SAWTRI BULLETIN

SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH INSTITUTE
OF THE CSIR

P.O. BOX 1124
PORT ELIZABETH

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EDITORIAL

Survey of the Research Needs of the South African Textile Industry

During the past year the Director and senior staff visited 38 textile manufacturing firms, of which 16 were concerned mainly with cotton, 8 with wool and 14 with "multifibre" operations or else with fibres other than wool or cotton. Collectively these firms represent the major part of the South African Textile Industry. Each was requested to complete a questionnaire concerning the research which in the industry's opinion should be carried out at SAWTRI. The questionnaire listed 12 of the categories in which SAWTRI is equipped to carry out research, namely:

Effluent Treatment
Raw Fibre Scouring
Worsted Carding
Worsted Spinning
Short Staple Processing
Phormium tenax
Textile Physics
Chemistry, dyeing and finishing of wool, mohair and blends.
Chemistry, dyeing and finishing of cotton and cotton blends
Knitting
Weaving
Clothing Technology
Machine Development and Innovation

The questionnaire did not refer to the latest category dealing with woollen processing since this had not then come into existence yet.

The questionnaire also listed a number of different research topics which SAWTRI considered to be important (as many as 12 in each of the categories). A number of blank spaces were also provided to enable the firms to list projects of their own choice in each of the categories. The firms were asked to indicate the order of preference of the topics they selected, including those they had added themselves, and were requested to respond only to those categories which were of direct interest to them.

Of the firms contacted during the survey, 30 (79%) responded. Of these, 14 could be described as being "cotton" firms, 5 as "wool" firms and 11 as "multifibre" firms.

Table I contains the combined results of the survey in respect of all firms contacted. The table simply indicates the frequency with which each specific project was selected by the various firms. The projects listed in the questionnaire were coded "a" to "l" whereas new projects, suggested by the firms themselves, have been grouped under the column "NEW PROJECTS".

TABLE I

Category	Number of Projects Suggested by SAWTRI	Total Number of Times Selected by Firms														
		Project code appearing in questionnaire												Total a-l	New Projects	Grand Total
		a	b	c	d	e	f	g	h	i	j	k	l			
1. Effluent Treatment	7	4	11	4	5	13	19	15						71	8	79
2. Raw Fibre Scouring	3	2	2	5										9	1	10
3. Worsted Carding	7	4	1	1	2	1	3	4						16	2	18
4. Worsted Spinning	6	3	3	8	0	4	4							22	3	25
5. Short Staple Processing	5	11	7	13	5	10								46	5	51
6. *Phormium tenax*	4	2	2	2	2									8	1	9
7. Textile Physics	7	18	13	16	2	10	3	8						70	9	79
8a Chemistry: dyeing and finishing of wool, mohair and blends	7	5	4	7	3	3	5	7						34	6	40
8b Chemistry: dyeing and finishing of cotton and cotton blends	12	11	10	6	4	3	12	11	13	13	7	7	4	111	17	128
9. Knitting	8	3	6	7	6	3	3	4	7					39	1	40
10. Weaving	8	17	8	8	7	11	4	6	4					65	8	73
11. Clothing Technology	7	12	11	9	13	11	7	10						73	4	77
12. Machine Development and Innovation	0													0	9	9
														564	74	638

For the sake of brevity, the coding is not explained here and neither are detailed results of the survey provided but these have been analysed. From an analysis of the response of the firms, 50 research projects were identified which reflect the industry's most important research requirements.

RESEARCH TOPICS REFLECTING THE INDUSTRY'S MOST IMPORTANT RESEARCH REQUIREMENTS

(* indicates that research is already being carried out by SAWTRI)

Effluent Treatment

1.* Investigation of the purification and recycling of effluents from the dyeing and finishing of various fibres.
2.* Study of treatment and disposal of sludges.

Raw Fibre Scouring

3.* Improving scouring efficiencies with particular reference to additives and auxiliaries.

Worsted Topmaking

4.* The effect of fibre characteristics on the processing performance of different wools during topmaking.
5.* Investigation of the effect of using a steam box on the performance of wool during topmaking.
6.* Study of the effect of topdyeing on the processing performance of wool and wool/synthetic blends.

Worsted Spinning

7.* Study of the spinning performance of various wool and wool/synthetic fibre blends on the long staple system.
8.* Study of the performance of different yarns during brushing and the physical properties of the brushed yarns.
9.* Extending the range of RWCS yarns and a study of their performance characteristics.

Cotton Spinning

10.* Comparison of the processing performance of a range of cotton and cotton/synthetic blends on ring, rotor and Dref spinning systems.
11.* Evaluation of the ring and rotor spinning performance of SA cottons.
12. Study of the effect of immature cotton fibres on dyeing.

Bast Fibre Processing

13.* Continuation of the studies on the softening of *Phormium tenax,* both in respect of the construction and development of a suitable machine and of spinning finer yarns.

Textile Physics

14.* Study of the physical properties of fibres, yarns and fabrics and their inter-relationships.
15. Study of the measurement and evaluation of streakiness and barré of knitted fabrics.
16.* Study of the effect of yarn and fabric structural variables on the wrinkling performance of woven fabrics.
17.* Improving the dimensional stability of double jersey and single jersey cotton knitted fabrics.
18. Study of the physical properties of fabrics made from rotor-spun yarns.
19.* Evaluation of the correlation between laboratory tests and wear performance, and, if necessary, development of new tests for predicting wear performance.

Protein Chemistry

20.* Investigation of the chrome dyeing of wool.

21.* Investigation of the dyeing and finishing of wool-rich blends.

22.* Optimisation of the shrink-resist treatment of wool.

23. Evaluation and comparison of various methods of drying yarns and fabrics.

24.* Investigation of the radio-frequency dyeing of wool.

Cotton Chemistry

25. Study of the effects of resins on the properties of cotton and synthetic blend fabrics.

26. Investigation of the energy consumption of various dyeing and finishing machines and processes.

27. Investigation of ways of reducing oligomer formation during polyester dyeing.

28.* Study and comparison of the various methods of low add-on application of dyes, finishing agents, resins and sizes.

29.* Study of the combination of different dyeing and finishing treatments.

30. Study of the effect of fibre structure (heat setting, bulking etc) on the uptake of dyes by various synthetic fibres.

31.* Study of the response of various South African cotton cultivars to mercerisation, dyeing and resin treatment.

32.* Improvement of the exhaustion and fixation of dyes onto cotton and viscose.

33.* Study of the radio frequency dyeing of cotton and synthetic fibres.

Knitting

34.* Investigation of the effect of different types of knots on knitting performance.

35.* Study of the use of brushed yarns in knitwear.

36.* Study of the application of RWCS yarns to various apparel end-uses in knitwear.

37.* Study of the feasibility of knitting with zero take-down tension and its effect on fabric stability.

Weaving

38.* Development of fabrics using various fibres and new blend combinations.

39.* Study of the weaving of Dref-spun yarns.

40.* Development of lightweight wool and wool-blend fabrics.

41.* Improving the weaving performance of singles wool worsted yarns by sizing.

42. In depth study of the yarn requirements for efficient weaving on modern looms, taking into account the many variables.

43.* Developments of a technique for predicting the weaving performance of yarns.
44. Study of the effect of various yarn parameters, particularly hairiness, on air-jet weaving performance.

Clothing Technology

45. Improving selvedge constructions with specific reference to performance during subsequent dyeing and finishing.
46.* Investigation of the sewability and seam slippage of knitted and woven fabrics and improvement of these two properties.
47.* Investigation of the effect of various fibre, yarn and fabric properties and fusing conditions on fusing shrinkage, and development of a test method for predicting fusing shrinkage.
48. Investigation of the correlation between the various methods of measuring fabric shrinkage and those occurring under practical conditions.
49.* Investigation of the effect of various systems of washing and drycleaning on the properties of fused fabrics and seams.
50. Evaluation of new systems of producing seams in both knitted and woven fabrics, e.g. welding.

This list clearly shows that the large majority of research projects in which the industry expressed interest, are, in fact, already being investigated by SAWTRI.

INSTITUTE NEWS

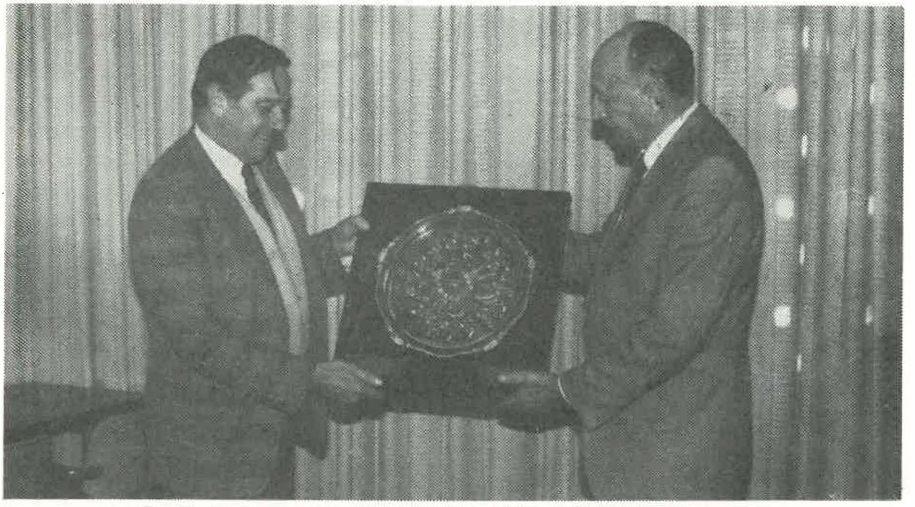
Final farewell to the 1980 Conference

On Monday, June 22, the Organising Committee of the 1980 Quinquennial Wool Textile Research Conference met at SAWTRI to wind up the business of the Conference following a farewell dinner the previous evening. A short ceremony, marking the end of the meeting, involved the handing over to SAWTRI of the beautiful gold and silver salver which had been presented to the CSIR on behalf of the overseas delegates by Dr. Gordon Crewther of the CSIRO. It was felt by the CSIR that, rather than display the salver in the Conference centre at Scientia, it be permanently installed at SAWTRI. The presentation at SAWTRI was made by Mr J. P. de Wit, CSIR Vice President responsible for SAWTRI and Dr. D. W. F. Turpie, Director of SAWTRI, received it on behalf of the Institute.

FINAL MEETING OF 1980 CONFERENCE ORGANISING COMMITTEE

Standing Left to Right: Mr. K. McCusker, CSIR Conference Division; Mr. N. J. Vogt, Regional Liaison Officer of the CSIR, East Cape Region; Mr. J. Bekker, S.A. Wool Board, Technical Centre, P.E., Dr. J. McPhee (Visitor), Deputy Managing Director of the I.W.S., Mr. W. MacDonald, Managing Director of Gubb and Inggs (Pty) Ltd., Mr. Jan Moolman, Director of Technical Services, S.A. Wool Board and Mr. M. A. Strydom of SAWTRI.

Sitting: Dr. D. W. F. Turpie, Director of SAWTRI, Mr. J. P. de Wit, Vice President, CSIR., Dr. D. P. Veldsman, Director of P.E. Tecknikon (Chairman), Miss. Ann van Dyk, CSIR Conference Secretariat and Mr. D. S. Uys, Manager, Mohair Board.



Dr. D. W. F. Turpie (left) receiving the Salver from Mr. J. P. de Wit.

WOOL BOARD /SAWTRI Steering Committee Meeting

The WOOL BOARD/SAWTRI Steering Committee met at SAWTRI on June 22nd. The importance of this meeting, in addition to that of its deliberations on wool research, lies in the fact that this was the first of two meetings per research year to be held instead of one only, which had been the custom in the past.

SAWTRI Senior Scientist for Australia

Dr L. Hunter, Assistant Director of SAWTRI, leaves for Australia in November, to attend various meetings. Dr Hunter is to attend the IWS Research and Development meeting in Melbourne on 19 and 20 November. While in Australia, Dr Hunter will also visit the CSIRO Textile Physics Division at Ryde, Sydney and the CSIRO Division of Textile Industries at Geelong. At the University of New South Wales, he will hold discussions with Prof Postle concerning a joint project involving SAWTRI and the University. Dr Hunter will return to South Africa on November 24th.

Honour bestowed upon SAWTRI senior scientist

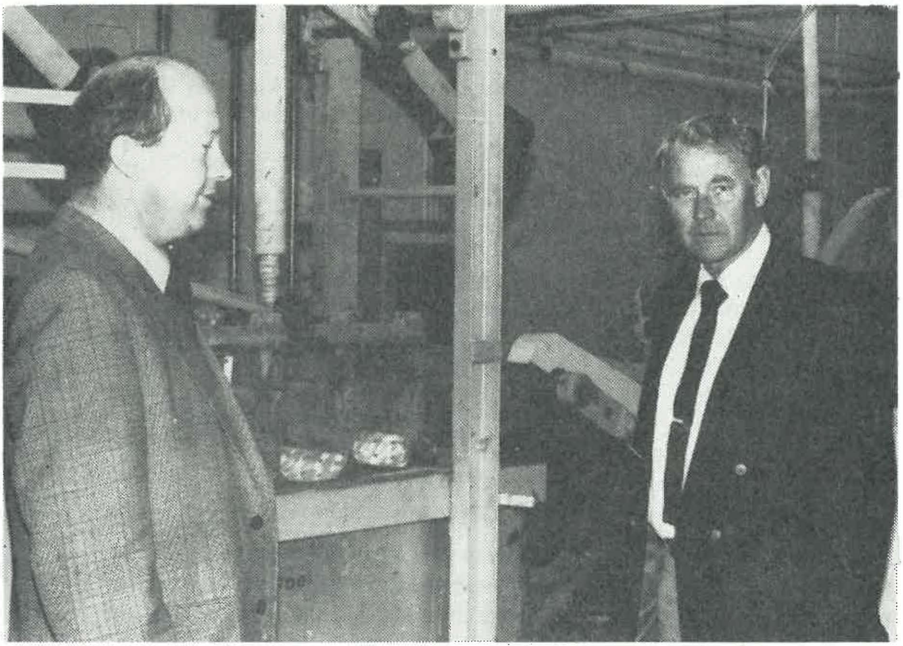
Dr N. J. J. van Rensburg, Group Leader of Textile Chemistry at SAWTRI has been notified that he has been awarded the Textile Institute Service Medal in recognition of both his devoted research in textile chemistry, dyeing and finishing and of his services to the Textile Institute in the Eastern Cape.

SAWTRI scientist visits UK and Israel

Dr T. Mozes, Head of Wool Scouring and Effluent Treatment at SAWTRI spent a few days with Dr Dai Morgan and other scientists at the IWS Technical centre in Ilkley, Yorkshire in June. He also visited factories in the area. From 5th to 10th July, Dr Mozes attended the Fourth International Conference on Surface and Colloid Science in Jerusalem and acted as chairman at one of the plenary sessions.

Visitors to SAWTRI

During July, August and the beginning of September the following people paid visits to SAWTRI from abroad: Mr Marshall French, Technical Adviser to Lesotho Handspun; Mr Armas of Prouvost Ersa, Logrono, Spain; Mr K. McQuilkin, Export Director for Chemby Marketing Limited, New Zealand, Mr D. Porritt of the firm William Tatham, Rochdale; Mr P. W. Sahr, Executive Vice-President, Schafhorst, West Germany and Mr W. Nierhaus of the same firm; Mr G. P. Taylor of Leesona Textile Machinery, Holland; Mr Tom McAuley of Dawson's International, United Kingdom; Mr M. Lambert, Director, Ille de France Breeding Society and Mr Levasher of the same organisation.



Mr. K. McQuilkin (left) and Dr. L. Hunter photographed in SAWTRI's Scouring Department.

SAWTRI PUBLICATIONS

Since the last edition of the Bulletin, the following Technical Reports have been published:

No. 476 : Barkhuysen, F. A., Van Rensburg, N. J. J. and Turpie, D. W. F.: *Continuous Dyeing Using Radio Frequency Energy. Part I — Preliminary Trials on Wool*

No. 477 : Hunter, L., Gee, E. and Smuts, S.: *A Comparison of some Commercial Self-Twist (STT) and Ring-Spun Wool Yarn Properties.*

No. 478 : Barkhuysen, F. A. and Van Rensburg, N. J. J.: *Sorption and X-Ray Diffraction Studies on Cotton Fabrics treated in Anhydrous and Aqueous Liquid Ammonia.*

A NOTE ON THE INFLUENCE OF FIBRE PROPERTIES ON THE RESISTANCE TO COMPRESSION OF DYED WOOL TOPS

by L. HUNTER and S. SMUTS

ABSTRACT

The resistance to compression of twenty-six wool tops, dyed commercially under identical conditions, was measured both prior to and after steam-relaxation. The results were related to the resistance to compression of the original undyed tops and also to the staple crimp of the grease wool and mean fibre diameter. It was found that dyeing had little effect on the resistance to compression of the tops measured after steam-relaxation. Futhermore, a fairly good correlation was found between the resistance to compression of the steam-relaxed dyed tops and that of the undyed tops, as well as between the former and the product of staple crimp and mean fibre diameter.

INTRODUCTION

Numerous studies have been undertaken on the relationship between the bulk resistance to compression of a randomised wool fibre assembly and the fibre properties. The findings of these studies have been reviewed in two earlier publications[1,2]. In the main, it has been shown that the resistance to compression (or bulk) of a wool sample is affected mainly by the fibre crimp characteristics and also to a lesser extent by fibre diameter. In practice, there is a good correlation between resistance to compression and the product of fibre diameter and staple crimp, and it has been suggested[3] that the quotient of resistance to compression and diameter, termed the bulk/diameter ratio, can be used as a measure of the overall crimpiness of a wool sample. Very little, however, is known of the resistance to compression of dyed wools and its correlation with the fibre properties. What is known is that top dyeing generally reduces the resistance to compression (by about 10%)[2,4] because the fibres are set in their semi-straightened form during the dyeing process and this set is partly stable to the normal wetting or steaming procedures used to relax the fibres prior to testing. Recently[5] it was shown that the resistance to compression of dyed tops had an effect on certain yarn properties, with, if anything, the resistance to compression of the steam-relaxed tops being better correlated with the yarn properties than the resistance to compression of the unrelaxed tops.

Because of the lack of information concerning the relationship between the resistance to compression of dyed wools and fibre characteristics, a study was undertaken in this respect.

EXPERIMENTAL

Twenty-six wool tops, differing in fibre characteristics were afterchrome dyed under commercial conditions[5]. After dyeing, samples of the tops were taken and tested for resistance to compression prior to and after steam-relaxation[2,4]. The method used to measure the resistance to compression was briefly as follows: A randomised (hand carded) fibre sample of 2,5 g was placed in a cylindrical chamber (20,03 cm^2 in cross-section) and precompressed for 3 minutes with a 196 cN (200gf) load. This load was then removed and a 9,8 N (1 kgf) load was carefully lowered onto the wool. The compressed height (in mm) of the wool sample (termed the "resistance to compression") was measured exactly 1 minute later. Details of the tops as well as the resistance to compression values are given in Table I.

RESULTS AND DISCUSSION

DYED *vs* UNDYED TOPS

Statistical analyses were carried out to determine the interrelationships between the resistance to compression of the dyed and undyed tops and between the values for the unrelaxed and steam-relaxed tops. The following significant regression equations were obtained.

Linear Regression Analysis

$RC_{SD} = 1{,}37\ RC_{UD} - 2{,}66$ .... (1)

Number of readings (n) = 26; Correlation Coefficient (r) = 0,90
where RC_{SD} refers to the resistance to compression of the steam-relaxed dyed tops and RC_{UD} is the resistance to compression of the unsteamed (i.e. unrelaxed) dyed tops.

$RC_{SD} = 0{,}605\ RC_{SW} + 6{,}6$ .... (2)
n = 26 ; r = 0,83
where RC_{SW} is the resistance to compression of the steam-relaxed undyed tops.

$RC_{UD} = 0{,}35\ RC_{SW} + 8{,}3$ .... (3)
n = 26 ; r = 0,73

Quadratic Regression Analysis

$RC_{SD} = 0{,}047\ (RC_{UD})^2 + 7{,}4$ .... (4)
n = 26 ; r = 0,90

$RC_{SD} = -\ 3{,}49\ (RC_{SW}) + 0{,}115\ (RC_{SW})^2 + 42{,}7$ .... (5)
n = 26 ; r = 0,87

$RC_{UD} = -\ 3{,}30\ (RC_{SW}) + 0{,}102\ (RC_{SW})^2 + 40{,}4$ .... (6)
n = 26 ; r = 0,82

From the results of the linear and quadratic regression analyses it can be seen that there is a fairly good correlation between the resistance to compression of the dyed and undyed tops, the correlation being better for the steam-relaxed than for the unrelaxed tops and also better for the quadratic than for the linear equations. In Fig. 1 the resistance to compression of the dyed tops (steam-relaxed and unrelaxed) has been plotted against that of the steam-relaxed undyed tops, with the corresponding quadratic regression curves superimposed. From Fig 1 and Table I it can be seen that the resistance to compression of the dyed tops was increased by steaming, which agrees with previous findings on undyed tops[2,4]. Steaming causes crimp recovery, and for dyed tops it can be expected that the amount of crimp recovery will depend upon the degree of crimp removal and the stability of the set (to steaming) imparted by the dyeing operation. In this particular instance, most of the crimp returned after steaming as indicated by the similarity between the results for the dyed and undyed relaxed tops (see Fig 1 and Table I). Previously[2,4], differences of about 10% were observed but, as mentioned earlier, this would be a function of both the degree of straightening (crimp removal) of the fibres prior to and during dyeing and the stability (to steaming) of the set imparted during dyeing.

EFFECT OF FIBRE PROPERTIES

Linear and quadratic regression analyses were carried out on the results, with resistance to compression as the dependent variable and staple crimp (per cm) of the grease wool and fibre diameter (μm) as independent variables. Another analysis was carried out with the product of staple crimp and mean fibre diameter (μm) as the independent variable, previous work[1] having shown that the latter generally provides a simple and fairly accurate measure of resistance to compression.

Linear Regression Analysis

RC_{SD} = 0,26 (Diameter) + 1,77 (Crimp) + 3,9 .... (7)
Contr. to fit (%): 5,3 76,2
n = 26 ; r = 0,90

RC_{UD} = 0,21 (Diameter) + 1,07 (Crimp) + 5,1 .... (8)
Contr. to fit (%): 7,9 59,9
n = 26 ; r = 0,82

RC_{SD} = 0,077 (Diameter x Crimp) + 9,9 .... (9)
n = 26 ; r = 0,89

RC_{UD} = 0,047 (Diameter x Crimp) + 10,1 .... (10)
n = 26 ; r = 0,82

$RC_{SW} = 0,103$ (Diameter x Crimp) $+ 7,7$ .... (11)
$n = 26 ; r = 0,87$

Quadratic Regression Analysis
$RC_{SD} = -4,1$ (Crimp) $+ 0,66$ (Crimp)$^2 + 2,20$ .... (12)
Contr. to fit (%): 28,9 56,6
$n = 26 ; r = 0,92$

$RC_{SD} = 0,00040$ (Diameter x Crimp)$^2 + 13,5$ .... (13)
$n = 26 ; r = 0,90$

$RC_{UD} = 0,00024$ (Diameter x Crimp)$^2 + 12,2$ .... (14)
$n = 26 ; r = 0,83$

$RC_{SW} = 0,00053$ (Diameter x Crimp)$^2 + 12,6$ .... (15)
$n = 26 ; r = 0,88$

From the results of the two sets of analyses (linear and quadratic), it appeared that the resistance to compression of the dyed tops was highly correlated with the fibre properties, mainly with crimp, the steam-relaxed values showing a better correlation than the unrelaxed values. The quadratic equations provided only a slightly better fit than the linear ones. Furthermore, the equation involving the product of diameter and crimp provided almost as good a fit to the data as the equation involving the separate terms of diameter and crimp, confirming numerous earlier findings on undyed wools[1]. It is also apparent from the various equations, that staple crimp contributed far more to the correlation than did diameter, which, once again, confirms earlier work on undyed wools[1].

In Fig 2 resistance to compression has been plotted against the product of diameter and crimp for the steam-relaxed dyed and undyed tops, respectively. This figure illustrates the similarity between the results for the dyed and undyed tops.

SUMMARY AND CONCLUSIONS

Twenty-six wool tops, differing widely in fibre characteristics, were afterchrome dyed under commercial conditions. The relationship between the resistance to compression of the dyed tops, prior to and after steam-relaxation, and that of the steam-relaxed undyed tops was investigated. In addition, the relationship between the resistance to compression of the dyed tops and mean fibre diameter and staple crimp (grease wool) was investigated and compared with that of the undyed wool.

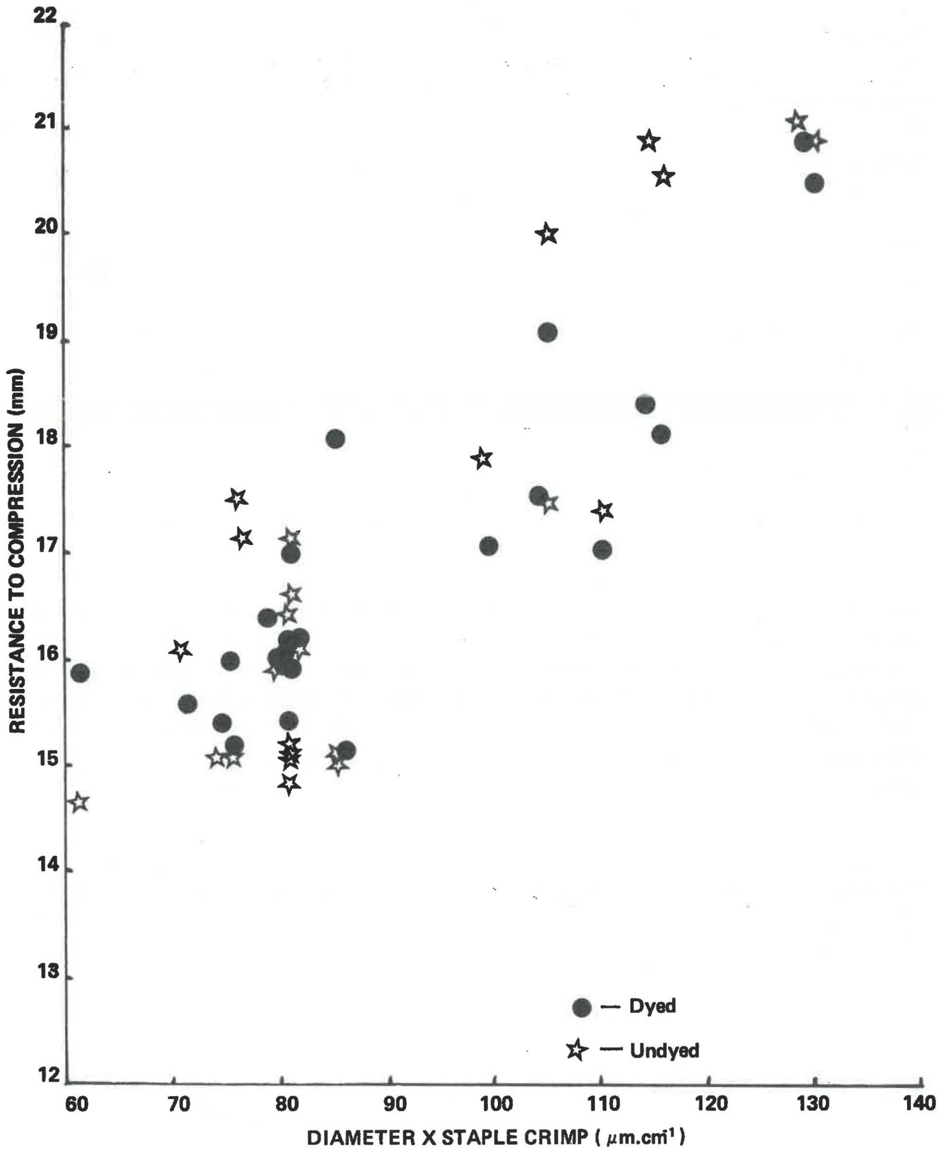


FIGURE 2

Relationship between the resistance to compression of steam-relaxed (dyed and undyed tops) and the product of mean fibre diameter and staple crimp (of the grease wool)

A fairly good correlation was found between the resistance to compression of the steam-relaxed dyed wool and that of the undyed wool which had been relaxed similarly, the correlation being worse, though still highly significant, when the results of the unrelaxed dyed tops were used.

The resistance to compression of the steam-relaxed dyed tops was highly correlated with mean fibre diameter and staple crimp, the latter contributing most to the correlation as was the case for undyed wool. The product of mean fibre diameter and staple crimp provided a fairly good measure of the resistance to compression of the dyed tops, particularly after they had been steam-relaxed, which is once again in line with previous findings on undyed wool.

For the particular dyeing conditions employed here, the resistance to compression of the steam-relaxed dyed tops was very similar to the corresponding values for the undyed tops. Larger differences were observed in previous studies but the differences obviously will depend upon the degree of crimp removal (fibre straightening) prior to and during dyeing as well as the permanency to steam-relaxation of the set imparted during dyeing.

It can be concluded that, for the specific set of commercial dyeing conditions employed in this study, the relationship between the resistance to compression of the steam-relaxed dyed tops on the one hand and fibre diameter and staple crimp on the other, was very similar to that for the undyed tops.

ACKNOWLEDGEMENTS

The authors are indebted to Mrs E. Payne and Miss C. Watermeyer for tenchnical assistance and to the South African Wool Board for permission to publish these results.

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A NOTE ON THE EFFECT OF ISOLATED CONES OF UNWAXED WOOL YARNS ON THE KNITTING PERFORMANCE OF MULTI-FEEDER CIRCULAR DOUBLE- AND SINGLE JERSEY MACHINES

by L. HUNTER, D. A. DOBSON and M. P. CAWOOD

ABSTRACT

The presence of a few cones of unwaxed 25 tex yarn on multi-feeder single- and double-jersey circular knitting machines, equipped with positive feed, did not appear to affect knitting performance adversely. In such cases, the waxed yarns probably maintained sufficient wax on the knitting needles to facilitate the knitting of the unwaxed yarns. Waxing the 25 tex wool worsted yarns, by means of solid paraffin wax discs, generally had a beneficial effect on the knitting performance of two double-jersey structures (interlock and Punto-di-Roma), but not on that of two single-jersey structures (plain and satin stitch).

INTRODUCTION

The importance of effective yarn lubrication, in reducing yarn tension, yarn breakages and stitch length variation during knitting, is well established[1-66], and even when using positive feed on circular machines, yarn-to-metal friction in many cases still has a very significant effect on knitting performance. There can be little doubt that, with respect to the yarn, proper lubrication is the most important means of ensuring low yarn friction and good knittability. Solid paraffin wax is generally best for this purpose, although in certain cases, for example fine wool worsted yarns, emulsion lubricants may be preferred, possibly because the solid wax disc causes physical damage (abrasion and tension) to the yarn[39].

Various studies[3,39-49,64-82] have shown that about 0,5 μg/cm of wax gives the lowest yarn-to-metal friction for most staple fibre yarns, although a higher level may be preferable from the point of view of optimum knitting performance[39] and because it allows a more acceptable margin of error in the application of the wax. Once the wax level exceeds the optimum level, the yarn friction increases again (see Fig 1)[9,29,44,45,47-50,52,53,55-58,64,76-81,83,84]. When lubricated under optimum conditions, the coefficient of friction (μ) of most staple yarn should be lower than about 0,15 and can be as low as 0,12[3,39,44,46-50,52,55,57-60,62,65,66,71-77,81,83,85,86]. Nevertheless, the presence of excessive quantities of oil or other additives on the yarn can have an adverse effect on its friction after waxing, in which case scouring prior to waxing may be necessary to overcome the problem[74,87].

Because the application of paraffin wax from a solid disc has certain practical disadvantages[44,45,50,57,60,64,88], such as possible variations in the level of application[1,4] from winding head to winding head and even at the same winding head over long periods and the problem of possible yarn damage (or at least inferior knittability) already referred to, alternatives to solid paraffin wax have been sought. These include the application of a fibre lubricant during the backwashing of dyed tops[89] and the use of liquid or emulsion rather than solid lubricants[39,51,53,55-57,64,82,90,91] either during winding or on the knitting machine[61]. In fact, certain workers[54,90,91] found that dipping cones into lubricants, (e.g. kerosene) improved the knittability of fine wool worsted yarns more than that obtained by means of the conventional paraffin wax.

Because variation in yarn friction between (and even within) cones from the same commercial batch often occurs in practice, it was decided to undertake a study to find out what effect isolated cones of unwaxed yarn (i.e. the extreme case) have on the knitting performance of multi-feeder circular machines employing positive feed.

EXPERIMENTAL

A batch of 25 tex wool yarn was split into two, one half being waxed with solid paraffin wax under optimum conditions and the other being left unwaxed. The yarns were then knitted into single jersey and double jersey structures under the following conditions:

Single Jersey

Machine	: Bentley JSJ 28 gauge (26″)	
Speed	: 18 rev/min	
Yarn Input Tension	: 3 cN	
No. of Feeders	: 30	
MTF	: Plain single jersey	— 20
	Satin stitch	— 15
No. of Machine Revolutions	: Satin stitch	— 150
	Plain single jersey	— 90

Double Jersey

Machine	: Mellor Bromley 8RD 18 gauge (30″)	
Speed	: 16,5 rev/min	
Yarn Input Tension	: 3 cN	
No. of Feeders	: 32	
MTF	: Interlock	— 16,5
	: Punto-di-Roma	— 16,5
Dial Height	: 1,2 mm	

Run-in-Ratio	: Interlock	— 1:1
	: Punto-di-Roma	— 1,5:1
No. of Machine Revolutions	: 150	

Positive feed was used on both machines, and the knitting was arranged so that, first of all, waxed yarns were knitted at all the feeders. Thereafter, an unwaxed yarn was substituted for a waxed yarn at one of the feeders and knitting resumed. Then another unwaxed yarn was introduced (i.e. replacing a second waxed yarn), until finally, unwaxed yarns were being knitted at all the feeders. A few courses were knitted in each case when changing a yarn before the actual test commenced.

After knitting, the number of holes (yarn breakages) was counted for each knitting condition. Trials were also carried out to determine whether spacing the *unwaxed* yarns between *waxed* yarns around the circumference of the machine or alternatively placing them adjacent to each other had any effect on the number of yarn breakages. This aspect was investigated for up to four unwaxed cones.

RESULTS AND DISCUSSION

It was found that the relative positions of the unwaxed yarns (i.e. whether placed adjacent to each other or spaced around the knitting machines) had no apparent effect on knitting performance and the results were averaged.

Double Jersey Structures

The yarn breakage patterns were similar for the interlock and Punto-di-Roma structures and the average values have been plotted in Fig 2 against the number of feeders knitting unwaxed yarns. From this figure it appears that, with up to about five cones of unwaxed yarn, (the balance of the 32 cones containing waxed yarns,) the number of yarn breakages (i.e. the number of holes) was not significantly affected by the number of unwaxed cones on the knitting machine. Thereafter, there was, initially, a gradual increase in the number of yarn breakages and then a more rapid increase, when about 25 of the 32 cones were unwaxed. When only unwaxed yarns were being knitted, the number of yarn breakages were considerably (almost ten times) higher than when only waxed yarns were knitted, confirming previous findings[1,33,58,59] on the importance of yarn friction (i.e. waxing) in the knitting performance of wool yarns on double jersey machines.

It appears, therefore, as though a few (about five or less) isolated cones of unwaxed or high-friction yarns on a multifeeder double jersey machine, equipped with positive feed, will not significantly affect the overall knitting

FIGURE I

Typical curve of yarn friction measured on a SAWTRI Friction Tester vs amount of wax applied

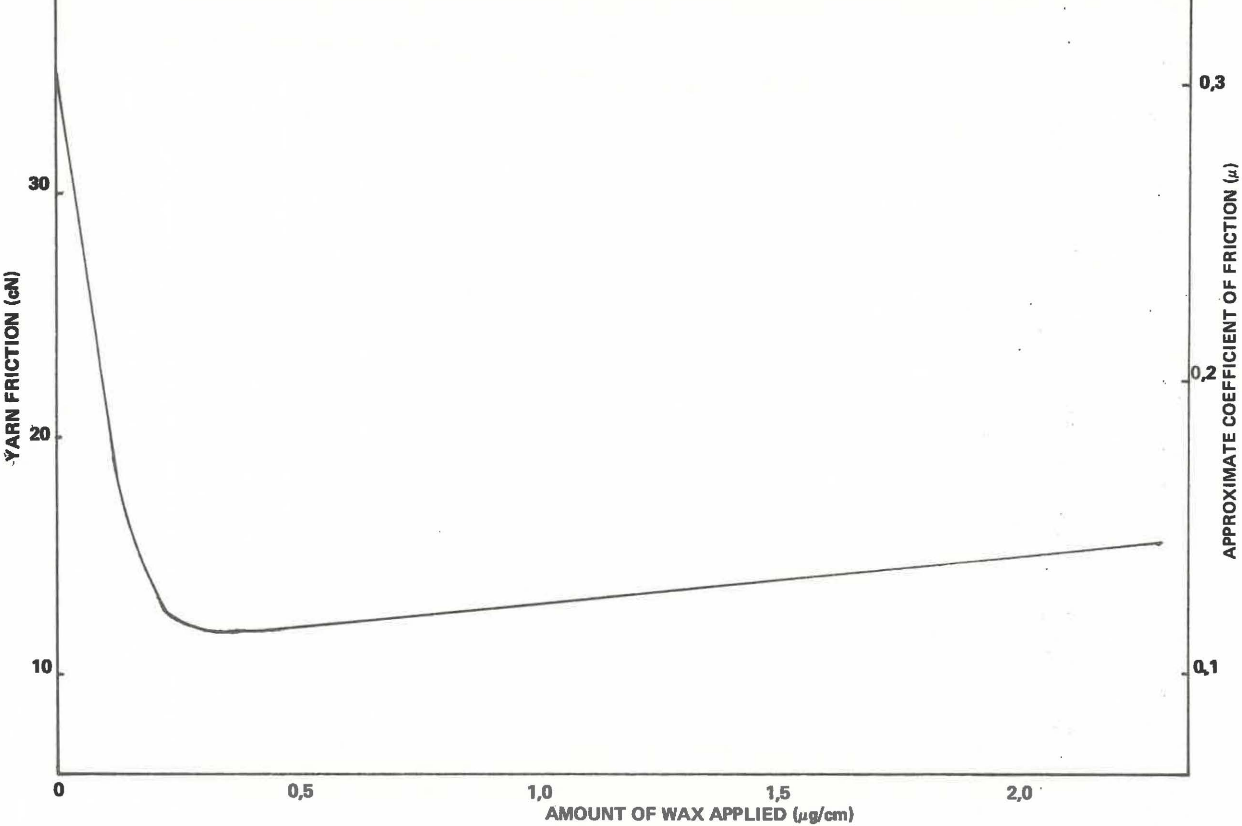


FIGURE 2

Yarn breakage pattern when increasing the number of cones of unwaxed yarn on a multi-feeder circular double jersey machine equipped with positive feed. (Average for interlock and Punto-di-Roma structures)

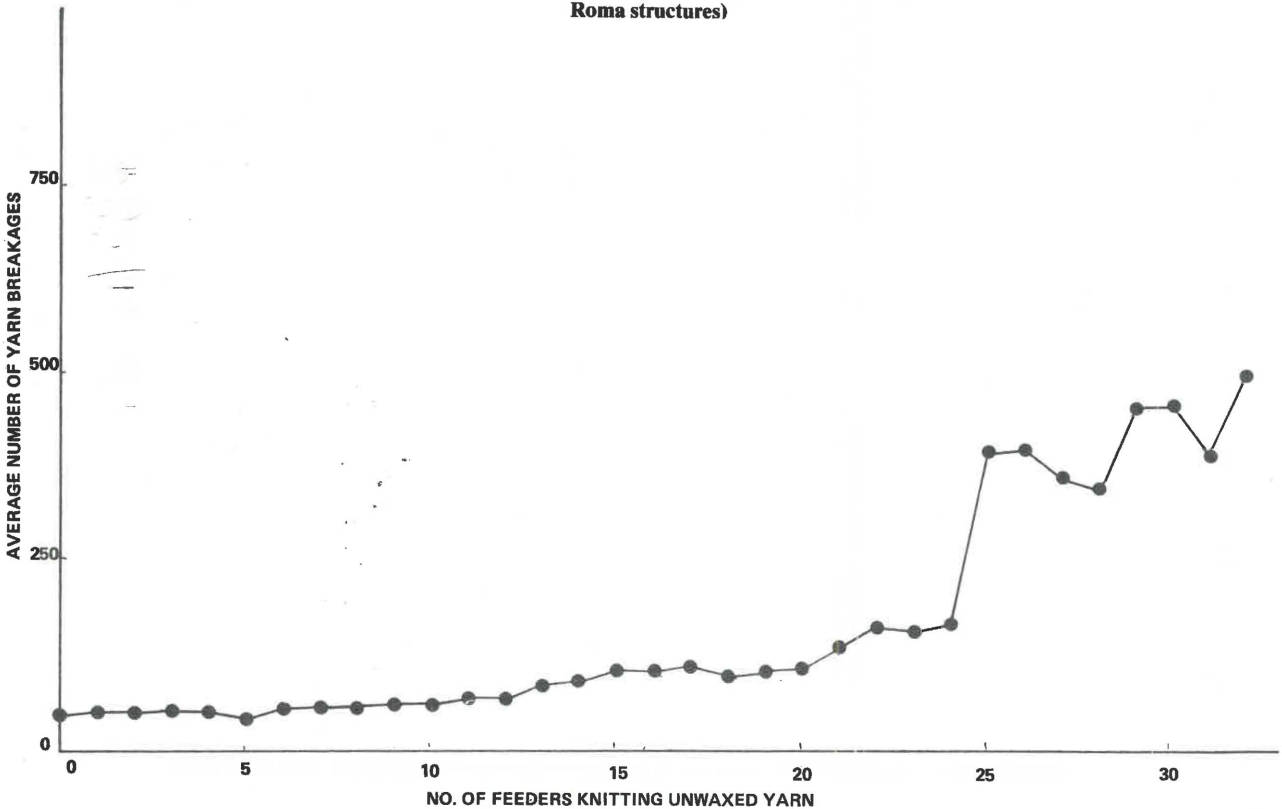
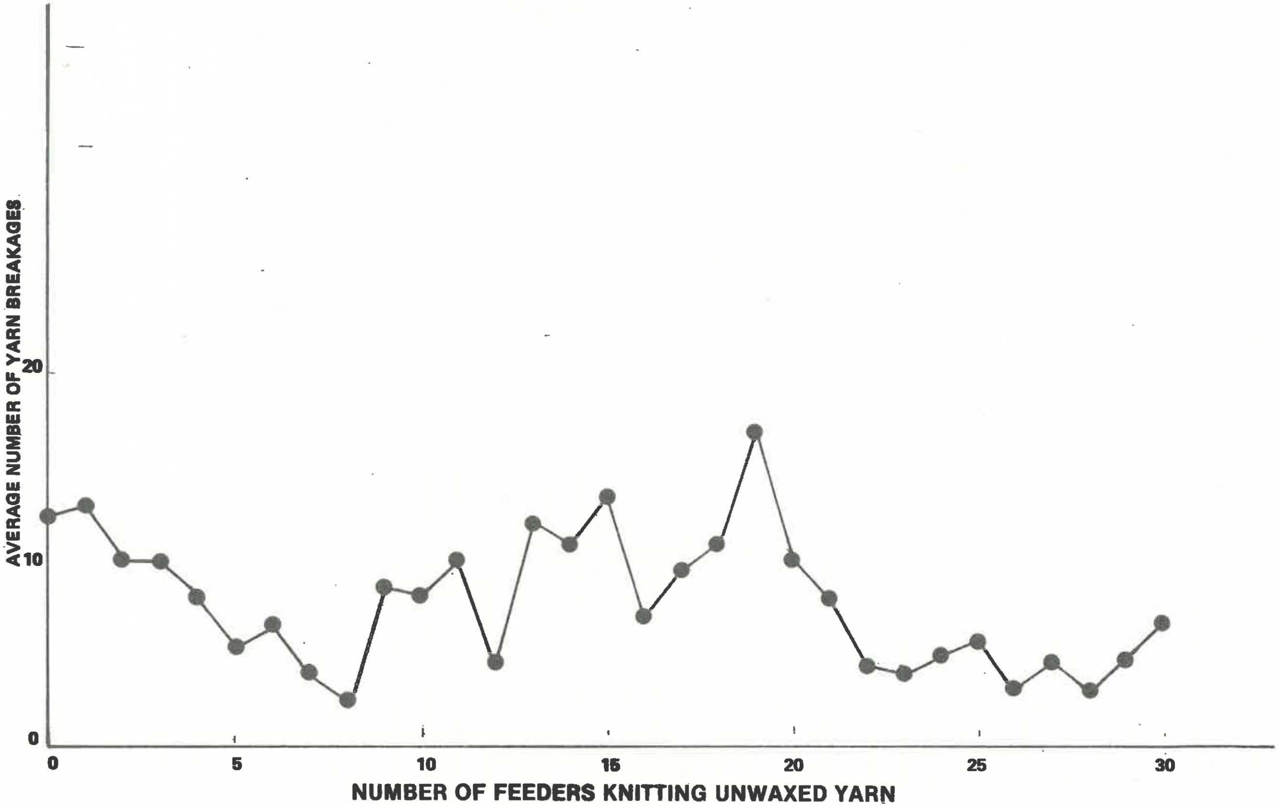


FIGURE 3

Yarn breakage pattern when increasing the number of unwaxed cones of yarn on a multi-feeder circular single jersey machine equipped with positive feed. (Average for plain and satin stitch structures)



performance whereas more than about five cones could. Probably wax is deposited on the knitting needles by the waxed yarns being knitted at the other feeders, forming a wax film which facilitates the knitting of the unwaxed yarns, the mechanism probably being similar to that observed by several workers[28,50,56-58,62,69,83] in their studies on yarn friction. These workers have shown that wax generally is applied to the yarn in discrete particles but the wax particles rub off onto the various guides, thereby lubricating them and ensuring a continuous wax film between guide and yarn, except where long lengths of yarn are unwaxed. Should a length of unwaxed yarn follow a waxed one, the yarn friction only increases very gradually as the unwaxed yarn gradually removes the wax film on the guides. Only when all, or at least most, of the wax has been removed from the guides does the yarn friction (and yarn tension) approach that of the unwaxed yarn. The same trend was reported previously for stitch length on a fully fashioned machine[46].

Single Jersey Structures

The yarn breakage pattern, with increasing number of unwaxed cones on the knitting machine, for the plain single jersey and satin stitch structures was similar and showed a relatively wide scatter. The average results for the two structures have been plotted in Fig 3. From this figure it can be seen that, if anything, the overall number of yarn breakages were lower when either mostly unwaxed yarns (22 or more out of 30) were knitted or when roughly 8 out of 30 cones contained unwaxed yarn. It is difficult to explain these trends, although it was found previously[39] that waxing could actually increase the number of breakages when relatively fine wool worsted yarns are knitted on a single jersey circular machine. It was speculated that this may have been due to mechanical damage caused to such a fine yarn by the wax disc and tensions during waxing. Nevertheless, if the respective trends observed previously[37,39] and now for the double- and single-jersey machines are taken into consideration then it appears that waxing medium to fine wool yarns, by means of a solid paraffin wax disc, is more beneficial for circular double jersey knitting machines than for circular single jersey machines, positive feed being used in both cases. It is conceivable that emulsion lubricants could have greater merit than solid wax discs for the lubrication of such wool worsted yarns destined to be knitted on circular single-jersey machines equipped with positive feed. It is possible, however, that the observed differences in the trends on the single- and double jersey machines could have been due to the difference in their gauges.

SUMMARY AND CONCLUSIONS

Although yarns can be lubricated quite effectively by means of solid paraffin wax discs during winding, it has been found that, in practice, the friction of commercial yarns often varies greatly from cone to cone. In some cases, the yarn friction from a particular cone is so high that it is unlikely that the yarn received any wax during the winding process. Although various studies have shown the overall importance of yarn friction (i.e. lubrication) in knitting, none appears to have covered the case where a few isolated cones of unwaxed yarns are knitted together with waxed yarns on multi-feeder circular double- and single-jersey machines equipped with positive feed. From what has been stated above, this is a very real possibility and it was therefore decided to carry out an investigation in this regard using 25 tex waxed and unwaxed wool worsted yarns. The wool worsted yarns were knitted into two single jersey structures (viz. plain and satin stitch) and two double jersey structures (interlock and Punto-di-Roma). The single jersey structures were knitted on a 28 gauge machine and the double-jersey structures on an 18 gauge machine, employing approximately 30 feeders in both cases.

Knitting commenced with waxed yarns being supplied at all the feeders, whereafter the waxed yarns were progressively replaced by unwaxed yarns until only unwaxed yarns were being knitted. The number of yarn breakages (holes) which occurred during knitting was recorded, in each case.

Different positions of the unwaxed yarns on the knitting machine, i.e. adjacent to each other or between feeders supplying waxed yarns were studied for up to, and including, four unwaxed yarns, and it appeared that the yarn breakage pattern was independent of how the unwaxed cones of yarn were arranged around the machine. Futhermore, it was found that the two single jersey structures behaved similarly and so did the two double jersey structures.

In the case of the two double jersey structures, the number of yarn breakages, which occurred during knitting, remained approximately constant when the number of unwaxed yarns being knitted was increased from zero (i.e. all the yarns waxed) to about 5 (i.e. 27 of the 32 feeders knitting waxed yarns). Thereafter, as more and more unwaxed yarns were substituted for waxed yarns, the number of yarn breakages increased gradually, until there were about 25 (out of 32) feeders knitting unwaxed yarns, when the number of yarn breakages increased very rapidly to about seven times the level observed when knitting only waxed yarns. It appears that the waxed yarns deposited wax on the knitting needles and that this facilitated the knitting of the unwaxed yarns, provided not too many feeders were supplying unwaxed yarns.

In the case of the single jersey structures, no clear pattern emerged although, in general, fewest yarn breakages appeared to occur when there were a large number of feeders (22 or more of the 30) knitting unwaxed yarns. It was observed previously that waxing relatively fine wool worsted yarns with solid paraffin wax had a less beneficial effect when the yarn was knitted on single jersey machines than when it was knitted on double jersey machines, positive feed being employed in both cases. In the former case such waxing sometimes could even have an adverse effect on knitting performance, this appearing to be the trend in the present study as well.

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A PRELIMINARY INVESTIGATION OF THE USE OF RWCS YARNS IN MEN'S HALF-HOSE

by G. A. ROBINSON, C. M. SHORTHOUSE and D. A. DOBSON

ABSTRACT

Repco wrapped corespun (RWCS) wool yarns using either flat nylon or textured polyester as core and wrapper have been knitted into men's half-hose. A comparison of these socks with commercial wool/nylon (65/35) showed that reinforcement of the socks at the heels and toes was essential. The physical properties and wear performance of the socks, especially those containing textured synthetic yarns were comparable to the commercial control socks. There appears to be sufficient potential to justify further exploitation of the use of RWCS type of yarns in half-hose, since plating is eliminated and yarn breakages during knitting are reduced.

INTRODUCTION

Previous workers[1,2,4,5] have reported on the production and properties of RWCS yarns in knitwear. In view of the construction of RWCS wool yarns (i.e. wool yarn incorporating two synthetic filament yarns) they appeared to have potential for use in men's half-hose. It appeared possible that the RWCS yarns could replace the conventional arrangement of one end of wool plated with one or two ends of filament yarn, thereby eliminating certain disadvantages associated with plating.

Belin *et al*[3] reported that *wool stretch* yarns can be made advantageously on self-twist machines by incorporation of filaments of either textured nylon or fine elastane and that these were particularly useful for hosiery. Uptwisting was not necessary and a two-ply ST yarn was used with good results for socks.

Preliminary work was carried out on the knitting of RWCS wool/nylon yarns into half-hose. The use of RWCS yarn with flat filament core and wrapper produced a fine textured sock and the inclusion of polyester filament yarns gave melangé effects when only the wool component was dyed. This paper deals with the knitting of RWCS wool/nylon or wool/polyester yarns into socks as a possible replacement for the conventional socks knitted from wool/nylon blends currently in commercial production.

EXPERIMENTAL

Spinning

A 20,8 μm wool in top form was spun into the following RWCS yarns:

1. 26 tex, with 44 dtex flat nylon, as core and wrapper
2. 52 tex, with 44 dtex flat nylon, as core and wrapper, and
3. 52 tex, with 55 dtex textured polyester as core and wrapper

The yarns were uptwisted into STT yarns employing a tex twist factor of 23,5, cleared and waxed and wound onto suitable packages for knitting.

Knitting

Each of the three yarns was knitted into socks on a Bentley Komet BR 4-inch diameter 12gg, 168 needle half-hose machine. The same machine settings were also used for the production of commercial control socks. The knitting details are shown in Table I.

It can be seen from Table I that the four lots of socks from RWCS yarns were produced by:

(a) knitting two ends of 26 tex RWCS wool/nylon without reinforcement at the heel and toe;
(b) knitting two ends of 26 tex RWCS wool/nylon and replacing one of the ends by two 110 dtex nylon reinforcement at the heel and toe;
(c) knitting one end of 52 tex RWCS wool/nylon without reinforcement, and
(d) knitting one end of 52 tex RWCS wool/textured polyester without reinforcement.

A control sock knitted from one end of 34 tex wool plated with two 78 dtex textured nylon yarns, the latter being replaced by two 110 dtex nylon for reinforcing the heel and toe, was also knitted for comparison purposes. This was designated (e).

Finishing

All the different sock lots were scoured in a side paddle machine at 50°C for 20 min, the wool component dyed under standard commercial conditions, chlorine-Hercosett treated and cured, deodorised, rinsed, softened, hydro-extracted and tumble dried before finally boarding in an autoclave at 130 -135°C.

Physical Testing

Abrasion tests were carried out on the heels and toes of the socks and the percentage mass loss calculated after 10 000, 20 000 and 30 000 cycles on the Martindale Tester. Pilling was assessed (IWS ratings) after 1 000 and 2 000 cycles by application of the standard pill test except that the samples were rubbed against the standard abrasion cloth. Bursting strength was measured on a Mullen Tester. The results are shown in Tables II and III.

TABLE I

KNITTING DETAILS FOR HALF-HOSE

Sock	Leg and Foot			Heel and Toe		
	Spun Yarn	Plated Yarn	Total Yarn Linear Density (tex)	Spun Yarn	Reinforcement Yarn	Total Yarn Linear Density (tex)
a	Two 26 tex RWCS wool/nylon (44 dtex)	—	52 composition 65/35	Two 26 tex RWCS wool/nylon (44 dtex)	—	52 composition 65/35
b	Two 26 tex RWCS wool/nylon (44 dtex)	—	52 composition 65/35	One 26 tex RWCS wool/nylon (44 dtex)	Two 110 dtex textured nylon	48 composition 35/65
c	One 52 tex RWCS wool/nylon (44 dtex)	—	52 composition 85/15	One 52 tex RWCS wool/nylon (44 dtex)	—	52 composition 85/15
d	One 52 tex RWCS wool/polyester (textured) (55 dtex)	—	52 composition 80/20	One 52 tex RWCS wool/polyester (textured) (55 dtex)	—	52 composition 80/20
e (control)	One 34 tex wool	Two 78 dtex textured nylon	50 composition 65/35	One 34 tex wool	Two 110 dtex textured nylon	56 composition 60/40

TABLE II

PHYSICAL PROPERTIES OF HALF-HOSE AT HEEL AND TOE

Type of Sock Yarn	Reinforcement	Martindale Abrasion Test: Abrasion Resistance (% Mass Loss)			Martindale Abrasion Test: Pilling (IWS)		Bursting Strength (kN/m²)	Resultant Yarn Composition
		10 000 cycles	20 000 cycles	30 000 cycles	1 000 cycles	2 000 cycles		
a. Two 26 tex RWCS wool/nylon (44 dtex)	None	5,0	9,1	14,1	3,8	4,5	932	65% wool 35% nylon
b. One 26 tex RWCS wool/nylon (44 dtex)	Two 110 dtex nylon	1,4	2,8	2,1	4,7	5,0	1364	35% wool 65% nylon
c. One 52 tex RWCS wool/nylon (44 dtex)	None	9,0	15,8	21,6	3,8	4,3	805	85% wool 15% nylon
d. One 52 tex RWCS wool/polyester (textured) (55 dtex)	None	0,7	6,8	13,5	4,3	4,8	736	80% wool 20% polyester (textured)
e. One 34 tex wool Control	Two 110 dtex nylon	4,9	7,2	9,1	4,7	4,7	1290	60% wool 40% nylon (textured)

RESULTS AND DISCUSSION

The Effect of Reinforcement of the Heels and Toes

From Table II it can be seen that, when RWCS yarns were knitted into men's half-hose without reinforcement in the heels and toes the abrasion properties were inferior to those of the commercial control. The inclusion of the same decitex filament nylon reinforcement yarn as that used in the commercial control sock resulted in a significant improvement in the abrasion resistance, pilling and bursting strength.

Stretch Properties

From Table III it can be seen that the lateral stretch of the socks knitted from RWCS wool/polyester was comparable to that of the control, but the longitudinal stretch was inferior although satisfactory.

TABLE III

STRETCH PROPERTIES OF HALF-HOSE (HEELS AND TOES)

Type of Sock Yarn	Stretch % (at 9,8 N load)			
	Lateral		Longitudinal	
	Foot	Leg	Foot	Leg
RWCS 52 tex wool with 55 dtex polyester (textured) as core and wrapper	66	98	15	20
CONTROL 34 tex wool plated with two 78 dtex nylon (textured)	65	104	22	30

Wear Performance

Wearer trials were carried out on the socks and these showed that all the RWCS socks without reinforcement at the heels and toes were unacceptable whereas those socks which were adequately reinforced with synthetic filament at the heel and toe compared favourably with the commercial control.

SUMMARY AND CONCLUSIONS

RWCS wool yarns containing either a fine nylon core and wrapper or a textured polyester core and wrapper were used to produce men's half-hose. These socks, particularly at the heels and toes, were compared with commercial control socks in terms of their physical properties such as abrasion resistance, pilling and bursting strength. The stretch properties were also compared.

Reinforcement of the heels and toes was found to be essential. The inclusion of two 110 dtex nylon threads in these parts significantly improved their wear properties. In respect of the leg and foot portion of the socks, the socks knitted from RWCS wool/textured polyester appeared to be better than those knitted from wool/flat nylon and compared well with the 65/35 wool/nylon socks used as a control. The stretch properties of the RWCS socks were satisfactory. There is sufficient evidence that RWCS yarns could be used to advantage in men's half-hose since plating is eliminated and fewer yarn breakages occurred during knitting.

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