Ibid*, p. 71.

Published by
The South African Wool and Textile Research Institute,
P.O. Box 1124, Port Elizabeth, South Africa,
and printed in the Republic of South Africa
by Nasionale Koerante Beperk, P.O. Box 525, Port Elizabeth.

ISBN 0 7988 0863 2

E R R A T U M

In Technical Report No. 281, reference 2 on page 11 is given as "..... SAWTRI Technical Report No. 259 (JULY, 1975)". It should read "..... Technical Report No. 255, JULY, 1975".

