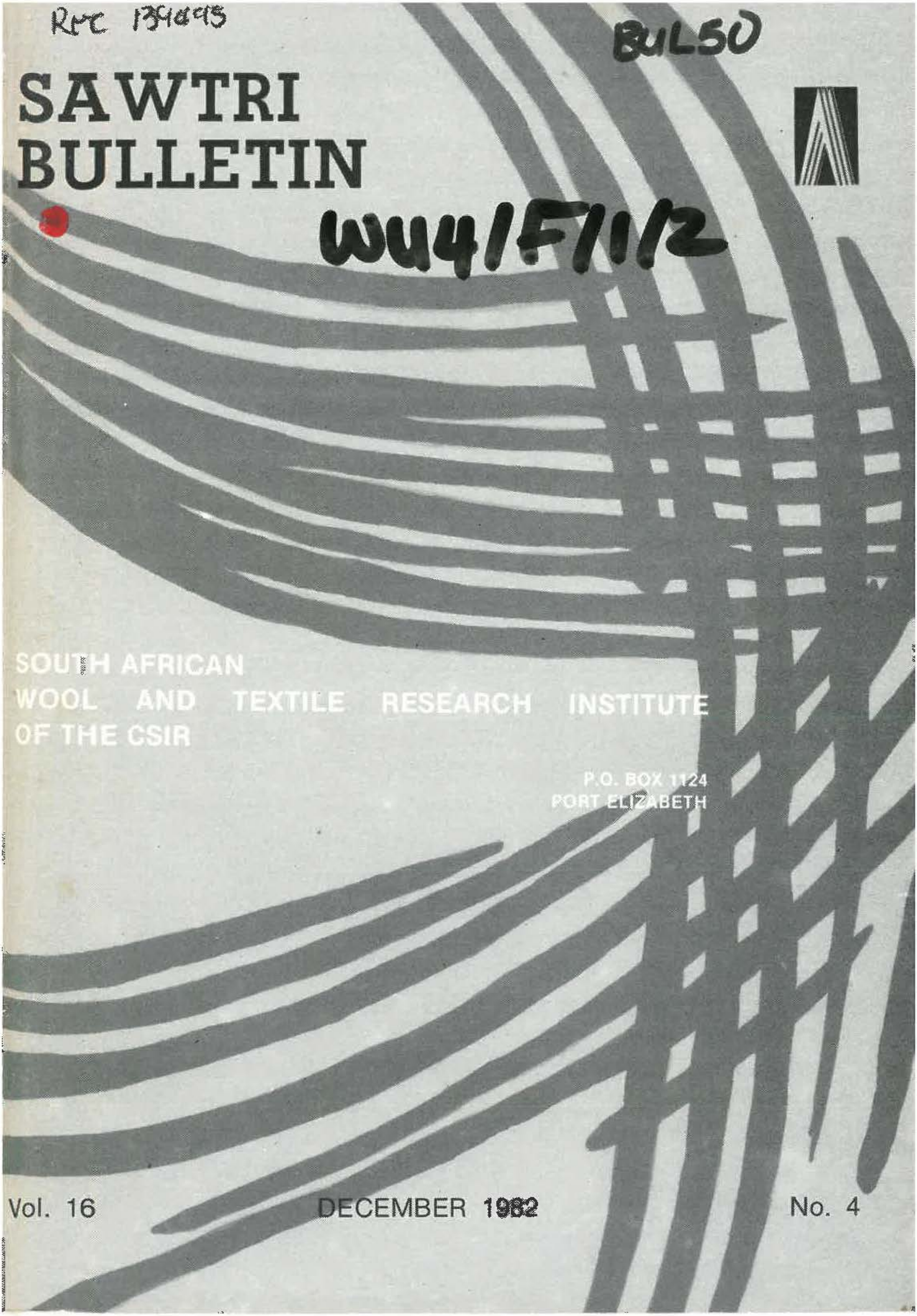
SAWTRI BULLETIN



SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH INSTITUTE
OF THE CSIR

P.O. BOX 1124
PORT ELIZABETH

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EDITORIAL

As we turn the pages of the calendar from one year to the next, the Institute can look back on 1982 as a year of progress in many directions.

A major building extension programme and the installation of new equipment were completed during the year. The extensions to the buildings have provided the Institute with much needed additional floor space for some of the existing departments and facilitated a more rational installation of processing machines in others. A new woollen processing department and larger steam generating and air-conditioning plant have also been added to the existing complex. This obviously caused some disruption but research has not been impeded unduly.

The new premises and equipment were displayed to the delegates attending the International Mohair Association (IMA) meeting which was held in Port Elizabeth during June this year and to a Cotton Symposium held in July. We are proud to announce that, following their visit to the Institute, the IMA has decided to become a corporate subscriber to our work and thus over one hundred firms have been added to our list of subscribers. The Institute's technical reports and other publications are now being received by almost 700 companies and organizations in 46 countries.

A further important development in the direction of closer contact with industry has been the establishment of Working Groups with various branches of the textile industry. If all the parties put their interest and enthusiasm into these Groups, the industry can but benefit.

The Director and Staff extend to all our readers best wishes for a successful and happy and peaceful 1983.

INSTITUTE NEWS

New Tariffs for Tests

The new tariffs for tests carried out at SAWTRI appear in a booklet which has just been released. The tariffs listed are effective from January to December, 1983. The booklets have already been mailed to recipients on our mailing list. The department of enquiries may be approached by anyone wishing to know more about testing facilities at the Institute. The attention of readers is drawn to the fact that a special section deals with all industrial enquiries.

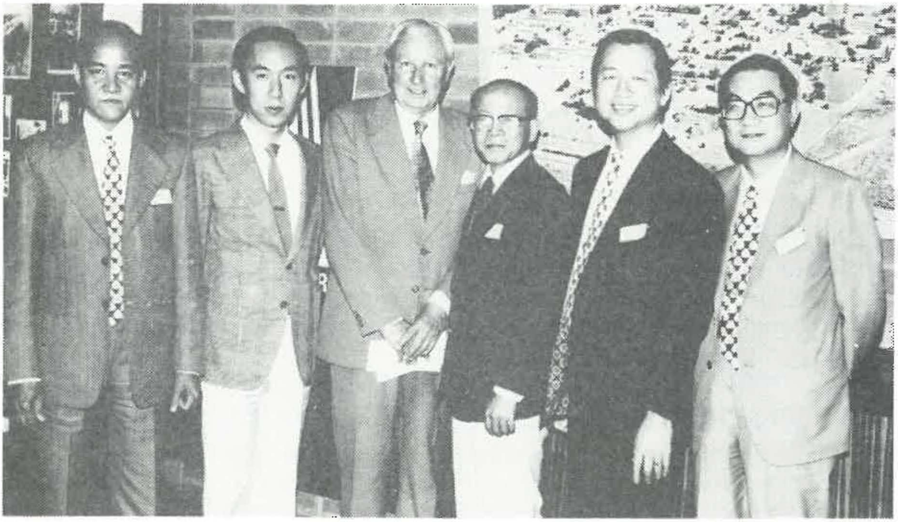
Regretfully, during 1982, while building operations were in progress, it was not possible to undertake certain tests and investigations expeditiously. Happily, however, now that building has been completed, the situation has returned to normal.

Director Attends Important IWS Committee Meeting

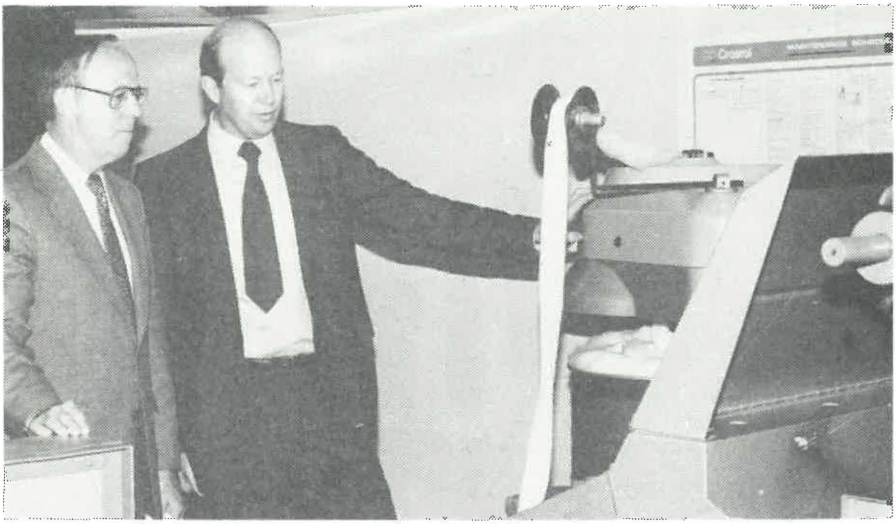
On November 25th and 26th, the Director, Dr D W F Turpie attended a special meeting of the Research and Development Committee of the IWS in Sidney, Australia. The meeting was called to discuss the proposals of the various advisory groups regarding overall planning for global research and development for wool.

While in Australia, Dr Turpie visited the laboratories of the Australian Wool Testing Authority in Melbourne and Sidney. He also paid visits to the University of New South Wales and a Wool broking firm, Farmer's Grazcos Coop. Ltd., in Sidney. The firm is implementing some of SAWTRI's findings on blending.

Visitors from Japan, Nov. 17th: L to R: Mr Hideho Saeki, Executive Director of Kurabo; Mr Theuns Botha, S A Wool Board; Mr Kiyoshi Miyamoto, Chairman, RAWW Wool Committee, JWSA; Mr N J Vogt, SAWTRI; Mr Yoshiji Ashida, Uniform Division Manager, Kanebo; Mr Kosaku Yoneda, Raw Wool Manager, Toyobo; Mr Saburo Yasui, Raw Wool Manager, Nikke; Mr Yasunari L Sugo, Production Manager, Nikke; Mr Teruo Ouchi, P.R. Manager, IWS, Japan.



Visitors from Taiwan, Dec. 8th: L to R: Mr Chris Chen, Manager, Chuwa Wool Industry Co. Taiwan Ltd.; Mr K T Chuang, General Manager, Treasure G Enterprise Co Ltd.; Mr N J Vogt, SAWTRI: Mr T Chang, President, Textile and Fibre Industries Ltd.; Mr C K Chen, General Manager, General Textile Manufacturing Co., Taipeh. (Leader, Mr Lin, not on photograph).



Mr Lawrence E Easter, Executive Vice President, Burlington Industries Wool Co, Virginia, USA, left, with Dr L Hunter, Assistant Director of SAWTRI, during the former's recent visit to the Institute.

Commercial Implementation of SAWTRI Shrinkproofing Process

Drs N J J van Rensburg and F A Barkhuysen recently spent two weeks with a Textile Mill in connection with the commercial implementation of the SAWTRI continuous shrinkproofing process in terms of a licensing agreement between the firm and SAIDCOR.

Japanese Delegation at SAWTRI

Accompanied by Mr Theuns Botha of the South African Wool Board, a delegation of Japanese Wool Industrialists visited SAWTRI on November 17th. The group was addressed by Mr N J Vogt, Group Leader, Publications and Information and Regional Representative of the CSIR, after which they were shown through the Institute.

Taiwan shows Interest

On Wednesday, 8th December, a delegation of Taiwanese Textile Industrialists, led by Mr Y L Lin, General Manager of the Reward Wool Industry Cooperation in Taipeh, and accompanied by Mr Theuns Botha of the S A Wool Board, was received at SAWTRI and taken on a conducted tour of the Institute by Mr Vogt.

Visit by Japanese Textile Businessmen on October 5th. L to R: Mr N J Vogt, SAWTRI; Mr M Tanaka, Kurabo Industries Ltd, Osaka; Mr S Satoh, C. ITOH & Co Ltd., Osaka; Mr Y Shimizu, Nagawa Co. Ltd., Nagoya; Mr A Masters of O S Blenkinsop (Pty) Ltd, Port Elizabeth.

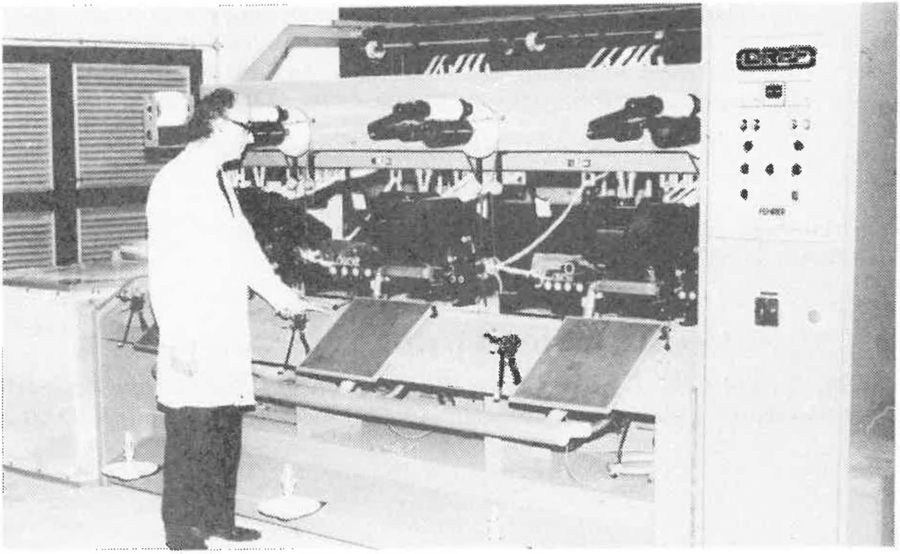
Advisory Committee for Mohair Production

Mr N J Vogt attended the Sixteenth meeting of the Advisory Committee for Mohair Production on the 24th November, 1982. The meetings normally take place in Pretoria but on this occasion it was held at the offices of the Mohair Growers' Association in Jansenville.

Mr Vogt presented a report on some of the Institute's current research work on Mohair. The report dealt with:

- Processing performance of South African Mohair during topmaking and spinning
- Determination of Mohair fineness by means of a Fibre Fineness Distribution Analyser
- Determination of Medullation and Kemp
- Radio Frequency Dyeing of Mohair
- Mohair Lustre

At the end of the meeting members of the Committee paid a short visit to the Angora goat experimental farm at Jansenville. The farm is now being prepared for stocking and in time will become a valuable branch of the research effort on behalf of mohair growers.



The DREF III friction spinning machine, recently installed at SAWTRI.

SAWTRI PUBLICATIONS

Since the September edition of "SAWTRI BULLETIN", the following *Technical Reports* have appeared:

No. 501: Mozes, T.E. and Pretorius, E.F., *Treatment of Wool Scouring Liquors, Part XV: A Pilot Study into the Application of the SAWTRI Bitfloc Process to the Clarification of Effluents.*

No. 504: Maasdorp, A.P.B., *The use of the Scanning Electron Microscope and X-ray Analysis to Determine the Distribution of Sulphur and Chromium in Mordant Dyed Keratin Fibres.*

No. 505: Barkhuysen F.A., *Some Chemical Properties and the Response to Liquid Ammonia and Sodium Hydroxide of Various South African Cotton Cultivars.*

No. 506: Maasdorp, A.P.B. *The Influence of pH on the Residual Chromium Contents of Wool Mordanting Liquors.*

No. 507: Hunter, L., Barella, A. and Manich, A.M., *The Diameter of Wool and Mohair Worsted Yarns as Measured on the ITQT "Digital" Hairiness Meter.*

No. 508: Strydom, M.A., Rottenbury, R.A., Turpie, D.W.F. and Smith, L.J., *The Processing Characteristics of South African Wools, Part XXI: An Interlaboratory Comparison of the Topmaking Performance of a Range of Bellies and Backs.*

No. 509: Smuts, S., Hunter, L. and Frazer, W., *Medullation in Mohair, Part I: Its Measurement Employing a Photo-Electric Technique.*

No. 510: Hunter, L. and Cawood, M.P., *The Correlation Between Two Different Sewability Tests and the Effect of Certain Wool Fibre and Fabric Properties on the Sewability of Woven Fabrics.*

SPECIAL PUBLICATIONS

Van Rensburg, N.J.J., *Review of Fire Accidents and Flammability-Toxilogical Aspects of Burning Textiles.*

PUBLICATION IN OTHER JOURNALS

Hunter, L. and Gee, E., *Correlation Between Cotton Fibre Properties and Ring-* and *Rotor Yarn Properties:* Melliand Textilberichte, ***63,*** 6 June, 1982).

A PRELIMINARY SURVEY OF THE DARK FIBRE CONTAMINATION IN SOME SOUTH AFRICAN FLEECE- AND BELLY WOOLS

by

M A Strydom and E Gee

ABSTRACT

Grab samples from some 209 producer batches of fleece- and belly wools offered during the 1981/82 season in the four wool exporting ports in South Africa were tested for the incidence of naturally pigmented and stained fibres. Excluding abnormally high values which occurred in seven of these samples, it was found that the bellies were slightly more contaminated (2,0 dark fibres per 20g) than the merino fleece wools (1,6 per 20g) and the fleeces from merino-related breeds (1,3 per 20g). The overall mean count of 1,5 dark fibres per 20g for all three types from all four ports were similar to typical values quoted for certain Australian merino fleeces, pieces and skirtings.

INTRODUCTION

The National Wool Growers' Association of South Africa defines merino wool as a "white wool"(1). However, discoloured or dark fibres can occur in such wools and the occurrence of such fibres has a severely limiting effect on the production of both undyed goods and on commodities which are to be dyed to pastel shades. Outreman *et al*(2,3) have shown that this problem is related to the difference in shade between the dark fibre and the fabric, and that it is far more acute in knitwear than in woven piecegoods.

Dark fibres in tops may have either a genetic origin (which is characterised by melanin pigmentation) or an external origin (i.e. staining by urine, dung, branding fluids or even textile dyes). Extensive surveys carried out at the German Wool Research Laboratories in Aachen have shown that commercial tops which are completely free of dark fibres are, for practical purposes, virtually non-existent(4,5). Although the incidence of these unwanted fibres is numerically low (Hohmann(6) *et al* suggests that their incidence can be described by a Poisson distribution), this does not diminish their importance in any way. The only practical method currently available to solve this problem is to remove the offending fibres manually. This is an extremely costly exercise and Blankenberg(7) has shown that in the case of a leading West German garment manufacturer, this could amount to as much as 25% of the yarn cost.

The Australian Wool Corporation recently calculated that 500g of coloured fibre (approx. 75 per 20g) in a shipment of 550 metric tons could result in a downgrading in value of such a consignment of as much as 15%(8). As an alternative to the manual removal of dark fibres Bereck *et al*(9) have recently suggested a selective bleaching method in an attempt to reduce these extremely high costs.

In view of the commercial importance of the incidence of dark fibres in wool, a suitable test procedure is very important and the IWTO has, for several years, been involved in assessing different test methods and attempting to reduce interlaboratory variations in test results(7,10). Progress in the latter respect has been hampered by the lack of an appropriate objective test method. An optical method for assessing dark fibre contamination(11) is currently being improved upon by an extensive programme at Centexbel(12) in an attempt to develop a comprehensive system of objective sliver fault analysis. In addition, attempts are also being made to study the actual colour levels of dark fibre contaminants in order to assist in solving this problem(13).

The South African wool clip is not free of this problem of dark fibre contamination(6,7) and breeders are constantly urged to eliminate this recessive genetic fault by strict culling(14). Data pertaining to the average incidence of dark fibres in relation to aspects such as which, of the production areas have high incidence and differences between different classes of wool would undoubtedly be very useful. This paper reports on the results of a preliminary survey of a selection of fleece- and belly wools drawn from the 1981/82 season.

MATERIALS AND METHODS

Selection of Samples

The rare-event Poisson-type distribution, which can be used to describe the occurrence of a dark fibre in a test specimen, necessitates stringent sampling procedures. It is therefore important that conclusions with respect to their occurrence in the whole batch should only be drawn with caution. It was assumed that a random test specimen drawn from a grab sample would provide a reasonably good representation of a sale lot for the purpose of a dark fibre count. Approximately 210 grab samples were selected from the broker's stores in Cape Town, Port Elizabeth, East London and Durban. These samples were selected to represent two main categories, namely pure merino wool and wool from merino-related breeds. The selection of merino wools was again divided into two classes, namely fleece wools and belly wools.

The grab samples from each batch were carefully sub-sampled further to produce a specimen of 0,5 to 1 kg for testing.

Preparation

Each sample was scoured in a hot water/detergent solution and after drying carded on a 53cm wide Turner Atherton card. The carded sliver was gilled once on a Schlumberger GNP gillbox to obtain a sliver of about 20 ktex. The samples for testing were obtained from the gill delivery by drawing 5 x 1,5m sliver lengths at regular intervals. The set of five sub-samples thus obtained was considered to be representative of the original grab sample and therefore representative of the original sale lot.

Testing

Testing was carried out along the lines of the relevant IWTO suggestions for sliver fault determination(16). Each of the five sub-samples was tested on a Toenniessen top tester against a low level of background lighting to increase the visibility of dark fibres. A single operator was used for the whole series of tests to restrict the problem of operator bias. Two categories of dark fibre, based solely on the judgement of the operator, were counted, namely pigmented fibres and stained fibres.

Each of the five sub-samples in the set was weighed and the number of dark fibres counted. The results were expressed as the incidence of coloured fibre per 20g of sliver(16).

RESULTS AND DISCUSSION

Table 1 shows the number of batches tested in the various categories from the different ports, and the spread of the individual results.

The results show a large scatter, particularly in respect of the pigmented fibres. Detailed examination of the individual results subsequently indicated that the distribution of results was such that the maximum values mostly represented isolated cases. Inclusion of such "abnormally" high results would cause biased average values and this was considered sufficient justification for omitting them from the analysis. "Cut-off" limits were therefore subsequently determined in order to obtain a more suitable distribution of the data which would be more useful within the scope of this preliminary study. This was done on the basis of the measured skewness of the distribution on a logarithm scale, which suggested that values in excess of 20 dark fibres per 20g could be omitted from the analysis. This resulted in the rejection of seven points from the original data set of 209 points. Although the measured skewness of the 202 remaining data points was still such that a perfect symmetrical distribution could not be assumed, it was considered as sufficient from a practical point of view.

Table 2 gives the mean dark fibre count and the range of values for the various categories for the four ports. Assuming a Poisson distribution, it can be calculated from the data in this table that the confidence limits of the mean were around 0,6 for the pigmented fibres and around 0,1 for the stained fibres.

There is some evidence that the Durban fleece wools had a slightly higher incidence of pigmented fibres than those from the other ports, although the merino bellies from Cape Town had the highest overall dark fibre count (3,4

TABLE 1. DISTRIBUTION OF TEST BATCHES AND SPREAD OF RESULTS

SOURCE AND CLASS		CAPE TOWN			PORT ELIZABETH			EAST LONDON			DURBAN		
		Merino Fleeces	Merino Bellies	Fleeces from other Breeds	Merino Fleeces	Merino Bellies	Fleeces from other Breeds	Merino Fleeces	Merino Bellies	Fleeces from other Breeds	Merino Fleeces	Merino Bellies	Fleeces from other Breeds
NUMBER OF LOTS TESTED		16	16	16	22	16	16	20	18	15	20	18	16
PIGMENTED FIBRES (PER 20g)	MIN.	0,4	0	0	0	0	0	0	0	0	0	0	0
	MAX.	132,2	23,8	3,5	4,3	1584	5,7	5,8	87,9	2,5	7,8	108	8,3
OTHER STAINED OR DISCOLOURED FIBRES (PER 20g)	MIN.	0	0	0	0	0	0	0	0	0	0	0	0
	MAX.	0,7	3,9	0,2	0,6	0,5	0	69,7	0,2	0	1,3	0,6	0

TABLE 2. MEAN VALUES AND RANGES*

SOURCE AND CLASS		CAPE TOWN			PORT ELIZABETH			EAST LONDON			DURBAN		
		Merino Fleeces	Merino Bellies	Fleeces from other Breeds	Merino Fleeces	Merino Bellies	Fleeces from other Breeds	Merino Fleeces	Merino Bellies	Fleeces from other Breeds	Merino Fleeces	Merino Bellies	Fleeces from other Breeds
PIGMENTED FIBRES (PER 20g)	RANGE	0-3,2	0-8,4	0-1,8	0-2,4	0-2,0	0-3,4	0-2,8	0-3,2	0-1,6	0-4,6	0-4,0	0-4,0
	MEAN	1,2	3,4	1,3	1,6	1,0	1,6	1,3	1,6	0,9	2,0	1,6	1,3
OTHER STAINED OR DISCOLOURED FIBRES (PER 20g)	RANGE	0-0,4	0-2,2	0-0,1	0-0,4	0-0,4	0	0-0,4	0-0,1	0	0-0,4	0-0,2	0
	MEAN	0,6	0,5	0,05	0,08	0,06	0	0,2	0,05	0	0,2	0,03	0

*Excluding all data points > 20 dark fibres per 20g.

TABLE 3. RESULTS OF ANALYSIS OF POOLED DATA

SOURCE AND CLASS		CAPE TOWN			PORT ELIZABETH			EAST LONDON			DURBAN		
		Merino Fleeces	**Merino Bellies**	**Fleeces from other Breeds**	**Merino Fleeces**	**Merino Bellies**	**Fleeces from other Breeds**	**Merino Fleeces**	**Merino Bellies**	**Fleeces from other Breeds**	**Merino Fleeces**	**Merino Bellies**	**Fleeces from other Breeds**
DARK FIBRE (PER 20g)	RANGE	0-3,6	0-8,8	0-1,8	0-2,4	0-2,0	0-3,4	0-3,4	0-3,2	0-1,6	0-5,2	0-4,2	0-4,0
	MEAN	1,3	3,9	1,4	1,4	1,1	1,6	1,4	1,6	0,9	2,1	1,7	1,3
AVERAGE FOR ALL THREE CLASSES (PER 20g)	RANGE	0-5,8			0-2,6			0-3,0			0-4,4		
	MEAN	2,1			1,4			1,3			1,7		

per 20g). Data of other stained or discoloured fibres were such that it was concluded that no real difference existed between any of the values.

If one considers a dark fibre, irrespective of the level of discolouration of its source, as a potential source of problems in the end product, then it is also useful to consider the pooled results of the two sets of data given in Table 2. This approach is similar to that adopted by Hohmann *et al* (6) and Table 3 gives the results of such an analysis.

On the basis of the pooled data, it may be concluded that the particular selection of fleeces from the merino-related breeds tested in this survey was the least contaminated. The overall dark fibre count of 1,3 per 20g was slightly better than that for the merino fleeces at 1,6 dark fibres per 20g. As expected, the bellies were generally the most contaminated (probably mostly as a result of urine-staining), with a mean dark fibre count of 2 per 20g.

In view of the results given in Tables 2 and 3 the question may now be posed as to how these values should be assessed in terms of processing requirements. Although there is a general lack of agreement between producer, topmaker and spinner on the maximum permissible level of contamination, Bell(17) suggested that a count as low as 0,3 dark fibres per 20g can lead to rejection of a top for certain critical end uses. On this basis, the average incidence in the selection of wools for this study was approximately five times higher (1,5 dark fibres per 20g, ranging from 0 to 3,8). However, a comparison based on average values is perhaps not fully justifiable and individual values obtained for the various lots tested would probably be more appropriate as a basis of comparison. In addition, comparisons will only be meaningful when the IWTO has succeeded in establishing maximum tolerance levels for trade purposes. On the other hand, the average values obtained for the selection of South African wools covered in this preliminary study are similar to, for example, an Australian Type 79B fleece or Australian pieces and skirtings (17).

SUMMARY AND CONCLUSIONS

The dark fibre contamination of some 209 lots of merino fleeces, merino bellies and fleeces from merino-related breeds was measured by visually inspecting scoured and gilled slivers obtained from the grab samples of these lots. The wools were selected from Cape Town, Port Elizabeth, East London and Durban offerings during the 1981/82 season. On the basis of a skewness test, a number of data points were omitted from the analysis because of their extremely high values which could have led to biased conclusions regarding mean values.

Initially, the data were analysed in terms of both the incidence of naturally pigmented fibres and of stained- and other discoloured fibres. On the assumption that *all* dark fibres constitute a problem in the end product, the pooled data were subsequently also analysed. This showed that the wools from merino-related breeds were, on average, the least contaminated (1,3 dark fibres per 20g) and, as expected, the belly wools the most (2,0 dark fibres per 20g). The overall levels of contamination of the two fleece wool categories were not much different to that of an average Australian fleece wool type.

It should be stressed that the results of this survey are to be considered as being tentative only, and general conclusions, for example regarding differences between ports, would only be valid after a further extensive testing programme. This is currently in progress.

ACKNOWLEDGEMENTS

The authors would like to thank the South African Wool Board for supplying the samples used in this survey and for their permission to publish the results. Thanks are also due to Messrs E F Pretorius, A H Adriaanzen and H W Labuschagne for preparation of the samples, and to Mrs L L Meiring for the measurements.

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THE DIMENSIONAL PROPERTIES OF GREIGE COTTON INTERLOCK FABRICS STABILISED IN DIFFERENT WAYS

by

L. Hunter and Emmerentia Kritzinger

ABSTRACT

The effect of various treatments, such as piece mercerisation and compaction, on the dimensional and certain other properties of greige cotton interlock fabric has been investigated. In general it was found that neither mercerisation nor compaction on their own imparted adequate dimensional stability to the fabrics. A combination of resin treatment and compaction resulted in the most stable fabric, the fabric effectively being set by the resin treatment.

INTRODUCTION

It is generally accepted that one of the main problems associated with the use of knitted cotton fabrics, more particularly in outerwear, is that of excessive dimensional changes during laundering. Considerable research and development effort, however, has been directed towards the solution of this problem and has led to various systems for stabilising knitted cotton fabrics(1-24). These include resin treatment, compaction and fabric mercerisation, although the latter is directed more towards improvements in lustre, dye levelness (and better coverage of immature cotton), print definition, dyestuff saving and strength after resin treatment. Contradictory statements (18,19,22,25-31) have been made concerning the effectiveness of piece mercerisation in stabilising the dimensions of knitted cotton fabric and it would appear as if, in most cases, a combination of treatments, for example, resin treatment and either compaction (3,11,12) or mercerisation (15,18,22) may be required for adequate dimensional stability and wear performance.

Although various claims are made with respect to the efficiency of the various systems in imparting dimensional stability, very little scientific information has been published to substantiate such claims. In the light of this it was decided to investigate the washing shrinkage of greige cotton interlock fabrics which had been stabilised by various techniques. Greige fabric, as opposed to finished fabric, was selected since this obviated the possible complications of finishing variables and, furthermore, greige fabric is considered particularly difficult to stabilise.

EXPERIMENTAL

An Albar cotton (see Table I) was processed into 25 tex Z670 ring-spun yarn (see Table II) which was then waxed and knitted into interlock fabric (MTF = 13,7) on an 18 gauge (Mellor Bromley 8RD) double jersey machine using positive feed. Lengths of the fabric were submitted to various manufacturers of machines which are marketed for the stabilisation (compaction and liquid nitrogen) or mercerisation of knitted cotton fabric. One length of fabric was also subjected to a liquid ammonia treatment at the Norwegian Textile Research Institute.

After the fabrics had been treated they were returned to SAWTRI for evaluation. The fabric dimensional properties (before and after washing), sewability, mass and bursting strength were measured and the results are given in Table III.

RESULTS AND DISCUSSION

Mercerisation

From the results given in Table III, it can be seen that the mercerisation process by itself generally was not effective in stabilising (i.e. setting) the dimensions of this greige fabric to washing.

The mercerisation treatment increased the wales per cm (i.e. caused the fabric to shrink in width) but generally this resulted in the fabric expanding in width during washing (negative shrinkage), the exception being the fabric treated on machine No. 3. The decrease in fabric width, brought about by mercerisation, resulted in an increase in fabric mass per unit area. Strahl(27) observed similar trends. Mercerisation also increased the fabric bursting strength and caused a deterioration in sewability (i.e. higher values).

If attention is now turned to the dimensional constants (k-values) after 10 wash/tumble dry cycles (i.e. 2 wash tests), it can be seen that the values still differed significantly from those of the greige fabric. Furthermore, there were significant differences between the relaxed k-values of the different mercerised fabrics and it is therefore not possible to arrive at generalised k-values for mercerised interlock fabric. The largest differences occurred in the k_2-values (i.e. in the length direction). These results indicate that the fabric extended in length and contracted in width during mercerisation and that only part of this and the original distortion was removed during washing. If the fabrics are assumed to be in their fully-relaxed state after the 10 wash/tumble dry cycles, then it can be concluded that mercerisation alters the fully-relaxed (minimum energy) state of knitted cotton fabrics, although the magnitude of the effect is not consistent for different mercerising machines, this probably being a function of the mercerisation conditions. Leah(1) arrived at similar conclusions concerning fabric dimensional properties while Greenwood(9) and Stevens(20) found a large setting effect when jet dyed fabric was mercerised, with the latter also increasing fabric bursting strength (16,17,20).

TABLE I

COTTON FIBRE PROPERTIES

Property	
2,5% Span Length (mm)	32
50% Span Length (mm)	16
Uniformity Ratio (%)	50
Micronaire	4,0
Fineness (mtex)	180
Maturity Ratio	0,81
Zero-Gauge Pressley (1 000 psi)	81
3,2 mm-Gauge Tenacity (cN/tex)	27,2
Bundle Extension (%)	6,1
Trash Content (%)	2,8

TABLE II

YARN PROPERTIES

Property	
Linear Density (tex)	24,6
CV (%)	1,5
Twist (turns/m)	670
CSP	2958
Tenacity (cN/tex)	18,4
Extension (%)	7,0
Irregularity (CV%)	15,2
Thin Places per 1 000 m	2
Thick Places per 1 000 m	218
Neps per 1 000 m	682
Hairiness (Hairs/m)	10

TABLE III: FABRIC TESTS

Treatment and Machine Code	Dry-Relaxed State									
					Sewability					
	Fabric Thickness (mm)	Wales per cm	Course per cm	Bursting Strength (kN/m^2)	Penetrations Exceeding 250cN (%)	Average Penetration Force (cN)	Fabric Mass (g/m^2)	k_1	k_2	k_3
Control	1,146	10,6	12,6	1538	0,69	45,1	251	143	18,4	7,8
Mercerisation										
1.	0,950	17,8	10,9	1736	69,4	191,4	359	188	15,2	12,4
2.	0,910	14,3	11,3	1517	65,2	185,6	283	149	15,4	9,7
3.	0,764	13,4	10,2	1788	12,7	96,3	263	138	14,5	9,5
4.	0,995	16,3	12,4	1881	57,4	171,2	343	177	16,4	10,8
Average	0,905	15,5	11,2	1731	51,2	161,1	312	163	15,4	10,6
Compaction										
1.	1,151	10,8	13,6	1316	0,56	46,8	275	158	20,0	7,9
2.	1,055	10,2	14,3	1249	1,64	54,3	274	158	21,0	7,5
3.	0,905	10,6	12,6	1611	2,9	64,5	245	143	18,4	7,8
Average	1,037	10,5	13,5	1392	1,7	55,2	265	153	19,8	7,7
Resin plus Compaction	0,882	13,8	11,8	1075	7,3	83,5	283	168	16,9	9,9
Liquid Nitrogen										
1.	1,206	11,0	13,9	1661	2,0	60,2	299	161	20,2	8,0
2.	1,192	11,8	13,0	1716	2,3	63,0	291	161	18,8	8,5
3.	1,207	11,4	13,3	1749	1,5	60,0	278	163	19,5	8,4
Average	1,202	11,4	13,4	1709	1,9	61,1	289	162	19,5	8,3
Liquid Ammonia	0,997	13,8	12,5	1771	64,7	159,0	317	169	17,5	9,7

***Each wash test involved five wash and tumble-dry cycles (AATCC TM 135 — IIIB)**

After one wash test*							After two wash tests*						
				Shrinkage (%)							Cumulative Shrinkage (%)		
Fabric Mass (g/m²)	k_1	k_2	k_3	Length	Width	Area	Fabric Mass (g/m²)	k_1	k_2	k_3	Length	Width	Area
345	196	22,3	8,8	18	12	27	358	204	23,2	8,8	21	12	30
395	209	19,5	10,7	22	-16	2	407	213	20,5	10,4	26	-19	2
365	193	20,1	9,6	24	-2	22	372	196	20,8	9,4	26	-3	22
340	179	17,4	10,3	16	8	23	354	186	18,1	10,3	20	7	26
385	199	19,3	10,3	15	-5	11	359	185	18,6	10,0	12	-8	5
371	195	19,1	10,2	19	-4	15	373	195	19,5	10,0	21	-6	14
370	213	23,9	8,9	16	11	26	355	204	23,3	8,8	14	10	22
352	203	22,8	8,9	8	16	22	360	208	23,6	8,8	11	15	24
—	—	—	—	—	—	—	322	187	22,4	8,4	18	7	24
361	208	23,4	8,9	12	14	24	346	200	23,1	8,7	14	11	23
296	175	17,7	9,9	4	0	4	302	179	18,0	10,0	6	0	6
365	197	22,5	8,8	10	9	18	370	200	22,8	8,8	12	9	20
367	203	22,3	9,1	15	6	21	371	205	22,7	9,0	17	5	22
349	204	23,0	8,9	15	6	21	352	206	23,2	8,9	16	6	21
360	201	22,6	8,9	13	7	20	364	204	22,9	8,9	15	7	21
344	183	20,3	9,0	14	-7	7	349	187	20,8	9,0	16	-8	8

Compaction

According to the results given in Table III, for the fabrics which had been compacted, it appears that compaction reduced washing shrinkage in length (by about 33% on average) but had little effect on shrinkage in width. These results are consistent with the operating principles of the system. The reduction in length shrinkage was achieved by the length compaction (induced length pre-shrinkage) imparted to the fabric by the process which, also increased the fabric mass. For all practical purposes, the wash-relaxed k-values of the compacted fabrics were the same as those of the greige fabric, indicating that compaction did not have a setting effect on the fabric. Compaction had little effect on fabric sewability, but in two out of three cases it resulted in a deterioration in fabric bursting strength.

Resin Treatment and Compaction

The combined resin and compaction treatment was the most effective of all the treatments in stabilising the fabric dimensions, the fabric only shrinking 6% in length, during the 10 wash/tumble dry cycles. The k-values clearly indicate that the treatment actually set the fabric in a distorted state, the fabric apparently shrinking somewhat in width and extending in length during the treatment. The bursting strength reflects the well-known loss in strength resulting from resin treatments. The treatment also caused a deterioration in fabric sewability but this was less marked than in the case of the mercerisation treatment.

Liquid Nitrogen Treatment

From Table III it is apparent that treatment with liquid nitrogen caused the fabric to shrink somewhat in both length and width thereby eliminating part of the potential fabric shrinkage. The treatment did not set the fabric since the k-values after the 10 wash/tumble dry cycles were similar to those of the corresponding greige fabrics. The liquid nitrogen treatment increased the fabric mass (as a result of the fabric shrinkage which occurred), sewability values and bursting strength.

Liquid Ammonia Treatment

The results given in Table III show that the liquid ammonia treatment caused the fabric to shrink in width but that it had little effect on the fabric length. This resulted in the fabric expanding in width and shrinking in length during washing. Length shrinkage was lower than that of the untreated greige fabric and this, together with the corresponding k_2-values, indicates that the treatment had some stabilising or setting effect on the fabric. The liquid ammonia treatment also significantly increased the fabric bursting strength and reduced its sewability to about the same extent as the mercerisation treatments.

SUMMARY AND CONCLUSIONS

The effects of various stabilising treatments on the dimensional and certain other physical properties of greige cotton interlock fabric have been investigated. Different pieces of the interlock fabric were subjected to mercerisation, compaction, liquid ammonia, liquid nitrogen and resin treatment plus compaction, respectively. Except for the liquid ammonia treatment, the treatments were carried out under commercial conditions, mostly by the various manufacturers of the machines. After the fabrics had been treated, they were returned to SAWTRI for testing.

It was found that only the combined resin and compaction treatment reduced the washing shrinkage in length to below 10%, this largely being achieved by the "setting" effect of the resin. The washing shrinkage of the piece mercerised fabrics differed significantly according to the different machines on which the fabrics had been treated but was unacceptably high in all cases, length shrinkage being the main problem. The dimensional constants (k-values) of the washed fabrics indicate that mercerisation had an effect, but not a very large one, on the relaxed (i.e. minimum energy) state of the fabrics, although the effect was not consistent for the different mercerising machines.

Compaction was found to reduce fabric length shrinkage while it had little effect on fabric width shrinkage. Length shrinkage during washing, however, was still more than 10%. Compaction did not significantly change the final wash-relaxed dimensions of the fabrics which means that the reduction in length shrinkage was achieved by inducing length shrinkage (i.e. by length compaction) during the treatment and not by setting or changing the relaxed (minimum energy) state of the fabric.

Relaxing the fabric in liquid nitrogen reduced the fabric length shrinkage by about 15% and the width shrinkage by about 7%, this being due to the shrinkage which took place during the treatment and not by setting or a change in the fabric minimum energy state.

The liquid ammonia treatment caused the fabric to shrink in width which resulted in width expansion during washing. It reduced the length shrinkage during washing to about 16% and changed the relaxed length dimensions (k_2-values) somewhat.

In the majority of cases, the treatments increased the fabric mass by causing the fabric to shrink in one or more directions, the change in mass mainly depending upon the shrinkage in area. Most of the treatments caused an improvement in fabric bursting strength, except for the compaction and resin plus compaction treatments. All the treatments had an adverse effect on fabric sewability, with the mercerisation and liquid ammonia treatments having the greatest effects. This work is being extended to cover finished fabrics.

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THE SIMULTANEOUS DYEING, SHRINK-RESIST AND FLAME-RETARDANT TREATMENT OF WOOL FABRICS USING REACTIVE DYES AND THPOH

by

G.H.J. van der Walt, Josée White and N.J.J. van Rensburg

ABSTRACT

The simultaneous dyeing, flame-retardant and shrinkresist treatment of prechlorinated wool fabrics using various reactive dyes and THPOH was investigated. The process produced level dyeings and the fabrics were shrinkresistant with acceptable LOI values. Furthermore, the handle and strength of the fabrics were acceptable, but in most cases there was some evidence of ring-dyeing. In general, slightly paler shades were obtained with the dye/THPOH treatment than those obtained with conventional exhaust dyeing, using the same concentration of dye.

INTRODUCTION

In common practice, the dyeing and chemical finishing of wool fabrics are usually carried out in two or more separate stages. Generally, dyeing is performed first followed by the application of the resin or other chemical finishing agents. It has long been the goal of the dyer and finisher to develop a single operation for the dyeing and finishing of wool fabrics using conventional equipment. A number of simultaneous shrinkproofing and dyeing processes have already been described in the literature. For example, Lewis(1), Silver, *et al* (2) and Van der Merwe and Van Heerden(3) described processes for the simultaneous shrinkproofing and dyeing of wool using a modified polyamide epichlorohydrin, or a polyacrylate resin and some reactive dyes.

There are various factors which have to be considered in the case of combined dyeing and shrinkresistant treatments for wool. For example, Lewis and Seltzer(4) showed that the chlorination of wool affected the exhaustion and fixation of dyes. Apart from the fact that chlorination increased the uptake of dye, an increase in Hercosett® concentration also increased the dye exhaustion and fixation. Internal deposition of polymers in wool can also alter the dyeing properties(5-7). For example, Needles and Sarsfield(8) found that chemical fixation of reactive dyes was markedly increased by the presence of a polymer within the wool. Furthermore, Temin and Park(9) showed that the uptake of dye by wool depended on the location of the polymer (i.e. whether deposited on the surface of the fibre, or internally), as well as on the degree of cross-linking of the polymer. Another important aspect which has to be considered is the fact that the presence of some flame retardants in the fibre can reduce the lightfastness of certain dyes(10).

It was recently found that prechlorinated wool fabrics could be rendered shrinkresistant and flame-retardant by a treatment with 20-25% THPOH(11). This high concentration of flame-retardant on the wool reduced the strength of the fabric somewhat, but the handle was not affected. Furthermore, when these fabrics were dyed subsequently, it was found that the chlorine-THPOH treatment generally increased the exhaustion and covalent fixation of the dyes(12).

Since very little information is available on the simultaneous dyeing, shrink-resist and flame-retardant treatment of all-wool fabrics the feasibility of such a process, using THPOH and a number of reactive dyes, was investigated.

EXPERIMENTAL

Fabric

An undyed plain weave all-wool fabric (150 g/m^2) with a high felting propensity was used.

Treatments

Chlorination

The fabrics were chlorinated with 1,5% active chlorine according to the process described previously(12), followed by rinsing and drying.

Combined THPOH-Dye Treatment

An aqueous solution of THPC [(tetrakis-hydroxymethyl) phosphonium chloride] was neutralised with 12N NaOH to a pH of 7,2, to produce a product what is generally referred to as THPOH. This solution was then added to an aqueous solution of the reactive dye. No precipitation of dye or flame-retardant was noticed for the specific dyes studied.

A Benz laboratory padder was used for the padding of the chlorinated wool fabrics in a solution containing 25% THPOH, 1,0 g/1 wetting agent and from 0% to 8% dye (on the mass of the fabric) to a wet pick-up of 100%. After allowing the fabrics to dry to a moisture content of 20%, they were exposed to ammonia vapour for 15 minutes at room temperature in order to polymerise the flame-retardant, followed by rinsing and drying. The fabrics were then padded through a 5% H_2O_2 solution, followed by rinsing and drying. Most of the treatments were performed at room temperature but in some cases the padding solution was heated to various temperatures up to 60°C.

Exhaust Dyeing

Some fabrics were dyed on an Ahiba laboratory dyeing apparatus according to the methods recommended by the various dyestuff manufacturers.

Testing

The limiting oxygen index (LOI) values of the fabrics were determined on a MKM JD-14 Oxygen Index Tester. The durability of the flame-retardant treatments to washing was studied by washing the fabrics in an automatic washing machine. Colour difference measurements were performed on a Hunter Lab apparatus and the lightfastness of the fabrics was determined in a Xenotest apparatus. Rubbing fastness was determined on a crockmeter and the washfastness was determined according to the ISO 3 test method. The fabrics were tested for felting shrinkage according to the IWS test method No. 185. The various physical properties were determined according to standard procedures.

RESULTS AND DISCUSSION

In general the dyeings obtained with the dye/THPOH treatment were level, despite the relatively high concentration of flame-retardant used. Furthermore, the fabrics had a very soft handle. Some physical properties of the wool fabrics treated with a reactive dye and THPOH are given in Table I.

TABLE I
PHYSICAL PROPERTIES OF WOOL FABRICS TREATED WITH THPOH AND DYE

Treatment	Breaking Strength (N)	Breaking Extension (%)	Bending Length (cm)	Bursting Strength (kN/m²)	Flat Abrasion (% mass loss at 2500 cycles)
25% THPOH	221	20,7	1,76	650	11,1
25% THPOH + 1,0% C.I. Reactive Red 2	219	19,9	1,76	657	10,1
Untreated Control	235	27,5	1,71	731	7,6

It is clear that the THPOH reduced the strength and abrasion resistance of the fabric somewhat, but that the addition of dye to the THPOH had no further effect on the physical properties tested.

The LOI values of the fabrics after one and five washing cycles and the percentage area shrinkage of the fabrics are shown in Table II. The LOI values of the fabrics were very good but those of the fabrics treated with THPOH and dye appeared to be slightly lower than those of the fabrics treated with THPOH only. The felting shrinkage of the fabrics was very low and the addition of the dye to the THPOH solution did not appear to affect the shrinkage results.

TABLE II
THE LOI AND AREA SHRINKAGE VALUES OF WOOL FABRICS TREATED WITH THPOH AND DYE

Treatment	LOI* after washing		Area Shrinkage (%)
	1 Cycle	5 Cycles	
25% THPOH	29,2	28,3	3,2
25% THPOH + 1,0% C.I. Reactive Red 2	28,6	27,1	3,5
Untreated Control	—	—	72,0

***The LOI of an untreated, unwashed wool fabric was 24,0**

In further studies the effect of the duration of exposure of the fabrics to the ammonia vapour on some physical properties of the wool fabric and the LOI values was determined. The results in Table III show no significant decrease in the bursting and breaking strength values of the treated fabrics with increasing exposure to ammonia. There was a slight increase in the LOI values of the fabrics however, when the exposure time was increased from 2 minutes to 45 minutes.

TABLE III
THE EFFECT OF THE PERIOD OF EXPOSURE TO AMMONIA VAPOUR ON THE LOI AND SOME PHYSICAL PROPERTIES OF WOOL FABRICS TREATED WITH THPOH AND DYE*

Period of Exposure	Bursting Strength (kN/m²)	Breaking Strength (N)	Breaking Extension (%)	LOI after washing	
				1 Cycle	5 Cycles
2	693	254	34,3	27,5	26,7
5	678	245	32,4	27,9	27,1
10	678	243	35,3	27,7	26,7
15	670	246	30,4	28,1	27,1
30	678	241	31,7	28,1	27,1
45	657	237	31,3	28,6	27,7
Untreated Control	731	235	27,5	—	—

***Simultaneous padding of 1,0% C.I. Reactive Red 2/25% THPOH on 1,5% prechlorinated wool fabric.**

The effect of the dye concentration on the colour and some fastness properties of the wool was then determined. Table IV shows that the depth of shade increased as the dye concentration increased. Furthermore, there was a shift in hue, with the shades becoming more yellow with increasing concentration of dye on the fabric. The fastness to washing of the dyed samples was fair, with the exception of the fabrics treated with 8,0% dye. The fastness to rubbing generally deteriorated with increasing dye concentration.

In some further studies a comparison was carried out between fabrics dyed with a range of reactive dyes according to the conventional exhaust dyeing technique and fabrics pad-dyed with dye and THPOH. The results are shown in Table V. In general, it appeared that slightly more dyestuff was needed in the simultaneous dyeing and THPOH treatment of wool fabrics to produce the

TABLE IV

THE EFFECT OF DYESTUFF CONCENTRATION ON CERTAIN COLOUR PROPERTIES AND TO FASTNESS TO WASHING AND RUBBING OF THPOH-TREATED WOOL FABRICS

Dyestuff	Dye Add-on (%)	Colour difference values*				Fastness to washing (ISO 3)			Rubbing fastness	
		ΔE	ΔL	ΔC	ΔH	Effect on shade	Cotton Staining	Wool Staining	Dry	Wet
C.I. Reactive Red 2	0,5	—	—	—	—	3-4	3	5	5	3
	1,0	7,11	-5,74	2,84	3,08	3-4	3	5	5	2
	2,0	13,13	-11,11	2,89	6,38	4	3	5	4-5	2
	3,0	17,37	-14,93	-0,17	8,88	5	3	5	4-5	1
	5,0	18,65	-15,84	-3,33	9,26	5	2-3	5	3	1
	8,0	18,68	-15,84	-2,78	9,78	3	2	5	1	1

*Simultaneous padding of 0,5% dye/25% THPOH on 1,5% prechlorinated wool fabric was taken as reference sample same depth of shade as that obtained with the conventional exhaust dyeing process. The fabrics were also ranked by a panel of observers and their findings were found to be in agreement with the results shown in Table V.

TABLE V
THE COLOUR DIFFERENCE VALUES BETWEEN WOOL PAD-DYED WITH DYE AND THPOH AND WOOL DYED WITH VARIOUS CONCENTRATIONS OF DYE BY THE EXHAUSTION TECHNIQUE

Dye Exhaustion (%)	Colour difference value (ΔE)*			
	C I Reactive Orange 68	C I Reactive Red 99	C I Reactive Blue 94	C I Reactive Yellow 25
0,50	7,24	6,90	4,35	14,92
0,75	6,02	2,21	4,04	7,16
1,00	8,82	3,87	7,43	5,03
1,25	12,07	6,00	10,35	6,01
1,50	11,19	8,83	12,01	11,11

***Simultaneous padding of 1,0% Dye/25% THPOH on 1,5% prechlorinated wool fabric was taken as reference sample.**

Some studies were then carried out on the effect of the THPOH treatment on the lightfastness of four reactive dyes. The results in Table VI show that the THPOH reduced the lightfastness considerably in the case of C.I. Reactive Orange 68, while the change in lightfastness was somewhat smaller in the case of the other dyes.

During the studies on the simultaneous dyeing and THPOH treatment of wool fabrics it was noticed that ring dyeing occurred in many cases. In an attempt to increase dyestuff penetration the padding solution was heated to various temperatures, up to 60°C, prior to padding the fabrics. The results in Table VII show the depth of shade of the fabrics increased when the temperature increased. Furthermore, photographs of cross-sections of the treated fibres showed that the penetration of the dyestuff into the fibre increased as the temperature of the padding solution increased. In general the treatment of the wool at elevated temperatures did not significantly affect the felting shrinkage and LOI values of the samples.

TABLE VI
THE EFFECT OF THPOH ON THE LIGHTFASTNESS OF WOOL FABRICS

Dyestuff	Treatment*	Lightfastness
C.I. Reactive Red 99	Conventional Exhaust Dyeing Dye + THPOH	7 6
C.I. Reactive Orange 68	Conventional Exhaust Dyeing Dye + THPOH	6 1-2
C.I. Reactive Blue 99	Conventional Exhaust Dyeing Dye + THPOH	7 5-6
C.I. Reactive Yellow 25	Conventional Exhaust Dyeing Dye + THPOH	5-6 5

***1,0% dye was used in both cases**

TABLE VII
THE EFFECT OF THE TEMPERATURE OF THE PADDING SOLUTION ON THE COLOUR VALUES OF THE WOOL FABRICS

*Dyestuff	Temperature (°C)	Colour difference value (ΔE)**
C.I. Reactive Red 2	20	—
	30	0,64
	40	1,07
	50	2,75
	60	4,83
C.I. Reactive Red 99	20	—
	30	0,57
	40	1,98
	50	3,88
	60	6,54

***1,0% Dye/25% THPOH padded onto prechlorinated (1,5% active chlorine) wool fabrics**
****The 20°C value was taken as reference**

SUMMARY AND CONCLUSIONS

The simultaneous dyeing, flame-retardant and shrinkresistant treatment of wool fabrics using a solution containing a reactive dye and THPOH was investigated. In general level dyeings were obtained. The treatment reduced fabric strength and abrasion resistance slightly, but produced flame-retardant and shrinkresistant fabrics. The LOI values of the fabrics treated with THPOH plus dye, however, were slightly lower than those of the fabrics treated with THPOH only. There was no significant difference in area shrinkage of the fabrics treated with THPOH only and those treated with a dye and THPOH.

It was found that an increase in the period of exposure of the THPOH treated fabrics to ammonia vapour (to polymerise the flame-retardant) did not affect the strength of the fabrics significantly. The LOI values, however, showed a tendency to increase slightly.

An increase in dyestuff concentration in the THPOH solution resulted in increase in the depth of shade but a decrease in rubbing fastness. The fastness to washing remained fairly constant up to a fairly high concentration of dye (5%) after which it deteriorated. When the depth of shade of fabrics treated simultaneously with dye and THPOH was compared with that of conventional exhaustion dyed wool, it was found that, in general, slightly more dyestuff was required in the former case than in the case of wool fabrics dyed by the exhaustion process. The fastness to light of the fabrics treated with THPOH and dye was lower than that of the fabrics containing dye only, indicating that the THPOH had an adverse effect on lightfastness.

In general a ring dyeing effect was obtained with the simultaneous dye/THPOH treatment and in an attempt to improve dyestuff penetration into the fibre, the temperature of the padding solution was increased from room temperature (20°C) to 60°C. In almost all cases the depth of shade increased with an increase in the temperature of the padding solution, while the degree of dye penetration into the fibre also improved.

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SOME PROPERTIES OF KARAKUL YARNS SPUN ON A DREF II MACHINE

by

L. Hunter, H. Taylor and H.H. Erdursun

ABSTRACT

Card sliver and tops, produced from five types of karakul wool, were each spun into yarns of different linear densities and twist levels on a Dref II machine. Spinning limits and yarn properties were measured. The spinning limits of the various lots varied from about 140 to 190 tex.

INTRODUCTION

The processing performance of willeyed karakul during topmaking has been studied and reported⁽¹⁾. In view of the fact that the Dref II friction spinning system appears to lend itself to the spinning of karakul⁽²⁾ it was decided to investigate the spinning of card slivers and tops, produced in the earlier study⁽¹⁾, on a Dref II machine and to study the physical properties of the resultant yarns.

EXPERIMENTAL

Details of the raw karakul fibre were given in an earlier report⁽¹⁾, while Table I gives the fibre diameter and length characteristics of the card slivers and tops produced.

Three different spinning trials were carried out on the Dref II machine. In the first, the spinning limits were determined by increasing the yarn take-off speed until it was no longer possible to spin the yarn for a minimum period of 10 minutes. The speed of the card cylinder was kept constant at 2 850 rev/min, that of the paradisc at 2 000 rev/min and that of the perforated drums at 3 400 rev/min. The feed rate was 0,78 m/min for the card slivers and 0,80 m/min for the tops.

In the other two series of experiments, 250 and 500 tex yarns, respectively, were spun, each at low, normal (medium) and high twist factors. In all these

TABLE I

FIBRE DIAMETER AND LENGTH CHARACTERISTICS OF KARAKUL PRIOR TO AND AFTER DREF SPINNING

	Fibre Diameter		**Fibre Length (WIRA Single Fibre Length)**						
Type	**Mean**	**CV**	**Mean**	**CV**	**% Fibres shorter than:**			**5% Tail**	**Fibres shorter than 0,25xmean**
	(µm)	**(%)**	**(mm)**	**(%)**	**15 mm**	**20 mm**	**25 mm**	**(mm)**	**(%)**
Card Sliver*									
616	29,4	46,7	44,7	56,7	11,6	17,3	23,8	93,6	8,0
625	33,3	41,9	43,7	54,9	11,7	18,7	25,8	89,5	6,8
626	27,1	47,4	39,5	60,9	13,8	24,5	33,3	87,9	7,8
603	30,6	49,3	36,4	55,3	16,2	25,4	33,5	74,7	7,4
632	32,5	44,1	47,3	60,1	11,7	19,1	24,7	103,2	8,6
Mean	30,6	45,9	42,3	57,6	13,0	21,0	28,2	89,8	7,7
After Spinning**									
616	28,1	46,2	50,5	54,0	10,3	15,2	21,0	95,3	8,5
625	32,6	43,3	52,4	51,2	8,9	12,1	17,1	102,9	7,4
626	27,2	48,4	44,7	52,9	10,7	15,9	22,4	89,9	7,8
603	30,0	48,4	34,5	56,0	15,4	26,0	36,4	71,3	5,2
632	33,2	44,5	48,1	54,6	11,6	16,1	21,2	96,4	8,9
Mean	30,2	46,2	46,0	53,7	11,4	17,1	23,6	91,2	7,6
Tops*									
616	31,3	48,4	56,9	44,3	2,2	4,6	8,1	106,4	2,0
625	34,7	41,9	54,6	43,3	2,2	5,0	9,1	99,3	1,8
626	29,4	48,8	49,6	45,8	3,9	7,1	12,2	93,5	2,6
603	31,1	49,3	52,3	35,9	1,9	3,9	7,6	82,5	1,3
632	34,4	44,5	56,5	43,3	1,4	3,6	7,7	104,4	1,3
Mean	32,2	46,6	54,0	42,5	2,3	4,8	8,9	97,2	1,8
After Spinning**									
616	30,0	46,6	54,6	46,6	4,0	7,1	10,3	101,3	3,8
625	33,3	40,8	50,0	49,2	7,7	11,3	16,1	96,7	6,2
626	29,2	46,8	52,8	45,5	4,2	7,8	12,0	99,2	3,4
603	31,2	47,2	48,2	47,7	7,5	11,2	15,7	91,4	4,8
632	34,3	42,6	55,7	53,7	8,4	12,9	17,5	112,7	7,6
Mean	31,6	44,8	52,3	48,5	6,4	10,1	14,3	100,3	5,2

***Input to Dref** ****On delivery side of Dref Card Cylinder**

TABLE II
YARN PROPERTIES AT SPINNING LIMITS

Type	Tex		Average No. of Fibres in yarn cross-section	Breaking Strength (cN)	CV (%)	Extension (%)	Irregularity (CV %)	Thin Places per 1000/m	Thick Places per 1000/m	Neps per 1000 /m	Hairiness		Tenacity (cN/tex)
	Nominal	Mean									Mean (Hairs /m)	CV (%)	
Card Sliver:													
616	141	142,0	128	360	17	13,2	20,8	368	24	328	65	3	2,5
625	163	174,0	128	441	16	13,2	21,2	240	112	232	90	8	2,5
626	186	186,0	185	511	11	16,2	18,5	112	32	232	81	12	2,7
603	162	164,3	137	360	20	12,4	19,4	176	64	200	88	0	2,2
632	190	185,5	134	437	22	11,6	19,3	136	48	320	77	4	2,4
Tops													
616	151	150,8	136	297	25	10,6	19,1	240	56	64	81	7	2,0
625	155	153,3	113	164	26	13,6	19,7	256	48	48	65	3	1,1
626	154	156,6	156	328	16	10,6	18,6	136	24	24	77	11	2,1
603	162	160,5	134	432	14	11,4	19,5	120	48	24	77	9	2,7
632	162	156,0	113	279	20	12,4	19,8	128	96	16	57	4	1,8

experiments the speed of the card cylinder was kept constant at 2 850 rev/min and that of the paradisc at 2 000 rev/min.

For the 250 tex yarns, the yarn delivery speed was 95 m/min, while the speed of the perforated drums was 1 420 rev/min for the low twist level, 2 100 rev/min for the intermediate (normal) twist level and 2 800 rev/min for the high twist level. The feed rates were varied between about 1,02 and 1,42 m/min so as to keep yarn linear density as close to 250 tex as possible.

For the 500 tex yarns, the yarn delivery speed was 102 m/min, while the perforated drum speed was 1 410 rev/min at the low twist level, 1 810 rev/min at the intermediate twist level and 2 550 rev/min at the high twist level. The feed rate (sliver input speed) was varied from about 2 to 2,4 m/min so as to maintain the yarn linear density as close to 500 tex as possible.

For the experiments involving spinning limits, fibres emanating from the card cylinder were collected at the beginning and end of the trials and these were analysed for length and diameter, mainly with a view to determining what fibre breakage took place. The results are given in Table I, together with those of the original card slivers and tops.

The properties of the yarns were tested and are given in Tables II to IV.

RESULTS AND DISCUSSION

Fibre Breakage

From Table I it can be seen that, as expected, the tops were slightly coarser and longer and contained significantly fewer short fibres than the card sliver from which they were produced. This merely reflects the removal of shorter fibres, which also tend to be finer, during combing. If the fibre properties are compared prior to and after passing through the carding cylinder (or opening roller) on the Dref II (Table I) then it appears that the opening action tended to increase the short fibre content and CV of length and to reduce mean fibre length slightly for the tops while the reverse appeared to be true for the card sliver. It is surmised that the opening action caused fibre breakage, thereby reducing the mean fibre length and increasing the short fibre content but that some short fibres were liberated as fly waste and removed by the vacuum system, the balance between short fibre creation (i.e. breakage) and removal determining the resultant fibre length and short fibre content.

Spinning Limits

According to Table II the spinning limits varied from about 140 to 190 tex, it being possible to spin the tops into finer yarns on average ($\simeq$ 155 tex) than the card slivers ($\simeq$ 170 tex). In both cases, it was possible to spin type 616 into a slightly finer yarn than the other lots, probably because it was relatively both fine and long. The yarn properties did not show consistent differences between the five different karakul lots although the yarns spun from card sliver tended to be more uneven and hairier than those spun from the tops. They also tended

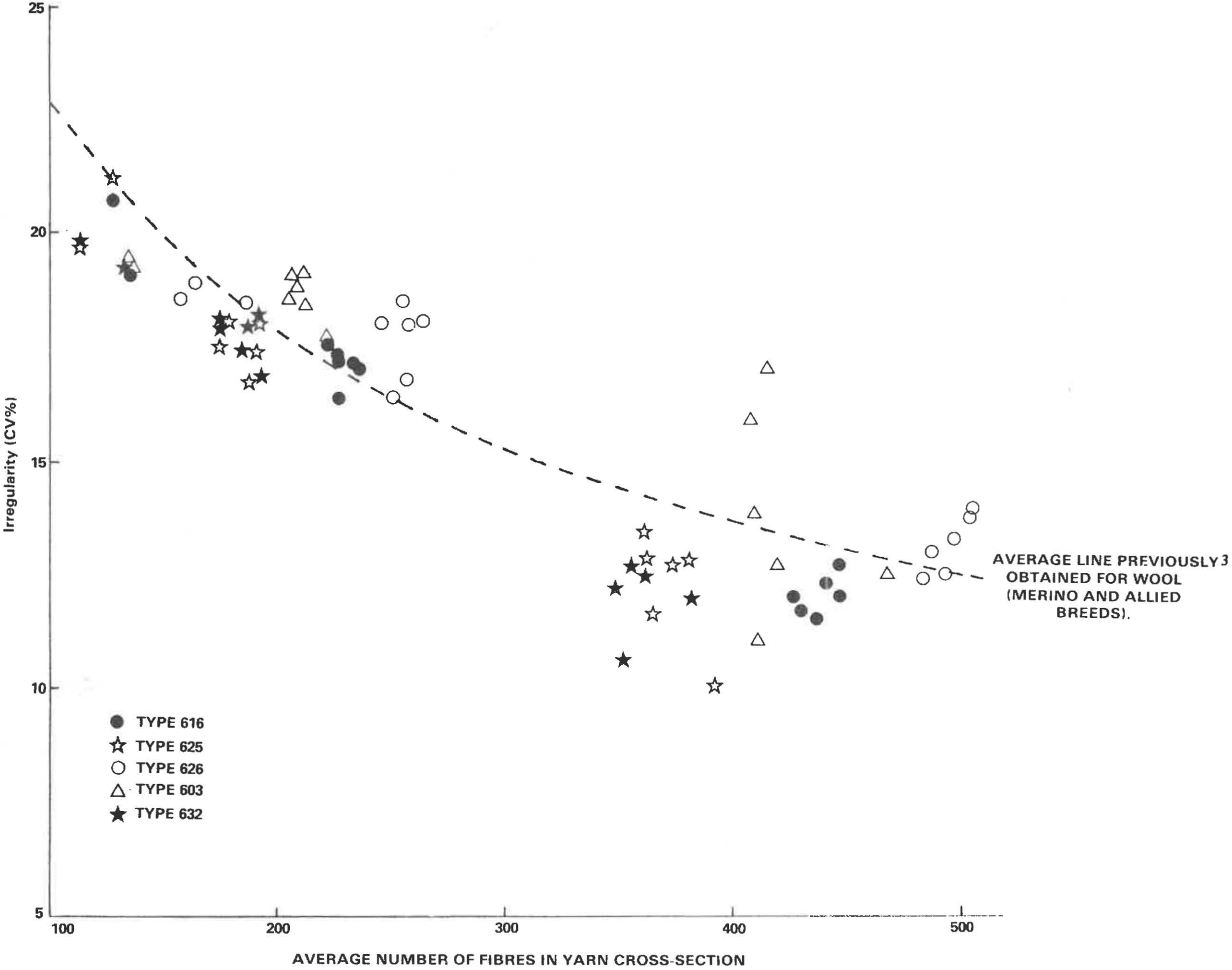

FIGURE 1. Yarn Irregularity vs Average Number of Fibres in Yarn Cross-Section

to be stronger and to have higher extension values, probably because their spinning limits were coarser.

Properties of 250 tex yarns

From Table III it can be seen that the average yarn tensile properties, hairiness and frequencies of imperfections were better at the highest twist level than at the lowest twist levels, the "normal" twist values generally being intermediate. Furthermore, the yarns spun from the tops were generally superior to those spun from the card sliver, particularly with respect to the frequencies of imperfections. There were not very large differences between the properties of the yarns spun from the different karakul types although type 626 tended to produce the best yarns and types 625 and 632 the worst.

Properties of 500 tex yarns

According to Table IV, the yarn tensile and hairiness values increased with increasing twist, which agrees with the results obtained on the 250 tex yarns. Yarn irregularity did not appear to change in a consistent manner with changes in twist. The yarns spun from the card slivers tended to be more even and to have higher extensions than the yarns spun from the tops, although the latter tended to be stronger and less hairy. As in the case of the 250 tex yarns, there was a tendency for type 626 to produce the best yarns and for types 625 and 632 to produce the worst yarns.

General

In Fig 1, yarn irregularity has been plotted against the average number of fibres in the yarn cross-section, with the curve previously obtained(3) for wool yarns spun on the Dref II superimposed. It can be seen that, at the same average number of fibres in the yarn cross-section, the yarns spun from the finer karakul types 616, 626, and 632, particularly the latter two, were more irregular than those spun from the coarser ones (625 and 632). It can also be seen that the points were scattered about the line representing the wool yarns spun from merino and allied breeds(3). These wools were much longer and generally also much finer than the karakul lots used in this study, which suggests that the irregularity of yarns spun on the Dref II is largely independent of the fibre length, even though a slight effect was detected previously(3).

SUMMARY AND CONCLUSIONS

Card slivers and tops produced from five different types of karakul (types 603, 616, 625, 626 and 632) were spun into yarns of different linear densities and twists on a Dref II machine and their spinning limits determined. The lots ranged in length from about 35 to 55 mm and in diameter from about 27 to 34 μm. The physical properties of the finest yarns which could be spun, as well as those of 250 and 500 tex yarns were measured.

TABLE III
PROPERTIES OF 250 TEX YARNS

Type	Tex		Average No. of Fibres in yarn cross-section	Breaking Strength (cN)	CV (%)	Extension (%)	Irregularity (CV %)	Thin Places per 1000/m	Thick Places per 1000/m	Neps per 1000 /m	Hairiness		Tenacity (cN/tex)
	Nominal	Mean									Mean (Hairs /m)	CV (%)	
Card Sliver (Low Twist)													
616	250	244,7	221	401	21	13,2	17,5	344	16	112	144	6	1,6
625	250	237,1	175	260	19	15,4	17,5	216	16	48	139	21	1,1
626	250	245,4	244	321	25	12,0	18,1	232	8	120	108	0	1,3
603	250	245,6	205	216	26	13,4	19,0	360	8	48	136	1	0,9
632	250	258,6	187	248	30	13,6	18,1	200	16	120	105	8	1,0
Tops (Low Twist)													
616	250	250,8	226	380	20	14,6	16,4	56	0	0	101	4	1,5
625	250	243,5	179	108	29	16,4	18,0	136	0	0	130	3	1,5
626	250	251,4	250	592	19	11,8	16,4	32	0	0	89	1	0,4
603	250	248,2	207	459	28	11,0	18,8	104	0	0	103	7	1,8
632	250	242,2	175	190	37	19,4	18,1	72	24	8	125	13	0,8
Card Sliver (Normal Twist)													
616	250	259,9	235	492	21	14,6	17,0	64	16	48	111	5	1,9
625	250	252,9	186	269	25	15,6	18,0	168	0	24	122	7	1,1
626	250	256,1	254	709	21	14,2	18,5	112	8	104	94	3	2,8
603	250	263,6	220	537	22	12,2	17,7	88	16	56	131	4	2,0
632	250	266,1	192	478	23	15,2	16,9	128	8	96	134	2	1,8

TABLE III (cont.)
PROPERTIES OF 250 TEX YARNS

Type	Tex		Average No. of Fibres in yarn cross-section	Breaking Strength (cN)	CV (%)	Extension (%)	Irregularity (CV %)	Thin Places per 1000/m	Thick Places per 1000/m	Neps per 1000 /m	Hairiness		Tenacity (cN/tex)
	Nominal	Mean									Mean (Hairs /m)	CV (%)	
Tops (Normal Twist)													
616	250	249,1	225	729	14	10,8	17,3	40	0	0	83	1	2,9
625	250	258,6	191	390	20	15,6	17,4	112	8	0	113	12	1,5
626	250	257,4	256	905	13	15,2	16,8	24	8	0	75	1	2,9
603	250	253,1	211	791	19	13,2	18,4	48	8	0	96	3	3,1
632	250	254,5	184	467	19	15,4	17,4	88	16	0	126	8	1,8
Card Sliver (High Twist)													
616	250	258,0	233	908	11	16,8	17,1	32	16	72	89	3	3,5
625	250	221,2	163	417	19	13,2	18,9	168	16	32	90	2	1,9
626	250	262,6	261	870	9	19,4	18,0	56	24	32	91	4	3,3
603	250	245,7	205	803	10	17,0	18,5	80	16	48	114	10	3,3
632	250	261,8	189	641	18	11,2	18,1	120	48	104	104	4	2,4
Tops (High Twist)													
616	250	250,5	226	932	11	16,6	17,2	32	16	0	80	4	3,7
625	250	254,3	187	635	16	12,8	16,7	32	0	0	83	1	2,5
626	250	258,5	257	944	13	19,6	18,0	40	8	8	87	1	3,6
603	250	248,3	207	888	15	17,2	19,1	40	24	8	102	1	3,6
632	250	245,8	177	723	13	11,4	18,0	40	24	8	85	2	2,9

TABLE IV
PROPERTIES OF 500 TEX YARNS

Type	Tex		Average No. No. of Fibres in yarn cross-section	Breaking Strength (cN)	CV (%)	Extension (%)	Irregularity (CV %)	Hairiness		Tenacity (cN/tex)
	Nominal	Mean						Mean (Hairs/m)	CV (%)	
Card Slivers (Low Twist)										
616	500	470,2	425	400	24	13,2	12,0	196	3	0,8
625	500	530,2	391	520	17	15,2	10,0	214	2	1,0
626	500	507,8	504	420	31	7,3	14,0	195	1	0,8
603	500	502,3	418	590	24	8,4	12,7	224	7	1,2
632	500	481,7	348	400	38	10,2	12,2	203	4	0,8
Tops (Low Twist)										
616	500	492,6	445	310	25	11,6	12,7	227	2	0,6
625	500	488,7	360	350	32	10,2	13,4	199	1	0,7
626	500	498,3	495	580	24	7,2	13,3	206	1	1,2
603	500	488,2	407	380	32	9,8	15,9	236	0	0,8
632	500	497,4	359	340	25	13,6	12,7	195	4	0,7
Card Slivers (Normal Twist)										
616	500	475,6	429	1050	14	10,9	11,7	180	1	2,2
625	500	515,1	380	470	22	16,8	12,8	229	9	0,9
626	500	485,3	482	1360	11	15,6	12,4	182	6	2,8
603	500	490,8	409	950	16	10,6	11,2	222	1	1,9
632	500	498,4	360	480	20	15,3	12,5	225	2	1,0

TABLE IV (cont.)
PROPERTIES OF 500 TEX YARNS

Type	Tex		Average No. of Fibres in yarn cross-section	Breaking Strength (cN)	CV (%)	Extension (%)	Irregularity (CV %)	Hairiness		Tenacity (cN/tex)
	Nominal	Mean						Mean (Hairs/m)	CV (%)	
Tops (Normal Twist)										
616	500	487,6	440	1150	16	10,9	12,3	185	4	2,4
625	500	506,0	373	580	15	14,0	12,7	217	1	1,1
626	500	489,2	486	1800	10	16,9	13,0	179	1	3,7
603	500	496,9	414	1490	11	14,1	17,0	213	5	3,0
632	500	487,1	352	520	22	12,7	10,6	185	4	1,1
Card Slivers (High Twist)										
616	500	482,8	436	1540	7	18,0	11,5	166	1	3,2
625	500	493,8	364	1210	12	12,6	11,6	203	1	2,4
626	500	506,6	503	1700	17	22,2	13,9	192	3	3,4
603	500	559,2	466	1800	8	20,5	12,5	193	3	3,2
632	500	526,0	380	1430	10	13,8	12,0	193	2	3,0
Tops (High Twist)										
616	500	494,1	446	1820	18	21,7	12,5	166	2	3,7
625	500	490,2	361	1040	21	7,5	12,9	169	2	2,1
626	500	495,8	492	1740	18	18,7	12,5	163	1	3,5
603	500	489,7	408	1810	18	22,0	13,9	159	1	3,7
632	500	496,7	358	1430	14	9,6	12,6	165	2	2,9

The spinning limits of the various lots varied from about 140 to 190 tex, it being possible to spin the tops into slightly finer yarns ($\simeq$ 155 tex) than the card slivers ($\simeq$ 170 tex). The spinning limits of the different karakul types did not differ by much.

Generally, the highest of the three twist levels studied produced the best yarns with, if anything, the yarns spun from the tops being slightly better than those spun from the card slivers. The differences between the properties of the yarns produced from the various karakul types were neither consistent nor large, if anything, type 626 on the average producing the best yarns and types 625 and 632 the worst. The irregularity of the yarns was related to the average number of fibres in the yarn cross-section, although at the same average number of fibres in the yarn cross-section the finer karakul types tended to produce more irregular yarn. The irregularity of the karakul yarns spun in this study was similar to that of yarns spun previously on the same machine from wools from merino and associated breeds.

At the highest twist levels the tenacities of the karakul yarns varied from about 2 to 3,7 cN tex. Should higher tenacities be required it would be advisable to introduce a core during spinning.

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