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Dimensional Stability of Single Jersey Fabrics of LincLITE® and Conventional Yarns. I.

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Abstract: Dimensional constants (k values) of single jersey fabrics made from LincLITE® and conventional yarns are calculated under dry, steam, full relaxation treatments. Fabrics were made under different tightness factors such as high, medium and low with different twist factors, twist directions and feeder blending. LincLITE® yarns made to get soft and bulkier effects with yarn count of 39 tex and conventional yarns made into 39 tex and 48 tex yarn counts. Various effects on K values are analysed using correlation coefficients. K-values are increased with relaxation progression and have shown some differences between in LincLITE® and conventional fabrics, and feeder blended fabrics. Loop shape factor is highly affected by tightness factor, relaxation and feeder blending in LincLITE® fabrics, whereas twist factor not significantly effects on loop shape factor in conventional fabrics. Stitch density significantly increases with relaxation in conventional fabrics and no significant effect shows with LincLITE® fabrics.

Keywords: Dimensional stability, Dimensional constants, LincLITE®, Conventional fabrics, Single jersey fabrics, K-values

Introduction

It is well known that although, the shrinkage of wool fabrics is far lower than other knitted fabrics made from hygroscopic fibers such as cotton, ramie etc., dimensional stability of knitted fabrics cannot be obtained without proper arrangement of optimum geometry. Thus, stabilization of knitted fabrics is assumed to be followed by relaxation parameters such as stitch density, wale and course factors, loop shape factor, density ratio between wale and course [1,2].

In this study, we used LincLITE® - and conventional- yarns with different parameters. LincLITE® yarns, which were developed by Wool Research Organisation of New Zealand in an effort to make soft and bulkier yarns [3], were prepared from 100 % Merino fibers. The bulkiness of LincLITE® yarns, which is important to trap large amount of air in order to achieve good thermal properties, fullness, handle and cover factor [4,5], were obtained by hot wet processing technique using the LincLITE® machine developed by WRONZ developments Ltd.

For these LincLITE® yarns, fiber components are mixed uniformly in a certain ratio at the gilling stage and they are spun conventionally into the LincLITE® yarns. In this study, we measured the variations of stitch length, fabric density and shrinkage of wale and course directions. Single jersey fabrics with high, medium and low tightness factors, which is knitted from LincLITE®- and conventional- yarns with various yarn parameters, were subjected to dry, steam, wet and full relaxation and washing and tumbler relaxation treatments to obtain above mentioned measurements. Based on these data, stitch density constants (K-values) were calculated for LincLITE® and conventional single jersey fabrics.

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Experimental

To prepare required knitted specimens of single jersey fabrics out of LincLITE® and conventional yarns, yarn specifications given in Table 1 were used. Single jersey fabrics were produced by using a Stibbe 12 gauge single cylinder machine with 12 inches diameter, 452 needles and 2 feeders.

Each of the samples was knitted into plain stitch with increment of tightness factors as a function of three twist levels of yarns. Preparation of tightness factors for LincLITE® yarn were made into two ways, one for actual linear density for Linclite series 1 and the other one for nominal count on basis of yarn volume for Linclite series 2, in order to compare with corresponding level of the conventional yarns, respectively 39 tex and 48 tex. Table 2 gives the knitting details used to make single jersey samples of LincLITE® and conventional fabrics in terms of different twist factors (twist direction as Z and S) and different tightness factors.

It is well known that wool fabrics have two main reasons for their dimensional changes such as relaxation and felting. The relaxation of wool fabrics normally takes place without relative longitudinal movement of fibers within yarns. Therefore, the extent of relaxation depend on the method of process used and this should be always be related to the end uses of the fabric. The most commonly used relaxation treatments involve the dry-, wet-, fully- relaxed treatments with wetting, hydro extraction and tumbler drying. Much researches have been applied to studying the effects of various relaxation treatments on the dimensions of the knitted fabrics made on different material. Most researchers have confined that strain related relaxation parameters can be expressed in terms of a set of K-values [1,6,7]. It is generally accepted that density factors Kc, Kw and Ks are constants for all plain knitted fabrics depending on the fiber type [8].

Table 1. Specifications used for spinning the yarns

	48 tex Conventional yarn			39 tex Conventional yarn				31 tex LincLITE® yarn blended at gill			
Twist factor	2100 (2106)	2400 (2411)	2700 (2701)	2100 (2123)	2400 (2398)	2400 (2398)	2700 (2685)	2100 (2082)	2400 (2394)	2100 (2082)	2700 (2700)
Twist (tpm)	303 (304)	346 (348)	390 (390)	336 (340)	384 (384)	384 (384)	432 (430)	374 (374)	431 (430)	374 (374)	485 (485)
Twist	Z	Z	Z	Z	Z	S	Z	Z	Z	Z	Z
Notation	YC1	YC2	YC3	YC4	YC5	YC6	YC7	YL1	YL2	YL3	YL4

Note: ( )-actual resultants.

Table 2. Knitted sample details in terms of twist and tightness factors

Sample	Twist factor \ Fabric tightness	Low (CF:1.2)	Medium (CF: 1.4)	High (CF:1.6)
LincLITE® 1 (31 tex)	2100 Z(YL1)	L104	L102 (CF:1.4)	L106
	2400 Z(YL2)		L105 (CF:1.4)	
	2100 S(YL3)		L108 (CF:1.4)	
	2100 S(YL3) & 2100 Z(YL1)		L111 (CF:1.4) (2xYL3) & (2xYL1)	
	2100 S(YL3) & 2100 Z(YL1)		L116 (CF:1.4)(2xYL3) & (1xYL1)	
	2700 Z(YL4)		L114 (CF:1.4)	
LincLITE® 2 (31 tex)	2100 Z(YL1)	L204	L202 (CF:1.4)	L206
	2400 Z(YL2)		L205 (CF:1.4)	
	2100 S(YL3)		L208 (CF: 1.4)	
	2100 S(YL3) & 2100 Z(YL1)		L211 (CF:1.4) (2xYL3) &(2xYL1)	
	2100 S(YL3) & 2100 Z(YL1)		L216 (CF:1.4) (1xYL3) & (1xYL1)	
	2700 Z(YL4)		L214 (CF:1.4)	
Conventional (39 tex)	2100 Z(YC4)		C102 (CF:1.4)	
	2400 Z(YC5)		C105 (CF:1.4)	
	2400 S(YC6)		C108 (CF:1.4)	
	2400 S(YC6) & 2400 Z(YC5)		C111 (CF:1.4)(2xYL3) & (2xYL1)	
	2400 S(YC6) & 2400 Z(YC5)		C116 (CF:1.4)(2xYL3) & (1xYL1)	
	2700 Z(YC7)		C114 (CF:1.4)	
Conventional (48 tex)	2100 Z(YC1)	C204	C202 (CF:1.4)	C206
	2400 Z(YC2)		C205 (CF:1.4)	
	2700 Z(YL3)		C208 (CF: 1.4)	

Note: LincLITE® 1: knitted fabrics based on yarn linear density to be compared to conventional 39 tex yarn, LincLITE® 2: knitted fabrics based on yarn volume density to be compared to conventional 48 tex yarn, CF: fabric tightness factor (tex/mm)=yarn linear density/stitch length=tex/mm.

Fabric samples given in Table 2 were subjected to dry, steam and fully relaxations due to the strains imparted during knitting. The treatments were made on dry, steam, mild wet and fully and severe wet and tumble relaxation.

Dry Relaxation

Knitted samples were laid on a flat smooth surface in a tension free state and without any creases for more than 48 hours in the standard room conditions of relative humidity 65 ± 2 % and temperature 20 ± 2 °C.

Steam Relaxation

Dry relaxed knitted samples were laid on the smooth flat surface of a Hoffman type press and conditioned to full relaxation with the upper presser open in order to allow the samples to be fully conditioned in steam without forcible agitation. After steam relaxation, the measurements were taken as in ISO 3005-1978 and ISO 3759.

Fully and Wet Relaxation

Dry relaxed samples with sample size 300 × 400 mm were

prepared in the form of double thickness. Then, the fabrics were pre-conditioned in an oven of with the atmosphere of relative humidity not more than 10 % and temperature not more than 50 °C and maintained for more than 24 hrs in the standard room atmosphere of relative humidity 65 ± 2 % and temperature 20 ± 2 °C. The testing was carried out in Wascator Form71 Special Laboratory Washing Machine referenced by ISO 6330x 7A cycle.

Washing and Tumble Relaxation

The fully and wet relaxed fabric samples were pre-conditioned in an oven with the atmosphere of relative humidity, not more than 10 % and temperature not more than 50 °C and maintained for more than 24 hrs in the standard room atmosphere of relative humidity 65 ± 2 % and temperature 20 ± 2 °C. Then, samples were washed vigorously in Wascator Form 71 Special Laboratory Washing Machine. Measurements were taken after tumble drying and conditioned under standard atmosphere of relative humidity 65 ± 2 % and temperature 20 ± 2 °C. Testing procedures were followed ISO 6330.

After relaxation treatments, stitch length, fabric density and shrinkages of wale and course directions were measured from knitted samples and then, the stitch density constants were calculated using following formulae [1,9].

$$C \times l = K_C \ (C = K_C/l) \quad (1)$$

$$W \times l = K_w \ (W = K_W/l) \quad (2)$$

$$S \times l^2 = K_C \ (S = K_S/l^2) \quad (3)$$

$$K_C/K_W = K_P = \text{loop shape factor} \quad (4)$$

where C: course density (courses/cm)

Table 3. Density constants (K-Values) of LincLITE® knitted fabrics

Relaxation treatment			Dry relax (1)	Steam relax (2)	Full relax (3)	Full relax (4)
LinCLITE® 1	2400Z CF;1.2 L104	Kc	45.9±0.58	47.0±0.62	50.8±0.67	49.1±0.50
		Kw	41.9±0.24	39.5±0.26	39.4±0.35	36.4±0.11
		Ks	1922.61±24.26	1857.14±25.33	2003.7±36.73	1787.9±22.08
		Kc/Kw	1.09	1.19	1.29	1.35
	2100Z CF;1.4 L102	Kc	48.4±0.59	48.6±0.53	52.0±0.79	50.1±0.65
		Kw	40.3±0.20	38.2±0.18	39.6±0.13	35.5±0.16
		Ks	1953.06±18.30	1865.05±37.07	2062.02±27.78	1778.9±22.08
		Kc/Kw	1.20	1.27	1.31	1.41
	2400Z CF;1.4 L105	Kc	46.9±0.26	47.6±0.32	49.9±0.32	48.0±0.40
		Kw	40.4±0.23	38.6±0.12	39.5±0.07	35.9±0.29
		Ks	1905.77±16.57	1834.84±13.37	1969.68±15.57	1720.9±26.58
		Kc/Kw	1.16	1.23	1.26	1.34
	2100S CF;1.4 L108	Kc	49.4±0.0.43	49.2±0.41	51.0±0.32	47.7±0.61
		Kw	40.5±0.13	38.2±0.07	38.1±0.30	34.6±0.31
		Ks	2007.67±26.84	1879.36±16.73	1959.05±21.82	1650.6±34.04
		Kc/Kw	1.22	1.29	1.34	1.38
	(2x2100Z) & (2x2100S) CF;1.4L111	Kc	46.3±0.15	46.5±0.32	51.8±0.38	41.8±0.34
		Kw	38.2±0.12	35.9±0.11	35.5±0.19	32.5±0.09
		Ks	1770.46±10.59	1669.02±14.55	1835.79±20.47	1629.2±15.98
		Kc/Kw	1.21	1.30	1.46	1.29
	(1x2100Z) & (1x2100S) CF;1.4 L116	Kc	48.0±0.79	48.8±0.61	49.7±1.01	50.2±0.48
		Kw	39.4±0.10	39.1±1.11	38.1±0.18	33.9±0.14
		Ks	1890.22±33.06	1845.47±25.05	1887.67±52.44	1519.8±29.80
		Kc/Kw	1.22	1.25	1.30	1.32
	2700Z CF;1.4 L114	Kc	48.9±0.35	48.6±0.21	50.3±0.32	48.1±0.24
		Kw	40.5±0.29	38.7±0.14	39.8±0.25	36.3±0.27
		Ks	1976.82±20.79	1876.12±11.75	1988.86±20.47	1743.8±19.87
		Kc/Kw	1.21	1.26	1.26	1.33
	2400Z CF;1.6 L106	Kc	47.2±0.29	48.7±0.44	50.3±0.33	47.3±0.35
		Kw	37.7±0.18	37.3±0.20	38.7±0.15	35.3±0.17
		Ks	1776.8±14.27	1818.01±22.94	1946.64±17.92	1669.8±19.85
		Kc/Kw	1.25	1.30	1.30	1.34

W: wale density (wales/cm)
S: stitch density (stitches/cm^2)
l: stitch length (cm)
K_c, K_w and K_s: stitch density constants without dimensions

Results and Discussion

Based on the stitch lengths, wale and course densities of knitted fabric samples tested, the density constants (K-values) were calculated according formulae (1), (2) (3) and (4). Calculated K-values for single jersey fabrics from Linclite yarns and conventional yarns are given in Tables 3, 4 and 6, 7 respectively. In these tables, treatment (1): Dry relaxation of knit fabrics and static dry in standard atmosphere; treatment (2): steam wet relaxation at 100 °C, with static dry at standard atmosphere; treatment (3): fully wet relaxation, with agitation at 40 °C, static dry at standard atmosphere, treatment (4): Fully wet relaxation, with agitation at 40 °C, tumble dry were used.

It is shown that all dimensional constants change with progression of relaxation. Washing and tumble dry relaxation give more vigorous treatment to the fabrics to come towards a minimum energy state. The same tendency can be observed in Linclite 2 single jersey fabric data given in Table 4 also. Thus, K values of LincLITE® 2 fabrics are different than that of LincLITE® 1 fabrics, due to their bulkiness variations. LLincLITE® 2 yarns were made based on yarn volume density to be compared to conventional 39 tex yarns. Table 5 shows the results of correlation coefficients between the characteristics of both LincLITE® 1 and LincLITE® 2 single jersey fabrics considered under different significant levels.

Loop shape factor (Kc/Kw), which is one of the most important factor for dimensional changes of knitted fabrics, is highly affected by tightness factor. It shows a positive correlation, which means loop shape factor increases with

Table 5. Principal correlation coefficients between characteristics of fabrics from LincLITE® yarns

Characteristics	Ks	Kw	Kc	Kc/Kw
Tightness factor	-S	-HS	NS	HS
Twist factor	-NS	-NS	-NS	NS
Relaxation	NS	-NS	-NS	HS
Feeder blending	-NS	-S	-S	HS
Ks	-	HS	HS	NS

Note: HS: highly significant at 0.01 level, S: significant at 0.05 level, SS: slightly significant at 0.01, (-) negative correlation, NSS: near slightly significant around 0.01 level, NS: not significant.

Table 4. Density constants (K-Values) of LincLITE® 2 knitted fabric

Relaxation treatment			Dry relax (1)	Steam relax (2)	Full relax (3)	Full relax (4)
LincLITE® 2	2400Z CF;1.2 L204	Kc	48.0±0.29	48.2±0.11	52.1±0.39	49.8±0.17
		Kw	45.3±0.20	41.9±0.15	41.2±0.16	37.3±0.19
		Ks	2146.7±8.06	2018.5±6.61	2145.3±10.6	1858.6±12.88
		Kc/Kw	1.06	1.15	1.26	1.34
	2100Z CF;1.4 L202	Kc	47.0±0.44	48.1±0.28	51.7±0.21	50.9±0.16
		Kw	43.1±0.24	39.8±0.08	39.5±0.18	36.2±0.08
		Ks	2025.4±23.49	1917.9±12.43	2043.3±12.79	1841.1±2.41
		Kc/Kw	1.09	1.21	1.31	1.41
	2400Z CF;1.4 L205	Kc	47.6±0.46	48.5±0.37	55.2±0.55	48.0±0.49
		Kw	41.5±0.20	39.6±0.28	39.4±0.12	35.9±0.07
		Ks	1971.5±17.80	1918.0±22.38	2001.7±20.14	1726.7±18.26
		Kc/Kw	1.15	1.22	1.40	1.34
	(2x2400Z) & (2x2400S) CF;1.4 L211	Kc	47.4±0.41	48.9±0.29	55.5±0.55	55.9±0.52
		Kw	40.0±0.10	37.8±0.10	36.9±0.12	33.9±0.11
		Ks	2045.4±14.76	1845.5±10.12	2047.6±25.62	1896.8±20.03
		Kc/Kw	1.19	1.29	1.50	1.65
	2700Z CF;1.4 L214	Kc	47.2±0.33	47.6±0.33	49.2±0.42	47.3±0.31
		Kw	41.3±0.23	39.1±0.24	39.5±0.26	36.0±0.16
		Ks	1948.8±18.76	1861.4±22.88	1942.2±21.37	1700.4±13.66
		Kc/Kw	1.14	1.22	1.25	1.31
	2400Z CF;1.6 L206	Kc	47.2±0.30	48.0±0.39	49.7±0.34	48.3±0.45
		Kw	40.2±0.28	38.2±0.21	39.3±0.19	35.5±0.09
		Ks	1895.1±18.02	1833.6±23.74	1955.2±21.73	1716.6±12.6
		Kc/Kw	1.17	1.26	1.26	1.36

Table 6. Density constants (K-Values) of knitted fabrics made from conventional yarns (39 tex) as a function of relaxation and tightness levels

Relaxation treatment			Dry relax (1)	Steam relax (2)	Full relax (3)	Full relax (4)
Conventional (39 tex)	2400Z CF;1.2 C104	Kc	49.6±0.20	50.9±0.71	51.6±0.36	54.6±0.04
		Kw	42.3±0.30	40.7±0.13	41.2±0.21	39.1±0.16
		Ks	2059.9±29.98	2068.6±31.86	2128.2±21.79	2130.7±19.44
		Kc/Kw	1.17	1.25	1.25	1.33
	2100Z CF;1.4 C102	Kc	48.1±0.64	49.0±0.50	49.9±0.33	52.3±0.53
		Kw	40.5±0.43	39.2±0.10	39.5±0.15	37.4±0.29
		Ks	1946.7±36.42	1923.6±18.37	1973.4±16.27	1958.7±28.24
		Kc/Kw	1.12	1.25	1.26	1.40
	2400Z CF;1.4 C105	Kc	47.6±0.67	49.2±0.52	50.2±0.96	53.2±0.88
		Kw	39.9±0.27	39.9±0.11	40.3±0.13	38.8±0.15
		Ks	1897.0±35.16	1963.7±24.07	2023.8±44.09	2067.7±36.3
		Kc/Kw	1.19	1.23	1.25	1.37
	2400S CF;1.4 C108	Kc	48.6±0.53	50.5±0.41	51.9±0.49	51.7±0.74
		Kw	39.9±0.10	39.7±0.04	39.6±0.15	38.1±0.16
		Ks	1937.7±23.04	2002.6±17.32	2055.1±24.66	1968.5±27.16
		Kc/Kw	1.22	1.27	1.31	1.36
	(2x2400Z) & (2x2400S) CF;1.4 C111	Kc	47.4±0.0.49	48.9±0.61	54.1±0.76	55.1±0.46
		Kw	39.0±0.18	38.77±0.22	38.7±0.19	37.3±0.20
		Ks	1847.09±21.06	1930.6±24.14	2094.0±35.01	1990.2±52.68
		Kc/Kw	1.22	1.26	1.40	1.48
	(1x2400Z) & (1x2400S) CF;1.4 C116	Kc	47.69±0.40	48.4±0.60	50.8±0.57	50.6±0.70
		Kw	39.7±0.10	39.2±0.13	39.3±0.17	38.7±0.33
		Ks	1895.3±19.22	1936±29.18	1993.3±30.26	1957.9±38.97
		Kc/Kw	1.20	1.23	1.29	1.31
	2700Z CF;1.4 C114	Kc	47.7±0.57	48.5±0.60	49.8±0.49	50.3±0.83
		Kw	40.3±0.25	39.9±0.19	40.2±0.12	38.7±0.16
		Ks	1919.9±23.97	1939.7±25.77	2002.8±17.83	1945.0±32.33
		Kc/Kw	1.18	1.22	1.24	1.30
	2400Z CF;1.6 C106	Kc	47.8±0.64	50.9±0.16	51.8±0.46	54.20±0.36
		Kw	38.0±0.31	39.2±0.12	40.0±0.14	38.5±0.13
		Ks	1816.2±38.79	1995.6±10.11	2073.4±20.57	2073.4±20.57
		Kc/Kw	1.26	1.30	1.30	1.41

increasing of fabric tightness of LincLITE® fabrics. Thus, loop shape factor is strongly and positively correlated with feeder blending and relaxation. But, twist factor has not significantly affected on Kc/Kw. On Ks values, only tightness factor slightly affected, but Ks reduces with increasing fabric tightness.

As with LincLITE® fabrics, single jersey fabrics with conventional yarns also show increase of all K values under progression of relaxation. Thus, treatment (4) gives much better relaxation values to single jersey fabrics made from conventional yarns of 39 tex (Table 5) and 48 tex (Table 6). When comparing LincLITE® 1 and Conventional 39 tex fabrics, the Kc/Kw factor deviates around 1 % to 2 % only, while considering the single jersey fabrics with same twist factor and cover factor (with the exception of 2400Z, CF1.6 fabrics), in which about 5 % deviation was observed.

Table 8 shows the results of principle correlation coefficients between characteristics of single jersey fabrics of conventional yarns of 39 tex and 48 tex yarn counts.

Significant of effect of characteristics on K values are same as Table 5 with some exceptions indicated by conventional fabrics (given in bold letters in Table 8). As contrary to LincLITE® fabrics, Kc/Kw factor of conventional fabrics highly increase with progression of relaxation. Thus, stitch density factor (Ks) is also highly increased with progression of relaxation. In addition, wale density factor (Kw) is significantly increased (at 0.05 level) with increasing yarn twist factor.

Table 7. Density constants (K-Values) of fabrics made from conventional yarns (48 tex), as a function of relaxation and tightness levels

Relaxation treatment			Dry relax (1)	Steam relax (2)	Full relax (3)	Full relax (4)
Conventional (48 tex)	2400Z CF;1.2 C204	Kc	48.7±0.65	50.3±0.36	51.4±0.40	55.6±0.60
		Kw	43.6±0.35	41.6±0.18	41.2±0.22	39.9±0.22
		Ks	2121.9±43.43	2092.6±18.57	2110.3±17.78	22.18±15.95
		Kc/Kw	1.12	1.21	1.25	1.39
	2100Z CF;1.4 C202	Kc	49.0±0.38	49.1±0.35	50.9±0.54	53.9±0.29
		Kw	41.7±0.07	39.6±0.16	40.1±0.41	38.2±0.09
		Ks	2044.4±18.32	1945.1±16.24	2039.5±24.02	2056.5±11.71
		Kc/Kw	1.14	1.24	1.27	1.41
	2400Z CF;1.4 C205	Kc	49.3±0.18	49.8±0.42	51.9±0.58	55.1±0.22
		Kw	41.4±0.28	39.5±0.21	40.2±0.10	38.8±0.14
		Ks	2040.3±21.63	1966.1±21.80	2085.0±23.30	2138.8±14.61
		Kc/Kw	1.19	1.26	1.29	1.42
	2700Z CF;1.4 C208	Kc	50.23±0.14	49.8±0.46	51.1±0.18	53.9±0.37
		Kw	42.0±0.33	40.1±0.21	40.5±0.20	39.0±0.16
		Ks	2107.4±19.88	1995.1±22.34	2060.8±9.69	2100.3±18.15
		Kc/Kw	1.19	1.24	1.26	1.38
	2400Z CF;1.6 C206	Kc	49.6±0.53	50.6±0.38	52.6±0.59	53.8±0.57
		Kw	38.9±0.28	39.1±0.17	39.9±0.08	38.1±0.11
		Ks	1928.7±31.28	1975.5±19.37	2096.7±24.65	2049.5±26.19
		Kc/Kw	1.27	1.29	1.32	1.41

Table 8. Principal correlation coefficients between characteristics of conventional yarn fabrics

Characteristics	Ks	Kw	Kc	Kc/Kw
Tightness factor	–S	–HS	NS	HS
Twist factor	–NS	**S**	–NS	**HS**
Relaxation	**HS**	–NS	–NS	HS
Feeder blending	–NS	–S	–S	HS
Ks	–	HS	HS	NS

Note: HS: highly significant at 0.01 level, S: significant at 0.05 level, SS: slightly significant at 0.01, (–) negative correlation, NSS: near slightly significant around 0.01 level, NS: not significant.

Conclusion

The dimensional stability phenomena were investigated using density constants and statistical correlations among the related properties for knitted fabrics, which were prepared by using LincLITE® and conventional yarns as raw materials and by diversifying into different tightness factors (low medium and high levels).

The results of the study have indicated that the fabric tightness, stitch density and relaxation, and yarn twist and feeder blending in knitting affected the magnitude of such properties of fabric firmness as wale-, course-, stitch- density and to loop shape factor. Studies of relaxation of these knitted fabrics with three levels of tightness factors have shown some differences between the LincLITE® and conventional fabrics and feeder blended fabrics, even between the LincLITE® fabrics in configurations of knitted fabrics.

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