Middle-East Journal of Scientific Research 11 (4): 498-502, 2012
ISSN 1990-9233

Studies on the Properties of Some Selected Polyester Textured Yarns

K.O. Fashola, A. Giwa, E.B. Iliya and J.G. Onemano

Department of Textile Science and Technology, Ahmadu Bello University, Zaria, Nigeria

Abstract: The study was carried out to investigate the properties of some polyester textured yarns. Five textured yarns of different linear densities were used. The spinning and texturing of the yarn samples were carried out in the industry. Tensile properties such as tenacity, breaking force, extension, specific work of rupture were examined at five different gauge lengths. The results obtained show a significant decrease in tenacity, breaking load, extension and specific work of rupture with increased gauge- length. These properties increased with increase in linear density, with the exception of extension which decreased with increased linear density.

Key words: Tensile · Count (denier) · Bulk Ratio · Crimp contraction · Stretch potential · Recovery potential

INTRODUCTION

Polyesters are polymers which contains an ester (-coo-) group in their chain [1]. A polyester fibre is "a manufactured fibre in which the fibre forming substance is any long chain synthetic polymer composed of at least 85% by weight of an ester of a dihydric alcohol and terephthalic acid [2]. However, polyester normally melts and flows under the influence of temperature at above 260°C [3]. The various commercial polyester melt-spinning processes are classified according to the degree of molecular orientation in the spun fibre.

Polyester spinning processes operating at speeds of 500-1500m/min, give low oriented spun yarns, (LOY). Processes operating at speeds of 1500-2500 m/min give medium oriented spun yarns (MOY). Yarns referred to as partially oriented yarns (POY) are produced by spinning at speeds of 2500-4000 m/min. Between 4000—6000 m/min, highly oriented spun yarns (HOY) are obtained. Above 6000 m/min, fully oriented yarns (FOY) are obtained [2].

Textured yarn is a generic term for filaments or spun yarns that have been given notably greater apparent volume or bulk than conventional yarns of similar filament count or which have been made more extensible by filament distortion through physical, chemical or heat treatment or a combination of these [4]. Texturing introduces permanent distortions, crimps, loops, coils, or crinkles without destroying the essential continuity of the filaments. This improves the texture of the yarns [2].

Texturing gives yarns a soft and woolly feel and increases the warmth and comfort of fabrics. The loops and crimps entrap a multitude of small pockets of air. The filaments in a textured yarn reduce air movement to a minimum and conduct heat more readily than static air. The filaments prevent air movement and hold the fabric together [5].

The prime purpose of texturing filament yarns is to create bulky structure which is desirable for the following reasons: The voids in the structure cause the materials to have good insulation properties. The voids in the structure change the density of the material which makes it to have light weight with good covering properties. The disorganized surface of the yarn gives dispersed light reflection which in turn gives a desirable mat appearance. The sponge like structure feels softer than the lean twisted flat yarn. The crimp filament structure gives a lower effective modulus of elasticity to the structure as compared to a flat yarn.

The properties of the yarns themselves are largely dependent on several factors, such as the structure of the polymer, the kind and amount of modifier, the spinning method and the degree of stretching during fibre and yarn formation. The last two items affect the molecular orientation and the crystallinity of the yarn to a large degree [6].

MATERIALS AND METHODS

Materials: Five samples of textured polyester yarns of different count (D_1 – D_5) were used for this work. The materials were obtained from Integrated Fibres Limited, Kano, Nigeria.

Corresponding Author: K.O. Fashola, Department of Textile Science and Technology, Ahmadu Bello University, Zaria, Nigeria.

Table 1: Moisture Content, Moisture Content, Mean count (denier), Bulk Ratio, Number of filaments, Crimp contraction%, Stretch potential%, Recovery potential%.

Samples	*D1*	*D2*	*D3*	*D4*	*D5*	*S.D*
Moisture Content	1.00	1.08	1.00	0.71	0.86	0.14628739
Mean count (denier)	79.40	125.10	148.40	240.30	302.40	90.4805338
Bulk Ratio	1.69	1.63	1.64	1.58	1.53	0.06107373
Number of filaments	36	36	36	72	72	19.7180121
Crimp contraction%	12.50	15.00	15.00	17.50	17.50	2.09165007
Stretch potential%	31.40	29.40	28.20	27.20	24.20	2.67432234
Recovery potential%	16.20	15.80	14.70	12.90	11.10	2.12673459

Equipment: Draw-texturing machine (Barmag model); Instron tensile tester; Wrap reel; Microscope; Digital balance; Hot box oven; Meter rule.

Conditioning of Samples: The samples were allowed to condition at temperature of 25±2°C and relative humidity of 65±2% before the tests were carried out. All tests were also performed under standard conditions.

Moisture Content Determination: The yarn skein was weighed before the test (W_1) and dried in the oven at a temperature of 107±2°C. Thirty minutes later the sample was weighted and its mass recorded. Subsequent weighing was carried out every twenty minutes until a constant mass was obtained. The result of mass determination at the last weighing was considered to be the constant mass (W_2). The moisture content was calculated using the relations:

$$W = W_1 - W_2 \quad (1)$$

$$M = \frac{100W}{W_2 - W}\% \quad (2)$$

Where

W = Mass of absorbed water

W_1 = Initial mass

W_2 = Dry mass

M = Moisture content

The results are shown in Table 1.

Yarn Count Determnations: The count of the yarns was determined in accordance with British Standards Handbook, II (1974). 100m length of yarn was wound using the wrap reel and weighed. The yarn count was evaluated using the formula:

$$Denier = \frac{W}{L} \times 9000$$

Where

W = Weight of yarns in grams

L = Length in metres

The mean yarn count, standard deviation and C.V% are presented in Table I.

Bulk Test: Yarns of equal length were wound using the wrap reel at the same tension and then weighed. The ratio of the weight of the original yarn (W_1) to that of the textured yarn (W_2) indicates the bulk ratio.

$$\text{Bulk ratio (B)} = \frac{W_1}{W_2}$$

The mean bulk ratio, standard deviation and C.V% are shown in I.

Microscopic Examination: The specimens were washed with water and allowed to dry. The number of the constituent filaments in the yarns was determined using a research microscope. Visual investigations were also made. The observations made are recorded in Table 1.

Determination of Crimp Contraction, Stretch and Recovery Potentials: A length of yarn 40cm long was withdrawn from the package and loaded with 6g at a point about 30cm from one end. It was then cut free from the package at a point between the package and the weight, but close to the latter. From the weighted end, 20cm length of yarn was measured (L_1).

The length (L_1) was then contracted or shrunk by immersing completely for 5 minutes in a cylinder of water at the boil. The contracted yarn was removed and the length (L_2) taken immediately. After measuring, it was then loaded at the lower end with a 15g weight and allowed to stretch. The fully extended length (L_3) was determined and the stretch load was removed.

After 5 minutes the final or recovered length (L_4) was measured. The crimp contraction (%), stretch (%) and recovery potential (%) were obtained using the following relationships.

$$Crimp\ contraction\,(CC)\% = \frac{L_1 - L_2}{L_1} \times 100$$

$$\text{Stretch Potential (SP)\%} = \frac{L_3 - L_2}{L_3} \times 100$$

$$\text{Recovery Potential (RP)\%} = \frac{L_3 - L_4}{L_4} \times 100$$

The mean results, standard deviation and C.V% are shown in Table 1.

Tensile Tests: The tests were carried out in accordance with the British Standard Handbook II (1974) using the Instron tensile tester (model 1026). The samples were tested at five different gauge-lengths. Each sample was tested at a constant rate of extension of 200mm/min and extended axially until it broke under a maximum load of 500g.

Determination of Tenacity: The tenacity was obtained using the relationship below:

$$Tenacity = \frac{Breaking\ load}{Linear\ density} \quad (N / denier)$$

The results are shown in Figure 1.

Determination of Breaking Extension: The breaking extension was obtained using the following relationship:

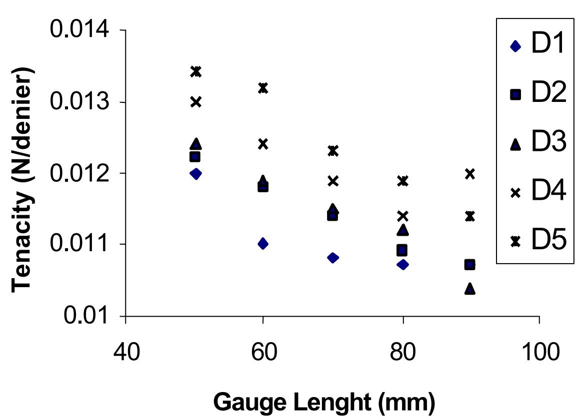

Fig. 1: Tenacity versus Gauge Length

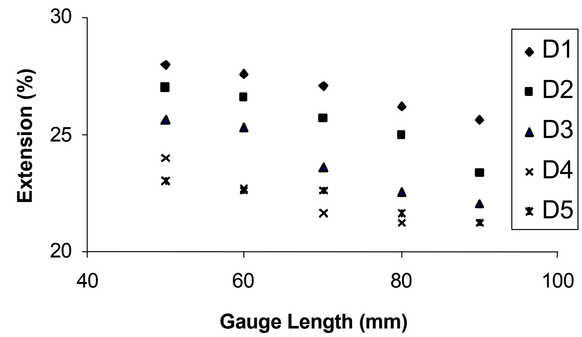

Fig. 2: Extension versus Gauge Length

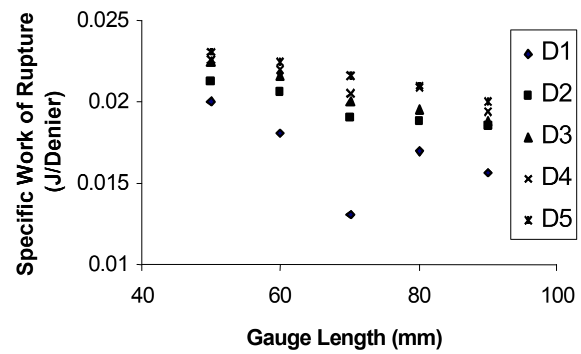

Fig. 3: Specific Work of Rupture versus Gauge Length

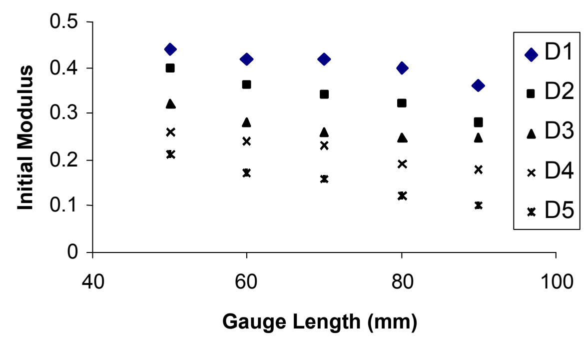

Fig. 4: Initial Modulus versus Gauge Length

$$\text{Breaking Extension} = \frac{Elongation}{Initial\ Lenght} \times 100$$

The results are displayed in Figure 2.

Determinations of Specific Work of Rupture: The work of rupture was determined by finding the area under the load-elongation curve using the counting the square method. The specific work of rupture was determined by the following relationship.

$$Specific\ work\ of\ rupture = \frac{Work\ of\ rupture}{count\,(tex)\,x\,guage\ length}$$

The result is presented in Figure 4.

Initial Modules Determinations: Initial modulus was found by taking the tangent of the angle between the initial parts of the curve and the horizontal axis. The results are shown in Figure 4.

RESULTS AND DISCUSSION

Moisture Content: Table 1 shows the moisture content of the textured yarns samples. It is observed that, there are only slight variations in their moisture content and also in general their moisture content is very low. This is because of the recurring benzene ring in polyester which imparts hydrophobicity and low water absorption [7]. The moisture absorption of polyester textured yarns is very low, compared with other synthetic textured yarns. This low moisture absorption explains on the one hand why the polyester textiles dry very quickly and on the other hand, there is almost no difference between the tenacity and extension values of dry or wet polyester textured yarns [7].

Yarn Count: From Table I, it is seen that the count increases from D_1 – D_5. The 'count' of a yarn is a numerical expression which defines its fineness. This shows that the degree of coarseness increases in the order D_5, >D_4,>D_3, D_2 >D_1. The higher the count, the coarser the yarn and vice-versa [8].

Bulk Ratio: From Table I, it is observed that the bulk ratio decreases as the linear density increases, D_5, >D_4,>D_3, D_2 >D_1. This is because more filaments occupy more spaces than filaments in the normal yarns [9].

Crimp Contraction, Stretch and Recovery Potential: Crimp characterizes the non-linearity of the yarn longitudinal axis. It influences the choice of the fibre spinning system, the processes of making yarn, the properties and outward appearance of produced yarn and manufactured goods [10]. In synethtic filament yarns, the crimp is highly elastic, this leads to fabrics that retain for a long time their soft and bulk characteristics. Table 1 shows the crimp contraction, stretch and recovery potential of the textured yarn samples. The results indicate that there is slight increase in the crimp contraction from D_1 to D_5. The reason may be that polyester textured yarns have uniform electron density which does not change greatly during contraction. They tend to form a more homogenous morphology [11].

Percentage Extension: From Figure 2, the extensibility is seen to be reduced with increased gauge-length. This implies that, the yarns can withstand more strain at the lower gauge length than at higher length. This is also due to the weaklink effect [12]. It is also observed that the extension decreases as the linear density increases. This implies that as the orientation increases, extension decreases.

Tenacity: Figure 1 shows the mass stress at break for individual specimens. It is observed that the tenacity decreases with increased gauge-length. This may be due to the weaklink effect. With increasing gauge-length, the probability of a weak places being available increases. In tensile testing, the weakest place within the test length is tested and not the mean value, then with increases in gauge length, it is to be expected that the breaking load will reduce, for the same yarn count [13]. It is also observed tenacity increases with linear density. This is because of the increase in molecular orientation, in other word, as the linear density increases, the orientation increases and bigger load is required to break the specimen [2].

Specific Work of Rupture: Figure 3 shows the energy needed to break 1.0 tex yarns at different gauge-length. The decrease in the values is due to the "weak –link" effect.

CONCLUSION

The objective of the work is to study the properties of Nigerian manufactured polyester textured yarns. Five polyester textured yarn samples were used, viz, D_1 – 75 denier, D_2 – 125 denier, D_3 – 150 denier,, D_4 – 250 denier, D_5 – 300 denier. The samples were tested for some physical and mechanical properties such as the count, bulk, crimp behaviour, stretch and recovery behaviour, breaking force, tenacity, extension, work of rupture etc. From the results obtained the following inferences can be deduced.

Properties such as tenacity, extension and specific work of rupture were found to decrease with increased gauge-length but they increased with increased in linear density. The crimp behaviour were found to be slightly increased and the bulk ratio decreased with increased density. The water sorption was generally low and the variations among the samples were marginal.

REFERENCES

1. Mohamad Ghaharpour, Abousaeed Rashidi and Habib Tayebi, 2011. Adsorption Behavior of Disperse Orange 30 on Polyester Fabric. World Applied Sciences J., 14(9): 1291-1295.
2. Mark, *et al*., 1988. Encyclopedia of Polymer Science and Engineering, second edition, volume 12, Interscience Publication, New York, pp: 118-188.
3. Muralidhara, K.S. and S. Sreenivasan, 2010. Thermal degradation and burning behavior of cotton, polyester and polyester/cotton blended upholstery fabrics. World Applied Sciences J., 10(5): 531-537.
4. American Society for Testing and Materials Standard definitions (1976); Third edition, U.S.A, pp: 78-79.
5. Lord, P.R., 1973. Spinning in the 70's merror publication co Ltd., England, pp: 47-65.
6. Press, J.J., 1959. Man-made textile encyclopedia, textile book publishers Inc., New York., pp; 94-126.
7. Ludewig, H., 1971. Polyester fibres chemistry and technology. Wiley and sons ltd., London, pp: 367-446.
8. Booth, J.E., 1968. Principles of textile testing, third edition, Bolton institute of Technology.
9. Isaac, G.E., 1973. Advances in False-twist turning processes. Shirley Institute, Manchester M208 Rx, pp: 35-71.
10. Koblyakou, A., 1986. Laboratory practice in the study of textile materials: MOSCOW, pp: 97-144.
11. Hawkins, G. and J.O. Warwicker, 1976. Recent developments in draw-texturing, Shirley institute, 49-54: 103.
12. Morton, W.E. and J.W.S. Hearle, 1975. Physical properties of textile fibres. Textile Institute Manchester, pp: 306-308.
13. Further, R., 1985. Strength and elongation testing of single and ply yarn's manual of textile technology. The textile institute. Manchester. M35DR England, pp: 23-82.