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SAWTRI BULLETIN

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SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH INSTITUTE
OF THE CSIR

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SAWTRI BULLETIN

Editor: P. de W. Olivier

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SOUTH AFRICAN
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OF THE CSIR

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P.O. Box 1124
Port Elizabeth

EDITORIAL COMMITTEE

Dr D. W. F. Turpie, Chairman
P. de W. Olivier, Editor
Dr L. Hunter
Dr N. J. J. van Rensburg
M. A. Strydom

The Director and Staff of the South African Wool and Textile Research Institute wish readers of the "BULLETIN" the very best for Christmas and the New Year. We thank you for your interest and support during the past year and look forward to extending the cordial relationships that have existed between the Textile Industry and the Institute for so many years.

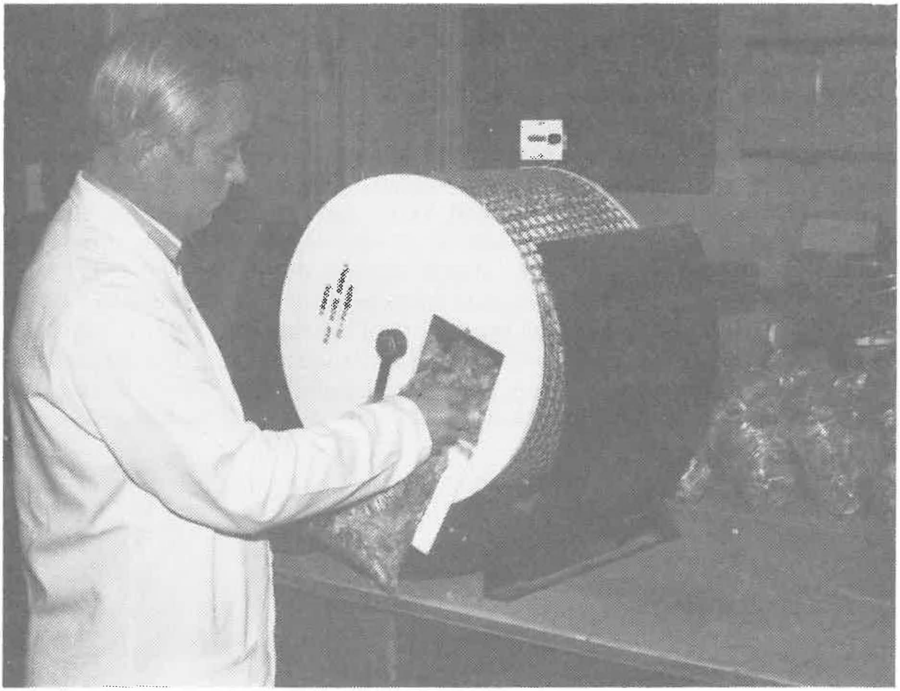
EDITORIAL

On Tuesday, 27th July, 1982, the South African Wool and Textile Research Institute will reach yet another important milestone in its history. This is the occasion of a two-day symposium "New Technologies for Cotton" which is being held under the auspices of the South African Advisory Committee of the Textile Institute. Organisation of the Symposium is by SAWTRI and the Eastern Cape Section of the Textile Institute. A large number of local and overseas delegates are expected to attend. Newsletters and forms for completion indicating intention to register, have been sent to some 750 people here and abroad. An extremely encouraging number of interested persons have already indicated that they will register for the Symposium. The international character of the Symposium is reflected by the large number of speakers from West Germany, the United States of America, France, Switzerland, the United Kingdom, Holland, Austria, Italy and Zimbabwe. Although the accent throughout will be on new technologies for cotton a considerable number of papers will be of interest to the textile industry in general. Delegates may expect to attend sessions dealing with the very latest developments cutting across the entire cotton industry, from breeding through growing, harvesting, mechanical processing of the raw fibre, fabric properties, dyeing and finishing and quality control to marketing. The programme provides for eight plenary lectures and thirteen parallel sessions of three papers each. The venue of the Symposium is the University of Port Elizabeth.

INSTITUTE NEWS

Defribber for Raw Wool Samples

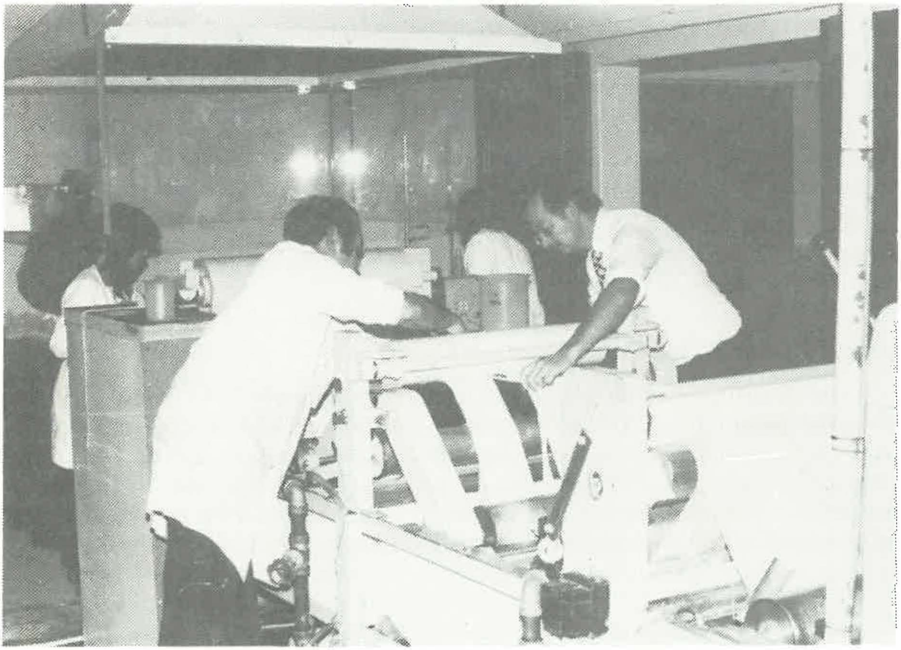
Recent research by SAWTRI has shown that the degree of "fribbiness" of raw wool plays a significant role in the amount of fibre which is rejected as waste during topmaking and which therefore does not count in the determination of the commercial top and noil yield. Fribs comprise second or double cuts which are brought about during shearing and cause a short portion of the staple to become partly or completely detached from the staple and also very short staples such as are prevalent in locks and certain outsorts. To obtain a reproducible estimate of the fribbiness of the wool, a method involving a hand operated laboratory de-fribbing apparatus was devised. The apparatus comprises a cylindrical wire cage closed at both ends and fixed to a central shaft. A trapdoor in one of the closed ends allows the introduction and retrieval of the sample. The ejected material is collected, cleaned and weighed and expressed as a percentage of the wool base in the original sample. A technical report is being prepared for publication.



The SAWTRI Raw Wool Sample Defribber

Shrinkresist Treatment of Wool Tops

A modification of the SAWTRI process for the shrinkresist treatment of wool tops has been developed recently. Pilot scale trials at SAWTRI have shown that the process can be used successfully in the shrinkresist treatment of a wide range of wool tops. A patent application has been filed and details of the process will be released in due course.



Shrinkproofing Trials under way at SAWTRI

SAWTRI Senior Scientists for Australasia

Dr L. Hunter, Assistant Director, left for Australia in November to attend a continuation of the previous Research and Development meeting of the IWS which had not been completed, on behalf of the Director. While in Australia, Dr Hunter visited the University of New South Wales, the CSIRO laboratories in Sydney and those at Geelong. On his return to South Africa, Dr Hunter made a brief stop at Mauritius where he addressed interested people telling them more about SAWTRI's activities and the 1982 Cotton Symposium. He also visited factories on the island.

Dr N. J. J. van Rensburg, who is in charge of Wet Processing and Dyeing and Finishing at SAWTRI, was invited to read a paper at a shrinkproofing conference organised by the CSIRO Division of Textile Industry in Geelong, Australia for 23 and 24 November. The conference was attended by experts on the shrinkproofing of wool from all over the world who gathered to discuss the present situation regarding this important process. Dr Van Rensburg talked about the SAWTRI modified process for the shrinkproofing of Wool referred to elsewhere in this Bulletin. While in Australia, Dr Van Rensburg also visited the CSIRO laboratories at Geelong to discuss wool scouring and general textile effluent problems. He visited a wool factory engaged in the shrinkproofing of wool top by the Kroy process.

Dr van Rensburg then crossed to New Zealand where, at the Wool Research Organisation of New Zealand (WRONZ) he discussed matters of mutual interest with scientists working in his field.

Returning to Australia, he visited the University of New South Wales in Sydney to discuss matters of mutual interest with textile scientists before returning to South Africa.

Assistant Director for Bremen Cotton Conference

The International Cotton Test Conference to be held in Bremen, West Germany from 21 to 23 January, 1982, will be attended by Dr L. Hunter, SAWTRI's Assistant Director, who will present a paper dealing with The Correlation between Cotton Fibre Properties and Ring- and Rotor Yarn Properties. The Conference is organised bi-annually jointly by the Bremen Fibre Institute and the Bremen Cotton Exchange, and is probably the most important and internationally represented conference of its kind in the world. Four hundred participants from 35 countries are expected to attend to hear the presentation of some 24 papers by speakers from 12 countries. Instruments for the testing of cotton will also be on display during the conference.

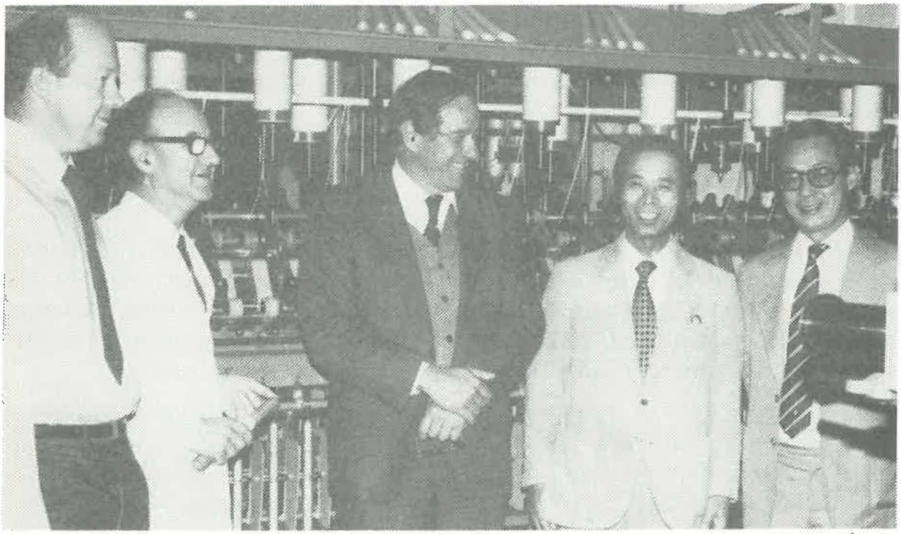
SAWTRI Research Advisory Committee Meets

The RAC met at SAWTRI on November 5th to deliberate on research proposals for the new financial year under the Chairmanship of CSIR Vice-President, Mr J. P. de Wit.

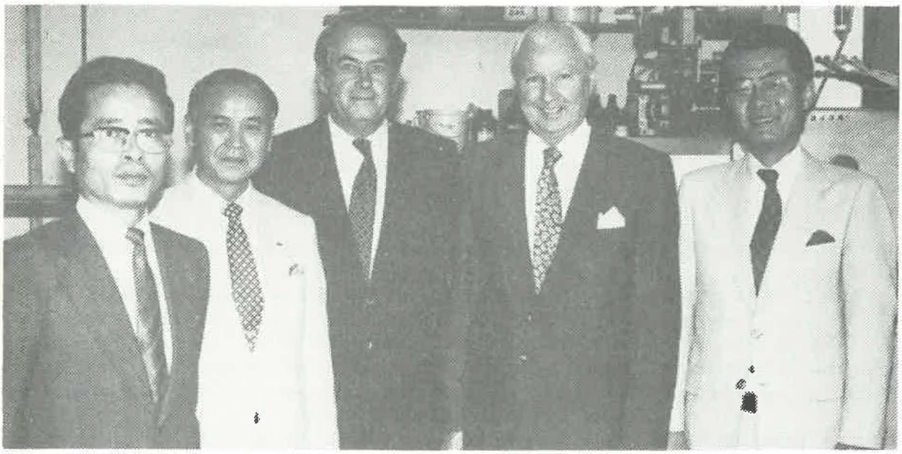
Visitors to SAWTRI

Mr Andre Riekardt, newly appointed personnel manager of the South African Wool Board paid a brief visit to the Institute on September 24th to familiarise himself with the functions of SAWTRI.

On October 13th two important IWS personages from the Far East visited SAWTRI. From Hong Kong came Mr R. C. M. Lai, who is Branch Manager of the IWS Macau office. The other visitor was Mr Hideo Sawachi, Branch Manager of the Tokyo, Japan, Office of the IWS.



L to R: Dr L. Hunter, Mr S. Marsland, Dr D. W. F. Turpie, Director, Mr Hideo Sawachi and Mr R. C. M. Lai.



L to R: Mr N. Ikegami, Mr S. Kobayashi, Mr J. Robertson of Jacques Segard & Co., Mr N. J. Vogt, Regional Representative of the CSIR and Mr Y. Itoh.

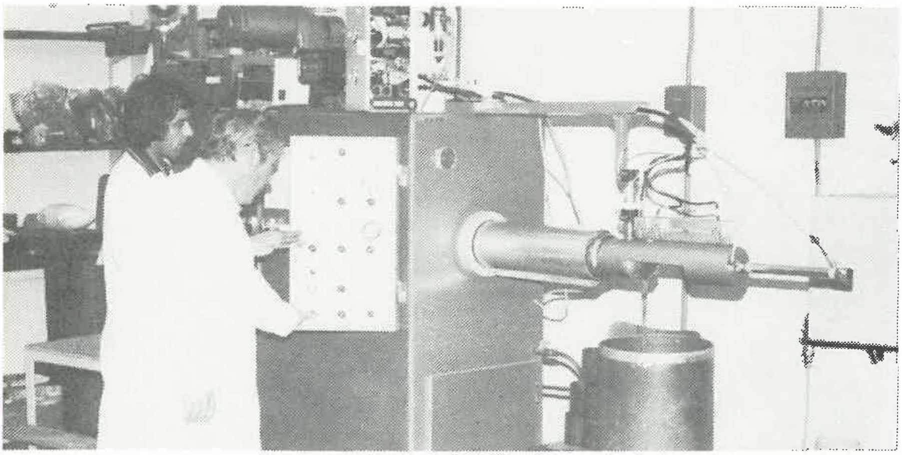
Messrs J. Kübler and H. Schwensfeier of the firm Schubert and Salzer, Ingolstadt, West Germany spent the day of 29 October at SAWTRI to discuss matters relating to the 1982 Cotton Conference

On November 4th, yet another group of visitors from Japan came to SAWTRI. These gentlemen representing wool and related industries in Japan were Mr N. Ikegami, Assistant Manager, Product Division, Japan Felt Industrial Co. Ltd., Mr S. Kobayashi, Manager, Japan Felt Industrial Co. Ltd., and Mr Y. Itoh, Assistant Manager, Wool Department, Kanematsu-Gosho Ltd.

Dr D. L. Bosman, Director of the National Timber Research Institute of the CSIR and member of SAWTRI's Research Advisory Committee arrived at the Institute a day before the RAC meeting on the 5th November to familiarise himself with the work carried out at the Institute.

Mr Fred Herbst, Head of Publications and Publicity of the CSIR's Information and Research Services Division in Pretoria, spent the day of November 5th at SAWTRI to learn more about the Institute's work. He also held discussions with the CSIR's Eastern Cape and Border Representative, Mr N. J. Vogt who is responsible for all SAWTRI's publicity activities.

The SAWTRI Research Advisory Committee Meeting held at the Institute on November, 5th was attended by:
Standing, L to R: Mr J. J. S. Marais, Cotton Board; Mr G. F. Fouche, Secretary of SAWTRI; Dr J. H. Hofmeyr, Director, Animal and Dairy Research Institute; Dr de V. Aldrich, Pep Stores; Dr D. L. Bosman, Director, National Timber Research Institute; Mr O. H. G. Beier, O. T. H. Beier & Co. Ltd; (in front) Dr D. J. Rossouw, Director, Tobacco Research Institute; Mr E. Wilson, Hex Tex; Mr J. Egelbrecht. Mohair Board; Mr A. Nilsen, Veldspun and Dr P. S. Rautenbach, Industrial Development Corporation.
Seated, L to R: Dr L. Hunter, Assistant Director, SAWTRI; Dr D. W. F. Turpie, Director, SAWTRI; Mr J. P. De Wit, Vice President, CSIR (Chairman); Mr W. Mac Donald, S.A. Wool and Mohair Processors' Association and Mr J. Z. Moolman, S.A. Wool Board.



Dr F. A. Barkhuysen, Head of Dyeing at SAWTRI and Mr. T. McAuley of Dawson's International (Scotland) Manufacturers of the Smith Fastran RF Dyeing Machine during the latter's recent visit to SAWTRI.

The Director of Information and Research Services of the CSIR, Mr Dennis Kingwill, paid a brief visit to the Institute and the Regional Office on the same day, during the course of which he attended the AGM of the Midlands Regional Research Committee together with Drs G. Nelson and D. R. Cooper, Directors of the NIPR and LIRI respectively, and Dr D. W. F. Turpie, Director of SAWTRI.

Dr H. G. van Heerden, Cotton Breeder of the Department of Agriculture and Fisheries' Research Station at Loskop, near Groblersdal had extensive discussions with the Assistant Director of SAWTRI, Dr L. Hunter on November 5th. They dealt with matters relating to trials being carried out at SAWTRI in connection with the evaluation of new cotton cultivars.

The Institute received for the first time the new Director of the Technical Centre of the IWS at Ilkley, Yorkshire, Mr J. F. Graham. Accompanied by the Deputy Managing Director of the IWS in London, Dr J. McPhee, and Messrs J. Z. Moolman and J. Becker of the South African Wool Board, he came to discuss those projects of SAWTRI's Research Programme for 1982/83 sponsored by the Wool Board.

Correction

In the September, 1981 edition of the "Bulletin", it was incorrectly stated that Dr N. J. J. van Rensburg (See p.7) had been awarded the Textile Institute's Service Medal for "both his devoted research in textile chemistry, dyeing and finishing and of his services to the Textile Institute in the Eastern

Cape''. We have been notified by the Textile Institute that the award has been made in recognition of valuable services rendered to the Textile Institute by Dr Van Rensburg. We apologise for this oversight and for possible inconvenience to the parties concerned.

Dr L. Hunter seen with Mr J. F. Graham in one of the Testing laboratories at SAWTRI.

SAWTRI PUBLICATIONS

Since the last announcement in the Bulletin of September, 1981 the following Technical Reports have been published:

No. 479: Strydom, M. A.: *The Processing Characteristics of South African Wools,* Part XIX: *The Effect of Mechanical Sifting on the Processing Performance of Binned Locks.*

No. 480: Delaney, P.: *The Bending Properties of Some Plain and Twill Weave Wool Fabrics.*

No. 481: Hunter, L., Cawood, M. P. and Dobson, D. A.: *A Comparison of the Performances of Different Types of Knots during the Knitting of Wool Yarns.*

No. 482: Smuts, S., Hunter, L. and Van Rensburg, H. L. J.: *Some Typical Single Fibre Tensile Properties for wools Produced in South Africa.*

No. 483: Hunter, L.: *The Effect of Fibre Properties on Spinning Performance and Yarn Properties for After-Chrome Dyed Wool Tops.*

No. 484: Robinson, G. A., Cawood, M. P. and Gee, E.: *The Dimensional Changes of Outer Fabrics and Interlinings during Fusing*. Part 2: *Effect of Fusing Various Interlinings to an All-Wool Outer Fabric.*

No. 485: Smuts, S., Hunter, L. and Van Rensburg, H. L. J.: *The Effect of Fibre Diameter and Crimp on some Single Fibre Tensile Properties of Wool*

No. 486: Barkhuysen, F. A., Turnbull, R. H., Grimmer, G., West, A. and Van Rensburg, N. J. J.: *Continuous Dyeing Using Radio Frequency Energy,* Part II: *A Preliminary Assessment of Potential Energy Saving.*

Other Publications

Hunter, L. and Cawood, M. P.: *Sewability of Knitted Fabrics, Journal of Dietetics and Home Economics* 9(1), 22 (1981)

Erdursun, H. H. and Hunter, L.: *A Review of the Processing of Wool and Wool Blends on the Short Staple (Cotton) System,* SAWTRI SPECIAL REPORT (November, 1981)

A NOTE ON DIFFERENT TREATMENTS FOR RETARDING THE PHOTOCHEMICAL DEGRADATION OF *PHORMIUM TENAX*

by N. J. J. VAN RENSBURG

ABSTRACT

Curtaining fabric containing Phormium tenax *fibres was treated with a wide range of chemicals to reduce the discolouration and strength loss caused by sunlight. In general it was found that treatments with methylolmelamine resins, beryllium oxide and chemical delignification produced the most promising results.*

INTRODUCTION

It has been known for a long time that sunlight degrades cellulosic materials. Almost a century ago (in 1883) Witz established that light could induce certain chemical modifications in cellulose[1]. Since those early years a lot of research has been carried out in this field and it is now known that there are two mechanisms whereby cellulose is degraded by light, namely photolysis and photosensitized degradation[2]. Most of the studies carried out to date dealt specifically with the cotton fibre, and relatively little is known about the degradation of other types of cellulosic fibres, such as bast and leaf fibres.

The cotton fibre comprises mainly cellulose and photochemical degradation occurs basically in the cellulosic chains, which are progressively broken down, resulting in a collapse of the molecular structure and significant fibre strength losses[2-5]. Bast and leaf fibres, on the other hand, also contain a fairly high percentage of non-cellulosic matter, such as lignin and pectins[6]. These compounds differ considerably from cellulose and their presence in the fibre may affect the rate of photodegradation of the cellulosic chains, i.e. they could act as photosensitizers and thus accelerate the rate of photochemical breakdown. Futhermore, lignin and pectins are also subject to photochemical degradation and they could be converted into products which may adversely affect certain fibre properties, such as colour.

The lignin and pectin contents of a number of vegetable fibres are as follows[7]:

Fibre	Lignin and Pectin Content (%)
Cotton	0,5
Ramie	0,7
Linen	10,5
Sisal	14,5
Phormium tenax	23,1
Jute	24,4

It is quite clear that the various vegetable fibres differ significantly in their lignin and pectin contents. It is also likely that they would differ in their susceptibility to degradation by sunlight. As far as cotton is concerned, it is known that the fibre can be protected against photochemical degradation by various treatments[8-13]. In the case of fibres which contain a very high percentage of lignin and pectin, however, little is known about the nature of the photodegradation reaction and furthermore relatively few treatments have been proposed for protecting such fibres against degradation by light.

It is well-known that fibres such as jute and sisal are susceptible to sunlight degradation, which leads to a yellow or brown discolouration[14]. According to most research workers lignin is the main cause of the discolouration[14-17]. Gupta[14] and Majumdar[18] claimed that an appreciable improvement in the lightfastness of jute could be obtained when most of the lignin (more than 90%) was removed from the fibre. Warty[17] reported, however, that the presence of as little as 0,2% lignin in jute after delignificition by sodium chlorite still resulted in a perceptible discolouration of the fibres upon exposure to sunlight, and claimed that the lignin had to be removed completely to eliminate yellowing. Lengagne[19], on the other hand, recommended a treatment which did not remove all the lignin from the fibre and yet produced a fabric which retained its white colour after exposure to light.

During the course of some work on *Phormium tenax* it was noticed that these fibres showed a tendency to discolour upon exposure to sunlight. In view of the high lignin and pectin content of these fibres, this was not surprising. A literature survey showed that very little is known about the effect of light on *Phormium tenax*. It was decided, therefore, to apply some of the treatments which had been proposed for protecting jute as well as other cellulosic fibres against degradation by sunlight, to *Phormium tenax* and to evaluate their effectiveness in reducing the discolouration and photodegradation of this fibre. These treatments included various aminoplast resins, polymers, flame-retardants, dyes, pigments, fungicides and a number of chemical delignification treatments.

EXPERIMENTAL

A woven curtaining fabric (435 g/m^2), comprising R126 tex polyester/cotton (50/50) warp yarns and R200 tex *Phormium tenax*/polypropylene/polyester (55/23/22) weft yarns, was used in this study. The phormium fibre was softened chemically as was described previously[20].

The various resin treatments were carried out according to the conventional pad-dry-cure technique using 10% $MgC\ell_2$/citric acid (on mass of resin) as catalyst. The different polymers were applied to the fabrics by padding, followed by drying at 120°C. The dyes and flame-retardants were applied to the fabric according to the methods recommended by the various manufacturers. Chemical delignification treatments were carried out according to the Bossuyt method, using sodium chlorite at pH 4,5 as described by Lengagne[19], or according to the method described my Majumdar[18], using sodium hypochlorite at different pH values. Inorganic pigments were applied according to the method described by Esteve et al[21]. The fungicides were applied in the usual manner.

The samples were exposed to sunlight behind glass in an exposure cabinet in the usual manner. The yellowness index of the samples was determined on a Zeiss Elrepho apparatus using the formula suggested by Berger[22]. Bursting strength of the fabrics was also determined.

RESULTS AND DISCUSSION

The yellowness index of the various samples prior to exposure and after being exposed to sunlight for different periods is shown in Table I. The table also gives the bursting strength values of the samples prior to exposure and after being exposed to sunlight for 34 weeks. It can be seen that most of the treatments did not have a pronounced effect on the yellowness index of the fabrics *prior to exposure*, with the exception of the coloured compounds which were used, such as the dyes and pigments. The delignification treatments, especially the Bossuyt method, resulted in a bleaching of the fabrics. When the actual increase in the yellowness of the different fabrics is considered (i.e. when the after exposure values are compared with the unexposed ones), some interesting trends are noticed. Firstly, for relatively short exposure times (e.g. 4 weeks), most of the treatments reduced the rate of yellowing of the fabrics, compared with the untreated control. A few of the treatments did, however, accelerate the rate of yellowing (e.g. thiourea, $TiC\ell_4/Sb_2O_3$, most of the dyes, the Bossuyt method and copper naphthanate). When the exposure time was increased, however, the picture changed drastically, and many of the treatments which decreased the rate of yellowing (compared to the untreated fabrics) after 4 weeks actually produced fabrics which yellowed more rapidly than the control after being exposed to sunlight for 34 weeks. None of the treatments was successful in preventing the yellowing of the *Phomium tenax* fabrics completely, but some of the more promising ones slowed down the rate of yellowing of the fabrics considerably, compared to that of the untreated fabric. It must be pointed out that these fabrics were exposed to direct sunlight in an exposure cabinet and, that the conditions of exposure were much more severe than those to which curtains would normally be subjected in dwellings and offices.

It is known for example, that the temperature in these exposure cabinets can rise to extremely high values in summer. For example, during these trials the temperature on the fabric surface was measured on a summer's day in

February and it was found that the temperature reached a value of 50°C at 9h00 and gradually increased to about 80°C at 13h00, whereafter it decreased to about 55°C at 16h00. Curtains would never be exposed to sunlight under such severe conditions during actual wear and the level of protection against discolouration offered by these treatments, if anything, would therefore be better in practice.

In general, the highest level of protection against discolouration of the fabrics was obtained with the aminoplast resin treatments, more specifically the methylolmelamine resins when applied at the 10% level (e.g. treatment No's 3, 6, 7, 8 and 11), and furthermore certain delignification treatments carried out according to the methods described by Majumdar. (No's 38 and 39). The only other treatments which offered some protection were those based on certain pigments, namely Pigment Yellow 34 (No. 29) and beryllium oxide (No. 32). Due to its colour, however, Pigment Yellow 34 would be of limited use in practice. Returning to the methylolmelamine resins, it is clear that the level of protection offered against discolouration decreased when the resin add-on level decreased. In practice it would not be advisable to use less than 10% resin. As far as the delignification treatments are concerned, the Bossuyt method involving sodium chlorite did not seem successful, despite the fact that it bleached the fabrics considerably. The Majumdar method, which employs sodium hypochlorite, on the other hand, proved more successful. It is quite clear, however, that only certain specific treatments should be employed. For example, the single treatments resulted in a lower rate of discolouration in sunlight than where the treatments were performed three times. Furthermore, better results were obtained at the lower pH values, while an increase in the amount of chlorine used did not offer any advantages.

Apart from monitoring the discolouration of the fabrics upon exposure to sunlight, the strength losses of the fabrics were also determined. Figure 1 shows the effect of sunlight on the bursting strength of the untreated control fabric. It is clear that there was a progressive strength loss when the exposure time was increased. After 34 weeks the strength loss amounted to 50%. Table I shows the bursting strength of the different fabrics prior to exposure and after being exposed to sunlight for 34 weeks. These results in general compare favourably with those of Young[23], who studied the weathering of cotton/polyester yarns in Australia and found strength losses varying from 50% to 80% after the yarns had been exposed to sunlight for 24 weeks. Table I shows that, as far as the different treatments were concerned, the highest level of protection against strength losses was obtained with the UV absorbers. (The average strength loss after exposure was about 26%). Certain aminoplast resin treatments, thiourea and some pigments also slowed down the rate of degradation of the fabrics. When the treatments were evaluated in terms of their effect on the rate of discolouration as well as the strength loss of the fabrics after exposure, it is clear that the methylolmelamine resins produced somewhat better results than the pigment beryllium oxide and the delignification treatment (Majumdar process). In fact, the bursting strength of the fabrics treated with 10% methylolmelamine resin was higher after exposure than that of the untreated control fabric after exposure, while that of the fabrics treated with beryllium oxide and sodium hypochlorite (Majumdar process) was lower. The strength of the unexposed fabrics, however, was lower for the Majumdar process than for the aminoplast resin treatment due to the chemical treatment itself.

SUMMARY AND CONCLUSIONS

Various chemical treatments which have been recommended for inhibiting or retarding the photochemical degradation of cotton, jute and other cellulosic fibres, have been applied to *Phormium tenax* in an attempt to enhance the resistance of this fibre to degradation by sunlight. The treatments included various aminoplast resins, polymers, ultraviolet absorbers, flame retardants, dyes, pigments, rotproofing agents, fungicides as well as some chemical delignification processes. The effect of the various treatments on the discolouration of some *Phorium tenax* curtaining fabrics, comprising a blend of *Phormium tenax*/polypropylene/polyester/cotton (40/16/30/14), in sunlight was monitored. Furthermore, the strength loss of the fabric at the completion of the study was determined.

In general, most of the treatments reduced the discolouration of the fibres when relatively short exposure times (4 weeks) were considered. When the exposure time was increased to 34 weeks, however, only a few of the treatments produced fabrics which yellowed less than the untreated control. None of the treatments completely inhibited the discolouration of the fabrics, but some of the more successful ones reduced the rate of discolouration considerably, compared to the control. The best results were produced by the treatments with methylolmelamine resins, beryllium oxide pigment or chemical delignification with sodium hypochlorite.

When the treatments which retarded the discolouration of the fabrics were evaluated in terms of their effect on the bursting strength of the fabrics after exposure to sunlight, it was found that the methylolmelamine resins produced fabrics which were stronger than the original untreated control, while the beryllium oxide pigment and the delignification with sodium hypochlorite produced fabrics which were weaker than the control.

In general the efficiency of these treatments seems to depend on various factors, such as add-on level, pH of treatment, etc. and some more work will have to be carried out to further optimise the reaction conditions.

ACKNOWLEDGEMENTS

The author wishes to thank Mrs S. G. McCormick for technical assistance.

The permission of the Department of Industries to publish this report is acknowledged.

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TABLE I

THE EFFECT OF VARIOUS TREATMENTS ON THE YELLOWNESS INDEX AND BURSTING STRENGTH OF *PHORMIUM TENAX* FABRICS BEFORE AND AFTER EXPOSURE TO SUNLIGHT

Sample No.	Treatment	Type	Yellowness Index*				Bursting Strength (kN/m^2)		
			Before exposure	After 4 weeks	After 9 weeks	After 34 weeks	Before exposure	After 34 weeks	% change
1.	2% Aerotex M3 + Mg $C\ell_2$/citric acid	Amino-plast resin	−3,1	−8,9	−9,2	−12,0	1883	1072	57
2.	6% " " "	"	−3,9	−8,4	−9,1	−11,2	1922	1128	59
3.	10% " " "	"	−3,2	−7,3	−7,9	−10,0	1687	1056	63
4.	2% Cassurit HML " "	"	−3,7	−9,2	−10,4	−12,2	1929	925	48
5.	6% " " "	"	−3,4	−8,4	−8,8	−11,2	1880	1089	58
6.	10% " " "	"	−4,1	−7,1	−7,6	−9,5	1769	1180	67
7.	10% Cassurit MLP " "	"	−4,1	−7,4	−6,8	−9,5	1733	1004	58
8.	10% Fixapret CP " "	"	−4,5	−8,8	−9,1	−11,9	1824	925	51
9.	10% Fixapret AH " "	"	−4,1	−6,7	−8,4	−12,1	1785	971	54
10.	10% Aerotex M3 + acetic acid/$CoC\ell_2$	"	−3,0	−6,1	−7,2	−9,5	1831	1330	73
11.	10% Cassurit HML " "	"	−2,1	−5,4	−5,6	−8,9	1788	1272	71
12.	2% Hercosett	Polymer	−3,7	−8,2	−9,3	−11,9	1978	1023	52
13.	2% Primal B85	"	−3,1	−8,6	−9,5	−11,9	1942	876	45
14.	2% Synthapret BAP	"	−4,0	−8,6	−7,3	−10,7	1880	938	50
15.	2% Helizarin Binder FA	"	−4,1	−8,8	−9,6	−12,2	1935	1004	52
16.	1% Tinuvin 327	UV absorber	−2,1	−6,0	−7,0	−11,9	1935	1272	66
17.	2% " "	"	−1,2	−4,3	−7,3	−11,7	1876	1435	76
18.	1% " 326	"	−1,9	−4,7	−6,0	−11,3	1834	1491	81
19.	2% " "	"	−3,3	−4,7	−7,0	−11,9	1847	1304	71
20.	2% Thiourea	—	−3,1	−12,6	−12,8	−13,0	1889	1278	68
21.	2% THPOH	Flame retardant	−2,9	−9,5	−9,9	−13,1	1821	785	43
22.	2% $TiC\ell_4/Sb_2O_3$	"	−4,5	−14,9	−16,2	−15,4	1733	1115	64
23.	2% Pyrovatex CP	"	−3,1	−6,9	−7,1	−9,5	1700	981	58
24.	2% Solophenyl Brill Blue BL	Dye	17,1	8,9	4,8	−4,9	1870	817	44
25.	2% " Scarlet BNLE	"	−2,6	−9,1	−8,7	−11,1	1903	804	42
26.	2% Procion Blue MXR	"	17,7	7,6	−3,3	−5,8	1883	830	44
27.	2% " Red MX5B	"	−11,0	−7,6	−7,5	−11,4	1873	1007	54
28.	2% Pigment Blue 15	Pigment	21,5	20,2	17,9	13,6	1992	860	43
29.	2% " Yellow 34	"	−23,5	−20,7	−18,5	−19,5	1889	902	48
30.	2% Lead chromate	"	−23,5	−18,4	−14,8	−11,6	1670	1226	73
31.	2% Cobaltous hydroxide	"	−5,8	−8,4	−9,2	−13,6	1880	1167	62
32.	2% Beryllium oxide	"	−4,6	−8,0	−7,9	−10,7	1840	853	46
33.	2% Copper naphthanate	Rot proofing agent	11,3	3,5	0,4	−6,1	1906	856	45
34.	2% Fungitex PLE	Fungi-cide	−4,0	−8,4	−9,5	−12,3	1886	801	42
35.	10 g/ℓ NaOH pretreatment, then 3 g/ℓ $NaC\ell O_2$ (Bossuyt method)	Deligni-fication	7,1	0,3	−1,6	−5,5	1958	802	41
36.	3 g/ℓ $NaC\ell O_2$ "	"	7,7	1,1	4,4	−5,2	1860	873	47
37.	3 g/ℓ $C\ell_2$, pH 10,5 (Majumdar method)	"	−4,5	−7,6	−8,4	−11,6	1906	811	67
38.	" " " 6,5 "	"	−3,8	−5,1	−5,3	−9,4	1693	686	41
39.	" " " 4,0 "	"	−6,6	−7,0	−6,3	−10,1	1540	713	46
40.	9 g/ℓ " " 10,5 "	"	−0,8	−5,6	−6,7	−10,6	1850	781	42
41.	Treatment No 37 (repeated thrice) "	"	−1,1	−7,1	−7,8	−11,1	1857	768	41
42.	"" " 38 (" ") "	"	0,7	−2,4	−1,6	−6,9	1102	574	52
43.	"" " 39 (" ") "	"	1,2	−2,7	−1,9	−7,0	1121	556	50
44.	"" " 40 (" ") "	"	3,1	−0,5	−0,1	−5,8	1733	768	44
45.	Untreated control	—	−4,2	−10,3	−9,8	−12,3	1950	980	50

* Low values indicate a high degree of yellowness

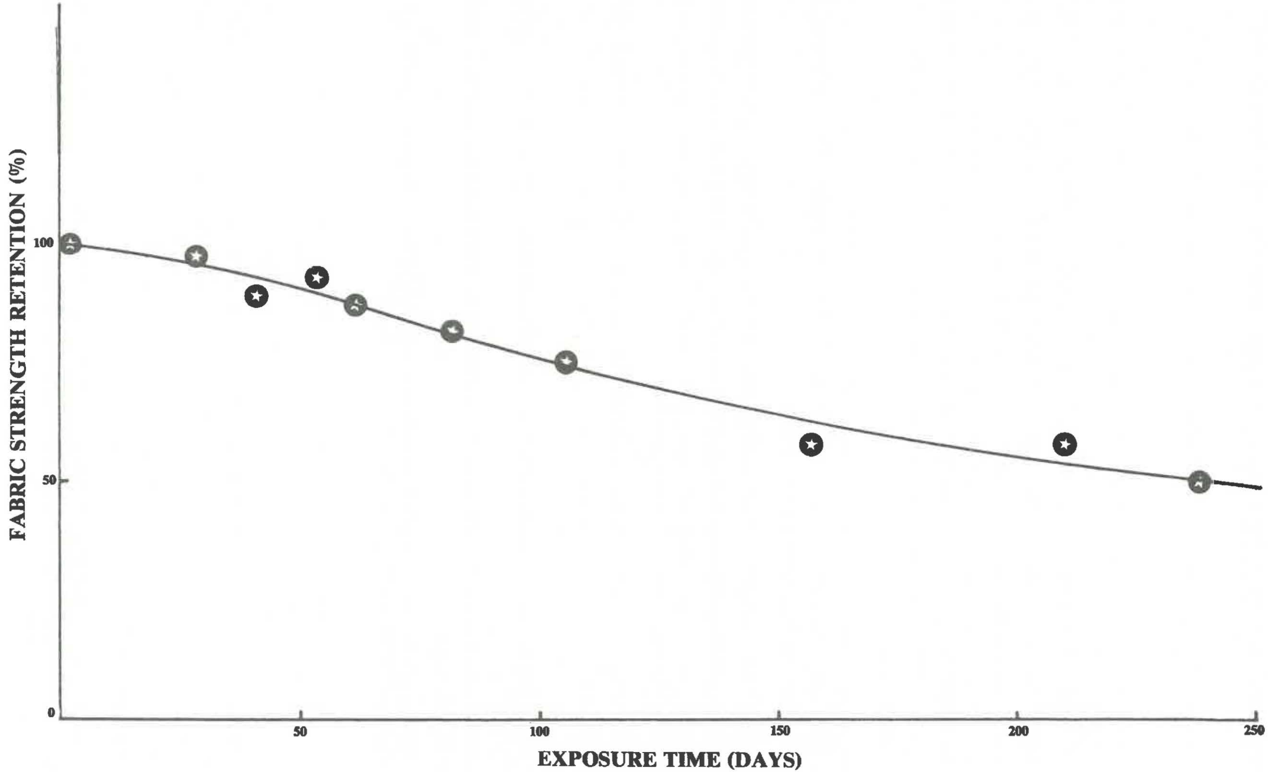

FIGURE 1
THE EFFECT OF SUNLIGHT ON THE STRENGTH OF *PHORMIUM TENAX* CURTAINING FABRIC

A NOTE ON VARIATIONS OF THE RWCS TECHNIQUE

by P. C. M. SHORTHOUSE and G. A. ROBINSON

The Repco Wrapped Core Spun Technique (RWCS)[1,2,3], which involves a continuous filament core and wrapper yarn, was initially developed for the spinning of fine (RWCS) mohair yarns for *weaving*. These yarns were uptwisted (STT twisted) after spinning and then steamed. Subsequently this work has been extended to knitwear[4,5,6]. A similar approach, i.e. using the core-spinning principle, was adopted by Belin *et al*[7] who reported that wool stretch yarns could be produced on self-twist machines by incorporating either textured nylon or fine elastane as cores with the *two* rovings, and used these in ST form in half hose.

The fact that previously, yarns have always been STT twisted (with very low twist) has been found to be a drawback commercially. This prompted further work into the knitting of ST yarns.

Laboratory size quantities of nominally 50 tex yarns were spun on the modified Repco spinner from a 64^s quality wool using 78 dtex nylon textured filament yarns as core and/or wrapper and using various processing conditions. *The yarns were not uptwisted.*

Three processing routes were selected as having sufficient potential for further study:

1. 50 tex wool yarn with 78 dtex nylon textured filament as core and wrapper (RWCS [ST]).
2. 50 tex wool yarn with 2 x 78 dtex nylon textured filament as wrapper only (RWS [ST]), and
3. 50 tex wool yarn with 78 dtex nylon textured filament as core in each of two strands (RCS [ST]) as previously reported[1,7].

These three ST yarns were processed satisfactorily on a modified Repco spinner and then knitted on a Bentley Komet BR 4 inch diameter, 12 gg sock machine into half hose. The socks were paddle scoured, dyed, tumble dried and post boarded on formers at 130°C for 3 mins. The RWCS (ST) and RCS (ST) yarns from these small quantities were knitted without any yarn breakages. There were indications, however, that the RWS (ST) yarn might cause problems during knitting of the heel and toe sections, caused by run back of the wool on the filament yarn.

The finished socks knitted from the three different yarn types compared favourably with conventional half hose knitted from 34 tex ring spun wool yarn plated with 2 x 78 dtex textured nylon filament yarn.

Although only limited trials have been carried out, the results were sufficiently encouraging to warrant further yarn processing and knitting on a larger scale.

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A NOTE ON THE PRODUCTION AND PROPERTIES OF SOME WOOL AND WOOL/POLYESTER STRETCH YARNS

by M. A. STRYDOM

ABSTRACT

Two worsted-type stretch yarns (all-wool and 55/45 polyester/wool) were produced by assembly-winding two ends of each of these with an elastomeric component, followed by conventional uptwisting. The all-wool stretch yarn proved to be about half as strong as the wool/polyester stretch yarn but its extension at break test results were approximately 50% higher. The extension values were found to increase with an increase in elastomer linear density, an increase in the stretch ratio of the elastomer and an increase in the level of uptwisting of the resultant yarn assembly.

INTRODUCTION

As the name implies, stretch yarns are yarns which are capable of a pronounced degree of stretch and recovery from stretch. These yarns are converted into stretch fabrics which possess a higher extensibility under small loads than normal fabrics, and this property can be utilized to obtain increased comfort, fit, and freedom of action in various types of garment[1].

According to the Textile Institute's Textile Terms and Definitions, stretch yarns may consist of either a conventional yarn (usually synthetic) which has been textured or a synthetic elastomeric thread in continuous filament form. Textured nylon and polyester yarns, in particular, have been very successful in the production of knitted stretch fabrics, where the knitted loop structure in itself provides excellent stretch characteristics[2]. In woven constructions, stretch was normally obtained by using natural rubber yarns (for example for swimwear and foundation garments)[3], until the late fifties and early sixties when firms like Du Pont in the USA began commercialising polyurethane elastomer threads[4] which, today, are commonly known as Spandex, elastane or elastomers. Meredith and Fyfe[5] have shown that elastomers are superior to their natural rubber counterparts in terms of tenacity and toughness, as well as in terms of their heat resistance. It has been claimed[5] that although the elastic recovery of the elastomers is less than that of rubber, and varies slightly from one brand type to the other, these properties are more than adequate. Also, the fineness of filament and their good dyeing properties make them in many cases superior to natural rubber[5].

Spandex yarns can be used in three different forms in a fabric. They can be used either bare for one-way stretch (in woven constructions for foundation wear), or in knitted form for two way stretch (for swimwear or surgical hose), or covered (normally folded with two other yarns). Alternatively, they can be core-spun on normal ring frames with wool or cotton for the production of woven stretch fabrics[6], or by using a self-twist spinner. The latter route is claimed to have been found particularly suitable for hosiery yarns[7].

There is no doubt that the recent upsurge in the world-wide sales of elastomeric yarns can be closely lined to the growth in the leisurewear market. The trend appears to be that more time is becoming available for "non-work", or leisure activities[8], and coupled to this it also appears that more of the available leisure time is being spent on some sort of active sport participation. A third factor for the growth in the leisurewear market is that leisure- or sportswear is becoming very fashionable in itself, irrespective of whether the wearer is actively participating in sport or not[9]. Not only does the elastomeric component impart stretch and comfort to such garments, but even in the more traditional woven structures for leisurewear (corduroys, denims, flannels and tweeds) it also imparts improved fit, appearance and comfort[9,10]. Woven stretch fabric in standard polyester/wool blends have also recently appeared on the market in South Africa and expectations are that the recent trends in Europe and the USA will also take effect locally to the extent that by 1982 up to 10% of the trouser market will be in stretch fabric[11].

As mentioned earlier, one method of obtaining stretch yarns is by assembly-winding and elastomer with two spun yarns followed by subsequent uptwisting. SAWTRI recently acquired a Mettler FSM-LHG assembly winder which is a purpose-built winder for producing spun yarn/elastomer assemblies, and this note describes some trials on the machine using wool and wool/polyester spun yarns. In particular, it was decided to study the effects of variations in the elastomer linear density, stretch ratio and uptwist level on some of the physical properties of the resultant stretch yarn composites.

MATERIALS AND METHODS

Machine Details

The Mettler FSM-LHG is based on conventional winder designs with the added facility of a positively driven feed unit for the elastomeric thread. Two to four ends of spun yarn are creel-fed onto the winding head while the elastomer is fed from a positively driven feed roller. The tension (and thus the degree of stretch) of the elastomer can be varied by selecting one of four different speed settings which determines the ratio of the surface speed of the take-up roller to that of the feed roller. The four settings are equivalent to stretch ratios of 1:4,27; 1:3,98; 1:3,74 and 1:3,49. The take-up speed is variable and for the purpose of these trials was fixed at 500 m/min. A general view of one of the sections on the winder is shown in Fig. 1.

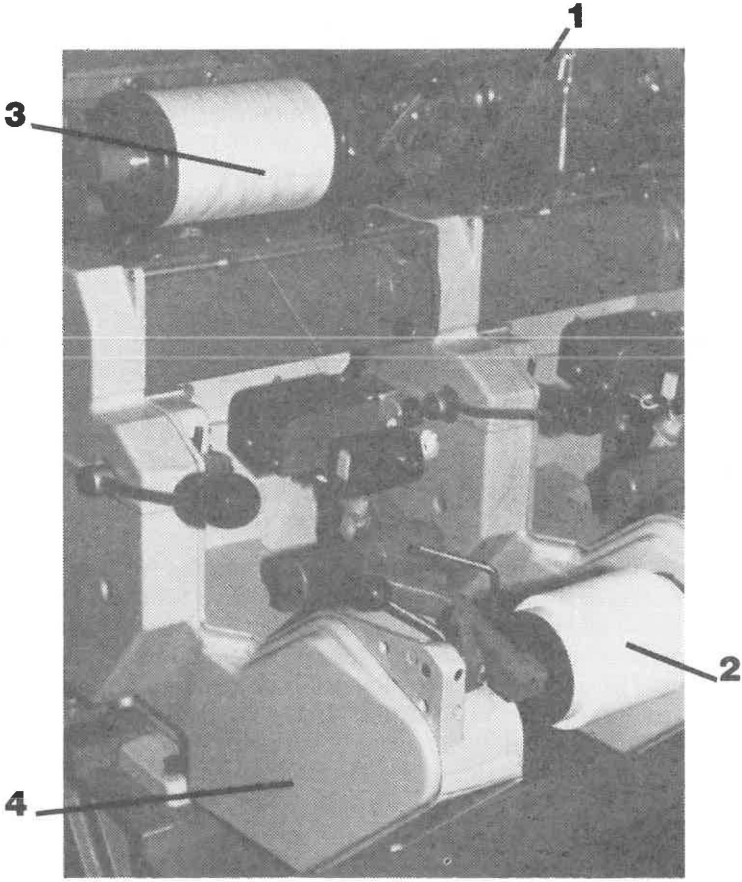

FIGURE 1
GENERAL VIEW OF WINDING HEAD

1. Two ends of spun yarn from creel
2. Feed roller with elastomer
3. Take-up roller with spun yarn/elastomer assembly
4. Stretch ratio change pulley housing.

Yarn Details

Two different types of spun yarn were selected for this work, namely and undyed shrinkproofed 100% wool yarn (20 tex Z734) and an undyed 45/55 wool/polyester yarn (20 tex Z734 comprising an intimate blend of wool with ®Trevira 220 staple fibre). Two ends of each of these two types of yarn were assembly-wound with a ®Glospan continuous filament spandex thread of one of the three linear densities, namely either 44 dtex, or 78 dtex or 156 dtex (unstretched). In each case, each of the four stretch ratios mentioned above was used. The assembly was subsequently uptwisted (S-twist) on a Platt-Saco Lowell Twistomatic twisting frame using either 450 turns/m or 600 turns/m . All the yarns were then tested for breaking strength and tenacity, irregularity and extension at break. To facilitate interpretation of the data, each of these physical properties was related to elastomer linear density (X_1), stretch ratio (X_2) and uptwist level (X_3) by means of a multiple regression analysis.

TABLE 1, YARN PHYSICAL PROPERTIES

Level of Uptwisting (turns/m)	Elastomer Linear Density (dtex)	Stretch Ratio	All-Wool					Wool/Polyester (45/55)				
			Actual Resultant Yarn Linear Density (tex)	Tenacity (cN/tex)	Irregularity (CV%)	Extension at break (%)	Hairiness (Hairs/m)	Actual Resultant Yarn Linear Density (tex)	Tenacity (cN/tex)	Irregularity (CV%)	Extension at break (%)	Hairiness (Hairs/m)
450	44	4,27	41,0	8,2	13,2	29,9	20	42,6	16,9	12,2	19,5	20
		3,98	40,7	8,5	13,4	30,8	18	42,5	17,2	12,4	19,8	21
		3,74	40,3	8,1	13,5	31,1	16	42,9	17,2	12,2	20,3	29
		3,49	40,6	8,2	13,0	30,8	18	42,9	17,3	12,4	19,8	20
	78	4,27	40,4	8,9	13,4	31,6	18	43,2	16,4	11,7	20,1	22
		3,98	40,7	8,8	13,2	31,4	18	42,9	17,0	12,1	19,9	23
		3,74	40,4	9,0	13,3	32,3	19	43,4	16,4	12,1	19,8	20
		3,49	40,7	8,6	13,5	29,1	18	42,7	16,4	12,2	20,1	21
	156	4,27	43,0	8,7	13,2	33,7	19	44,8	16,1	11,5	21,0	28
		3,98	42,8	8,9	13,2	34,9	19	45,0	15,8	11,5	20,7	27
		3,74	43,1	8,3	13,0	32,3	19	45,3	15,9	11,5	21,1	23
		3,49	43,1	8,3	13,6	31,8	18	45,9	15,2	11,7	20,0	25
600	44	4,27	41,5	8,4	13,0	31,3	20	42,2	17,1	11,9	20,6	18
		3,98	41,5	8,4	13,0	33,1	20	43,5	17,2	11,9	21,1	16
		3,74	41,3	8,7	12,7	33,1	19	43,3	17,1	11,9	20,7	14
		3,49	41,2	9,0	13,1	35,0	19	42,2	16,3	12,2	20,9	16
	78	4,27	42,5	8,5	13,0	34,8	18	43,6	16,6	11,7	21,0	19
		3,98	42,3	8,7	13,3	35,4	19	43,4	17,0	11,7	21,0	19
		3,74	42,0	8,8	12,8	34,5	18	43,7	17,3	11,7	20,6	18
		3,49	42,8	8,4	13,0	33,5	19	42,2	17,2	11,9	21,4	19
	156	4,27	43,2	8,8	13,3	37,0	22	46,3	16,6	11,6	22,9	19
		3,98	43,8	8,7	13,4	37,3	20	46,1	15,6	11,5	22,8	21
		3,74	44,2	9,0	13,2	39,7	19	46,6	17,2	11,6	22,7	21
		3,49	45,0	8,7	13,1	38,2	18	46,6	15,4	11,4	21,6	21
Mean values		At 450 turns/m	—	8,5	13,3	31,6	18,3	—	16,5	12,0	20,2	23,2
		At 600 turns/m	—	8,7	13,1	35,2	19,3	—	16,7	11,8	21,4	18,4
Control Yarns		At 450 turns/m	—	7,7	14,1	30,3	14,0	—	17,2	12,9	17,8	12
		At 600 turns/m	—	8,1	14,0	31,2	13,0	—	18,2	13,3	18,9	10

RESULTS AND DISCUSSION

The test results of the two sets of yarns containing the elastomeric component are given in Table 1, together with those of the two corresponding control yarns (i.e. the two yarns containing no elastomer). The all-wool control yarn exhibited much higher breaking extension test results than the wool/polyester yarn while the higher twist level gave higher extension results. The wool/polyester yarn was, as expected, appreciably stronger than the all-wool yarn. There appeared to be no appreciable difference in the hairiness of the four control yarns. As far as yarn irregularity was concerned (which was very low), uptwisting did not appear to show a marked effect on the test results. In general, the wool/polyester yarns appeared to be slightly more regular than the all-wool controls.

To facilitate interpretation of the data given in Table 1, the significant regression equations relating the yarn physical properties to the elastomer linear density, stretch ratio and level of uptwisting are given in Table 2.

TABLE 2

REGRESSION EQUATIONS* RELATING YARN PHYSICAL PROPERTIES TO ELASTOMER LINEAR DENSITY (X_1), STRETCH RATIO (X_2) AND LEVEL OF UPTWISTING (X_3)

Dependant Variable	Yarn Composition	Regression Equation	% Fit (r^2 x 100)
Resultant Yarn Linear Density	All-wool	$5 \times 10^{-5} X_1 X_3 + 39{,}6$	92,1
	Wool/Polyester	$5 \times 10^{-5} X_1 X_3 + 41{,}6$	
Tenacity (cN/tex)	All-wool	Not significant, mean value 8,6	—
	Wool/Polyester	Not significant, mean value 16,6	
Irregularity (CV %)	All-wool	Not significant, mean value 13,2	—
	Wool/Polyester	$4{,}1 \times 10^{-4} X_2 X_3 - 5{,}3 \times 10^{-3} X_1 + 13{,}2$	93,7
Hairiness (Hairs/m)	All-wool	$-1{,}3 \times 10^{-2} X_3 + 25{,}7$	41,5
	Wool/Polyester	$1{,}8 \times 10^{-5} X_1^2 - 1{,}3 \times 10^{-2} X_3 + 25{,}7$	
Extension at Break (%)	All-wool	$6{,}6 \times 10^{-5} X_1 X_3 + 1{,}8 \times 10^{-2} X_3 + 20{,}8$	98,5
	Wool/Polyester	$2{,}1 \times 10^{-5} X_1 X_3 + 6{,}4 \times 10^{-3} X_3 + 16{,}5$	

* Significant at the 95% confidence limits and based upon 48 observations

Table 2 shows that the actual yarn linear density depended upon both the elastomer linear density and level of uptwisting. The contributions of the elastomer to the resultant yarn linear density varied from about 1 tex (using the 44 dtex elastomer and uptwisting to 450 turns/m) to about 4,7 tex (using the 156 dtex elastomer and uptwisting to 600 turns/m).

The tenacity results showed that the only detectable effect was brought about by composition of the spun yarn. The stretch ratio, level of uptwisting or elastomer linear density had no effect on tenacity which was, on average, 8,6 cN/tex for the yarns comprising the all-wool yarns components and 16,6 cN/tex for the wool/polyester spun yarns.

Yarn irregularities were found to be slightly lower than for the control yarns, and in the case of the yarns comprising the all-wool components also independent of stretch ratio, elastomer linear density or level of uptwisting. The average value of 13,2% was slightly higher than the wool/polyester yarns. Here, the irregularity increased slightly with an increase in stretch ratio and level of uptwisting and decreased slightly with an increase in the elastomer linear density.

The mean hairiness values tended to be higher for both stretch yarns than for the corresponding control yarns, most probably because of the additional winding process required for the production of the former. The hairiness in both cases appeared to decrease with an increase in the level of uptwisting and in the case of the wool/polyester stretch yarn, also to increase with an increase in the elastomer linear density.

As far as extension at break was concerned, this property is one of the most important requirements of stretch yarns although recovery from extension is probably just as important from a functional point of view[12,13]. Table 1 shows that on average, the mean values of the stretch yarns were some 10% (relative) higher than those of the control yarns. It is interesting to note that on average the all-wool stretch yarns had extension at break values some 50% (relative) higher than the wool/polyester yarns. Table 2 shows that the extension at break increased with an increase in the elastomer linear density, stretch ratio and level of uptwisting. For example, increasing the values of linear density and uptwist level from, respectively, 44 dtex to 156 dtex, and from 450 to 600 turns/m increased the extension from 19,8% to 22,3% in the case of the wool/polyester yarn and from 30,2% to 37,8% in the case of the all-wool yarn.

Depending on the stretch ratio and elastomer linear density, and based upon a nominal resultant linear density of 40 tex, it can be calculated from the data in Table 1 that the elastomer comprised from 2,6% to 10,4% of the composite yarns tested in this study.

SUMMARY AND CONCLUSIONS

Two worsted-type stretch yarn assemblies were produced on a Mettler stretch yarn assembly winder and converted to stretch yarns by subsequent uptwisting. These comprised a two-ply all-wool yarn and a two-ply 55/45 polyester/wool yarn into which was incorporated an elastomer component of either 44 dtex, 78 dtex or 156 dtex linear density. The stretch ratio at which the elastomer was assembly wound with the two ends of worsted yarn varied from 4,27 to 3,49. The assemblies were uptwisted with either 450 turns/m or 600 turns/m . The elastomer component represented between 2,6% and 10,4% of the resultant stretch yarn linear density.

Yarn tenacity was found only to depend on the composition of the spun yarns, being approximately twice as high for the wool/polyester stretch yarn than for its all-wool counterpart. The irregularity results of the all-wool yarns were independent of stretch ratio, uptwisting level or elastomer linear density while it decreased slightly with an increase in elastomer linear density and increased slightly with an increase in stretch ratio and uptwist level in the case of the wool/polyester yarns. The hairiness of the stretch yarns was slightly higher than that of the controls and tended to decrease with an increase in the uptwist level.

The extension at break values were approximately 10% (relative) higher than those of the control yarns and the all-wool stretch yarns had values considerably higher (about 50%) than those of the wool/polyester stretch yarns. Extension at break was found to increase with an increase in elastomer linear density, an increase in stretch ratio and an increase in the uptwist level.

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USE OF TRADE NAMES

®Trevira is a registered trade mark of Messrs Hoechst and ®Glospan is a registered trade mark of Messrs Globe Manufacturing Co., Fall River, Massachusetts. Their use in the experiments described in this report does not constitute a recommendation.

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