SAWTRI
TECHNICAL REPORT

No. 530

Studies on the Dref III Spinning System
Part I: An Introductory Study on the Spinning of Polyester/Cotton Yarns

by
W. Thierron and L. Hunter

SOUTH AFRICAN
WOOL AND TEXTILE RESEARCH
INSTITUTE OF THE CSIR

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

ISBN 0 7988 2731 9

STUDIES ON THE DREF III SPINNING SYSTEM
PART I: AN INTRODUCTORY STUDY ON THE SPINNING OF POLYESTER/COTTON YARNS

by W. THIERRON and L. HUNTER

ABSTRACT

Cotton/polyester yarns were spun on a Dref III spinning machine and their properties compared with those of the corresponding yarns spun on ring and rotor machines. The yarns were spun to two linear densities and at three twist levels in each case. The properties of the 60 tex Dref III yarns were generally intermediate between those of the rotor and ring yarns, the latter performing best. Some additional tests were carried out on the Dref III, to determine the effects of machine settings, such as core to sheath ratio, linear density and delivery speed on yarn tenacity. Core to sheath ratios of between 70/30 and 50/50 and linear densities of more than 60 tex appeared to produce the optimum results, with delivery speed having little effect.

INTRODUCTION

Friction spinning appears to be assuming of increasing importance and several publications have appeared on this subject[1-7]. Dref II friction spinning for coarse yarns has been in use for several years[8-15]. At the 1979 ITMA exhibition, held in Hanover, West Germany, the Dref III spinning system, aimed at producing finer yarns than the Dref II, was introduced as a prototype and following extensive trials, under production conditions, the Dref III spinning machine[16, 17] went into series production in 1982. In addition to the vertical flow of fibres from the card cylinder into the gap between the two spinning drums, as in the Dref II, the Dref III system incorporates a second supply of fibres, through a conventional apron drafting system at one end of the spinning drums. The latter provides the core of the yarn[18] (see Fig. 1). With this system it is possible to produce yarn linear densities ranging from 35 to 160 tex. It is claimed[19] that a large variety of fibres, such as cotton and man-made fibres, including aramid fibres which are generally difficult to spin on the conventional system, can be spun with relative ease on the Dref III system. Since the yarn sheath and core are fed into the machine independently, it is possible to use different materials for each. This facility for pre-determining the position of the fibres in the yarn cross-section is of particular interest in the production of bi-component yarns. It enables, for example, fibres with desirable aesthetic and comfort properties to be positioned on the yarn surface and other fibres, incorporated for technical or cost reasons, to be positioned (hidden) in the body (core) of the yarn. In addition to conventional type yarns, a filament or elastic

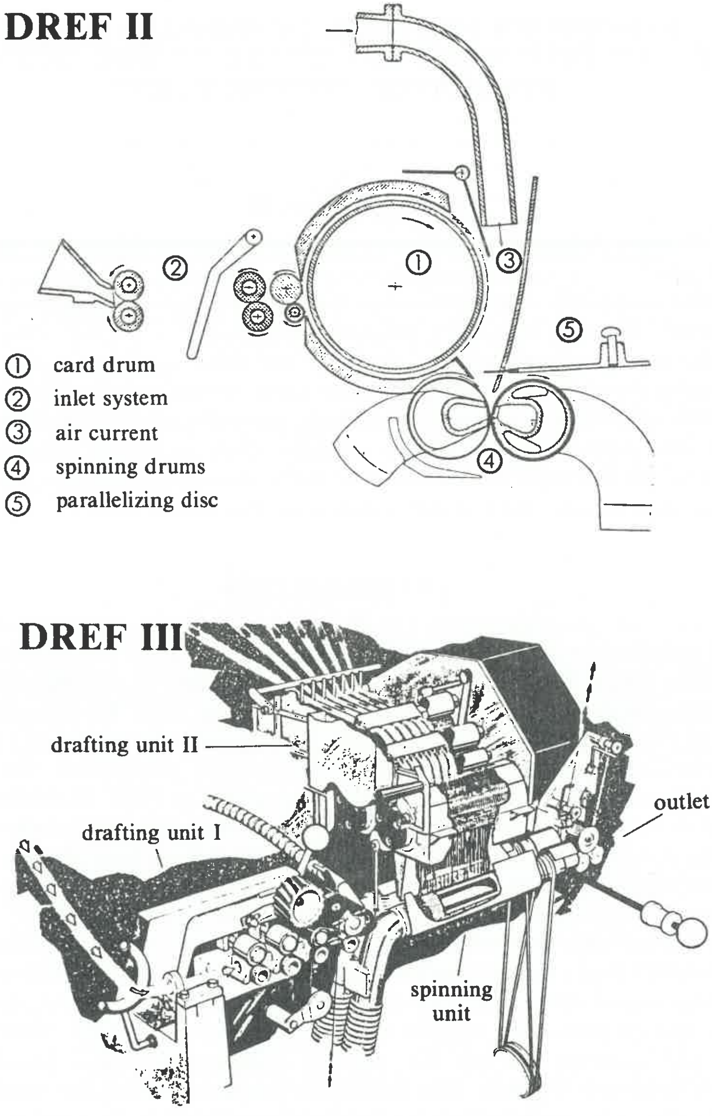


Fig. 1 – The Dref II and Dref III friction spinning systems.

core can be introduced very easily into the system, via the front roller, to produce a very strong or elasticised yarn with the filament core covered completely by the sheath fibres.

A Dref III spinning frame was installed at SAWTRI and the first trials were carried out at the beginning of 1983. This report deals with an introductory study carried out on the spinning of polyester/cotton yarns on the Dref III machine and a comparison between these yarns and the corresponding yarns spun on ring and rotor (OE) machines.

EXPERIMENTAL

Raw Material and Processing Details

As raw material, an Acala (AOX 1517/70) cotton was used in blends with a ®Trevira 120 (38 mm, 1,5 dtex semi-dull) staple fibre. Each material was processed into lap through a blowroom having three cleaning points (Porcupine, two-bladed and Kirschner beaters). The laps were then processed on a Platt card. For the purpose of this study the following drawframe slivers were produced:

A	100%	Polyester
B	100%	Cotton
C	70/30	Polyester/Cotton
D	50/50	Polyester/Cotton

On the rotor system, the yarns were spun using wire covered opening rollers. In addition, however, limited trials were carried out with pinned opening rollers, since in some cases, the wire ones produced poor Classimat and irregularity results. Due to a lack of raw material, only the yarns with medium twist factors were spun for these trials, results obtained with the wire opening rollers having revealed that twist level had no consistent effect on the results.

Each card sliver was subjected to two drawframe passages at a speed of 122 m/min, with 6 doublings at each passage. Two different linear densities were produced at the second passage, namely 3,0 ktex for Dref III and rotor spinning and 4,5 ktex for ring spinning. In preparation for the ring spinning, the 4,5 ktex drawframe sliver was processed into a 690 tex roving. Twelve different yarns were spun on each system (see Table I).

On the Dref III system there was always a ratio of 70/30 of core to sheath. The fibres used in the sheath were always 100% cotton whereas the core sliver comprised 100% polyester in trials 1-6 and 70/30 polyester/cotton in trials 7-12, so as to produce yarns with the desired compositions of either 70/30 polyester/cotton or 50/50 polyester/cotton. Approximately 2 kg of yarn were spun in each case.

TABLE 1

SPINNING AND YARN PARAMETERS

Yarn Parameters				Spinning Parameters									
				Dref III			Rotor				Ring		
Yarn No.	Linear density (tex)	Blend poly-ester/cotton	Twist level	Yarn pro-duction speed (m/min)	Spin-ning drum speed (min^{-1})	Card drum speed (min^{-1})	Yarn pro-duction speed (m/min)	Rotor speed (min^{-1})	Opening roller speed (min^{-1})	Twist factor (turns/cm $\sqrt{tex}$)	Yarn pro-duction speed (m/min)	Spindle speed (min^{-1})	Twist factor (turns/cm $\sqrt{tex}$)
1	40	70/30	low	250	4 000	12 000	86,5	45 000	6 000	33,4	21,5	10 000	28,7
2	40	70/30	medium	250	5 000	12 000	72,0	45 000	6 000	38,2	20,9	11 000	33,5
3	40	70/30	high	250	6 000	12 000	64,0	45 000	6 000	45,3	19,8	12 000	38,3
4	60	70/30	low	250	4 000	12 000	106,0	45 000	6 000	33,4	21,9	8 000	28,7
5	60	70/30	medium	250	5 000	12 000	92,0	45 000	6 000	38,2	20,7	9 000	33,5
6	60	70/30	high	250	6 000	12 000	76,5	45 000	6 000	45,3	20,3	10 000	38,3
7	40	50/50	low	250	4 000	12 000	86,5	45 000	6 000	33,4	21,5	10 000	28,7
8	40	50/50	medium	250	5 000	12 000	72,0	45 000	6 000	38,2	20,9	11 000	33,5
9	40	50/50	high	250	6 000	12 000	64,0	45 000	6 000	45,3	19,8	12 000	38,3
10	60	50/50	low	250	4 000	12 000	106,0	45 000	6 000	33,4	21,9	8 000	28,7
11	60	50/50	medium	250	5 000	12 000	92,0	45 000	6 000	38,2	20,7	9 000	33,5
12	60	50/50	high	250	6 000	12 000	76,5	45 000	6 000	45,3	20,3	10 000	38,3

Yarn tests

Single thread strength and extension were measured on an Uster automatic strength tester (constant rate of load) while skein strength (CSP = count strength product) was measured on a Heal tester. Yarn irregularity and frequencies of imperfections were measured on the Uster range of equipment, using standard settings and following standard procedures. Hairiness was measured on a Shirley Yarn Hairiness Meter at the standard distance of 3 mm. The yarn faults were counted and classified during winding on a machine equipped with an Uster Classimat. The yarns were tested at 20°C and 65% RH.

Additional Dref III experiments

To gain some additional information and experience on the influence of different machine settings on the Dref III system, some additional small scale trials were carried out. In one such trial investigated the influence of yarn linear density on yarn tenacity was investigated. Yarns with a linear density of 30 to 120 tex were spun and the CSP measured. Furthermore, in order to investigate what influence the core to sheath ratio has on yarn strength, 100% cotton yarns were spun with different core to sheath ratios and their CSP measured. The influence of different yarn production speeds on yarn tenacity (CSP) was also measured.

RESULTS AND DISCUSSION

Tenacity and CSP results

In Figs. 2 and 3 the yarn tenacity and CSP results, have been plotted against twist level and it can be seen that, in all cases, the tenacity of the Dref III yarns was higher than that of the rotor yarns spun with the wire covered opening rollers but lower than that of the ring yarns. Yarn twist level did not have a consistent effect on yarn tenacity and CSP, although in most cases an increase in twist level resulted in a small increase in both tenacity and CSP of the ring yarns. Values for the 70/30 polyester/cotton yarns generally were higher than those of the 50/50 polyester/cotton yarns due to the higher content of the stronger polyester fibres. The yarn tensile properties have been averaged over the three twist levels and in Fig. 4 tenacity and CSP have been plotted against yarn linear density to illustrate the effect of linear density on tenacity. It can be seen that the yarn tenacity increased with increasing yarn linear density, the Dref III yarns showing a greater increase than the ring and rotor yarns. The same applied to the CSP values. The rotor yarn CSP and tenacity values with the pinned opening rollers were significantly higher than those with the wired opening rollers. The tenacity values for the 60 tex Dref III yarns, however, were still better than those of the rotor yarns. Statistical analysis of the average values showed that there was a high correlation between the CSP and single thread tenacity values, and the following regression equation was obtained:

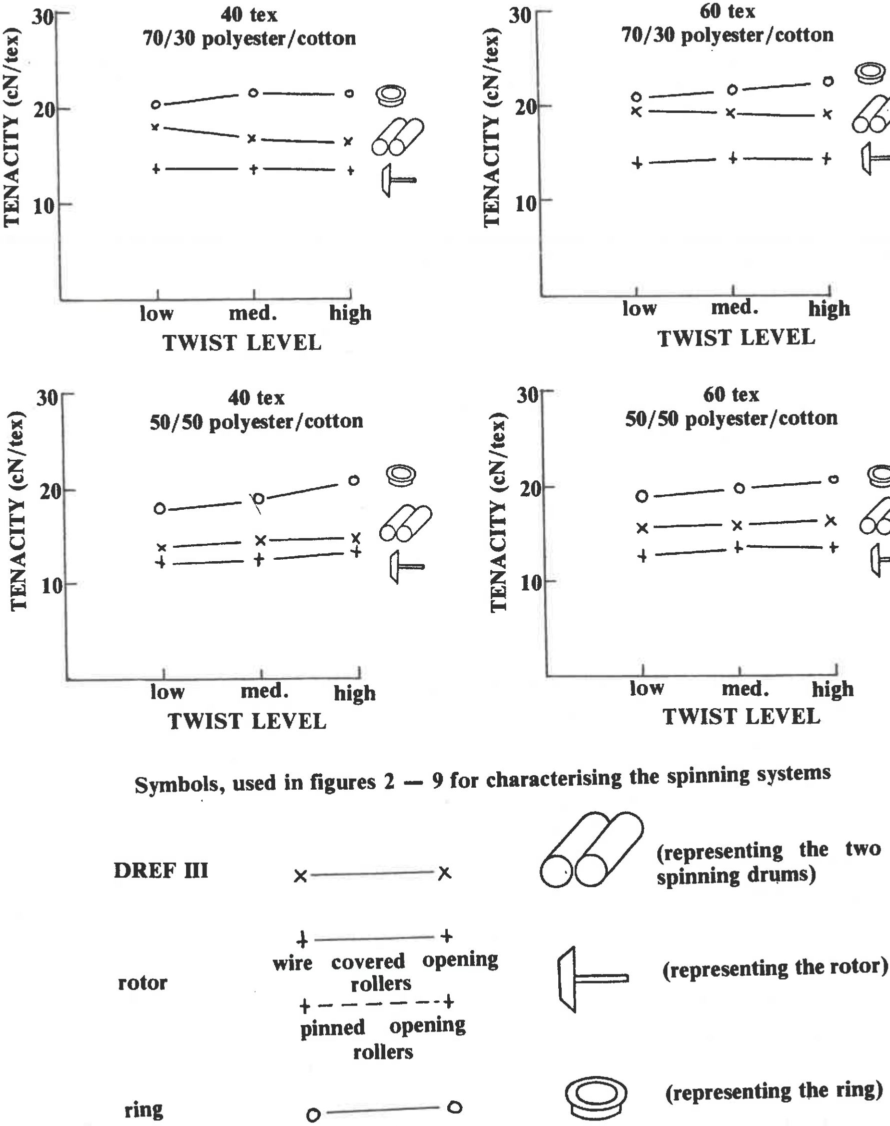


Fig. 2 – Yarn tenacity vs twist level

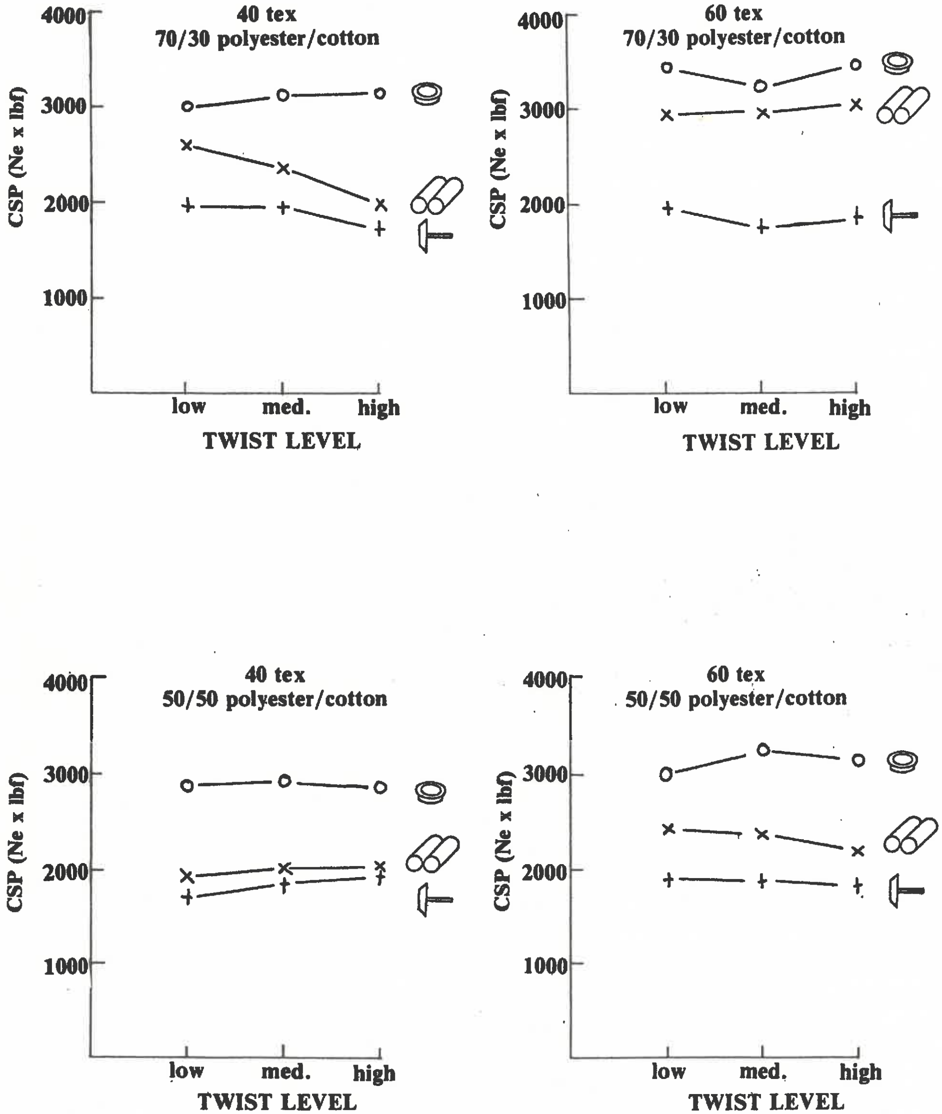


Fig. 3 – CSP vs twist level

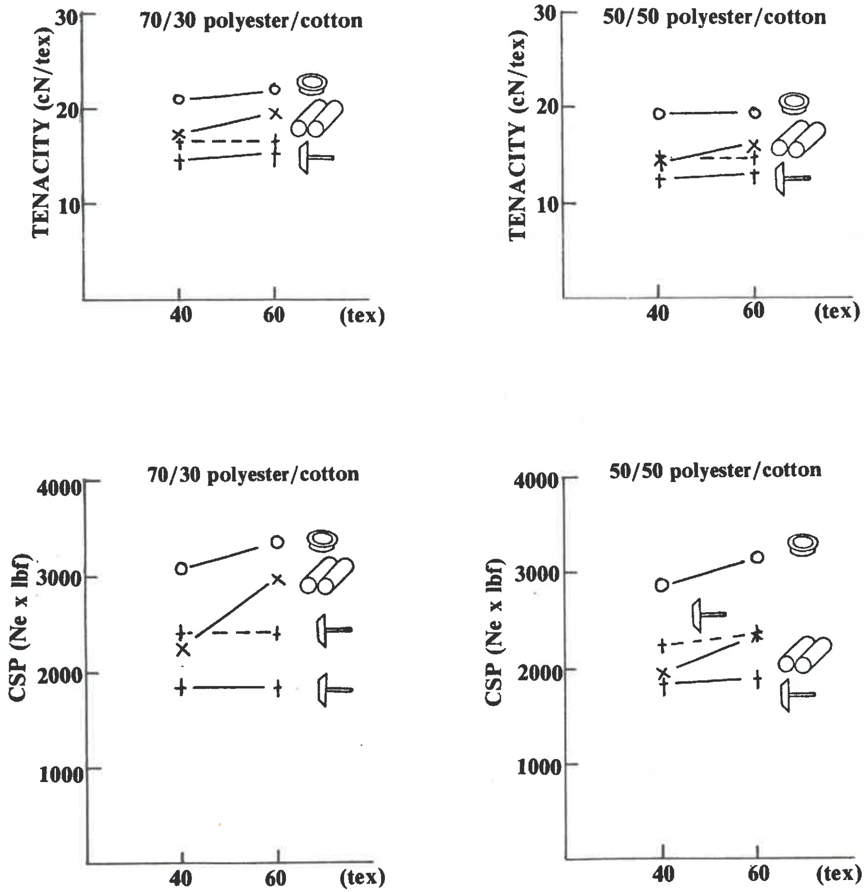


Fig. 4 – Yarn tenacity and CSP vs yarn linear density (averaged over the three twist levels)

Tenacity (cN/tex) = 0,0055 x CSP + 3,5
Number of readings (n) = 16; correlation coefficient (r) = 0,96

Extension

The extension values obtained on the Dref III, rotor and ring yarns were not significantly affected by the twist level. In Fig. 5 the average extension values have been plotted against yarn linear density. It can be seen that the extension of the Dref III yarns was slightly higher than that of the ring and rotor yarns, extension increasing as the yarn linear density increased for the Dref and ring yarns.

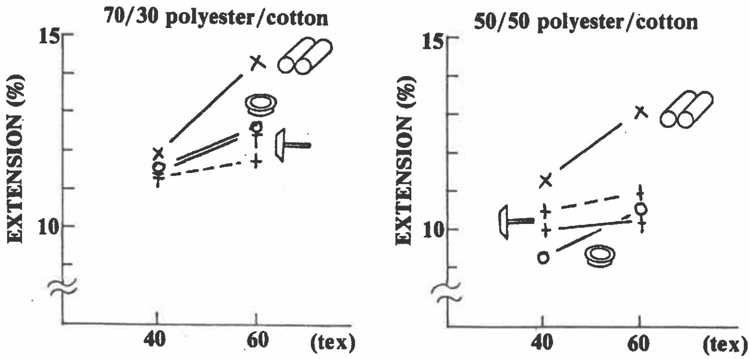


Fig. 5 – Yarn extension of breakage vs yarn linear density (averaged over the three twist levels)

Irregularity

The irregularity (CV %) values were not influenced by the twist levels and the values were therefore averaged over the three twist levels and plotted against yarn linear density in Fig. 6. The irregularity of the Dref III yarns decreased considerably as the yarn linear density increased. This indicates further that the Dref III yarn quality improved considerably when a coarser yarn was spun. The irregularity values for the 60 tex Dref III yarns were slightly higher than those for the rotor yarns, spun using the pinned opening rollers, but lower than those spun using the wire covered opening rollers. The irregularity of the ring yarns was lower than that of the Dref III and rotor yarns. There was little difference between the irregularity of the 70/30 polyester/cotton yarns and that of the 50/50 polyester/cotton yarns.

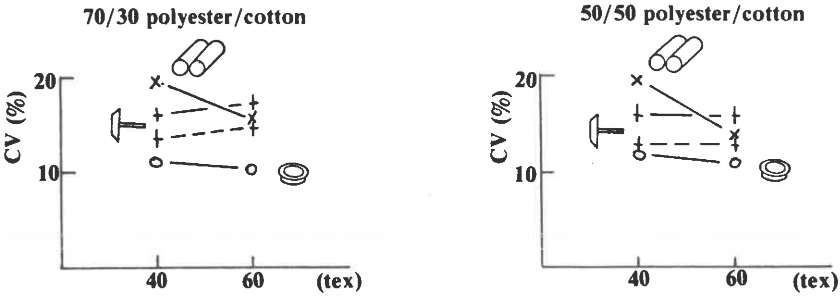


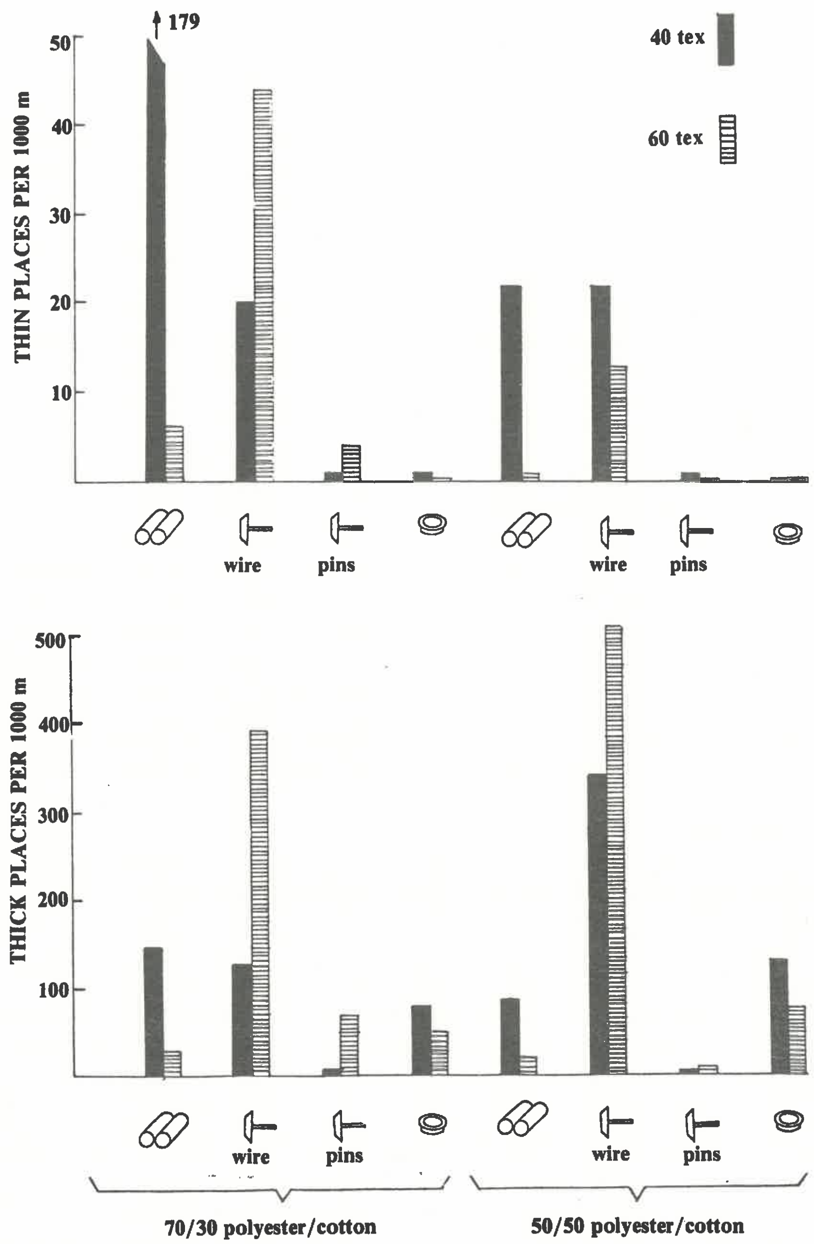
Fig. 6 – Yarn irregularity (CV %) v yarn linear density (averaged over the three twist levels)

Imperfections

Since twist had no significant effect on the frequency of imperfections, the values were averaged over the three twist levels. The effects are illustrated by means of bar diagrams (Fig. 7). It can be seen, that, as the yarn linear density increased, the level of imperfections for the Dref III yarns decreased significantly. The frequency of thick and thin place values of the 60 tex Dref III yarns compared favourably with those of the ring spun and of the rotor yarns, spun with the pinned opening rollers, whereas those of the rotor yarns, spun with the wire opening rollers, were significantly higher. The Dref III yarns had a higher nep content than the ring and rotor yarns. The 70/30 polyester/cotton Dref yarns generally contained more imperfections than the corresponding 50/50 polyester/cotton.

Hairiness

The yarn linear density and twist level appeared to have little effect on yarn hairiness (Fig. 7). The ring and rotor yarns gave comparable results, which were significantly lower than the values obtained on the Dref III yarns.



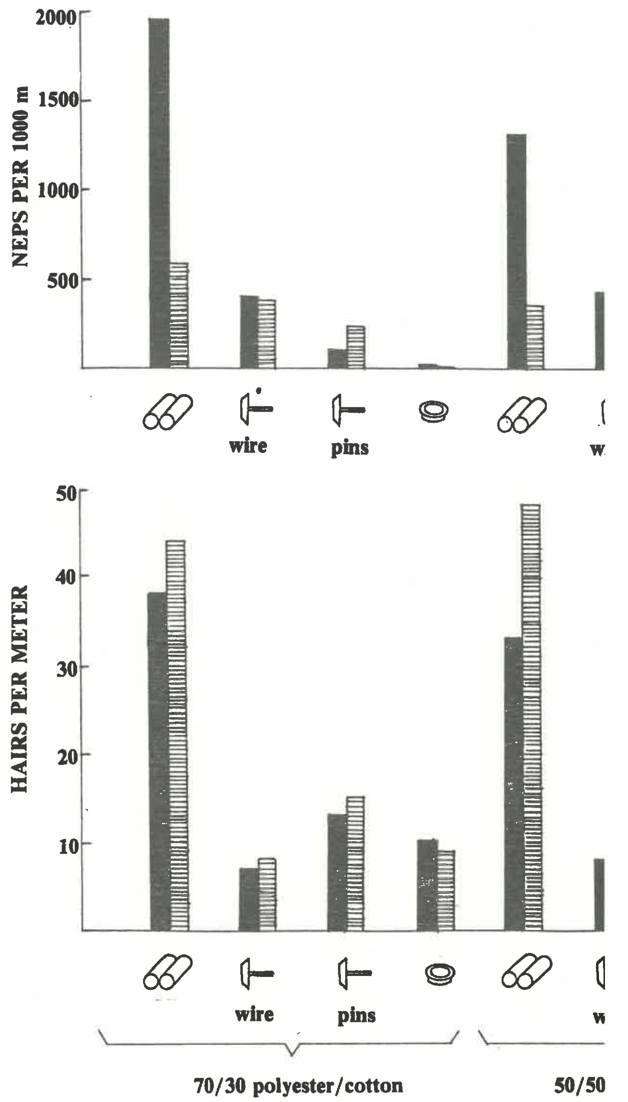


Fig. 7 – Average values for the frequencies of yarn im

Classimat faults

The Classimat results varied considerably according to the spinning system, the lowest results being obtained on the ring yarns and the rotor yarns produced with the pinned opening rollers. The Dref III yarns generally contained far more faults than the ring yarns but far fewer than the rotor yarns spun with the wire covered opening rollers. The exceptionally high fault levels of the latter yarns could be due to the fact that wire covered opening rollers are more suitable for 100% cotton. Pinned opening rollers are generally used for the spinning of a wider range of fibres.

Since twist level did not have a consistent effect on the frequency of faults, the values were averaged for further comparisons. For the rotor yarns spun with the wire covered opening rollers it can be seen that the results of the 50/50 polyester/cotton yarns were better than those of the 70/30 polyester/cotton yarns, probably because the former contained a higher percentage of cotton which is more suited to this type of opening rollers. For the Dref III, the 60 tex yarns contained far fewer faults than the 40 tex yarns, as illustrated in Fig. 8. The results for the rotor yarns, spun with the wire covered opening rollers, have not been plotted because of the effect of the opening roller already referred to. The 60 tex Dref III and ring yarns produced comparable numbers of total faults but the number of "objectionable" faults was considerably higher for the 60 tex Dref III yarns than for the ring yarns and the rotor yarns spun with the pinned opening rollers. In this connection, it is significant that the number of D_3 and D_2 faults were rather high for the Dref III yarns. These long faults, having a mass in excess of 150 to 250 percent of the yarn average, were mainly responsible for the large number of "objectionable" faults recorded and the reason for this should be examined in future studies.

Additional Dref III experiments

Fig. 9 shows the results of an experiment on the Dref III machine to determine the effect of yarn linear density on CSP and therefore also on yarn tenacity since CSP and tenacity have already been shown to be highly correlated for the Dref III yarns. Fig. 9 shows that CSP increased very rapidly as the yarn linear density increased from 30 tex to 60 tex, after which it levelled off.

When the effect of core to sheath ratio was investigated for a 40 tex cotton yarn, it was found that a yarn comprising wrapper fibres only (i.e. no core fibre supplied via the apron drafting system) could be spun. At least 100 fibres appeared to be required in the cross-section of the core feed to prevent a breakage (interruption) in the false-twisted core feed to the drums. With 100% wrapper fibres, the principle of the spinning system is similar to that of the Dref II system.

From Fig. 10 it can be seen that the optimum core to sheath ratio lay between about 50/50 and 70/30. Outside these limits, the tenacity decreased

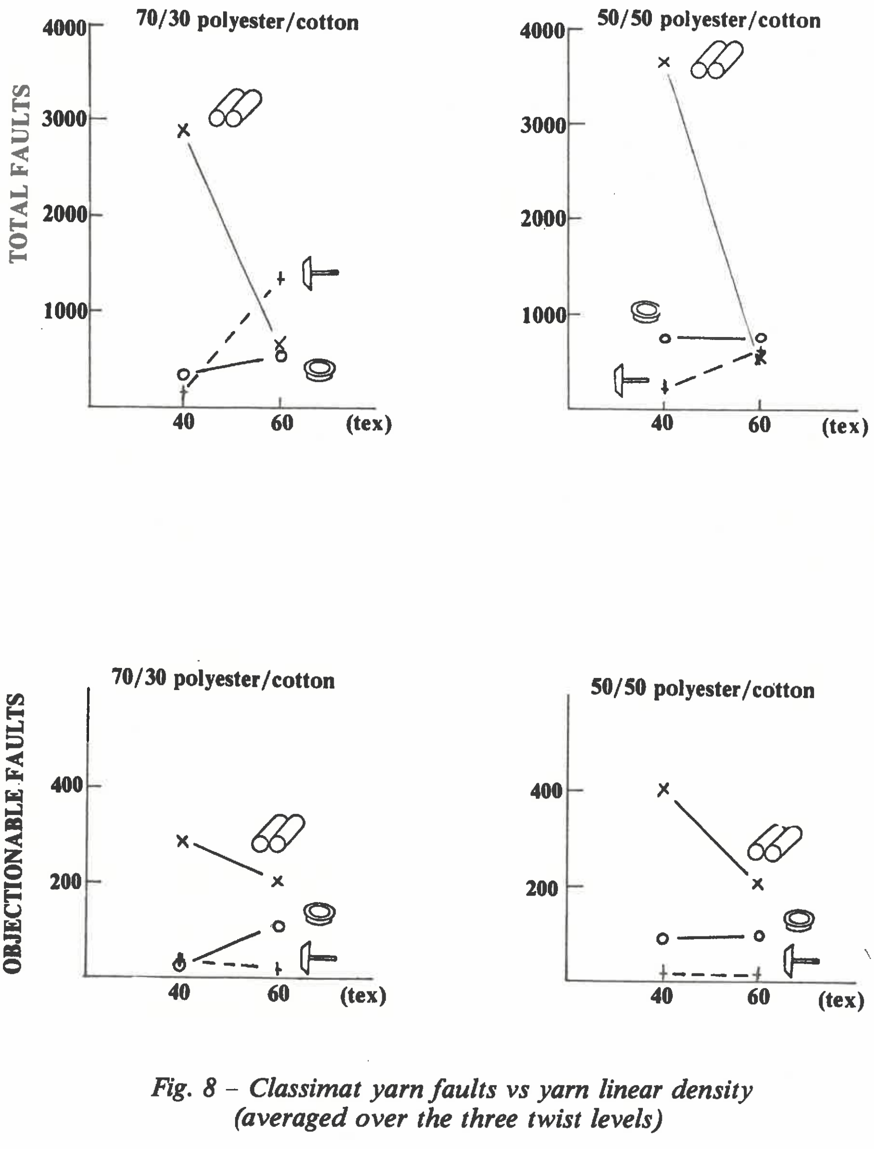


Fig. 8 – Classimat yarn faults vs yarn linear density (averaged over the three twist levels)

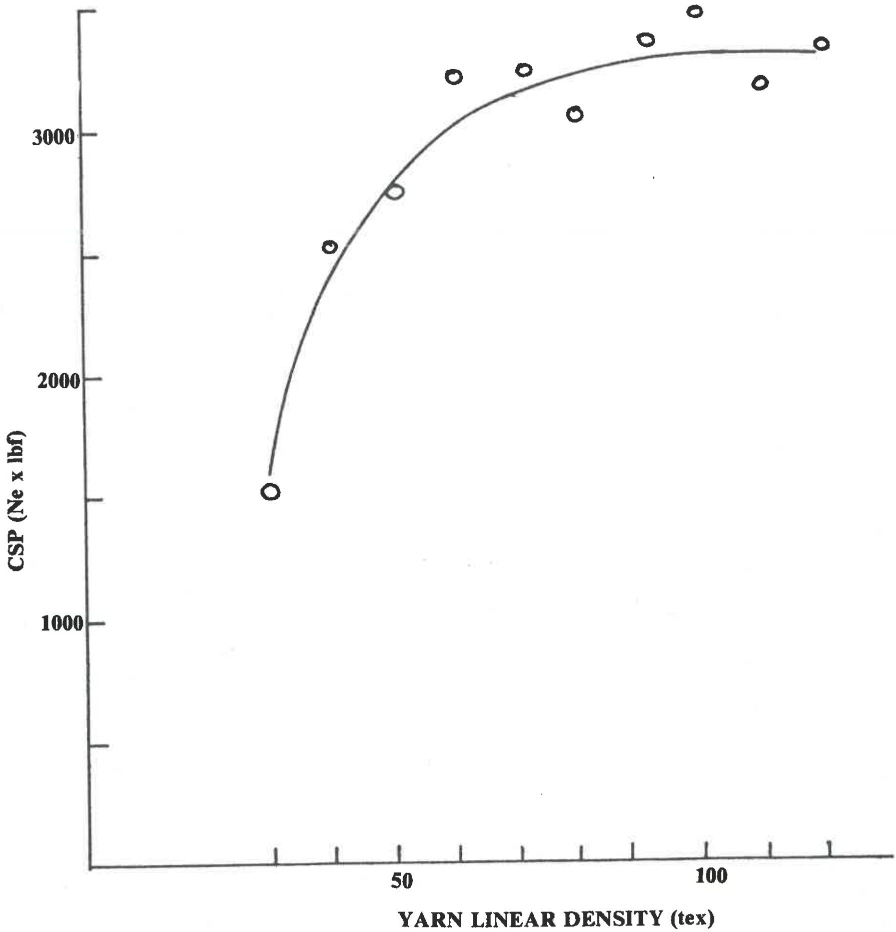


Fig. 9 – CSP vs yarn linear density (DREF III) (70/30 polyester/cotton)

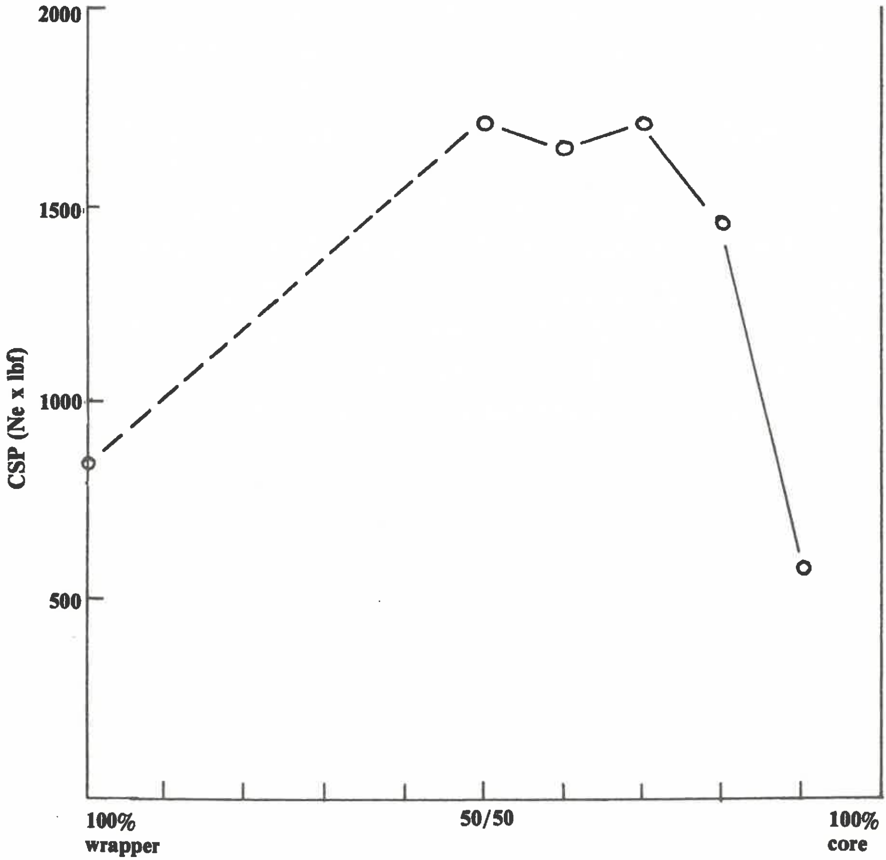


Fig. 10 – Effect of sheath to core ratio on CSP for 40 tex cotton yarns.

rapidly. It is possible that the optimum core to sheath ratio depends upon the yarn linear density and the blend. This aspect will be further investigated.

Fig. 11 shows that a change in yarn production speed, in the range of 100 to 300 m/min had virtually no influence on yarn CSP. This, however, does not necessarily mean that the overall yarn quality remained the same since imperfections and irregularity values were not measured. Fig. 12 illustrates the effect of small differences between the speeds of the two spinning drums on yarn CSP.

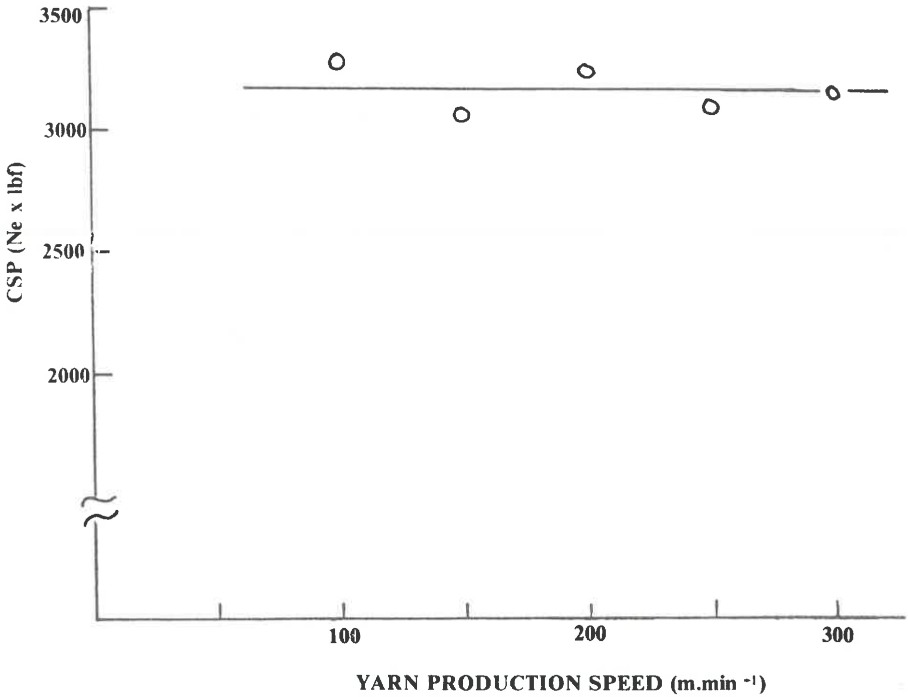


Fig. 11 – CSP vs Dref III yarn production speed (60 tex 70/30 polyester/cotton)

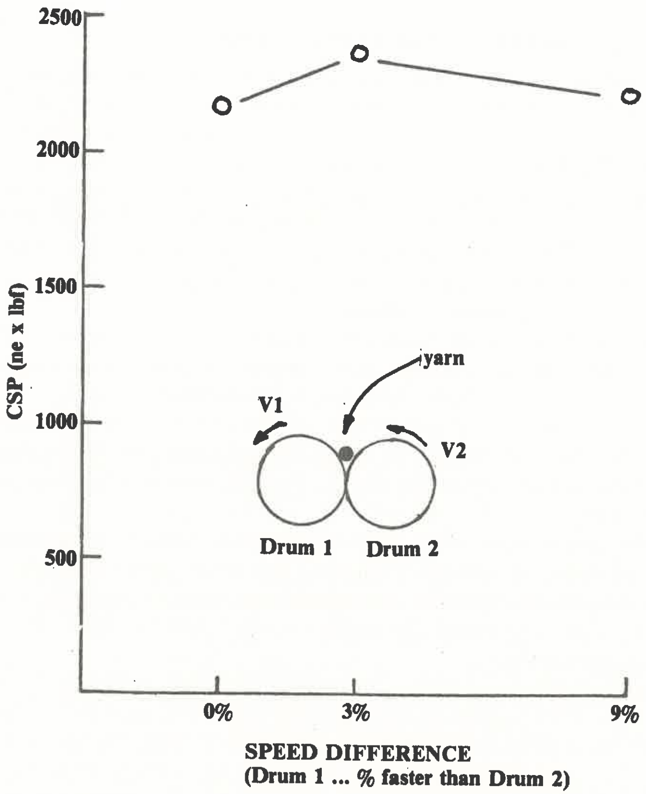


Fig. 12 – The effect of small differences between the speeds of the two spinning drums on Dref III yarn CSP (40 tex, 70/30 polyester/cotton)

SUMMARY AND CONCLUSIONS

An introductory study was carried out on the spinning of polyester/cotton yarns on the Dref III spinning systems and the yarn properties compared with those of yarns spun on ring and rotor machines, respectively. Both 70/30 and 50/50 polyester/cotton blends were spun to two linear densities (40 and 60 tex) at three twist levels on all three types of spinning systems. Additional small-scale experiments were carried out on the Dref III to establish the effects of yarn production speed, core to sheath ratio and yarn linear density on the yarn CSP. Two different types of opening rollers (pin and wire covered) were studied on the rotor spinning machine.

It was found that twist level, within the ranges studied, generally did not have a consistent effect on the various yarn properties and the results could therefore be averaged over the three twist levels for further analysis.

Generally the properties of the 60 tex Dref III yarns were intermediate between those of the rotor and ring yarns, the latter generally performing best. It was found that the overall quality of the 60 tex Dref III yarn was far superior to that of the 40 tex yarn.

Rotor yarns spun with wire covered opening rollers contained an excessive number of faults (Classimat) whereas the rotor yarns spun with the pinned opening rollers showed results comparable to those of the ring yarns. A high correlation was found between the single thread tenacity and CSP results for all three spinning systems.

From the additional small scale trials on the Dref III, it emerged that the polyester/cotton yarn CSP increased very sharply when the yarn linear density was increased from 30 to 60 tex, after which it levelled off. The CSP of the 60 tex 70/30 polyester/cotton yarn was not affected to any great extent when the yarn production speed was increased from 100 to 300 m/min. The optimum core to sheath ratio appeared to lie between about 50/50 and 70/30 for a 60 tex cotton yarn.

ACKNOWLEDGEMENTS

The authors wish to thank Mr H. Taylor for producing the slivers and for spinning the ring and rotor yarns, Mrs. S. Hill for yarn testing and Miss S. Verrie for the CSP testing.

THE USE OF PROPRIETARY NAMES

The names of proprietary products where they appear in this report/publication are mentioned for information only. This does not imply that SAWTRI recommends them to the exclusion of other similar products.

REFERENCES

1. Gruoner, S., *Melliand Textilber.,* **57** (2), 703 (1976).
2. Gruoner, S., *Text. Prax. Int.,* **32**, (8), 912 (1977).
3. Trommer, G., *Textiltech.,* **27** (10), 612 (1977).
4. Trommer, G., *Textiltech.,* **28** (9), 543 (1978).
5. Brockmanns, K.J., *Textilbetrieb,* **100** (1), 41 (1982).
6. Lünenschloss, J., Brockmanns, K.J., *Melliand Textilber.,* **63** (3), 175 (1982).
7. Lenox-Kerr, P., *Text. Asia,* **13** (10), 67 (1982).
8. Mitteregger, A., *Textilbetrieb,* **35** (7/8), 22 (1977).
9. Fuchs, H., *Melliand Textilber, Int.,* **60** (4), 289 (1979).
10. Spencer, J.D., Taylor, H., *SAWTRI Bull.,* **13** (4), 29 (1979).
11. Czupper, F., *Textilbetrieb,* **98** (5), 30 (1980).
12. Hunter, L., Gee, E., Spencer, J.D. and Taylor, H., *SAWTRI Techn. Rep.,* No. 462, (July, 1980).
13. Robinson, G.A., Hunter, L. and Taylor, H., *SAWTRI Techn. Rep.* No. 493, (1981).
14. Gsteu, M.G., *Int. Text. Bull. Spinning* (1), 65 (1982).
15. Gsteu, M.G., *Melliand Textilber. Int.,* **63** (5), 325 (1982).
16. Fuchs, H., *Melliand Textilber. Int.,* **60** (8), 638 (1979).
17. Leitner, J., *Am. Text., K/A Ed.. AT* **11** (9), 26 (1982).
18. United States Patent, 4, 245, 368 (Feb. 10, 1981).
19. Gsteu, M.G., *Proc. Symp. on New Technologies for Cotton,* 131 (July, 1982).

ISBN 0 7988 2731 9

Published by
The South African Wool and Textile Research Institute
P.O. Box 1124, Port Elizabeth, South Africa
and printed in the Republic of South Africa
by P U D Repro (Pty) Ltd., P.O. Box 44, Despatch