International Journal Of
Recent Scientific Research
ISSN: 0976-3031
Volume: 7(3) March -2016

INFLUENCE OF SPECIMEN LENGTH AND EXTENSION RATE ON TENSILE BEHAVIOUR OF SPUN YARNS

Bharani M

THE OFFICIAL PUBLICATION OF
INTERNATIONAL JOURNAL OF RECENT SCIENTIFIC RESEARCH (IJRSR)
http://www.recentscientific.com/ recentscientific@gmail.com

Available Online at http://www.recentscientific.com

International Journal of Recent Scientific Research
Vol. 7, Issue, 3, pp. 9612-9619, March, 2016

ISSN: 0976-3031

International Journal of Recent Scientific Research

RESEARCH ARTICLE

INFLUENCE OF SPECIMEN LENGTH AND EXTENSION RATE ON TENSILE BEHAVIOUR OF SPUN YARNS

Bharani M

Department of Textile-Fashion Technology, Bannari Amman Institute of Technology, Sathyamangalam - 638 401, Tamil Nadu, India

ARTICLE INFO

Article History:

Received 16th December, 2015
Received in revised form 24th January, 2016
Accepted 23rd February, 2016
Published online 28th March, 2016

Keywords:

Extension, Extension Rate, Modulus, Specimen Length, Tenacity, Trevira CS

ABSTRACT

The present research work was carried out to investigate the tensile behaviour of yarns spun from inherently flame-retardant Polyester Fibres (Trevira CS), produced on most common spinning systems. Trevira CS fibres were successfully processed on popular spinning systems such as Ring spinning, Rotor spinning and Air-jet spinning to produce 20 Ne yarns. The tensile behaviour of Ring-spun, Rotor-spun, Air-jet-spun yarns has been investigated at varying specimen lengths and high extension rates. It is observed that the increase in specimen length from 200 mm to 500 mm decreases continually the yarn tenacity, breaking extension, but increases the breaking work and the modulus. The Rotor-spun yarn exhibits a minimum reduction in tenacity while the Air-jet-spun yarn shows a greater drop in tenacity and breaking extension when tested at longer specimen lengths. Amongst all yarns, the Ring-spun yarn exhibits highest tenacity and modulus followed by Rotor-spun yarn and Air-jet-spun yarn. The yarn tenacity, breaking extension, modulus, breaking work, breaking time are found to be logarithmic functions of specimen length. The increase in extension rate from 5 m/min to 400 m/min considerably increases the yarn tenacity but does not have a regular effect on its breaking extension. The percentage increase in tenacity is higher in case of Ring-spun yarn followed by the corresponding Rotor-spun and Air-jet-spun yarns. All these observations ascribe to the nature of the responses of the constituent fibres in the yarns and differences amongst the structures of these yarns.

INTRODUCTION

Every spinning system produces a yarn of unique structure owing to its specific method of fibre integration and nature of twisting. Hence, the geometric configurations of fibres are different in the yarns spun on different spinning systems. For instance, a Ring-spun yarn exhibits a near cylindrical helix structure, which is not true in case of Rotor-spun yarn and almost not valid in Air-jet-spun yarn. The core-sheath structure and differential twisting of fibres is a common feature of Rotor-spun yarn. Similarly, an Air-jet-spun yarn consisting of a core of parallel fibres wrapped by sheath fibres, exhibits a fasciated yarn structure.

Therefore, due to the marked structural differences, the responses to the tensile forces of these yarns are expected to be different. In addition, the failure mechanics of yarns as a combined phenomenon of fibre slippage and breakage is also understood to be different in the above yarns of differing structural features. Also, in many textile operations, yarns are subjected to sudden stresses at high stress-induced speeds. For instance, during the insertion of weft, whether by projectile or air-jet, the yarn has to withstand accelerations of many thousands of times greater than that due to gravity.

Though several researchers [1-26] in the past have dealt with the effect of extension rate and gauge length on tensile properties of yarns, their focus was more on the tenacity and extension and there was a very limted scope for understanding the effect on modulus and related aspects.

Hence it becomes important to understand the stress-strain responses, especially the modulus of yarns, under non-standard loading conditions, varying over a range of strain rates and specimen lengths. The present work was planned to investigate the stress-strain responses of structurally different Ring-spun, Rotor-spun, and Air-jet-spun spun yarns at high strain rates and different specimen lengths so that more appropriate yarn engineering and utilization techniques can be established.

Corresponding author:* **Bharani M
Department of Textile-Fashion Technology, Bannari Amman Institute of Technology, Sathyamangalam - 638 401, Tamil Nadu, India

Experimental Procedure

MATERIALS

Trevira CS flame-retardant fibres were used in the present study. Yarn samples of 20 Ne were spun from pure Trevira CS fibres in Ring spinning, Rotor spinning, and Air-jet spinning to observe the process performance of Trevira CS fibres as well as to investigate the response of these yarns' structures to their tensile behaviour. Ring-spun yarns of 20 Ne were produced from pure Trevira CS fibres and its blends on a Laboratory model G 5/1 Ringframe. Similarly, a 20 Ne Rotor-spun yarn was produced from on a Laboratory Rotor spinning machine Elitex BD-SD. Also, Air-jet-spun yarns of 20 Ne were spun on a Laboratory model Air-jet spinning machine MJS 802.

Measurement of Fibre Characteristics

Trevira CS fibres were tested on Lenzing Technik instruments for single fibre fineness, crimp, and tensile characteristics. The single fibre fineness and length characteristics were measured as per the BISFA 1998 test method. The crimp and tensile characteristics of single fibres were measured using the procedures described in ASTM D 3937-01 and D 3800-01 test methods respectively.

Measurement of Yarn Tensile Characteristics

The conditioned yarn samples were tested on Tensomaxx 7000 and Tensojet 4 for tensile characteristics, namely breaking force, tenacity, breaking extension, breaking work, modulus between 1% and 5% extension levels. The yarn samples were tested at different specimen lengths, viz. 200 mm, 300 mm, 400 mm and 500 mm at constant strain rates of 5 m/min and 400 m/min. These specimen lengths are chosen as they are the commercially practiced test conditions in most of the spinning mills and conform to most test standards. The modulus of the yarn can be determined with respect to its complete or a selected elongation range. It provides information about the elasticity of the yarn between the two points in a selected extension range, when the material is subjected to such loading conditions during any subsequent process. In the present study, two elongation values on the load-elongation curve, say 1% & 5% are chosen as they form the most common range of elongation to which any yarn is subjected during various processes before it ruptures. For each sample, 50 tests were conducted and the average values of breaking force, tenacity, breaking elongation, breaking work, and modulus were computed.

RESULTS AND DISCUSSION

Tensile Characteristics of Yarns

The tensile characteristics of all the yarns are analysed with respect to change in specimen length at different strain rates. The changes in tensile properties of yarns caused due to change in specimen length and increase in strain rate are subjected to tests of significance at 95% confidence level and inferences were drawn.

Influence of Specimen length
Ring-spun yarn

It can be understood from the analysis of results given in Table 1 for a Ring-spun yarn that an increase in specimen length from 200 mm to 500 mm decreases the yarn tenacity and breaking extension but increases the breaking work, breaking time and modulus at both 1% and 5% extensions. Typical graphs showing these trends for 20 Ne polyester Ring-spun yarn are given in Figures 1-5.

Table 1 Effect of Specimen length on Tensile Properties of 20 Ne Ring-spun yarn

L	**200**	**300**	**400**	**500**
t	0.3	0.4	0.5	0.7
F	805.2	784.3	752.3	761.2
T	27.27	26.56	25.48	25.78
E	12.92	12.42	11.98	11.88
W	901.1	1280.5	1595.3	2010.8
M_1	1.40	2.04	2.63	2.92
M_5	4.59	4.73	4.62	5.09

L: Specimen length (mm); t: Breaking Time (sec); F: Breaking Force (cN); E: Breaking Extension (%); T: Tenacity (cN/tex); W: Breaking Work (kgf.m); M_1: Modulus (N/tex) at 1% extn.; M_3: Modulus (N/tex) at 5% extn;

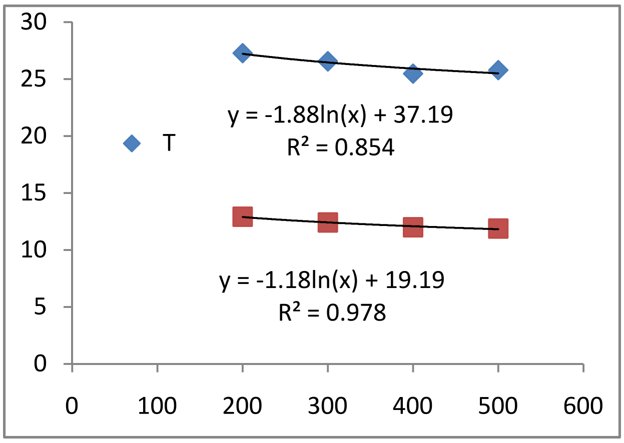

Fig. 1 Effect of Specimen length on Tenacity and Elongation (%) (20 Ne Ring-spun yarn)

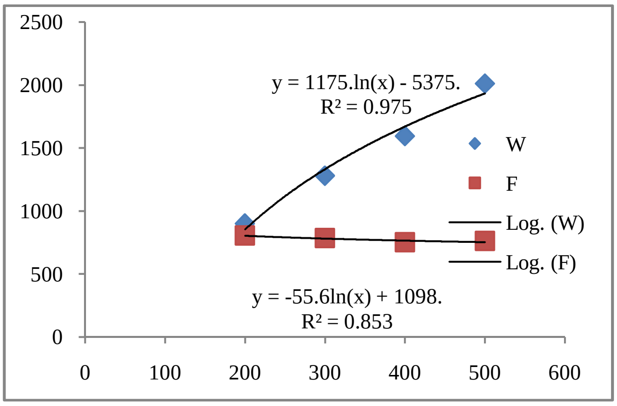

Fig. 2 Effect of Specimen length on Breaking Force and Breaking Work (20 Ne Ring-spun yarn)

The reduction in tenacity and the extension can be attributed to the well known weak-link effect (Midgeley and Pierce 1926), according to which the probability of presence of weakest link is greater in a longer specimen, which thus breaks early and results in lower strength and extension. The breaking work is a function of the product of breaking force and elongation (actual increase in the length of original specimen). The higher breaking work of a longer specimen of yarn as observed from Table 1 is due to the great increase in the length of the original specimen during extension.

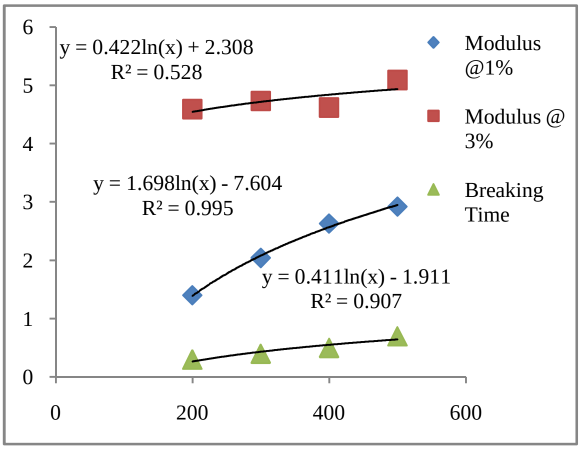

Fig. 3 Effect of Guage Length on Modulus and Breaking Time (20 Ne Ring-spun yarn)

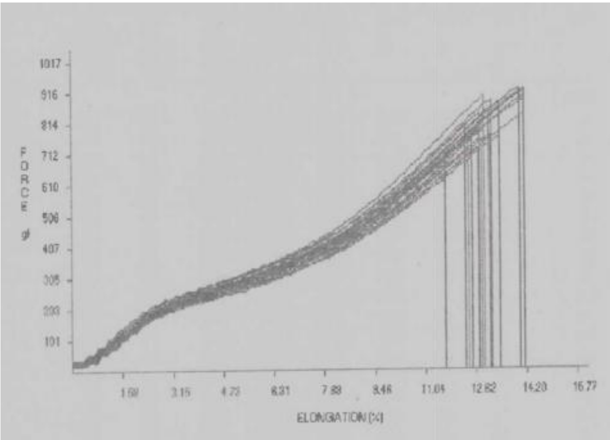

Fig. 4 Force-Elongation Curve at 200mm Specimen length of Ring-spun yarn

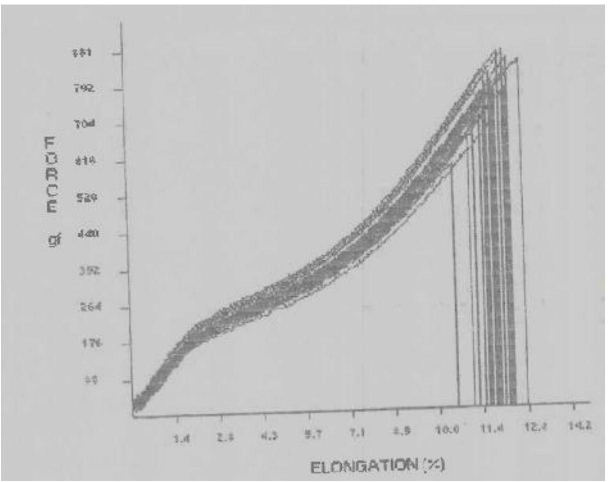

Fig. 5 Force-Elongation Curve at 500mm Specimen length of Ring-spun yarn

The modulus refers to the resistance offered by the yarn to extend and is determined by the ratio of stress to strain. The modulus measured at 1% extension is often referred to as the initial modulus. The modulus at 5% extension indicates the resistance offered by the yarn when it is subjected to such an extension level during post-spinning, weaving or knitting operations. From Table 1, it is observed that the modulus (at both 1% extension and 5% extension) increases with an increase in the specimen length of the yarn. In a shorter specimen, as it is strained initially, the instantaneous tension builds up results in quicker fibre straightening and ready extension, thus showing lower modulus. This effect can be understood from the nature of the force-elongation curve shown in Figure 4. On the contrary, the longer specimen exhibits lower extension owing to delayed tension build up, perhaps caused by partial relaxation of the applied stress and thus registering a relatively higher modulus. The nature of the load-elongation curve (Figure 5) of a longer specimen is essentially different from that of a shorter specimen.

Air-jet-spun Yarn

It can be seen from Table 2 that the influence of specimen length of tensile characteristics of Air-jet-spun yarn is almost similar as in the case of Ring-spun yarn discussed above. However, as compared to Ring-spun yarn, the Air-jet-spun yarn registers minimum reduction in tenacity and extension due to increase in specimen length from 200 mm to 500 mm. The nature of stress-strain curves for Air-jet-spun yarn differs considerably from that of Ring-spun yarn, which is clearly evident from Figures 6-10. The polyester fibres, which are relatively long expected to result in longer wrapper extent and firm wrappings in the Air-jet-spun yarn.

Table 2 Effect of Specimen length on Tensile Properties of 20 Ne Air-jet-spun yarn

L	200	300	400	500
t	0.2	0.3	0.4	0.5
F	543.1	535.2	521.0	501.5
T	18.45	18.00	17.75	17.65
E	10.9	10.57	10.19	9.76
W	571.5	847.2	1033.6	1289.4
M_1	1.39	1.75	1.79	2.10
M_5	2.83	3.34	3.53	3.70

L: Specimen length (mm); t: Breaking Time (sec); F: Breaking Force (cN); E: Breaking Extension (%); T: Tenacity (cN/tex); W: Breaking Work (kgf.m); M_1: Modulus (N/tex) at 1% extn.; M_3: Modulus (N/tex) at 5% extn

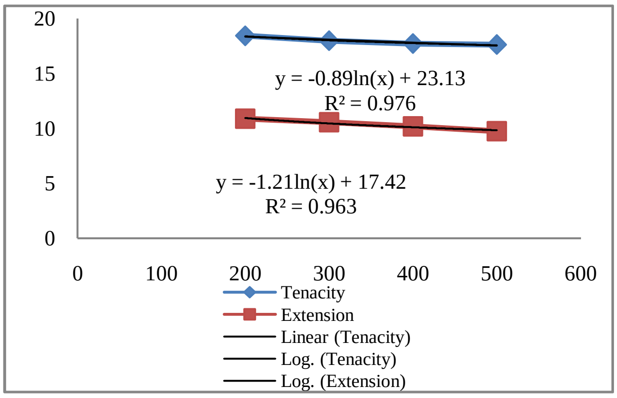

Fig. 6 Effect of Specimen length on Tenacity and Elongation (%) (20 Ne Air-jet-spun yarn)

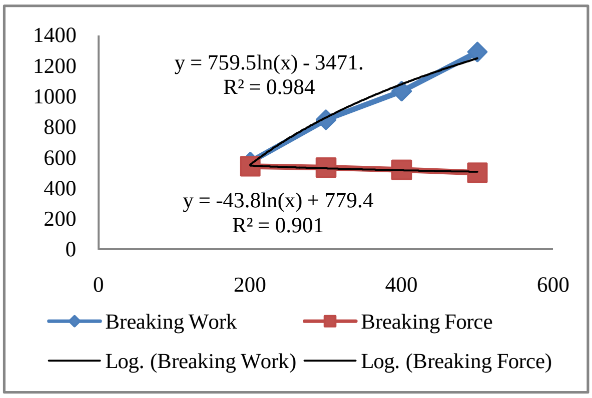

Fig. 7 Effect of Specimen length on Breaking Work and Breaking Force (20 Ne Air-jet-spun yarn)

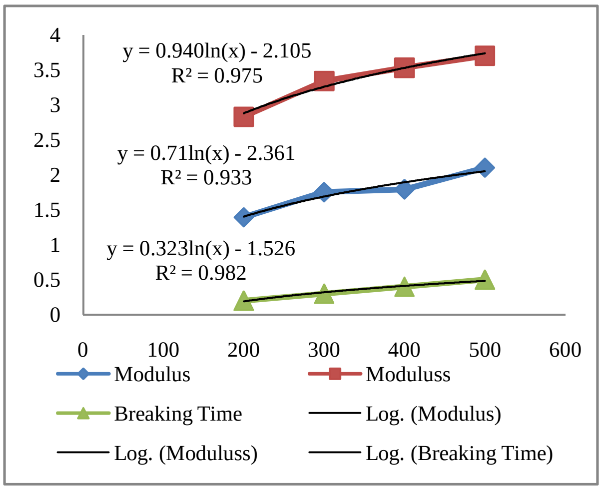

Fig. 8 Effect of Guage Length on Modulus and Breaking Time (20 Ne Air-jet-spun yarn)

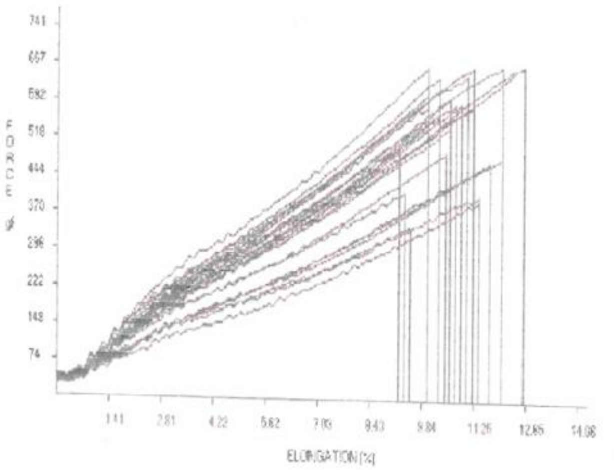

Fig. 9 Force-Elongation Curve at 200mm Specimen length of Air-jet-spun yarn

Rotor-spun Yarn

The Rotor-spun yarn also depicts similar tensile behaviour in response to variation in specimen length (Table 3) as already observed for Ring-spun and Air-jet-spun yarns. But interestingly, the drop in the tenacity and extension of longer specimen (500 mm) is substantial in Rotor-spun yarn, as compared to a shorter specimen (200 mm).

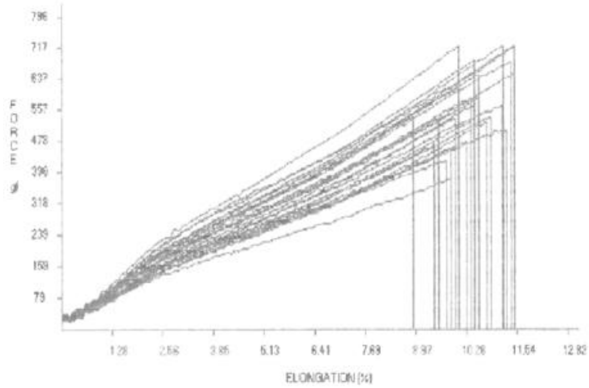

Fig. 10 Force-Elongation Curve at 500mm Specimen length of Air-jet-spun yarn

This is clearly evident from Figures 11-15. It was understood from the studies of Kaushik *et al*. [3] who studied the influence of extension rate and specimen length on the tensile behaviour of Rotor-spun acrylic/viscose yarn. They found that the maximum yarn tenacity occurs at a strain rate of 20 cm/min for a specimen length of 10 cm and at a strain rate of 100 cm/min for a specimen length of 50 cm. The breaking extension on the other hand, was shown to increase with increase in extension rate.

Table 3 Effect of Specimen length on Tensile Properties of 20Ne Rotor-spun yarn

L	200	300	400	500
t	0.2	0.3	0.4	0.6
F	568.9	528.4	540.6	521.0
T	19.27	17.80	17.74	17.40
E	10.88	10.27	10.21	10.02
W	644.4	858.0	1160.4	1373.9
M_1	1.50	1.96	2.31	2.77
M_5	4.89	5.02	5.03	5.17

L: Specimen length (mm); t: Breaking Time (sec); F: Breaking Force (cN); E: Breaking Extension (%); T: Tenacity (cN/tex); W: Breaking Work (kgf.m); M_1: Modulus (N/tex) at 1% extn.; M_3: Modulus (N/tex) at 5% extn;

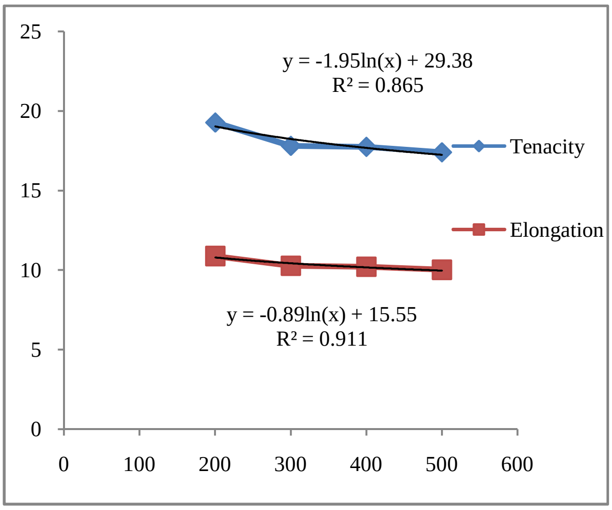

Fig. 11 Effect of Specimen length on Tenacity and Elongation (%) (20 Ne Rotor-spun yarn)

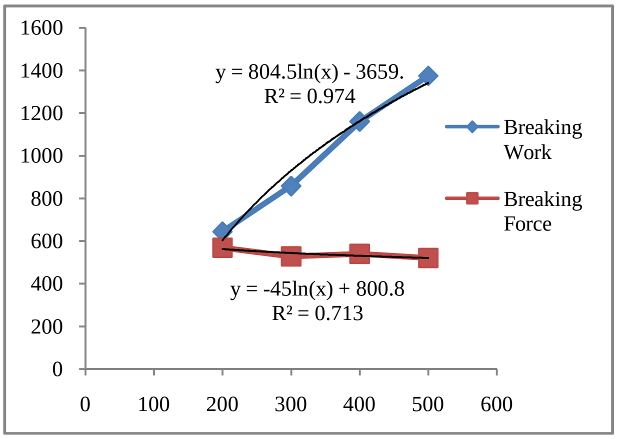

Fig. 12 Effect of Specimen length on Breaking Work and Breaking Force (20 Ne Rotor-spun yarn)

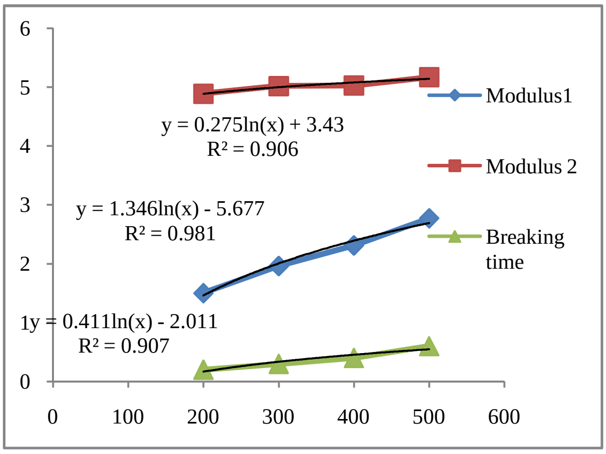

Fig. 13 Effect of Specimen length on Modulus and Breaking Time (20 Ne Rotor-spun yarn)

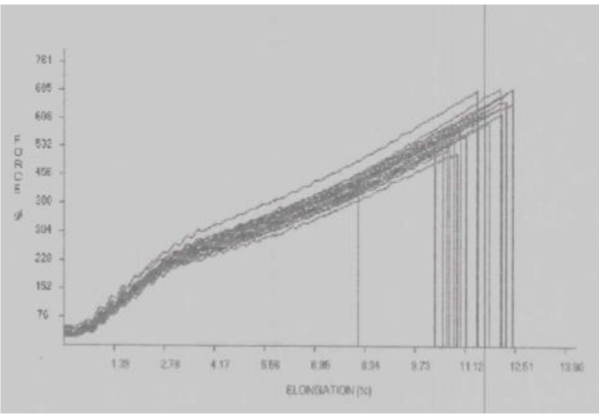

Fig. 14 Force-Elongation Curve at 200mm Specimen length of Rotor-spun yarn

When the tensile characteristics of 20 Ne Ring-spun, Rotor-spun and Air-jet-spun yarns are compared, it is observed that at all levels of specimen length, the Ring-spun yarn exhibits higher strength and modulus followed by Rotor-spun yarn and Air-jet-spun yarn. The Rotor-spun yarn has highest breaking extension and breaking work. The Ring-spun yarn shows lowest breaking extension while the Air-jet-spun yarn lies in between the Rotor-spun and Ring-spun yarns in this respect.

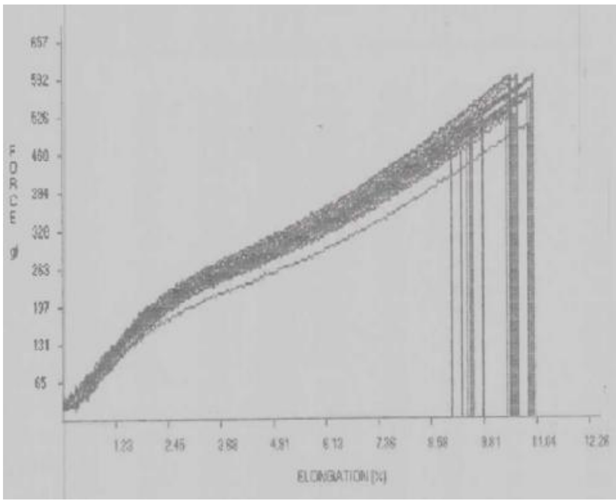

Fig. 15 Force-Elongation Curve at 500mm Specimen length of Rotor-spun yarn

Table 4 Coefficients of Determination for Yarn Tenacity (T) as a function of Specimen length (L)

Count	*Regression Equation*	R^2
20 Ne Ring-spun Polyester Yarn	T= -1.88ln(L) + 37.19	0.854
20 Ne Air-jet-spun Polyester Yarn	T = -0.89ln(L) + 23.13	0.976
20 Ne Rotor-spun Polyester Yarn	T = -1.95ln(L) + 29.38	0.865

These differences in tensile characteristics of above yarns are ascribed to marked differences amongst their structural features. Finally, by plotting the values of breaking force, tenacity, breaking extension, breaking work and modulus of all yarns against the values of specimen length, it is deduced that breaking force, tenacity, breaking extension, and breaking work, modulus are logarithmic functions of specimen length. The regression equations and coefficients of determination for all the yarns are given in Table 4.

Influence of Extension Rate

Ring-spun Yarn

The increase in extension rate from 5 m/min to 400 m/min increases the yarn tenacity but does not have a regular effect on yarn breaking extension (Table 5). The maximum tenacity was recorded for Ring-spun yarn at an extension rate of 400 m/min. At a very high extension rate, the loading of yarn resembles an impact test wherein due to the absence of an appreciable time for relaxation, the fibres are subjected to an instantaneous force, which results in catastrophic breakage of the very high proportion of fibres in the yarn and thus recording a higher tenacity.

Table 5 Effect of Extension Rate on Tensile Properties of 20Ne Ring-spun yarn

Extension Rate (m/min)	Breaking Force (cN)	Tenacity (cN/tex)	Extension (%)	Breaking Work (cN-mm)
400	849.5	28.77	11.63	2324
5	761.2	25.78	11.88	2011

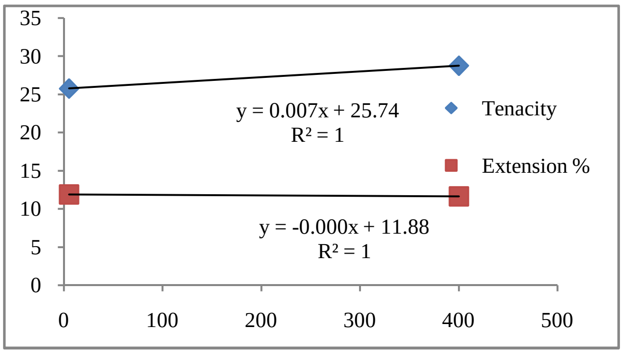

Fig. 16 Effect of Extension Rate on Tenacity and Extension (20 Ne Ring-spun yarn)

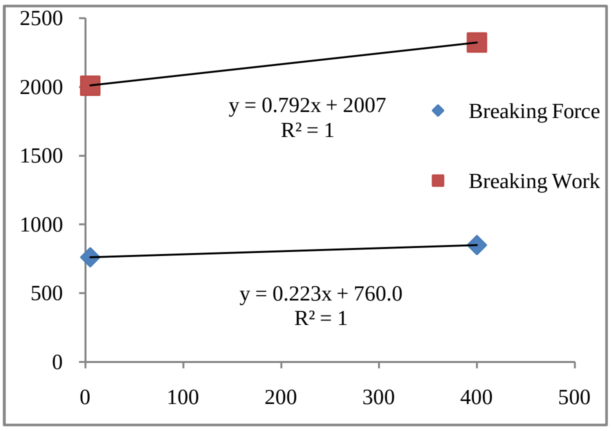

Fig. 17 Effect of Extension Rate on Breaking Force and Breaking Work (20 Ne Ring-spun yarn)

Air-jet-spun Yarn

The increase in extension rate from 5 m/min to 400 m/min increases the tenacity of Air-jet-spun yarn. The maximum tenacity was recorded at around 400 m/min (Table 6). The increase in the tenacity with an increase in strain rate is definitely due to breakage of more number of fibres in the yarn. The reduction in yarn extension at high strain rate (400 m/min) may be due to an instantaneous extension of the core fibres followed by loosening of wrapper fibres and the consequent slippage of core fibres.

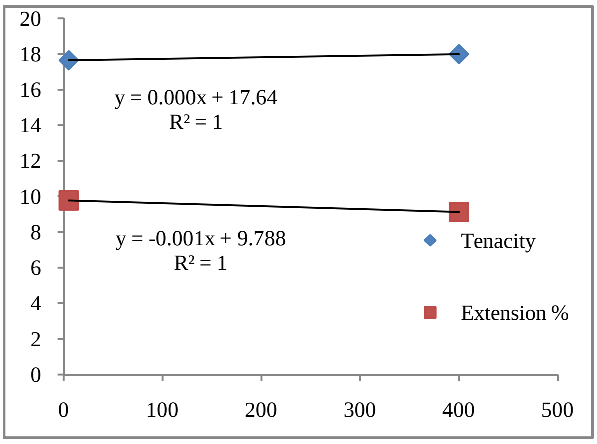

Fig. 18 Effect of Extension Rate on Tenacity and Extension (20 Ne Air-jet-spun yarn)

Table 6 Effect of Extension Rate on Tensile Properties of 20Ne Air-jet-spun yarn

Extension Rate (m/min)	Breaking Force (cN)	Tenacity (cN/tex)	Extension (%)	Breaking Work (cN-mm)
400	531.1	17.99	9.14	1227
5	521.2	17.65	9.78	1289

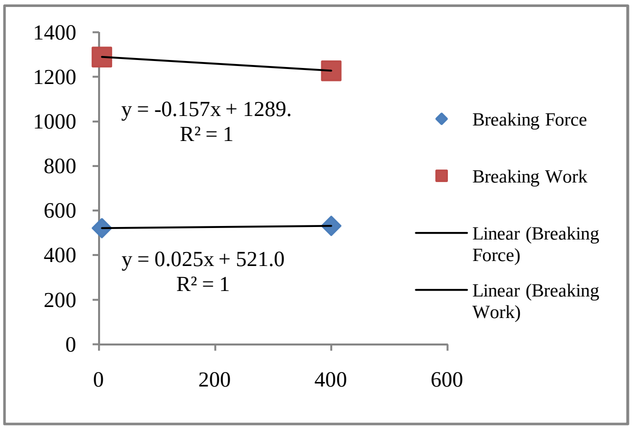

Fig. 19 Effect of Extension Rate on Breaking Force and Breaking Work (20 Ne Air-jet-spun yarn)

Rotor-spun Yarn

In case of Rotor-spun yarn, the increase in extension rate from 5 m/min to 400 m/min generally increases the tenacity with the maximum being recorded at around 400 m/min (Table 7). This can be attributed to the breakage of a higher proportion of fibres besides some contribution by wrapper fibres (which are expected to break due to application of a high instantaneous force).

Table 7 Effect of Extension Rate on Tensile Properties of 20 Ne Rotor-spun yarn

Extension Rate (m/min)	Breaking Force (cN)	Tenacity (cN/tex)	Extension (%)	Breaking Work (cN-mm)
400	525.0	17.78	9.95	1363
5	521.0	17.62	10.02	1374

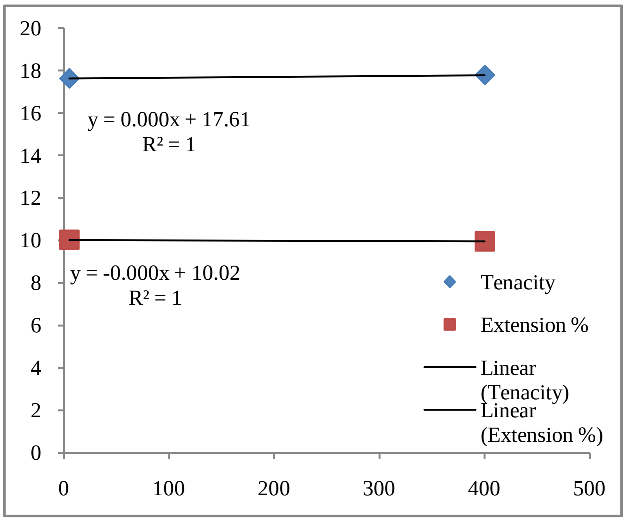

Fig. 20 Effect of Extension Rate on Tenacity and Extension (20 Ne Rotor-spun yarn)

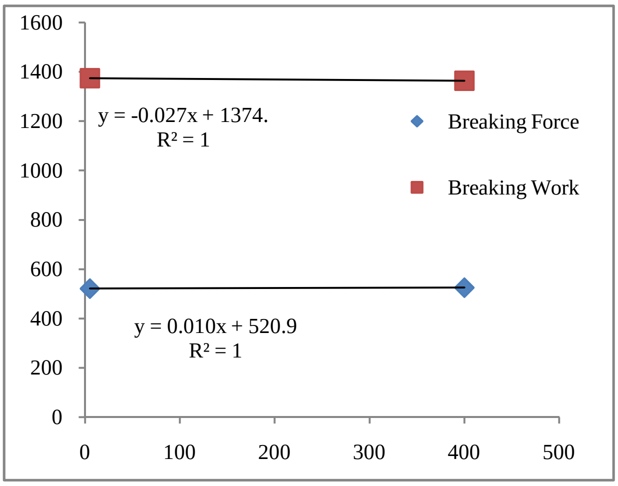

Fig. 21 Effect of Extension Rate on Breaking Force and Breaking Work (20 Ne Rotor-spun yarn)

It can be seen that an increase in extension rate from 5 m/min to 400 m/min considerably increases the yarn tenacity but decreases the yarn breaking extension. At a high strain rate of 400 m/min, the loading of yarn resembles an impact test wherein due to the absence of an appreciable time for relaxation the fibres are subjected to an instantaneous force, which results in catastrophic breakage of very large proportions of fibers in the yarn and thus recording a higher tenacity. The lack of an appreciable time for relaxation of stress by fibres and the absence of realignment causes a reduction in breaking extension of the yarn. This trend is exhibited by all the three types of yarns. Further, it is clear that the increase in yarn tenacity due to increase in extension rate from 5 m/min to 400 m/min is not statistically significant at the 95 % level of confidence but it is appreciable and of practical importance. The increase in strain rate does not have a significant effect on yarn extension-at-break. Finally, by plotting the values of breaking force, tenacity, breaking extension, breaking work and modulus of all yarns against the values of specimen length, it is deduced that breaking force, tenacity, breaking extension, and breaking work, modulus are logarithmic functions of specimen length. The regression equations and coefficients of determination for all the yarns are given in Table 9.

Table 9 Coefficients of Determination for Yarn Tenacity as a function of Extension Rate

Count	*Regression Equation*	*R^2*
20 Ne Ring-spun Polyester Yarn	T= 0.0076(TS)+25.742	1
20 Ne Air-jet-spun Polyester Yarn	T = 0.0009(TS)+17.646	1
20 Ne Rotor-spun Polyester Yarn	T = 0.0004(TS)+17.618	1

CONCLUSIONS

Trevira CS flame-retardant polyester fibres exhibit very good processability in Ring spinning, Air-jet spinning and Rotor spinning systems. The increase in specimen length of yarn continually decreases its tenacity, breaking extension but increases the breaking time, breaking work and modulus at 1% extension and 5% extension. Amongst all yarns, the Ring-spun yarn exhibits highest tenacity followed by Rotor-spun yarn and Air-jet-spun yarn. Rotor-spun yarn depicted highest modulus followed by Ring-spun yarn and Air-jet-spun yarn. The yarn tenacity, breaking extension, breaking work and breaking time and modulus are found to be logarithmic functions of specimen length. The increase in strain rate from 5 m/min to 400 m/min substantially increases the yarn tenacity but does not have a regular effect on its breaking extension. The percentage increase in tenacity is higher in case of 20 Ne Ring-spun yarn followed by the corresponding Rotor-spun yarn and Air-jet-spun yarn. The findings of the present work will be of great use to the spinners and quality control personnel to select suitable specimen lengths for different types of yarns to depict high tenacity, extension and breaking work and relatively low modulus depending upon the application. This study also helps to understand the performance of yarns, which are subjected to various strain rates during post-spinning, weaving and knitting operations.

Acknowledgement

We would like to acknowledge our gratitude to DRDO, New Delhi, for sponsoring this research work to develop flame retardant textile materials.

References

1. Midgeley E., and Pierce F.T., (1926), Tensile Tests for Cotton Yarns, the Rate of loading, *Journal of Textile Institute*. 17, T330-T341.
2. Meredith R., (1950), The Effect of Rate of Extension on the strength and Extension of Cotton Yarn, *Journal of Textile Institute* 41, T199-T224.
3. Kaushik R.C.D., Salhotra K.R., and Tyagi G.K., (1989), Influence of Extension Rate and Specimen Length on Tenacity and Breaking Extension of Acrylic/Viscose Rayon Rotor-spun Yarns, *Textile Research Journal* 59 (2), 97-100
4. Hearle J.W.S., and Thakur V.M., (1961), The Breakage of Twisted Yarns, *Journal of Textile Institute* 52, T149-T163.
5. Realff M.L., Seo M., Boyce M.C., Schwartz P., and Backer S., (1991), Mechanical Properties of Fabrics Woven from Yarns Produced by Different Spinning Technologies: Yarn Failure as a Function of Specimen length, *Textile Research Journal* 61 (9), 517-530
6. Hearle J W S, Grosberg P and Backer S, (1969), Structural Mechanics of Fibers, Yarns, and Fabrics Vol. 1, New York, Wiley-Interscience.
7. Oxenham W., Zhu R.Y., Leaf G.A.V., (1992), Observations on the tensile properties of Friction spun yarns, *Journal of Textile Institute*, 83,621-623.
8. Peirce F.T., (1926), Tensile Tests for cotton yarns, part V: The Weak Link Theorems on the strength of Long and composite specimens, *Journal of Textile Institute*, 17, T355-T368.
9. Grant J.N, Morlier O.E., 1948, Relation of Specific Strength of Cotton Fibre to Fibre Length and Testing Method, *Textile Research journal*, 18, ,PP 481-487.
10. Pillay K.P.R, (1965), Fibre Strength at finite Specimen length of raw material and Mercerised cotton: A study of Bundles in "Proc. Seventh Tech. Conference ATIRA, BTRA and SITRA," sec. A, PP. 15-30.

11. Kapadia D.F, (1935), Single-Thread Strength Testing of yarns at various lengths of Test specimens. *Journal of Textile Institute*, 26, T142-T266
12. Hattenschwiler P., Pfeiffer R., Schaufelberger J., 1984, The Tensile Strength of Yarns-Latest Reports from Mill Practice. Milliand Textilberichte [Eng.Ed.], 21-23,
13. Hussain G.F.S., Nachane R.P., Krishna Iyer.K.R., and Srinathan B., 1990, Weak-Link Effect on Tensile Properties of Cotton Yarns, *Textile Research Journal*, No.2, PP 69-77.
14. Maria Cybulska and Bhuvenesh c. Goswami, 2001, Tensile Behaviour of Staple Yarns, *Journal of Textile Institute*, 92 part 3 ©Textile institute.
15. Radhakrishnaiah P.and Gan Huang,, (1997). The Tensile and Rupture Behaviour Of Spun Yarns Representing Different Spinning Systems, School of Textile & Fibre Engineering, Atlanta, GA 30332-0295
16. Rengasamy, R.S.; Ishtiaque, S.M.; Ghosh, A.; (2005), Prediction of Spun Yarn Strength at Different Specimen lengths using Weibull Distribution; *Indian Journal of Fiber &Textile Research*, 30, 283-289.
17. Salhotra, K.R.; Balasubramanian, P.; (1986), Estimation of Minimum Fiber Length Contributing to Tenacity of Rotor-spun Yarns; *Indian Journal of Fiber & Textile Research Journal*, 11, 11-14,
18. Tallant, J.D.; Fiori, L.A.; Little, H.W.; Castillan, A.V.; 1963, Investigation of the Minimum Length of Cotton Fiber Effective in Single Yarn Tenacity; *Textile Research Journal* 33, 1005-1012.
19. Gulati, A.N.; Turner, A.J.; ,(1930), The Foundations of Yarn-strength and Yarn-extension, Part IV: The Influence of Yarn- twist on the Diameters of Cotton Yarns and on the Proportions of Fiber Slippage and Fiber Rupture in Yarn Breakage; *Journal of Textile Institute*, 21, T561-T582.
20. Hearle, J.W.S.; Sakai, T.; (1979), On the Extended Theory of Mechanics of Twisted Yarns; *Journal of Textile Machinery Society of Japan*, 25, 68-72,
21. Krause, H.W.; Soliman, H.A.; (1990), Theoretical Study on the Strength of Single Jet False Twist Spun Yarns; *Textile Research Journal*, 60, 309-318.
22. Tyagi, G.K.; Goyal, A.; Salhotra, K.R.; (2003), Sheath-slippage Resistance and Other Properties of Polyester-Viscose MJS Core-spun Yarns; *Indian Journal of Fiber & Textile Research*, 28,170-176,
23. Chasmawala, R.J.; Hansen, S.M.; Jayaraman, S.; ,(1990), Structure and Properties of Air-jet-spun Yarns; *Textile Research Journal*, 60, 61-69
24. Chasmawala, R.J.; (1988), Structures and Properties of Air-jet-spun Yarns; Masters Thesis, School of Textile Engineering, Georgia Institute of Technology, Atlanta, Georgia,
25. Lawrence, C.A.; Baqui, M.A.; (1991), Effect of Machine Variables on the Structure and Properties of Air-jet Fasciated Yarns; *Textile Research Journal*, 61, 123-130
26. Rajamanickam, R.; Hansen, S.M.; Jayaraman, S.A.; (1998), A Model for the Tensile Fracture Behavior of Air-jet-spun Yarns; *Textile Research Journal*, 68, 655-662.

****

How to cite this article:

Bharani M.2016, Influence of Specimen Length And Extension Rate on Tensile Behaviour of Spun Yarns. *Int J Recent Sci Res.* 7(3), pp. 9612-9619.

ISSN 0976-3031

9 770976 303009 >