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Shrinkage Control of Fleece Knit Fabrics by Some Yarn and Knitting Variables

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Abstract: The fibre pile or fleece knits can be made on circular knit machines with different types of construction. The machines may be complex, utilizing either spring or latch needles employing sinker-top, dial, cylinder, or dial/cylinder mechanisms. With this equipment, various effects can be produced. This paper describes the influence of some variables like count and twists of backing yarn and stitch length upon shrinkage of two and three-yarn fleecy fabrics. The results shows that by suitable combination of these variables the length wise and width wise shrinkage can be controlled.

Key words: Fleece Fabrics, Knitting, Shrinkage

Introduction

Fibre pile knitted fabrics, capable of resisting extreme climatic conditions without causing over-heating of the body or restricting movement, are being used extensively for a wide variety of garments. The production of pile knits has steadily grown in variety, importance and volume. They are constructed as fleece, high pile, terry and velour knits. Depending upon the type of construction, they are used for fur fabrics, rugs, sports wears, track suits and fashion apparel fabrics. Fleece fabrics which have a short to medium nap posses a soft, pleasant hand, provide warmth and body, as well as moisture wicking and absorption, if desired. The kind of fibres used are dependent upon the end-use objective. They are used for such purposes as liners, active sports wear, outer wear, and plush toys. The most typical garment applications are sweat- shirts, pants, track-suits and out-door-wear fabrics for jogging, hiking, fishing, camping, golf, tennis, baseball playing, riding cycling, hunting and causal wear etc.

Shrinkage of the knitted fabrics is an important characteristic which can be controlled by selecting suitable yarn and machine variables. Anand and Lawton (1987) concluded that area dimensions (shrinkage, spirality etc.) of loop pile knitted fabrics were controlled by ground yarn. They demonstrated that the area dimensions (shrinkage, spirality etc) of single jersey loop-pile (fleece) fabric can be predicated accurately and reliably from the stitch length. On the other hand Sharma *et al.* (1987) concluded that shrinkage decreased with decrease in twist factor and shrinkage increased by increased in twist factor. They also concluded that width-wise shrinkage is occasional and occurs only for tighter structures. After full relaxation, there is further increase in courses/cm and wales/cm because of more shrinkage occurs. While Ganaie (1998) mentioned that width wise shrinkage potential of finished rib fabric was greater than that of interlock fabric. Previous researcher Yousaf (1998) reported that shrinkage percentage increases gradually as the twist factor increases.

While Candan *et al.* (2000) concluded that the amount of relaxation shrinkage occurring with open end spun yarn is greater than that occurring with ring spun yarn.

Materials and Methods

The research work was conducted in the Deptt. of Fibre Technology, University of Agriculture, Faisalabad, Crescent Textile Mills Ltd., Faisalabad and Dil-Khush Hosiery, Faisalabad during the year 2000-2001. For fleece knitted fabric, yarn of different counts with different twist multiplier were used as below:

- Yarn Counts

a. Ground yarn = 30s
b. Backing yarns
C1 = 10s
C2 = 16s

- Twist factors (TM) of backing (fleece) yarn

T1 = 3.00
T2 = 3.25
T3 = 3.50

Knitting Process: Circular knitting machine was used for fleece knit fabric from the yarn samples especially spun for this research project. The Terrot Brand knitting machines of 20 inch gauge, engaged for the preparation of fleece knitted samples.

For fleece knitting fabric a yarn of 30s single count was use as a ground yarn and 10s, 16s counts were used as fleece yarn (backing yarn).

Raising Process: A Gessner brand (Model 1995-USA) raising machine having raising drum speed of 110 rpm was engaged to produce napping on loop pile knitted fabric samples. Knitted fabric samples were fed to the machine by feed roller. Raising was done with small raising and stripping roller which rotate around the raising drum. Twelve hooked fleet wire rollers pull the fabric while other twelve straight fleet wire roller strip the fabric. Raised fabric was removed by a doffer roller. Raising controlled by front/feed roller speed.

Fleece Fabric Construction: In fleece knitted fabric two and three yarns used for 2-yarn fleece and 3-yarn fleece knitted fabric respectively.

Variable Selected

- Yarn count (Backing)

C1 = 10s
C2 = 16s

- Twist multiplier (TM)

T1 = 3.00
T2 = 3.25
T3 = 3.50

Knitting Variables

- Fabric type
  - F1 = 3-yarn fleece
  - F2 = 2-yarn fleece
- Stitch length
  - L1 = 0.38 cm
  - L2 = 0.36 cm
  - L3 = 0.34 cm

The Shrinkage (lengthwise and widthwise) of knitted samples are measured according to ASTM Standards (1997). The test specimens were exposed to moving air for 4 hours in the standard atmosphere; then conditioned the specimens and marked representative distances in both length and width direction. Marked the specimens by laying out without tension on a flat, polished surface, taking care that the fabric is free from wrinkles or creases. Mark with indelible ink and a fine point pen, with threads sewn into the fabric, or with a specially designed stamping machine. Then after laundering and tumble drying as suggested by ASTM (D 1905), condition the specimen without tension on a flat polished surface and measure the distance between the marks. Then calculate the dimensional changes (shrinkage) in each direction using the following formula

$$\text{Shrinkage percentage} = \frac{D1 - D2}{D1} \times 100$$

Where
D1 = Original measurement
D2 = Final measurement

Results and Discussion

Lengthwise Shrinkage: The analysis of variance of data pertaining to the effect of fabric type (F), count (C), stitch length (L) and twist factor (T) upon length-wise shrinkage for fleece fabric is summarized in Table 1(a), which elaborates that fabric type, count, stitch length and twist factor exerted the highly significant effect on lengthwise shrinkage. However, the interactions of (F x C x T), (C x L x T), (F x C x T), (F x C x L), (L x T), (C x L), (F x T) and (F x L) exerted the highly significant effect, (F x C) exerted significant effect and (C x T), (F x L x T) exerted non-significant effect on length-wise shrinkage.

Table 1(b) presented the comparison of individual mean and illustrated that 3-yarn fleece (F1) recorded maximum value of shrinkage as 17.27 while 2-yarn fleece (F2) recorded the minimum values as 9.19 for shrinkage.

Regarding the count, Table 1(b) gives the comparison of the data recorded for the count C1 and C2 and predicted that 10s count (C1) recorded 12.30 percent shrinkage least excessive from count 16s (C2) as 14.15 percent. These results shows that length-wise shrinkage increases by using fine count. The present findings also supported by previous researchers as Gill (2000) concluded that, the length-wise shrinkage, width wise shrinkage increased for finer count yarns. While Heap and Steven (1996) reported that spinners and knitters must be aware of those feature of yarn construction which can alter the dimension of cotton circular knits and hence their potential shrinkage.

Regarding to the stitch length Table 1(b) aggregated the data recorded by the different stitch lengths for lengthwise shrinkage and prevailed that the stitch length L1 (0.38cm) recorded maximum value as 14.24 percent for shrinkage followed by L2 (0.36cm) and L3 (0.34cm) bearing the mean values as 13.59 and 11.86 percent respectively. The present results show that by decreasing the stitch length from maximum to minimum length wise shrinkage decrease. Previously, Anand and Lawton (1987) demonstrated that the area dimensions (shrinkage, spirality etc.) of single jersey loop-pile (fleece) fabric can be predicated accurately and reliably from the stitch length.

Regarding the twist Table 1(b) elaborates the data recorded by the different twist factors T1, T2 and T3 for length-wise shrinkage. For shrinkage the mean values as 12.19, 13.01 and 14.49 percent respectively. These findings show that by increasing twist factor, the shrinkage increases. Previously Knapton and Fong (1970) observed that shrinkage (lengthwise) depended on yarn twist.

Widthwise Shrinkage: Table 2(a) represents the statistical analysis of variance regarding the effect of fabric type (F), count (C), stitch length (L) and twist factor (T), upon widthwise shrinkage for fleece fabrics and analysed that the sources of variation viz., the fabric type, count, stitch length and twist pertained the highly significant effect on width-wise shrinkage while their third order interaction resulted the significant effect on widthwise shrinkage. However, the interactions (F x C), (F x L), (F x T), (F x C x L) and (F x L x T) exert highly significant effect while C x L and C x T are significant and (F x L x T) and (L x T) recorded non-significant effect on width wise shrinkage.

Individual comparison of means summarized in Table 2(b) which elaborates that 2-yarn fleece (F2) recorded maximum shrinkage of 12.35 percent than that of 3-yarn fleece (F1) as 6.79 percent.

Table 2(b) summarized the data under the effect of counts for widthwise shrinkage and segregated that the 16s (C2) recorded maximum shrinkage as 10.18 percent than that of 10s count (C1) having the mean value 8.96 percent. These results show that coarse count has less shrinkage value than fine count yarn. The present findings get the conformity from the previous reports of many investigators as Gill (2000) who concluded that the length wise and widthwise shrinkage for finer count increased.

Statistically analysed graded data tabulated in the Table 2(b) illustrated that minimum stitch length L3 (0.34cm) recorded the maximum shrinkage having the mean values 11.32 percent followed by L2 (0.36cm) and L1 (0.38cm) bearing the mean values as 9.34 and 8.05 percent respectively. These results confirmed that maximum stitch length produce minimum shrinkage while minimum stitch length gives more shrinkage. Previously, Anand and Lawton (1987) concluded that stitch length used in the ground structure, controls the fabric dimensions and properties to very large extent. This evidence is mentioned by the Black (1974) who concluded that widthwise shrinkage decreased with the increase in stitch length.Regarding the twist factor Table 2b aggregated the data for the effect of different twist on width wise shrinkage as 11.11 percent followed by T2 and T1, bearing the mean values as 9.36 and 8.24 percent respectively. These results shows that by increasing twist factor shrinkage slightly increase. The present findings are more or less varied from the previous findings. On the other hand Toyonori (1984) who concluded that in pile fabric the thickness and shrinkage increased by decreasing twist and count.

Table 1a: Analysis of Variance for Lengthwise Shrinkage

S.O.V.	d.f.	S.S.	M.S.	F.Value	Probability
Fleece (F)	1	1759.08	1759.08	5641.88	0.0000**
Count (C)	1	92.70	92.70	297.33	0.0000**
Stitch length	2	109.20	54.60	175.13	0.0000**
Twist (T)	2	97.67	48.83	156.63	0.0000**
F x C	1	2.12	2.12	6.80	0.0110*
F x L	2	216.05	108.02	346.48	0.0000**
F x T	2	5.91	2.95	9.48	0.0002**
C x L	2	24.72	12.36	39.65	0.0000**
C x T	2	0.65	0.32	1.05	0.3547N.S
L x T	4	6.33	1.58	5.07	0.0012**
F x C x L	2	31.42	15.71	50.38	0.0000**
F x C x T	2	3.22	1.61	5.17	0.0079**
F x L x T	4	0.72	0.18	0.58	
C x L x T	4	27.09	6.77	21.72	0.0000**
F x C x L x T	4	14.69	3.67	11.78	0.0000**
Error	72	22.44	0.31		
Total	107	2414.01			

** = Highly significant, * = Significant, NS = Non-significant

Table 1b: Individual Comparison of Treatment Means by LSD Test

Fleece	F1	F2	
Means	17.27 b	9.19 a	
Count	C1	C2	
Means	12.30 a	14.15 b	
Stitch length	L1	L2	L3
Means	14.24 c	13.59 b	11.86 a
Twist	T1	T2	T3
Means	12.19 a	13.01 b	14.49 c

Note: Means bearing the same letter have non-significant differences between them.

Table 2a: Analysis of Variance for Widthwise Shrinkage

S.O.V.	d.f.	S.S.	M.S.	F.Value	Probability
Fleece (F)	1	833.22	833.22	907.43	0.0000**
Count (C)	1	40.43	40.43	44.03	0.0000**
Stitch length	2	194.80	97.40	106.07	0.0000**
Twist (T)	2	150.0	76.0	81.68	0.0000**
F x C	1	130.63	130.63	142.27	0.0000**
F x L	2	69.89	34.94	38.05	0.0000**
F x T	2	10.62	5.31	5.78	0.0047**
C x L	2	5.76	2.88	3.13	0.0493*
C x T	2	6.48	3.24	3.53	0.0344*
L x T	4	3.68	0.92	1.00	0.4121N.S
F x C x L	2	76.01	38.00	41.38	0.0000**
F x C x T	2	5.01	2.50	2.73	0.0720*
F x L x T	4	13.36	3.34	3.63	0.0093**
C x L x T	4	3.91	0.97	1.06	0.3789N.S
F x C x L x T	4	9.72	2.48	2.70	0.0370*
Error	72	66.11	0.91		
Total	107	1619.88			

** = Highly significant, * = Significant, NS = Non-significant

Table 2b: Individual Comparison of Treatment Means by LSD Test

Fleece	F1	F2	
Means	6.79 a	12.35 b	
Count	C1	C2	
Means	8.96 a	10.18 b	
Stitch length	L1	L2	L3
Means	8.05 a	9.34 b	11.32 c
Twist	T1	T2	T3
Means	8.24 a	9.36 b	11.11 c

Note: Means bearing the same letter have non-significant

Conclusion

In comparison of (2-yarn fleece and 3-yarn fleece) knitted fabric it was reveals that width wise shrinkage is higher for 2-yarn fleece, however its length wise shrinkage is lower in competition than 3-yarn fleece. Width wise shrinkage is inversely proportional to stitch length while length wise shrinkage is directly proportional to the stitch length. Length wise shrinkage and width wise shrinkage are directly proportional to the yarn count. The shrinkage increases by the increase in twist factor of the fleece yarn.

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