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Effect of Twist and Repeated Extension on Tenacity and Breaking Extension of Acrylic-Viscose Rotor-spun Yarns

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Rotor-spun yarns showed a decrease in breaking strength and extension with an increase either in the amplitude of extension or the number of extension cycles, the decrease being less in acrylic-majority and low-twist yarns.

Keywords: Acrylic-viscose rayon yarn, Elastic recovery, High-twist yarn, Multiple stretching, Rotor-spun yarn, Tex twist factor

1 Introduction

The mechanical properties of a textile structure during its operational life are greatly influenced by the yarn structure, yarn twist and the kind and amount of strain deformation that the individual components of the structure suffer. Prediction of the behaviour of a textile product, therefore, calls for an understanding of the above effects. A lot of work has been done in recent years on synthetic fibre production and yarn manufacturing systems such as rotor spinning. The technologists have attempted to establish the optimum twist for optimum characteristics of rotor-spun yarns. Many researchers[1-5] have studied the relationship between twist and resistance to repeated extension for rotor-spun yarns prepared from cotton and man-made fibres. However, very little information is available on this aspect for acrylic and its blends, especially with viscose rayon. The present study aims at investigating the combined effect of twist and repeated extension on the tenacity and breaking extension of acrylic-viscose rotor-spun yarns.

2 Materials and Methods

All the yarns, with S twist, were spun from three different blends of acrylic and viscose rayon fibres on an Ingolstadt Rotor Spinner RU 11/RU 80 (4602). The specifications of acrylic and viscose rayon fibres are given in Table 1. The blend proportions and twist factors were decided in accordance with the factorial design[b]. Three twist factors, 32.15, 35.40 and 38.56, were used for 50% acrylic-50% viscose blend and one twist factor, 35.40, for 100% acrylic and 100% viscose yarns.

Yarn breaking strength and elongation, before and after repeated extension, were measured on an Instron. The yarns were stretched at different extension amplitudes, ranging from 6mm to 10mm, and different extension cycles, viz. 80, 120, 160 and 200. In each case, a 100 cm long test specimen was elongated at 200 mm/min extension rate.

3 Results and Discussion

3.1 Effect of Repeated Extension on Yarn Tenacity

The effect of twist factor and repeated extension on the tenacity of acrylic-viscose rotor yarns is shown in Table 2. Figs 1 and 2 show that the yarn strength reaches a maximum at a twist factor of 35.40 and then slightly decreases as can be seen from the results for 50% acrylic-50% viscose yarn. This trend can be attributed to the fact that at higher twist levels the increase in yarn strength owing to higher inter-fibre cohesion is more than offset by the decrease due to the fibre obliquity effect.

Figs 1 and 2 show that the yarn breaking strength decreases appreciably with the increase in the amplitude of extension. This trend can be attributed to the increased elongation of yarns, leading to a dec-

Table 1—Specifications of Acrylic and Viscose Rayon Fibres

Fibre	Fibre length mm	Fibre denier	Bundle strength g/den	Breaking extension %
Acrylic	38	2.0	1.67	39.53
Viscose	38	2.0	1.57	13.27

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[b]The factorial design has three variables, viz. blend proportion, twist factor and tightness factor (knitting). The effect of these variables will be reported in a subsequent paper.

Table 2 — Effect of Yarn Composition, Twist Factor and Repeated Extension on Tenacity of Acrylic-Viscose Rotor-spun Yarns[a]

Fibre composition (A : V)	Nominal tex twist factor	Parent yarn tenacity g/tex	Amplitude of extension[b], mm: 6 — Yarn Tenacity g/tex	6 — Change in Tenacity %	8 — Yarn Tenacity g/tex	8 — Change in Tenacity %	10 — Yarn Tenacity g/tex	10 — Change in Tenacity %	Number of cycles[c]: 80 — Yarn Tenacity g/tex	80 — Change in Tenacity %	120 — Yarn Tenacity g/tex	120 — Change in Tenacity %	160 — Yarn Tenacity g/tex	160 — Change in Tenacity %	200 — Yarn Tenacity g/tex	200 — Change in Tenacity %
100:0	35.40	10.85	10.70	-1.4	10.57	-2.5	10.13	-6.6	10.67	-1.6	10.43	-3.8	10.28	-5.2	10.12	-6.7
50:50	32.15	9.19	8.92	-2.9	8.54	-7.0	7.87	-14.3	8.99	-2.2	8.82	-4.9	8.51	-7.4	7.87	-14.3
50:50	35.40	10.13	8.90	-12.1	8.60	-15.1	7.93	-21.3	9.17	-11.2	8.90	-12.1	8.66	-14.5	7.92	-21.8
50:50	38.56	9.69	8.30	-14.3	8.10	-16.4	7.52	-22.3	8.56	-11.4	8.43	-13.0	8.18	-15.6	7.53	-22.2
0:100	35.40	11.83	10.07	-14.8	9.89	-16.3	8.30	-29.8	9.84	-16.8	9.65	-18.4	9.28	-21.5	8.30	-29.8

[a] Yarn linear density, 29.5 tex ; [b] Number of cycles, 200 ; [c] Amplitude of extension, 10mm; A — Acrylic ; V — Viscose

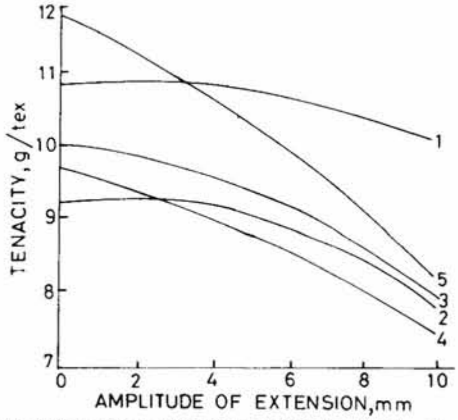

Fig. 1—Variation of tenacity with amplitude of extension for 200 extension cycles [(1) 100% acrylic; (2) 50% acrylic-50% viscose; twist factor, 32.15; (3) 50% acrylic-50% viscose; twist factor, 35.40; (4) 50% acrylic-50% viscose; twist factor, 38.56; and (5) 100% viscose]

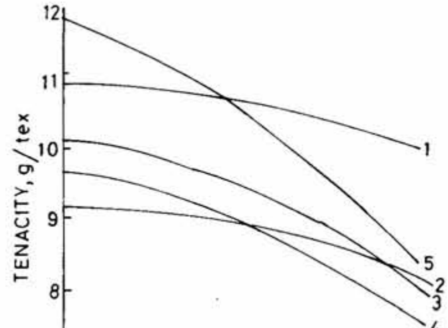

Fig. 2—Variation of tenacity with extension cycles for 10mm extension amplitude [(1) 100% acrylic; (2) 50% acrylic-50% viscose; twist factor, 32.15; (3) 50% acrylic-50% viscose; twist factor, 35.40; (4) 50% acrylic-50% viscose; twist factor, 38.56; and (5) 100% viscose]

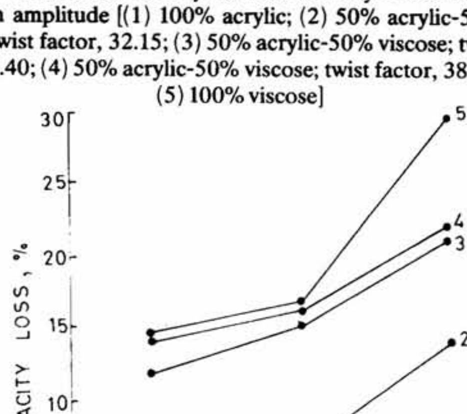

Fig. 3—Variation of tenacity loss with amplitude of extension for 200 extension cycles [(1) 100% acrylic; (2) 50% acrylic-50% viscose; twist factor, 32.15; (3) 50% acrylic-50% viscose; twist factor, 35.40; (4) 50% acrylic-50% viscose; twist factor, 38.56; and (5) 100% viscose]

rease in resistance to fatigue stretching. Figs 3 and 4 show that the strength loss is more in high-twist yarns, which is expected to be due to the alteration in plastic deformation of yarns with change in twist factor and specimen length[6]. On the other hand, 100% acrylic yarn shows lesser tenacity loss than the 100% viscose yarn.

Apart from yarn twist and amplitude of extension, the number of extension cycles also appears to contribute significantly to the breaking strength loss of acrylic-viscose rotor yarns. An increase in the num-

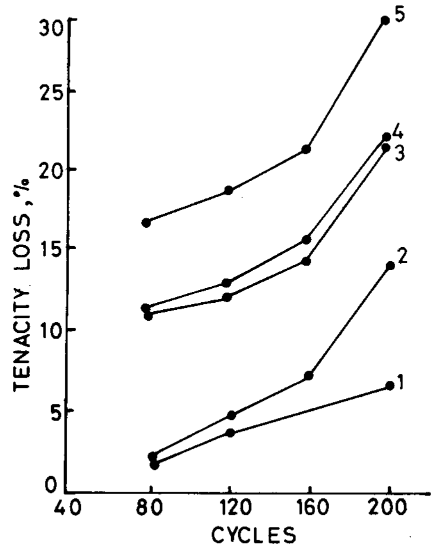

Fig. 4—Variation of tenacity loss with extension cycles for 10mm extension amplitude [(1) 100% acrylic; (2) 50% acrylic-50% viscose; twist factor, 32.15; (3) 50% acrylic-50% viscose; twist factor, 35.40; (4) 50% acrylic-50% viscose; twist factor, 38.56; and (5) 100% viscose]

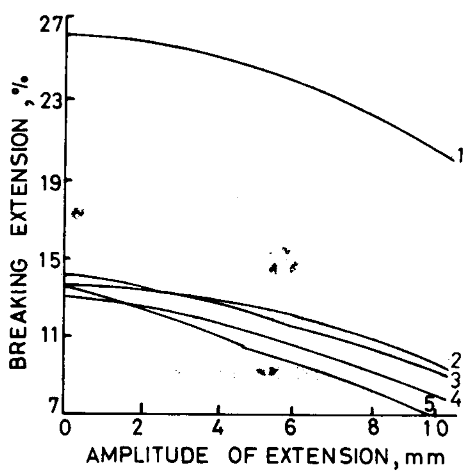

Fig. 5—Variation of breaking extension with amplitude of extension for 200 extension cycles [(1) 100% acrylic; (2) 50% acrylic-50% viscose; twist factor, 32.15; (3) 50% acrylic-50% viscose; twist factor, 35.40; (4) 50% acrylic-50% viscose; twist factor, 38.56; and (5) 100% viscose]

Table 3 — Effect of Yarn Composition, Twist Factor and Repeated Extension on Breaking Extension of Acrylic–Viscose Rotor-spun Yarns[a]

Fibre composition (A : V)	Nominal tex twist factor	Parent yarn breaking extn. %	Amplitude of extension, mm[b]						Number of cycles[c]							
			6		8		10		80		120		160		200	
			Breaking extn. %	Change in breaking extn. %	Breaking extn. %	Change in breaking extn. %	Breaking extn. %	Change in breaking extn. %	Breaking extn. %	Change in breaking extn. %	Breaking extn. %	Change in breaking extn. %	Breaking extn. %	Change in breaking extn. %	Breaking extn. %	Change in breaking extn. %
100:0	35.40	26.14	23.97	-8.3	21.33	-18.4	20.25	-22.5	23.49	-10.3	22.08	-15.5	20.96	-19.8	20.02	-23.4
50:50	32.15	13.43	11.87	-11.6	10.26	-23.6	9.55	-28.5	11.50	-14.4	11.03	-17.8	10.11	-24.7	9.55	-28.9
50:50	35.40	13.59	11.59	-14.7	10.15	-25.3	9.48	-30.2	11.32	-16.7	10.98	-19.2	10.86	-25.9	9.48	-30.2
50:50	38.56	13.40	10.46	-21.9	9.30	-30.5	8.75	-34.7	10.46	-21.9	10.29	-23.0	9.58	-28.9	8.75	-34.7
0:100	35.40	13.41	9.31	-30.5	7.8	-41.8	7.13	-46.8	9.53	-28.9	8.77	-34.6	7.75	-42.2	7.17	-46.8

[a] Yarn linear density, 29.5 tex ; [b] Number of cycles, 200; [c] Amplitude of extension, 10mm; A–Acrylic ; V–Viscose

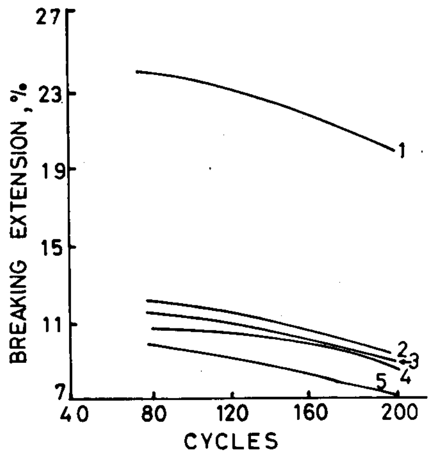

Fig. 6—Variation of breaking extension with extension cycles for 10mm extension amplitude [(1) 100% acrylic; (2) 50% acrylic-50% viscose; twist factor, 32.15; (3) 50% acrylic-50% viscose; twist factor, 35.40; (4) 50% acrylic-50% viscose; twist factor, 38.56; and (5) 100% viscose]

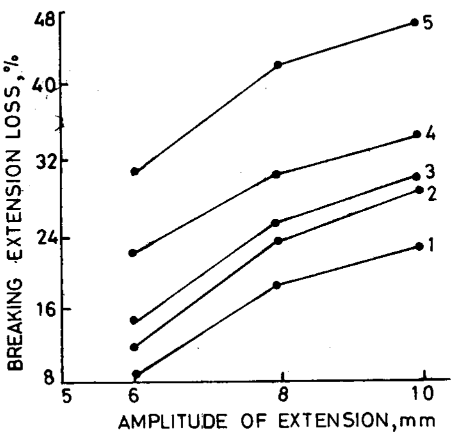

Fig. 7—Variation of breaking extension loss with amplitude of extension for 200 extension cycles [(1) 100% acrylic; (2) 50% acrylic-50% viscose; twist factor, 32.15; (3) 50% acrylic-50% viscose; twist factor, 35.40; (4) 50% acrylic-50% viscose; twist factor, 38.56; and (5) 100% viscose]

ber of extension cycles from 80 to 200 leads to a significant reduction in yarn strength. However, the reduction is of a lower magnitude in 100% acrylic yarn owing to the higher resistance of acrylic fibre to fatigue stretching[7].

3.2 Effect of Repeated Extension on Breaking Extension

The response of acrylic-viscose yarns to an increase in either the amplitude of extension or the number of cycles is shown in Table 3 and Figs 5 and 6. A marked fall in breaking extension is observed irrespective of fibre proportion and yarn twist. The apparent loss in breaking extension (Figs 7 and 8) may be assigned to the decreasing resistance of yarn to the effect of repeated extension owing to the plastic deformation of the specimen[6].

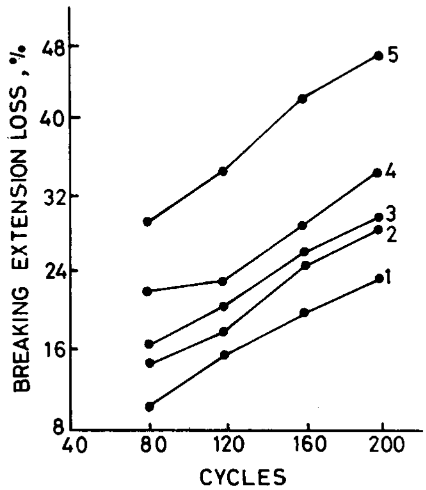

Fig. 8—Variation of breaking extension loss with extension cycles for 10mm extension amplitude [(1) 100% acrylic; (2) 50% acrylic-50% viscose; twist factor, 32.15; (3) 50% acrylic-50% viscose; twist factor, 35.40; (4) 50% acrylic-50% viscose; twist factor, 38.56; and (5) 100% viscose]

4 Conclusion

Repeated extension of acrylic-viscose yarns results in a decrease in breaking strength and breaking extension, the decrease being less in acrylic-majority yarns. The decrease in breaking strength and breaking extension increases with an increase either in the amplitude of extension or the number of cycles. The decrease is, however, less in low-twist yarns.

References

1 Barella A, *J Text Inst*, **63** (1972) 226.
2 Barella A and Vigo J P, *J Text Inst*, **66** (1975) 270.
3 Barella A and Vigo J P, *J Text Inst*, **68** (1977) 338.
4 Hunter L, *Text Prog*, **10**, No 1/2 (1978) 119.
5 Hearle J W S, *J Mat Sc*, **2** (1967) 474.
6 Zurek W, *The structure of yarns* (WNT - Warszawa, Poland) 1971, 331.
7 Barella A, Vigo J P and Munich A M, *J Text Inst*, **71** (1980) 242.