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Establishing the effect of loop length on dimensional stability of single jersey knitted fabric made from cotton/lycra core spun yarn

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Abstract

Munden and earlier workers established that in plain knitted fabrics the fabric dimensional parameters namely Kc, Kw and Ks are constant at dry and wet relaxed state for wool, cotton, orlon and nylon yarns. But in the present study of cotton/lycra core spun yarn single jersey derivative knitted fabrics the values for Kc, Kw and Ks varies with loop length. The ratio of Kc/Kw also varies with loop length. In this paper, Single jersey fabric is produced from Polyester/lycra air-covered yarn with different loop lengths. The study covers about the testing of dimensional properties of the single jersey knitted fabric. After the fabric production, the fabric was dry relaxed. Wales per inch, courses per inch, fabric width, loop length and fabric thickness are all measured. Then the fabric was wet relaxed and tested for the above parameters. Then the samples were heat set at various stretch levels at 180°C. From the study, it was found that the dimension of fabric shows considerable change during wet relaxation. The fabric shows very good appearance when heat set at all stretch levels at 180°C in course direction. The fabric with a loop length of 2.5 mm was found to have better appearance when compared to the fabrics of other loop lengths. In particular 10% stretch level shows a better appearance for 2.5 mm loop length.

Keywords: Dimensional stability, dry relaxation, wet relaxation, cotton/lycra core spun yarn, loop length, single jersey knitted fabric.

Introduction

Dimensional stability of weft-knitted fabrics is a serious problem in view of fabric quality control (Keshkari 2002; Punj. 2000). There are reports available on the geometry and dimensional properties of plain knitted fabrics (Mokhopadhyay *et al.*, 2003). Doyle and Hurd (1953), found that the stitch density of plain knitted fabrics in the dry relaxed state is dependent only on the loop length, and independent of other yarn and knitting variables.

Munden (1959) has shown that the natural shape of loop is determined by minimum energy conditions, and that assumes only loop similarity and derives geometrically the well-known relations ($k_c = c \times l$, $k_w = w \times l$, $k_s = k_c \times k_w$ and $k_r = k_c/k_w$ where c and w are the courses/unit length and wales/unit length and l is the loop length (length of yarn knitted in one loop), s the stitch density or No. of loops per unit area and Kc, Kw, and Ks are constants such that $k_c \times k_w = k_s$ and are called as fabric dimensional parameters). Munden found out the values for Kc, Kw and Ks for the worsted plain knit fabrics from experimental measurements.

Values for K	Dry relaxed	Wet relaxed
Kc	5.0	5.3
Kw	3.8	4.1
Kc/Kw	1.3	

Nuting and Leaf (1964) has proposed a generalized geometry of weft-knitted fabrics which introduced a term involving the yam diameter. Knapton (1979) has shown that dimensional stability in cotton plain-jersey fabrics can be attained by either mechanical relaxation techniques or chemical treatments, and that k-values are not entirely independent of the fabric tightness K ($=\sqrt{T}/l$, where T is the linear density in tex) and some yarn variables, and that the ratio t/l is in proportion to the fabric tightness for the completely relaxed cotton plain fabrics. Postle and Munden (1967) has shown that the value of ratio t/ l becomes 0.147 for plain-knitted fabrics. In this paper, studies have been done on the dimensional properties of knitted fabrics produced from air-covered elastomeric yarn. Here, Lycra polyester air-covered yarn is knitted into single jersey fabric and their properties have been tested on this knitted structure.

Experimental

The experimental samples were knitted on a 24 Gauge 24" dia high speed circular knitting machine equipped with positive feeders. Cotton/ Lycra core spun yarn of 30s count was used to produce the fabrics. The denier of lycra filament is 40. Samples were produced with 3 levels of loop length on single jersey derivatives. The samples were subjected to the following dry relaxation and wet relaxation. For dry relaxation, samples were left lying on a smooth flat surface in standard atmosphere for 3 days. Then the samples were bleached using hydrogen peroxide and dried in accordance with

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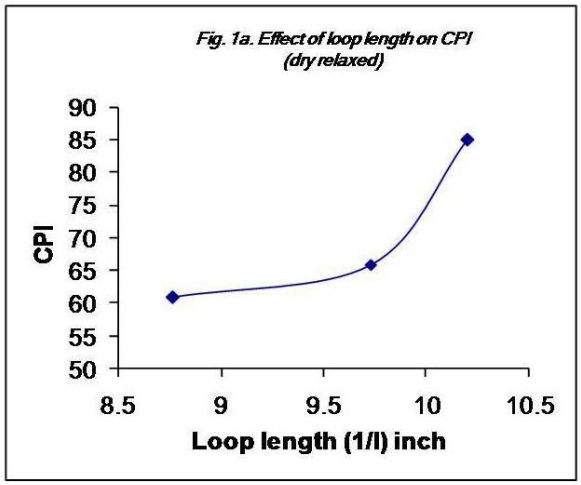

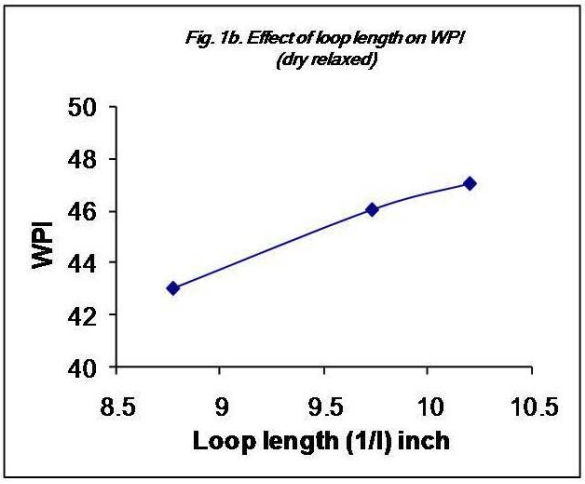

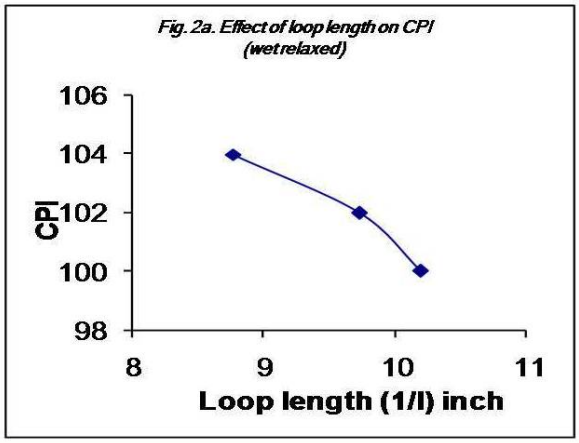

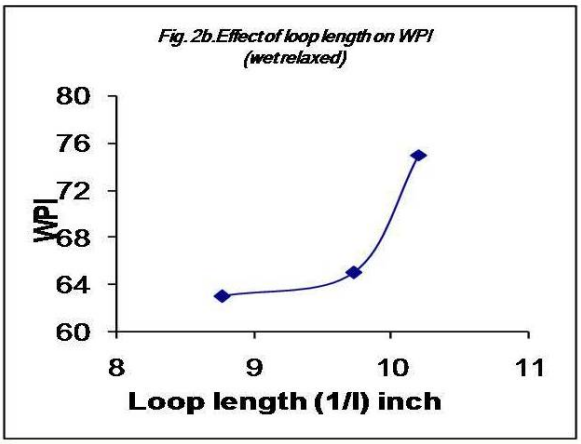

Table 1 Effect of loop length on fabric parameters at dry relaxed state

Loop length mm (inch)	CPI	WPI	K_c	K_w	N	K_s	K_c/K_w
2.5 (0.098)	85	47	8.33	4.61	3995	38.37	1.81
2.7 (0.106)	66	46	6.99	4.88	3036	34.11	1.43
2.9 (0.114)	61	43	6.95	4.90	2623	34.05	1.41

Table 2. Effect of loop length on fabric parameters at wet relaxed state

Loop length mm (inch)	CPI	WPI	K_c	K_w	N	K_s	K_c/K_w
2.5 (0.098)	100	75	9.8	7.35	7500	72.03	1.33
2.7 (0.106)	102	65	10.8	6.89	6630	74.41	1.57
2.9 (0.114)	104	63	11.86	7.18	6552	85.15	1.65

Table 3. Effect of stretching & heat Setting on CPI & WPI (2.5 mm loop length)

Loop length mm (inch)	Stretch level (%)	Course /inch	Wales /inch
2.5 (0.098)	10	110	58
	20	111	54
	30	114	50
	50	117	46
	70	119	44
	90	123	36

Table 4. Effect of stretching & heat Setting on CPI & WPI (2.7 mm loop length)

Loop length mm (inch)	Stretch level (%)	Course /inch	Wales /inch
2.7 (0.106)	10	104	56
	20	106	54
	30	109	52
	50	110	46
	70	115	42
	90	120	40

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current manufacturing practices. Measurement were taken on samples in wet relaxation state as reported by Bayazit Marmarali (2003).

Loop length l : The length of ten unrowed courses each of which containing fifty wales was measured and the average was calculated. This average value was divided by fifty to find the length of one loop (Choi & Ashdown, 2000).

Course and wales spacing: The number of courses and wales in a 1" length fabric were determined at ten different places on every sample with a magnifying glass and the average values were calculated. (Mikučionienė, 2004).

Results and discussions

The test results for Dry-Relaxed state are given in Table 1 and for Wet-Relaxed state in Table 2. From the Table 1, it is been found that the values of CPI, WPI, Kc, Kw, N, Ks and Kc/Kw varies with respect to loop length and also found decreased in the CPI, WPI, Kc, N, Ks and Kc/Kw values and an increased Kw value during Dry Relaxation process. Results are shown in Fig. 1a & 1b. From the Table 2, it is been found that the values of CPI, WPI, Kc, Kw, N, Ks and Kc/Kw varies with respect to loop length. Also there has been an increase in the initial CPI, Kc, Ks and Kc/Kw values, while a decrease in WPI & N value and a subsequent decrease and increase in Kw value during wet relaxation process. Results are shown in Fig. 2a & 2b. From the Tables 3-5, it is been found that CPI and WPI value varies with respect to stretch level at constant loop length and also a decrease in the wales per inch and increase in courses per inch.

From the Table 6, it is found that Courses per inch values varies with respect to loop length and also a considerable increase in the Course per inch after hot washing. Wales per inch values varies with respect to loop length and also decreases after hot washing (Table 7). Loop length values vary before and after wet relaxation and found a minimal change in the loop length after hot washing (Table 8). From the Table 9, it is been found that width of fabric values varies with respect to loop length and also a decrease in the width of fabric after hot washing. From the Table 10 and Fig. 3, it is been found that thickness of fabric values varies with respect to loop length and also an increase in the thickness of fabric after hot washing.

Table 5. Effect of stretching & heat setting on CPI & WPI (2.9 mm loop length)

Loop length mm (inch)	Stretch level (%)	Course /inch	Wales /inch
2.9 (0.114)	10	103	60
	20	104	54
	30	107	50
	50	109	46
	70	113	44
	90	119	40

Table 6. Effect of loop length on courses/inch

Loop length mm (inch)	Courses / inch		% change in course /inch
	For grey fabric	After wet relaxation	
2.5 (0.098)	85	100	17.65
2.7 (0.106)	66	102	54.55
2.9 (0.114)	61	104	70.49

Table 7. Effect of loop length on wales/ inch

Loop length Mm (inch)	Wales / inch		% change in Wales /inch
	For grey fabric	After wet relaxation	
2.5 (0.098)	47	75	59.57
2.7 (0.106)	46	65	41.30
2.9 (0.114)	43	63	31.75

Table 8. Effect of loop length before & after wet relaxation

Loop length (mm)		% change in loop length
For grey fabric	After wet relaxation	
2.3	2.5	8.7
2.5	2.7	8.0
2.7	2.9	7.41

Conclusions

From the study, it was found that the dimension of fabric shows considerable change during wet relaxation. The CPI increases from 17.65% to 70.49% and an average percentage change in CPI is 47.56% after Wet-Relaxation. The WPI decreases from 59.57% to 31.75% and an average percentage change in WPI is 44.2% after Wet-Relaxation. The fabric shows better appearance when heat set at all stretch levels at 180^0 C in course direction. A fabric with a loop length of 2.5 mm gives better appearance when compared to the fabrics of other loop lengths. In particular 10% stretch level shows impressive appearance for 2.5 mm loop length.

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Table 9. Effect of loop length on width of fabric

Loop length mm (inch)	Width of grey fabric (cm)	Width of fabric after hot wash (cm)	% of shrinkage in the fabric after hot wash
2.5 (0.098)	72.0	54.2	25.72
2.7 (0.106)	71.5	55.5	22.38
2.9 (0.114)	70.5	56.0	20.57