SAWTRI BULLETIN

SOUTH AFRICAN
WOOL TEXTILE RESEARCH INSTITUTE
OF THE CSIR
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PORT ELIZABETH

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SAWTRI BULLETIN

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EDITORIAL

Research on the Woollen System

Some months ago it was announced (SAWTRI BULLETIN, Vol. 14, No. 3) that it had been decided to introduce at SAWTRI, research on woollen processing. Following this decision, a staff member was sent to Galashiels, Scotland, to spend a year or more at the Scottish College of Textiles carrying out research on the woollen system.

From a survey covering 45 prominent organisations representing the larger part of the South African textile industry, the following emerged:

Neither for nor against SAWTRI entering this field	51%
Against	11%
In favour of	38%

Some of the positive replies were:

"We would welcome such research, especially in the apparel field".

"Woollen processing research would be of great value to the textile industry and (we) would suggest that SAWTRI enter this field at the earliest opportunity".

"Research on short staple processing covering all fibre blends would be of particular value, taking into account present fabric trends".

"If you envisage woollen processing through to spun yarn, then we believe (that) substantial opportunity exists in the carpet field".

It seems therefore as though there were a considerable section of the South African textile industry who could benefit from woollen processing research. The direction which such research should take to satisfy this section of the industry will naturally have to be considered carefully.

INSTITUTE NEWS

Once again, Lord Barnby

Lord Barnby of the United Kingdom, one of the best informed persons in the world on the development of combing wool fibres and a great friend of South Africa paid SAWTRI another of his regular visits. Having already entered his 98th year, Lord Barnby still possesses that clarity of recall which enables him to converse on important matters relating to the wool textile industry of the world as far back as the turn of the century. He recalls, for example, that his father's company of which he had been a senior member, was selling wool top in 1907 at 7½d per pound! Lord Barnby was deeply involved with the introduction of rectilinear combing in the United States of America after 1900. His life-long interest in, and knowledge of wool processing up to the combing stage naturally guided his attention to SAWTRI's new combing developments and he spent considerable time with one of the co-inventors of the SAWTRI Comb, Dr D. W. F. Turpie, showing a keen and knowledgeable interest in the prototype. We salute this great gentleman with his firm tread and bright eye and thank him for honouring us with his visits. We wish him well and look forward to his next visit.

Left to right: Mr Neville Vogt, CSIR Regional Liaison Officer; Mr W. F. Reynolds, close friend and business associate of Lord Barnby; Lord Barnby himself and Dr D. W. F. Turpie, SAWTRI's Director

Other Visitors to SAWTRI

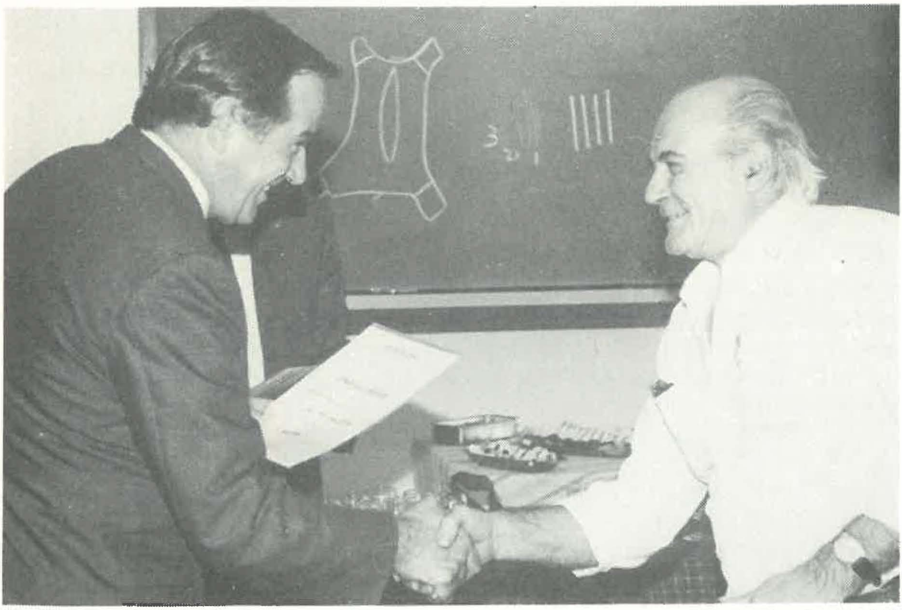
Messrs Soprani and Illorini of the Agnona Company in Italy and world renowned *haute couture* manufacturers of fabrics from exotic fibres such as vicuna, alpacca, cashmere and camel hair, had talks with Mr G. A. Robinson, Group Leader of fabric development and clothing technology on February 13th. Agnona, who are subscribers to SAWTRI, have cooperated with the Institute in the finishing of certain fabrics.

On March 2nd, Sir Ieuan Maddock, CB, OBE, FRS., Executive Secretary, British Association for the Advancement of Science, who is on an official visit to the CSIR, visited the Regional Office and in the evening, he gave a most informative and thought provoking lecture on Technology and the Future of Employment.

On March 3rd, Messrs W. D. C. Reed and Brian Baldwin of the Commercial Cotton Growers' Association of Zimbabwe, attended a meeting during which discussions were held with the Director, Dr Turpie, Mr N. J. Vogt, Drs Hunter and Van Rensburg, and Mr G. A. Robinson.

Another Successful Dornier Course

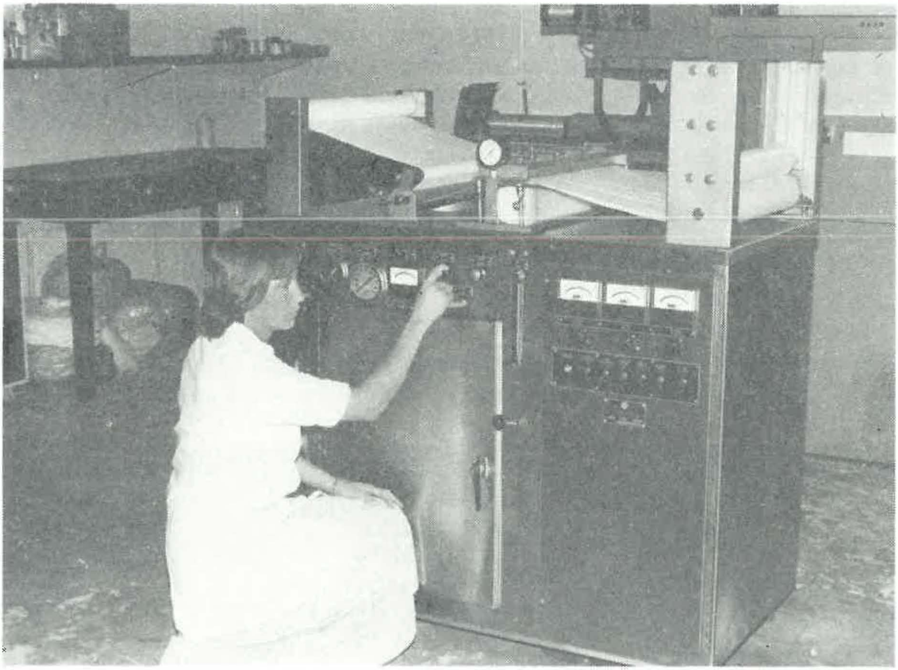
A second three weeks' course for weaving technicians and mill supervisors on the Dornier Rapier weaving machine was successfully concluded on the



Dr Turpie, handing a certificate ~~of~~ competence to one of the candidates, Mr Ambrosio Airaldi

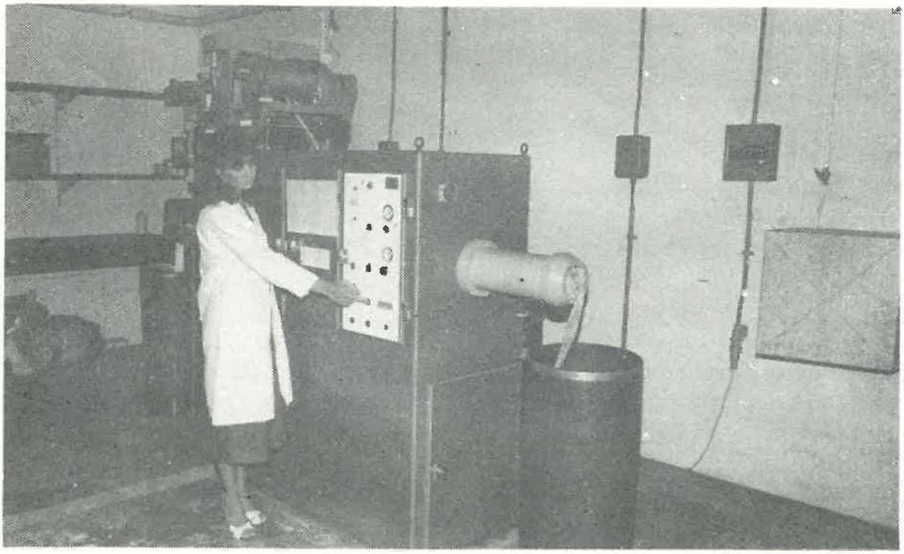
20th of February, when the Director, Dr Turpie, presented certificates to some eleven candidates from a number of South African textile mills. The course was conducted by Mr W. Brust of the Dornier Manufacturing Company in Lindau, West Germany.

New Instruments and Machines at SAWTRI



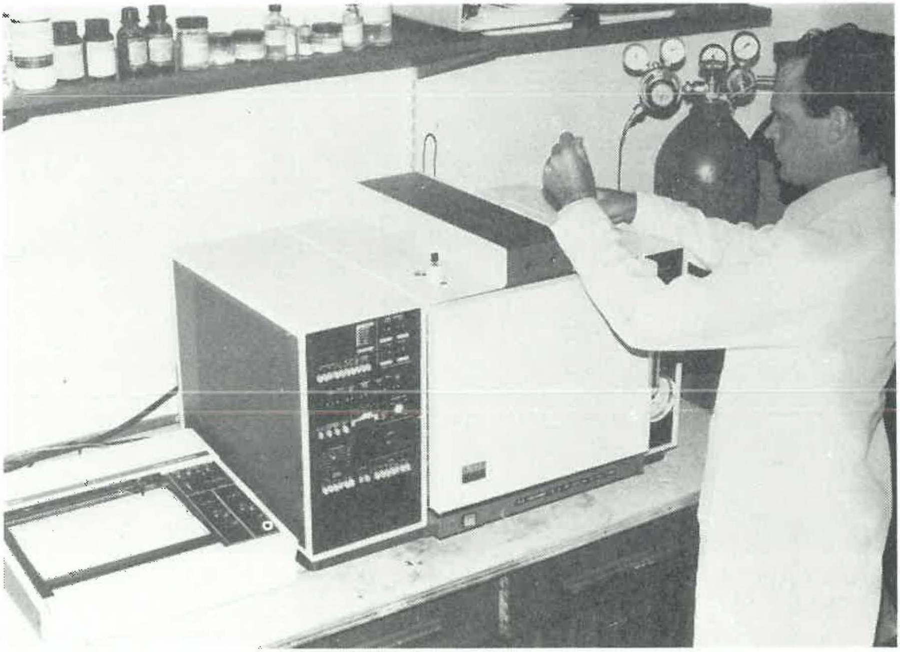
"FFT"-(FOAM TECHNOLOGY) MACHINE

This machine is used to apply dyes, resins and other finishing chemicals in the form of foam, to fabrics at very low pick-up levels (10—30%). The advantage of this technology is that water consumption is reduced and that, subsequently, during drying, less heat energy is required to remove moisture from textile materials.



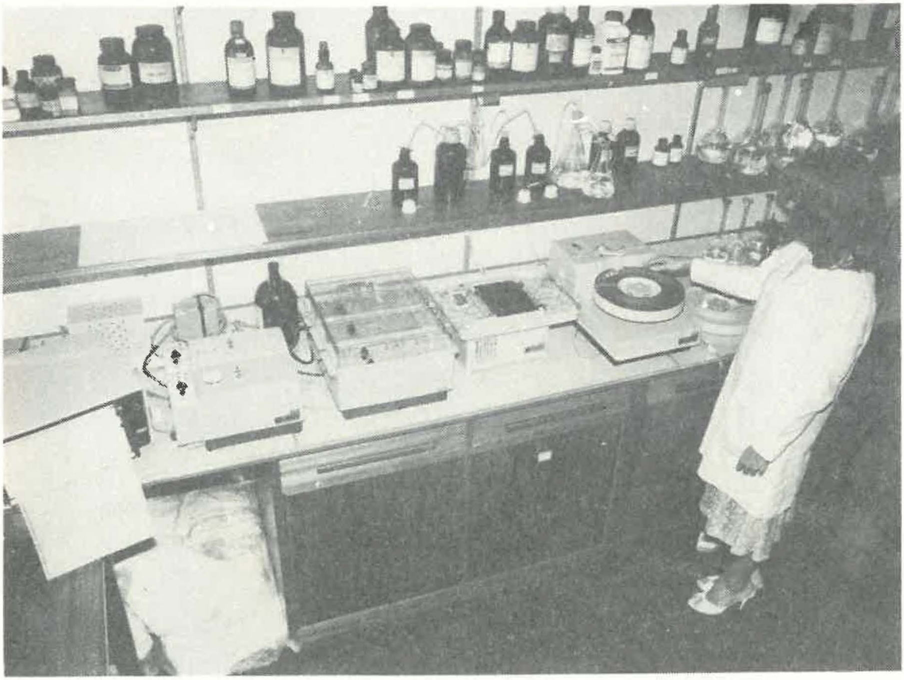
"FASTRAN" ELECTRONIC DYE FIXATION AND BLEACHING SYSTEM

This machine is used for continuous dye fixation by the application of radio frequency energy. Some of the advantages of using the "Fastran E.D.F." as an alternative to conventional steaming are claimed to be rapid and even heating throughout the fibre, dye penetration and fixation in minimum time and savings in dyestuff quantities. In this system the undyed fibres are fed to a padder where dyestuff is applied to the fibre in liquid form after which the fibre passes through a nip roller. The fibre containing the dye now is fed continuously through a tube in a radio frequency, dielectric field where the fibre is heated by R.F. energy to more than 100°C thereby allowing dye fixation to take place rapidly.



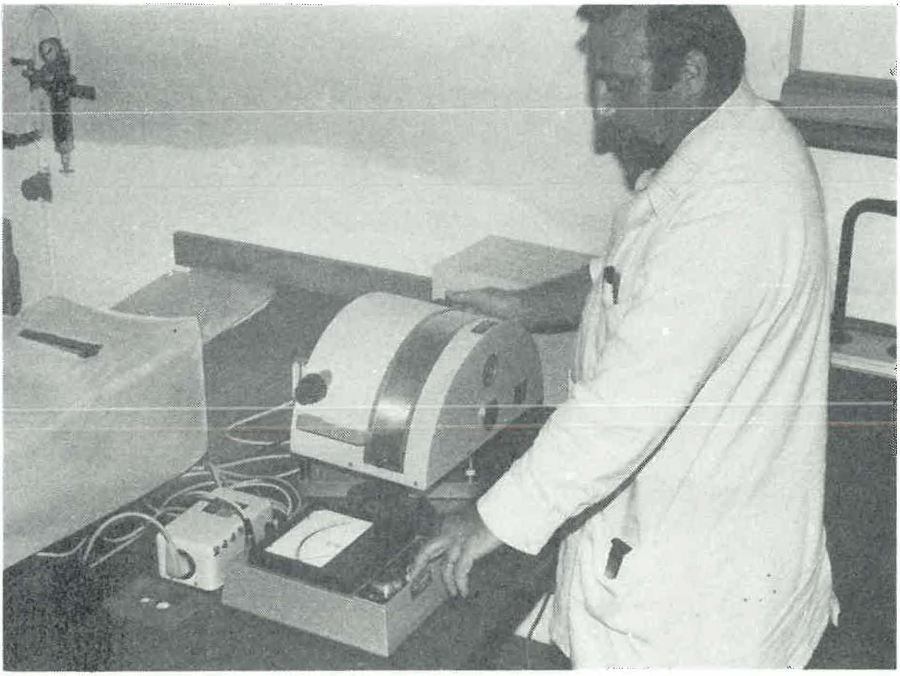
"VARIAN 3700" GAS CHROMATOGRAPH

This instrument is equipped with a flame ionisation detector and an electron capture detector and can be used for the quantitative determination of various chemicals. For example, the latter can be used for the determination of pesticides as well as mothproofing agents on textiles.



TECHNICON AUTO ANALYSER II

This is a continuous flow analytical instrument and can perform a wide variety of wet chemical determinations. At present the instrument is being used for the determination of the total organic carbon content of dyehouse effluent which in turn, gives an indication of the polluting substances in the effluent.



A GONIOPHOTOMETER has been acquired to measure the lustre of various fibres. It will be used for example, to study the effect of mercerising, on the lustre of cotton. It will also be used to determine to what extent the lustre of mohair is affected by wet processing. Furthermore, it could possibly be used to provide a means for determining "shine" of fabrics during wearer trials.

THE WRONZ STAPLEMETER

Designed to measure the staple length of greasy wool or clean wool staples from 11 mm to 250 mm, this instrument dispenses with the human factor in manual measurement, is more accurate and saves time. Coupled to the instrument is a programmable calculator capable of performing a variety of analyses of the measurement results.

Overseas Visits by SAWTRI Staff

Mr G. H. J. van der Walt, Head of Finishing, visited the United States of America during January and February this year. The main purpose of his visit was to attend a training course at Gaston County, Charlotte, North Carolina on the Foam Finishing Technology Machine recently installed at SAWTRI. Mr van der Walt also visited a number of textile companies among which Burlington Industries in Charlotte, Cotton Incorporated in Raleigh and Graniteville Mills in Graniteville, South Carolina. He also paid a visit to the Southern Regional Research Centre of the Department of Agriculture in New Orleans.

Dr F. A. Barkhuysen, Head of Dyeing, visited Selkirk, Scotland where he studied, from 10th October to 30th October, 1980, radio frequency dyeing and received training in the operation of the "Fastran" system. He also visited the Scottish College of Textiles in Galashiels and had talks with senior staff at WIRA in Leeds. Dr Barkhuysen rounded off his U.K. trip with visits to the IWS in Ilkley and the International Institute for Cotton in Manchester respectively.

SAWTRI PUBLICATIONS

Since the publication of the last SAWTRI BULLETIN, the following papers by SAWTRI scientists and other staff members were published:

SAWTRI Technical Reports

No. 463 : Hunter, L., Shiloh, Miriam and Smuts, S.: *The Interrelationship Between Fibre Properties, Loose Wool Felting and Fabric Felting.*

No. 467 : Mozes, T. E., van Rensburg, N. J. J. and Turpie, D. W. F.: *Treatment of Wool Scouring Liquors, Part XIII: Pilot Scale Studies on a Sludge Using a Horizontal Decanter Centrifuge and Bitterns.*

No. 468 : Mozes, T. E., van Rensburg, N. J. J. and Turpie, D. W. F.: *Treatment of Wool Scouring Liquors. Part XIV: Magnesium chloride as flocculant.*

No. 469 : Strydom, M. A. and Turpie, D. W. F.: *The Processing Characteristics of South African Wools, Part XVIII: Blends of Bellies and Backs with Inferior Fleeces.*

Other Papers

Olivier, de Wet: Advances made at SAWTRI in Mohair Research, *The Angora Goat and Mohair Journal,* Jan., 1981.

Correction

In the December, 1980 Bulletin (Vol. 14, no. 4) on page 6, fourth line from the bottom ". . . Part X : Cotton" should read "Part V : Cotton". We apologise for this error. (Editor)

A COMPARISON OF THE PERFORMANCE OF EXPERIMENTAL COTTON VARIETIES IN RING- AND ROTOR SPINNING

by L. HUNTER and H. TAYLOR

ABSTRACT

The fibre properties and processing performance of five experimental cotton varieties and one commercial cotton have been evaluated and compared. Full-scale processing equipment was used and yarns were spun on both rotor- and ring spinning machines. There was a general tendency for the total number of Classimat faults to decrease as the fibre length increased and for the total blow-room and card waste to increase as the trash content of the cottons increased. The FQI values provided a reasonable guide to the single thread tenacities of the ring-spun yarns but this was not the case for the rotor-spun yarns. One of the experimental cottons performed better overall than the commercial control.

INTRODUCTION

The South African Department of Agriculture and Fisheries has a continuous programme aimed at breeding improved cotton varieties which are most suited to conditions prevailing in South Africa.

SAWTRI is involved in this programme in that it screens the textile processing performance of those new cotton varieties which have shown promise from the agricultural point of view.

It is widely accepted[1] that cottons which are not very well suited to ring spinning may be admirably suited to rotor (open-end) spinning and vice versa. In view of the increasing importance of the latter method of spinning it is highly desirable that the performance of new cotton varieties are screened on this system as well as on the ring spinning system.

This report deals with five experimental cotton varieties and one commercial control from the 1980 season which were evaluated and compared using full-scale processing equipment.

EXPERIMENTAL

Fibre Properties

In all, six cotton samples, comprising five experimental varieties and one commercial cotton (No. 1) as control, were studied (see Table I).

Fibre properties were measured in the standard way and Table I gives the micronaire, fineness and maturity ratio as obtained on an IIC-Shirley Fineness/Maturity Tester as well as the values of 2,5% span length and 50%

TABLE I
FIBRE PROPERTIES

Code	Lot No.	Micro-naire	Maturity Ratio	Fineness (mtex)	Fibrograph			Bundle Tenacity				FQI*	K**
					2,5% Span Length (mm)	50% Span Length (mm)	Uni-formity Ratio (%)	Zero-Gauge		3,2 mm Gauge			
								cN/ tex	Pressley 1 000 (psi)	cN/ tex	Extension (%)		
OR 3 (control)	1	4,7	0,86	211	28,8	13,3	46	49,1	101	27,6	6,3	67	5,0
68/1/5C-2-5-2-3	2	4,1	0,84	180	28,9	13,8	48	41,3	85	24,9	6,1	70	3,7
U 73/1/5-2	3	4,2	0,87	178	27,7	13,0	47	45,6	94	24,1	5,8	65	4,1
72/12/2/2-1	4	4,6	0,91	196	29,5	13,9	47	43,2	89	29,8	5,8	82	3,9
72/13/2-4	5	4,3	0,85	188	27,1	11,6	43	47,1	97	21,5	5,9	50	5,6
70/1/6-8-3-1-1	6	4,4	0,81	205	32,2	14,8	46	45,1	93	28,9	6,4	79	4,0

*FQI provides a measure of ring-spun yarn tenacity

**K provides a measure of ring-spun yarn irregularity span length and Uniformity ratio as measured on a Fibrograph (Model 330). The fibre length uniformity ratio calculated from these two measurements is also given. Fibre bundle tenacity was measured at both zero and 3,2 mm gauge on a Stelometer, the values being corrected to the Pressley levels using the USDA calibration samples.

The fibre quality index (FQI) of each lot was calculated as follows[2,3]:

$$FQI = \frac{50\% \text{ Span Length x Tenacity x Maturity}}{\text{Micronaire}}$$

where the 50% span length is in mm and the tenacity is in cN/tex (3,2 mm gauge). In addition, the K-values, which are regarded[3] as a measure of yarn irregularity, were calculated as follows:

$$K = 29{,}4 \left[\frac{\text{Micronaire}}{\text{Maturity x } 50\% \text{ Span Length}}\right]^2$$

Opening and Cleaning

The six lots of raw cotton, coded 1 to 6, were processed through the blowroom, each cotton lot being passed through three successive cleaning points, i.e. Porcupine beater, two bladed beater and a Kirschner beater. Details of Trash Content of the cotton lint and the amount of waste extracted during processing are given in Table II. All the samples performed normally except sample No. 2 which displayed signs of stickiness by adhering to the lap head calender rollers.

Carding

The laps from the blowroom were processed on a Platts single card, fitted with a Graf Optima short-term autoleveller, at the rate of 7,5 kg/hour. The waste from each lot was collected and weighed (Table II).

TABLE II

TRASH CONTENT, BLOW ROOM & CARD WASTE

Lot No.	Shirley Analyser Trash (%)			Blow Room Waste (%)	Card Waste (%)
	Visible	Invisible	Total		
1	1,62	0,95	2,47	2,0	2,50
2	1,68	0,93	2,61	2,58	2,27
3	2,31	1,15	3,46	2,56	2,56
4	1,46	0,92	2,38	1,86	2,26
5	3,25	1,40	4,65	2,50	2,83
6	3,25	1,37	4,62	3,10	2,52

TABLE III

DRAWFRAME & SPEED FRAME PROCESSING DETAILS*

Lot No.	1st Passage D/Frame		2nd Passage D/Frame		Speed Frame (Roving)	
	Linear Density (ktex)	Irregularity (CV %)	Linear Density (ktex)	Irregularity (CV %)	Linear Density (tex)	Irregularity (CV %)
1	4,5	3,6	4,5	3,6	480	6,7
2	4,5	3,5	4,5	3,6	489	5,9
			2,5	3,6		
3	4,0	3,6	4,5	4,1	483	6,6
			2,5	4,3		
4	3,9	3,8	4,5	3,6	482	6,2
			2,5	3,6		
5	4,2	5,0	4,5	4,0	473	6,4
			2,5	4,5		
6	4,4	3,4	4,5	3,4	472	6,1
			2,5	3,6		

*Six doublings were used for both 1st and 2nd passage

Drawing

The individual lots of carded sliver were passed twice through a Zinser 720 drawframe running at a speed of 122 m/min, with 6 doublings at each passage. Two different linear densities were produced at the 2nd passage, namely 2,5 ktex for spinning on a Schubert & Salzer RU 11 rotor spinning machine without further processing and 4,5 ktex for reducing on a speedframe (see Table III).

Roving

Rovings of approximately 480 tex were produced on a Rieter speedframe from the 4,5 ktex second passage drawframe sliver (see Table III).

Spinning

The rovings were spun into 15 tex and 30 tex yarn with a twist factor of 38 (4 English) on a Platts ring spinning frame (see Table IV). The 2,5 ktex first passage drawframe slivers were spun into 20, 30 and 50 tex yarns with a twist factor of 48 (5 English) on a Schubert and Salzer RU 11 rotor spinning machine (see Table IV). The yarn linear densities and twists were selected according to normal practice, because it is generally not feasible to spin rotor yarns as fine or with as low twist factors as ring yarns.

TABLE IV

RING SPINNING CONDITIONS

Lot	Tex	Spindle Speed (rev/min)	Front Roller Speed (rev/min)	Twist (turns/m)	End Breaks*	CSP
1	30	11 000	192	699	1	2476
2	30	"	"	"	0	2483
3	30	"	"	"	0	2685
4	30	"	"	"	1	3081
5	30	"	"	"	0	2475
6	30	"	"	"	1	2548
1	15	"	138	988	0	2036
2	15	"	"	"	1	2044
3	15	"	"	"	1	2301
4	15	"	"	"	2	2431
5	15	"	"	"	2	1963
6	15	"	"	"	1	2384

*For the 15 tex the end breakages are based upon 252 spindle hours while for the 30 tex they are based upon 88 spindle hours

Yarn Tests

All the yarn tests were carried out using standard test procedures and equipment, with the yarns being conditioned and tested in a standard atmosphere (65% RH and 20°C). The results of the yarn tests are given in Tables VI to VIII.

TABLE V

ROTOR SPINNING CONDITIONS

Lot	Tex	Rotor Speed (rev/min)	Opening Roller Speed (rev/min)	Machine Twist (turns/m)	End Breaks per 15 rotor hours*	CSP
1	—	—	—	—	—	—
2	20	35 000	6 000	1 075	1	1 300
3	20	"	"	"	0	1 421
4	20	"	"	"	3	1 411
5	20	"	"	"	2	1 384
6	20	"	"	"	3	1 405
1	30	"	"	882	0	1 494
2	30	"	"	"	0	1 655
3	30	"	"	"	0	1 711
4	30	"	"	"	0	1 727
5	30	"	"	"	0	1 597
6	30	"	"	"	0	1 716
1	50	"	"	686	0	1 837
2	50	"	"	"	0	1 852
3	50	"	"	"	0	1 952
4	50	"	"	"	0	2 020
5	50	"	"	"	1	1 814
6	50	"	"	"	0	1 962

*Spinning was carried out on 12 rotors for approximately 1,25 hours

TABLE VI
CLASSIMAT RESULTS*

Ring Yarns				Rotor Yarns			
Lot	Tex	Objectionable Faults B4 + C3 + D2	Total Faults A1 + B1 + C1 + D1	Lot	Tex	Objectionable Faults B4 + C3 + D2	Total Faults A1 + B1 + C1 + D1
1	15	37	4 124	1	20	—	—
2	15	19	3 489	2	20	50	4 781
3	15	22	3 077	3	20	20	2 320
4	15	17	2 017	4	20	31	3 888
5	15	15	5 263	5	20	35	4 022
6	15	17	1 887	6	20	17	3 197
1	30	23	787	1	30	15	667
2	30	9	227	2	30	47	596
3	30	19	644	3	30	17	730
4	30	18	560	4	30	41	660
5	30	24	696	5	30	14	1 038
6	30	31	290	6	30	15	599
				1	50	27	234
				2	50	15	189
				3	50	11	99
				4	50	0	107
				5	50	12	263
				6	50	21	99

*Faults per 100 000 metres

TABLE VII

RING-SPUN YARN PROPERTIES*

Lot No.	Yarn Linear Density			Breaking Strength (cN)	CV (%)	Tenacity (cN/tex)	Extension (%)	Irregularity CV %	Thin places per 1000 m	Thick places per 1000 m	Neps per 1000 m	Hairiness	
	Nominal (tex)	Actual (tex)	CV (%)									Mean (Hairs/m)	CV (%)
1	15	14,7	0,9	215	8	14,6	7,3	20,7	207	518	452	32	19
2	15	14,8	0,9	206	11	13,9	6,8	21,6	384	748	490	33	4
3	15	15,1	0,8	235	12	15,6	5,9	20,4	231	551	463	21	20
4	15	15,2	1,6	245	9	16,1	6,2	20,1	155	448	322	32	25
5	15	14,6	1,5	198	13	13,6	6,0	24,0	627	951	656	27	37
6	15	14,6	1,2	221	9	15,1	6,2	19,5	211	467	471	27	50
1	30	28,4	0,6	475	7	16,7	7,8	15,8	9	133	145	23	33
2	30	29,3	0,5	495	8	16,9	7,5	14,8	3	55	133	19	39
3	30	28,9	0,5	514	9	17,8	7,2	15,1	2	112	253	28	34
4	30	29,9	1,0	558	7	18,7	7,4	14,3	1	25	70	28	37
5	30	30,1	1,7	494	8	16,4	7,8	16,1	7	115	173	32	25
6	30	30,2	1,8	529	7	17,5	7,6	15,1	3	71	84	29	19

*Yarns tested from spinning tubes

TABLE VIII

ROTOR-SPUN YARN PROPERTIES*

Lot No.	Yarn Linear Density			Breaking Strength (cN/tex)	CV (%)	Tenacity (cN/tex)	Extension (%)	Irregularity CV %	Thin places per 1000 m	Thick places per 1000 m	Neps per 1000 m	Hairiness	
	Nominal (tex)	Actual (tex)	CV (%)									Mean (Hairs/m)	CV (%)
2	20	19,4	1,2	177	13	9,1	6,8	23,3	563	205	536	10	46
3	20	20,1	2,7	217	10	10,8	7,4	20,9	374	129	383	6	9
4	20	19,2	2,5	191	12	9,9	6,4	23,7	670	234	531	6	12
5	20	20,3	1,5	191	10	9,4	6,5	22,1	511	191	746	7	7
6	20	19,9	0,9	189	10	9,5	6,1	21,5	448	211	516	6	13
1	30	28,9	1,3	289	10	10,0	7,8	18,2	75	72	244	9	7
2	30	29,9	1,6	310	9	10,4	7,6	17,9	40	70	185	9	7
3	30	29,7	1,9	325	8	10,9	8,4	18,0	66	49	150	8	11
4	30	29,1	1,5	314	10	10,8	7,3	19,4	165	65	184	10	54
5	30	29,8	3,6	313	9	10,5	7,9	19,1	132	69	180	8	8
6	30	29,2	0,8	303	9	10,4	7,6	18,5	89	74	202	8	8
1	50	49,5	1,4	531	7	10,7	8,4	15,6	29	13	57	11	14
2	50	50,3	1,0	568	7	11,3	9,4	15,1	6	6	17	10	7
3	50	49,3	1,3	573	6	11,6	8,7	15,3	19	8	33	10	19
4	50	50,0	2,8	583	7	11,7	8,6	15,5	11	5	31	8	7
5	50	49,2	1,7	558	8	11,3	8,8	15,4	21	9	81	12	15
6	50	47,6	1,0	565	6	11,9	9,1	14,9	13	5	34	8	12

*Yarns tested directly off rotor packages

RESULTS AND DISCUSSION

According to the fibre properties given in Tables I and II, it is not possible to single out any one of the cottons as being best in all respects. For example, cotton No. 6 was the longest and one of the strongest but it had a relatively low maturity and a relatively high trash content. Taking an overall view, sample No. 4, which had the highest FQI, was probably the best cotton even though its zero-gauge tenacity and extension (3,2 mm-gauge) were relatively low.

According to the results given in Table II, sample Nos. 5 and 6 contained the most trash and also yielded the most waste in the blow-room and during carding. Samples 1 and 4 contained the least trash and also produced the least waste. According to these results, sample No. 4 was, if anything, marginally better than sample No. 1 (the Control).

In view of the relatively short periods for which the cottons were spun, the end-breakage results given in Tables IV and V cannot be regarded as differing significantly.

According to the total number of Classimat faults (i.e. A1 + B1 + C1 + D1) which are to a large extent determined by the fibre properties, it appears that sample No. 6 was best on average, probably because of its good length characteristics. Next best appeared to be sample No. 4, which was the second longest cotton. On average, sample No. 5 exhibited the most Classimat faults, closely followed by sample No. 1. Sample No. 5 was the shortest of the six samples and it is therefore fair to conclude that the total number of Classimat faults was, in this case, largely although not solely, determined by the fibre length characteristics.

According to the results obtained on the ring-spun yarns (Tables IV and VII), sample No. 4 had the highest single thread tenacity and CSP and sample No. 5, the lowest. These results were consistent with the FQI results, since sample No. 4 had the highest FQI and sample No. 5 the lowest. It is noticeable that the rotor yarn single thread results (Table VIII) were not consistent and did not show similar trends to the ring-spun yarns which suggests that the FQI-values may not be a reliable indication of the single thread tenacity of rotor yarns. Nevertheless, sample No. 4 had the highest CSP values which is in agreement with the CSP results for the ring-spun yarns.

As far as the ring-spun yarns are concerned, sample No. 5 was the most irregular and it also had the highest K-value which is regarded as a measure of yarn irregularity when all other factors are constant. Nevertheless, for the other lots, the K-values did not rank the cottons in the same order as the yarn irregularity although there was a tendency for the cottons with relatively low K-values to produce relatively even ring-spun yarns. Once again, the rotor-spun yarns did not follow the same trends as the ring yarns, where sample No's 3 and 6 tended to produce the most even yarns and sample No. 4 the most uneven. As far as the other yarn properties are concerned, the trends were generally not consistent.

SUMMARY AND CONCLUSIONS

The fibre properties and performance of five experimental cotton varieties and one control, a commercially available cotton, were compared using full-scale equipment. Yarns of various linear densities were spun on both ring- and rotor-spinning machines and their properties compared.

It was found that one of the experimental varieties (No. 4) had a lower trash content and produced correspondingly less blow-room and card waste than the control cotton. The Shirley Analyser trash content values ranked the six cottons in virtually the same order as did the total waste produced in the blow-room and at the card.

The cotton fibre properties were such that no one particular cotton was consistently better than the others, although, on average, sample No. 4 was best and sample No. 5 worst. There was a tendency for the total number of yarn faults or thick places to increase as the fibre length decreased, with three of the experimental varieties generally performing better than the control sample. It was found that, whereas the FQI values provided some measure of the single-thread tenacities of the ring-spun yarns, they did not for the rotor-spun yarns. Sample No. 4 which generally had the best fibre properties produced the strongest ring-spun yarns but not the strongest rotor-spun yarn from the point of view of single-thread tenacity. Nevertheless, according to the CSP results, this cotton was also best.

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REFERENCES

1. Hunter, L., *Text. Prog.*, **10**, (1/2), (1978).
2. SITRA Newsletter, **16**, 7 (Sept./Oct., 1975).
3. Khanna, R. C., *Indian Text. J.*, **86**, 177 (Aug., 1976).

THE EFFECT OF FIBRE DIAMETER, STAPLE CRIMP AND RESISTANCE TO COMPRESSION ON THE BUNDLE TENACITY TENSILE PROPERTIES OF WOOL

by S. SMUTS and L. HUNTER

ABSTRACT

The effect of staple crimp, mean fibre diameter and resistance to compression on the bundle tensile properties of a wide range of unrelaxed and wet-relaxed wool tops has been investigated. It was found that the tensile properties were mainly affected by fibre crimp rather than by fibre diameter. Bundle tenacity decreased and bundle extension increased with an increase in crimp, irrespective of whether the crimp change was due to differences in the original crimp or due to crimp recovery resulting from relaxation of the tops. Bundle extension, however, also tended to increase with an increase in mean fibre diameter. The quotient of resistance to compression and fibre diameter, termed the "bulk/diameter ratio", was taken as a measure of the overall fibre crimp and was better correlated with bundle tenacity than staple crimp or resistance to compression.

INTRODUCTION

To date there appears to have been no systematic study on the effects of wool fibre properties on bundle tensile properties in which variations in fibre diameter, crimp and bulk resistance to compression have been considered, although various studies[1–9] have covered some of these properties. Certain of these studies[4,7,9] have shown that an increase in fibre crimp decreases bundle tenacity and that crimp removal increases tenacity[9]. Certain workers[2–8] found bundle tenacity to increase with an increase in mean fibre diameter, although, in view of the fact that changes in crimp were not always taken into consideration, it seems possible that changes in crimp rather than diameter may have been responsible for the observed trends in some of the cases. It is well-known that there is a general trend for crimp to decrease with an increase in mean fibre diameter.

In the light of the gaps in our existing knowledge concerning the effects of the various wool fibre properties on bundle tensile properties, it was decided to carry out an investigation covering the main fibre properties and encompassing a selection of wool tops differing widely in fibre properties. The effect which relaxation of the tops has on the bundle properties was also investigated.

EXPERIMENTAL

From a large number of tops, each having been produced in the same way from a different wool, 28 samples were selected which varied in mean fibre diameter (18 to 30 μm) and staple crimp (3 to 6 crimps/cm). The details of the tops are given in Table I.

Each top was tested for bundle tensile properties (3,2-gauge length)[10] and resistance to compression[7,11] in two different states. In the one state, termed the unrelaxed (UR) state, the tops were taken from the balls, pre-conditioned at 40°C/20% RH for two hours and conditioned overnight at 20°C/65% RH . For the wet-relaxed state (WR) a length of top was immersed for 2 hours in water which was at a temperature of 70°C and which contained a small amount of wetting agent. Thereafter the tops were dried, pre-conditioned and conditioned as before. The bundle tensile properties of all the samples were tested on the same day.

The bulk resistance to compression of the wool samples in the different states was measured, the differences between the values obtained on the unrelaxed and wet-relaxed samples providing a measure of crimp recovery. The quotient of resistance to compression and diameter, termed the bulk/diameter ratio, was taken as a measure of fibre crimp since earlier studies[12] have shown that resistance to compression is highly correlated with the product of staple crimp frequency and fibre diameter. This ratio is regarded as a better measure than staple crimp of the overall crimp characteristics of the wool[12].

RESULTS AND DISCUSSION

Effects of Fibre Properties

Multiple regression analyses were carried out on the bundle tenacity and extension results (log-log), first keeping the unrelaxed and wet-relaxed results separately and then pooling the results (see Table II).

From the results of the analysis, summarised in Table II, it can be seen that fibre crimp rather than fibre diameter influenced bundle tenacity. This is illustrated by the fact that, in all the analyses involving bundle tenacity, mean fibre diameter only emerged as being significant when resistance to compression was the other independent variable, in which case its significance was due to the fact that resistance to compression is a function of the product of staple crimp and mean fibre diameter. When resistance to compression was divided by mean fibre diameter to give, what has been termed, the bulk/diameter ratio (or overall crimpiness), then mean fibre diameter no longer contributed significantly towards the regression equation. Fig. 1 illustrates the effect of the bulk/diameter ratio on bundle tenacity.

According to the results obtained in this study, therefore, an increase in fibre crimp decreases the fibre bundle tenacity for both unrelaxed and wet-relaxed tops. It appears, too, that there was a better correlation between the

TABLE I

DETAILS OF TOPS

Code	Mean Fibre Diameter (μm)	Staple Crimp** (cm^{-1})	Resistance to Compression (mm)		Bundle Tenacity (cN/tex)		Bundle Breaking Extension (%)		Bulk/Diameter Ratio*	
			UR	WR	UR	WR	UR	WR	UR	WR
BR 2	20,7	5,8	15,5	22,7	11,6	10,8	25,1	26,3	0,75	1,10
BR 4	21,3	4,8	14,8	19,3	11,8	11,2	24,0	24,1	0,69	0,91
BR 17	21,1	4,8	—	—	11,4	11,2	23,3	24,8	—	—
BR 18	20,1	5,2	13,6	18,0	11,8	11,1	22,9	25,8	0,68	0,90
BR 20	22,9	5,3	14,7	17,2	12,0	11,4	22,7	25,2	0,64	0,75
BR 21	21,7	3,8	12,6	15,3	13,0	12,6	21,8	25,0	0,58	0,70
BR 23	24,7	3,0	13,2	14,8	12,2	12,7	20,1	21,4	0,54	0,60
BR 28	24,7	3,0	13,0	14,6	13,7	13,7	22,3	21,5	0,53	0,59
BR 29	27,1	2,9	13,3	14,7	12,5	13,2	20,4	21,0	0,49	0,54
BR 34	21,0	4,0	13,5	14,8	11,7	11,4	20,1	22,6	0,64	0,71
BR 44	23,2	3,0	13,2	14,5	12,2	12,3	22,2	21,0	0,57	0,62
BR 53	26,4	5,1	15,4	25,2	11,0	10,3	23,9	25,5	0,58	0,95
BR 56	18,3	5,1	14,6	16,9	11,5	10,7	22,0	23,4	0,80	0,93
PP 7	21,2	4,5	13,8	15,8	12,0	11,7	20,8	23,4	0,65	0,75
PP 13	19,5	4,0	13,6	15,3	12,0	11,5	20,9	22,7	0,70	0,79
PP 43	23,3	3,9	13,5	17,0	11,8	11,0	21,0	23,6	0,58	0,73
PP 55	21,5	2,8	13,3	16,3	12,3	11,9	22,9	23,7	0,62	0,76
PP 69	21,6	3,7	14,0	16,3	11,6	11,1	21,5	22,7	0,65	0,75
PP107	21,6	4,6	14,5	16,8	11,9	11,5	22,0	23,4	0,67	0,78
PP118	21,0	4,2	13,0	15,8	12,0	12,2	21,9	23,3	0,62	0,75
NGT5	30,0	2,9	14,7	18,2	12,5	12,6	20,8	22,2	0,49	0,61
NGT7	26,3	3,9	15,5	19,6	11,8	11,4	22,9	26,4	0,59	0,75
OSP8	21,6	3,7	13,8	16,7	11,4	10,7	22,0	21,8	0,64	0,77
PLS 3	21,4	3,3	13,7	15,6	11,6	11,3	21,4	23,7	0,64	0,73
PLS 8	21,2	3,7	13,3	16,8	11,0	10,5	20,9	22,0	0,63	0,79
PLS 10	19,9	5,2	13,4	15,7	11,5	11,3	20,8	23,4	0,67	0,79
PLS 12	21,4	4,2	13,2	15,5	11,1	10,8	21,2	21,7	0,62	0,72
PLS 20	21,5	3,4	13,5	14,6	11,5	11,6	21,7	20,9	0,63	0,68

$$\text{*Bulk/Diameter Ratio} = \frac{\text{Resistance to Compression}}{\text{Fibre Diameter}}$$

**Raw Wool

TABLE II

RESULTS OF STATISTICAL ANALYSES ON THE BUNDLE TENSILE PROPERTIES

Dependent Variable	Contribution of each Independent Variable				Significant Regression Equation	Correlation Coefficient (r)	% Fit
	X_1	X_2	X_3	X_4			
Tenacity(cN/tex)							
Unrelaxed	ns	25	*	*	$13,84\ X_2^{-0,11}$	0,50	25
	ns	*	ns	*	ns	—	—
	ns	*	*	26	$9,33 \times 10^{-2}\ X_4^{-0,216}$	0,51	26
Wet-relaxed	ns	42	*	*	$15,42\ X_2^{-0,210}$	0,65	42
	27	*	35	*	$9,79\ X_1^{0,370}\ X_3^{-0,350}$	0,79	62
	*	*	30	*	$26,2\ X_3^{-0,291}$	0,55	30
	ns	*	*	62	$10,42\ X_4^{-0,350}$	0,79	62
Pooled	19	*	29	*	$10,38\ X_1^{0,262}\ X_3^{-0,255}$	0,69	48
	*	*	26	*	$21,7\ X_3^{-0,228}$	0,51	26
	ns	*	*	47	$10,62\ X_4^{-0,257}$	0,69	47
Extension (%)							
Unrelaxed	ns	23	*	*	$18,49\ X_2^{0,122}$	0,48	23
	ns	*	34	*	$5,04\ X_3^{0,559}$	0,58	34
	ns	*	*	ns	ns	—	—
Wet-relaxed	ns	46	*	*	$17,18\ X_2^{0,219}$	0,68	46
	*	*	51	*	$8,15\ X_3^{0,372}$	0,71	51
	7	*	51	*	$12,85\ X_1^{-0,172}\ X_3^{0,400}$	0,76	58
	*	*	*	49	$25,35\ X_4^{0,310}$	0,70	49
	8	*	*	50	$12,74\ X_1^{0,230}\ X_4^{0,398}$	0,77	59
Pooled	*	*	54	*	$8,30\ X_3^{0,367}$	0,73	53
	3	*	54	*	$11,61\ X_1^{-0,120}\ X_3^{0,380}$	0,75	57
	*	*	*	46	$25,06\ X_4^{0,284}$	0,68	46
	10	*	*	48	$11,53\ X_1^{0,262}\ X_4^{0,380}$	0,76	58

* — Denotes that variable was not included in the analysis
ns — Denotes that variable made no significant contribution to the overall variation
X_1 — Mean Fibre Diameter (μm)
X_2 — Staple Crimp (cm^{-1})
X_3 — Resistance to Compression (mm)
X_4 — Bulk/Diameter Ratio
Number of samples $\simeq$ 28 except for the pooled results which involved twice as many

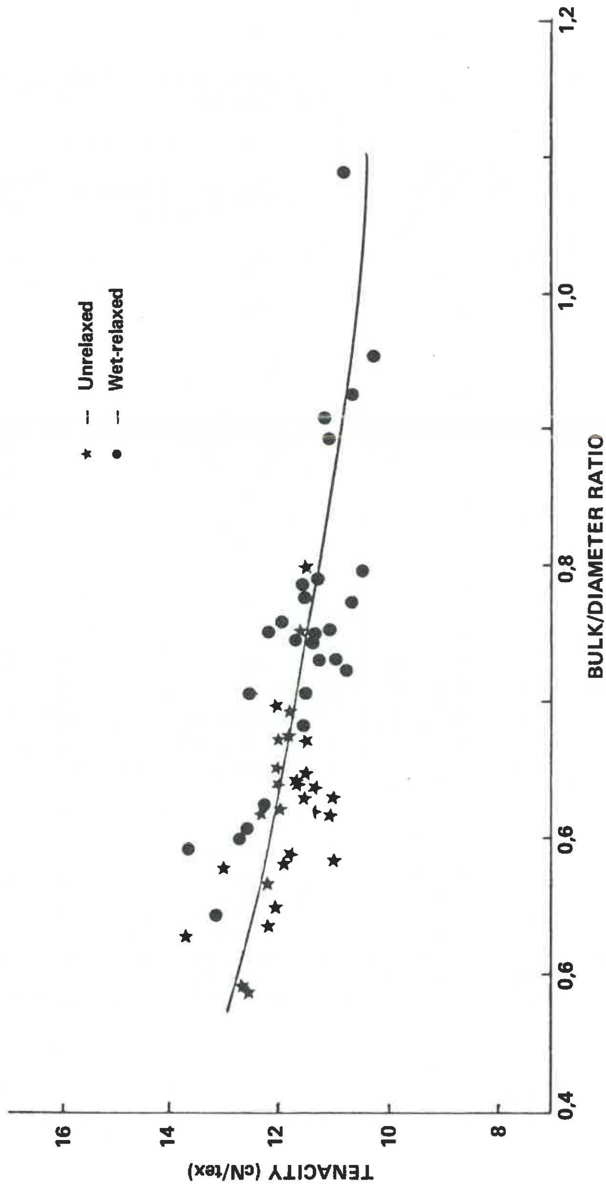

FIGURE 1

The relationship between bundle tenacity and the bulk/diameter ratio for unrelaxed and wet-relaxed wool tops

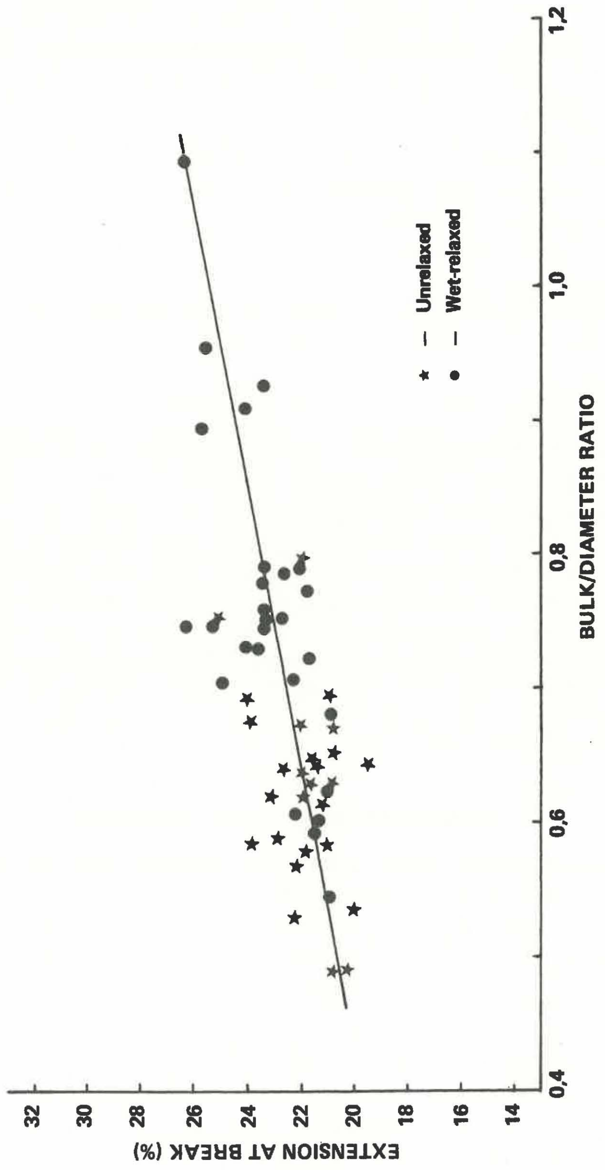

FIGURE 2

The relationship between bundle extension at break and the bulk/diameter ratio for unrelaxed and wet-relaxed wool tops

quotient of resistance to compression and mean fibre diameter, regarded as a measure of the overall single fibre crimp characteristics, and bundle tenacity than between bundle tenacity and staple crimp. No effect of fibre diameter *per sé* on bundle tenacity was observed even though the mean fibre diameter varied from 18 to 30 μm . As in the case of bundle tenacity, bundle extension was also essentially a function of the fibre crimp characteristics, as represented by staple crimp, resistance to compression or bulk/diameter ratio, with an increase in crimp being associated with an increase in bundle extension (see Table II and Fig. 2). An increase in mean fibre diameter, also appeared to increase the bundle extension.

Unpublished work[13] on more than one hundred wool lots confirmed the above findings on the effects of fibre diameter and crimp on bundle tenacity and extension.

From Table I it can be seen that wet-relaxation of the tops generally resulted in an increase in resistance to compression and the bundle extension and decreased the bundle tenacity which is consistent with other studies. By referring to Figs. 1 and 2 it appears that the changes in the bundle tensile properties brought about by wet-relaxation can be explained in terms of the changes in the fibre crimp characteristics. In view of the fact that the wet-relaxed and unrelaxed tensile results did not differ consistently, *when compared at the same bulk/diameter ratio,* it is not unreasonable to postulate that the observed effect of crimp on bundle tensile properties was due to the effect of crimp on the arrangement, alignment and tension distribution of the fibres in the bundle rather than to an associated change in the fibre tensile properties *per sé*. Nevertheless, this aspect is at present under investigation and will be reported on within the near future.

SUMMARY AND CONCLUSIONS

The effect of staple crimp, mean fibre diameter, bulk resistance to compression and wet-relaxation on the bundle tensile properties of wool tops were investigated. Twenty-eight wool tops ranging in staple crimp from 2,8 to 5,8 crimps/cm and in mean fibre diameter from 18 to 30 μm were covered in the investigation. The bundle tensile properties (measured at 3,2 mm-gauge) and the bulk resistance to compression of the tops were measured both prior to and after wet-relaxation in water at 70°C for two hours.

It was found that variations in fibre crimp rather than in fibre diameter were responsible for variations in the bundle tensile properties. An increase in crimp resulted in a decrease in bundle tenacity and in an increase in bundle extension. Wet-relaxation of the tops resulted in crimp recovery which in turn affected the bundle tensile properties in the same way as changes in the original fibre crimp. From this it would seem as if variations in crimp caused differences in the alignment, tension, etc. in the fibres in the bundle being tested

and that it was this rather than differences in the fibre tensile properties *per sé* which were responsible for the observed variations in the bundle tenacity. An increase in mean fibre diameter appeared to increase the bundle extension although its contribution to the overall correlation was not nearly as significant as that of crimp. Unpublished work on more than one hundred wool lots corroborated the findings of this study with respect to the effects of fibre diameter and crimp on bundle tensile properties.

The effect of mean fibre diameter on bundle tenacity reported by certain other workers may have been due to variations in crimp which were not taken into consideration.

The quotient of bulk resistance to compression and mean fibre diameter (termed the bulk/diameter ratio) was used as a measure of the overall fibre crimp characteristics and was found to be better correlated with the bundle tenacity than staple crimp or bulk resistance to compression.

The effect of fibre crimp and diameter on the single fibre tensile properties is being investigated at present.

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REFERENCES

1. Bosman, V., Waterson, E. A. and Van Wyk, C. M., The Onderstepoort J. of Veterinary Science and Animal Industry, **15** (No's 1 and 2), 313 (1940).
2. Maillard, F., Ammouroux, E., Sugier, H., *Bull. de L'Inst. de France* (No. 78), 2 (1958).
3. Küsebauch, K., *Mell. Textilber.,* **18,** 29 (1937).
4. De Beer, G. P. and Slinger, R. I., *SAWTRI Techn. Rep. No. 21* (1964).
5. Blankenburg, G., Spiegelmacher, P. and Schnabel, H., IWTO Report No. 4, Paris Meeting (Dec., 1972).
6. Blankenburg, G., Habitationschrift, Fakultät für Maschinenwesen der T.H., Aachen (1971) (Quoted in ref. 5).
7. Hunter, L. and Smuts, S., *SAWTRI Techn. Rep. No. 409* (May, 1978).
8. Ross, D. A., *J. Text. Inst.,* **51,** T240 (1960).
9. Blankenburg, G., *Verlag Opladen Forschungs-berichte des Landes Nordrhein-Westfalen,* No. 2249 (1972).

10. ASTM D 2524-79.
11. Slinger, R. I. and Smuts, S., *SAWTRI Techn. Rep. No. 89* (Jan., 1967).
12. Hunter, L., *Proc. 6th Int. Wool Text. Res. Conf.* (Pretoria), **I**, p.133 (1980).
13. Hunter, L., Unpublished work.

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