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Development of a Statistical Model for Predicting the Dimensional Stability of Socks during Wet Processing

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Abstract

One of the most important problems in socks manufacturing industry is change in size that affects the dimensions of final product. This dimension instability arises mainly due to the strains in the fabric getting relaxed during any wet treatment. Change in dimension play a vital role in achieving the required specifications of a sock. This dimensional change may be in a positive (growth) or negative (shrinkage) direction for fabric length and width. In this research article a statistical model is developed showing the effect of loop length, count and construction of cotton socks on its dimensional stability during wet processing. Carded cotton socks with different counts (16/1 Ne and 20/1 Ne) and loop lengths (0.30 cm and 0.40 cm) were developed. All the developed samples were subject to reactive dyeing, washing and boarding. The dimensional stability was calculated and analyzed by main effects plot.

Keywords: Socks; Dimensional stability; Wet processing; Statistical model

Introduction

Different materials and technologies can be used for the production of garments. The most common method used is knitting. Structural parameters and finishing process directly influence physical and chemical properties of final knitted product. Knit structure is used to make knitted socks. Knitted garments are more comfortable as compared to woven that's why most of the people around the world prefer knitted garments. Men's socks are mostly weft knitted garments linked with some serious problems of dimensional stability. They are not regular tubular in structure and have different type of yarns and specially knitted structure at heel and toe regions. Most of the regions in sock undergoes shrinkage after washing and produce the mis-matching problems [1-3].

Munden [4] and, Hurd and Doyle [5] have extensively discussed the dimensional properties of wool and cotton knitted fabrics and predicted that the dimensions of a knitted fabrics mainly depends upon the length of the yarn in the knitted loop. Munden carried out a study of fabric relaxation and fabric geometry with wool yarns. First of all, he discussed two relaxed states, if a fabric after knitting has been allowed to lie freely for a sufficient length of time; it eventually reaches a stable state which is called the dry relaxed states. In the dry relaxed state, the natural configuration of yarn is almost straight so that when it is un rowed, the yarn takes up an approximately straight form. The state of equilibrium reached by a fabric after static relaxation in water and subsequent drying is called the wet relaxed state. In the wet relaxed state, yarn is set so that the natural configuration of yarn is not straight but is set into a form approximating the loop shape in the fabric. This depicts that the forces which are necessary to keep the yarn in loop shape in the dry relaxed state, are reduced in the wet relaxed state [4].

Knapton et al. have also studied the dimensional properties of wool knitted fabrics and concluded the importance of K values on the dimensional properties [6]. The dimensional and physical properties of weft knitted fabrics, particularly made with cotton, wool and acrylic has been studied by many investigators [7-8]. However, not much has been reported for weft knits made out of viscose, modal and lyocell fibers. There has been a growing demand for absorbent fibers with the need hinging on comfort and fashion. All regenerated cellulosic fibers have the same chemical composition, yet they differ in density, molecular mass, degree of polymerization, super molecular arrangement, and above all, their degree of crystallinity and orientation. The main differences in structure, and consequently in fiber properties, originate from variations in production processes. Regenerated synthetic fibers, especially modal and lyocell fibers production has helped in the development of new apparels and created tremendous possibilities to achieve improved dimensional, physical, mechanical and aesthetic properties of apparel fabrics [9-10].

Rahman et al. investigated the effect of washing and drying variables on the dimensional stability and distortion of knitted fabrics. It was concluded that changes occurring after laundering were largely due to alterations in the loop shape, rather than yarn or loop length shrinkage [11]. Shrinkage and elongation usually arises due to strains in the fabric by different treatments. These changes may occur from minor of 0.04% to as much as 10% depending upon the type of fabrics and repeated washings [12]. It was also found that the shrinkage along length is governed by geometry of loop migration and curvature changes upon wetting and drying of fabric [13]. The fabrics having higher knitting stiffness, showed more shrinkage in area [14].

Dimensional changes in plain knit fabrics made of wool and synthetic blend fibers at different stitch knit lengths was studied. Results showed that plain knit fabric did not come to fully relaxed state by static wet relaxation. The prediction of washing performance is therefore an enormous task. It requires an in-depth knowledge of the geometry, stability and forces held within the fabric. Knitted fabrics are inherently difficult to stabilise, as the construction allows for contraction of up to 40%. The commercial knitter will therefore benefit from any research into the dimensional behavior and techniques of predicting stable dimensions.

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As per our knowledge, this behavior of different knitted fabrics i.e., single jersey, rib, interlock, fleece had been studied earlier but no significant research has been carried out on socks to sort out the problem of dimension stability keeping in view processing method. The major aim of this study is to study the effect of count on dimensional stability of socks during wet processing, to study the effect of loop length of the main yarn on dimensional stability of socks during wet processing and to study the effect of structure on dimensional stability of socks during wet processing.

Experimental

Material and method

The objective was to study the effect of loop length, count and construction of cotton socks on its dimensional stability during wet processing. For this purpose, carded cotton with different counts (16/1 Ne and 20/1 Ne) were used as main yarn to produce socks samples. Polyester Covered Lycra 20 75/36/1 (with Lycra 10%) was used as a platting yarn which remained same for all of the samples. The socks were developed on Lonati GL544 knitting machine with 4 inch diameter, 144 needles and 4 feeds. Two different loop lengths (0.30, 0.40 cm) were used for the development of plain and full sandwich terry socks. Then the samples were toeclosed on "Linking machine – Conti Complett 232". The experimental design is shown in Table 1.

Dyeing process

Samples were dyed in "Tupesa Maquinaria textile dyeing machine" using exhaust method with 0.64% (o.w.f.) Synazol Yellow 2GR, 0.10% (o.w.f.) reactive dyes using 20 g/L sodium chloride, 10 g/L soda ash and 0.5 g/L leveling agent (Sarabid LDR by Clariant). The time/temperature parameters were set as per the dye manufacturer's recommendations. The samples were rinsed and washed followed by neutralization with 1 g/L citric acid. Samples were then dried at 90°C for 20 minutes in "Lavatec FL 612 Tex" drying machine with 35 revolutions per minute.

Boarding process and parameters

The samples were pressed on Boarding machine Technopea Gibli at 190°C for 5 seconds with 5 bar pressure. Two different frame sizes (9.5, 11.5 cm) were used for stich length of (0.30, 0.40 cm) accordingly. The boarding parameters are shown in Table 2.

Testing material

BSEN ISO 6330 testing method was used to determine the dimensional stability. The conditioned samples were measured before and after the washing test. The dimensional stability was calculated:

DVL: Longitudinal dimensional variation

No	Factors	Units	Levels	
			1	2
1	Cotton count (Carded)	Ne	16/1	20/1
2	Loop length	cm	0.30	0.40
3	Fabric construction		Plain	Terry

Table 1: Experimental factors and their levels.

No	Boarding parameters			Frame Size (Cm)	Sample	
	Temperature °C	Time (Sec)	Steam Time (Sec)		Plain	Terry
1	190	5	2	9.5	0.30	0.30
2	190	5	2	11.5	0.40	0.40

Table 2: Parameters of boarding.

L_0: Marked square length before treatment

L: Marked square length after treatment

Result and Discussion

The design of experiment was created by full factorial design with one replicate (a total of 8 runs) as shown in Table 3. The dimensional stability of all the developed samples with different count, stitch length and construction was compared.

Table 3 shows that the dimensional stability of cotton socks depends upon the count, loop length and construction of the cotton socks. Within this frame the effect of each parameter was analyzed statistically using the main effect plot.

Effect of loop length on dimensional stability

It can be noticed in Figure 1 that by increasing stitch length dimensional change % of the knitted socks can be decreased. This deceased in dimensional stability of the knitted fabric samples with the increase in loop length may be attributed to the fabric become more open and the yarn will be more freedom to shrink with the increased loop length. So, stitch length has inverse relation with dimensional change % of the knitted socks.

Effect of loop length on dimensional stability

The construction has also an inverse relation with dimensional change % of the knitted socks from plain to full sandwich terry but the effect was not significant. As in full sand which terry the loops with pile length on inner side of the socks has much more freedom as compared to the plain socks. The stiches in the plain socks are tightly knitted with minimum freedom to shrink. So the effect of terry construction on dimensional stability is greater as compared to plain socks.

Effect of count on dimensional stability

Carded cotton with 20/1 count offers lower dimensional stability

S. no	Count (denier)	Stitch Length (cm)	Construction	Dimensional change %
1	16	0.30	Plain	-2.43
2	20	0.30	Plain	-1.86
3	16	0.40	Plain	-4.24
4	20	0.40	Plain	-5.02
5	16	0.30	Terry	-2.98
6	20	0.30	Terry	-2.25
7	16	0.40	Terry	-4.19
8	20	0.40	Terry	-5.62

Table 3: Design of experiment.

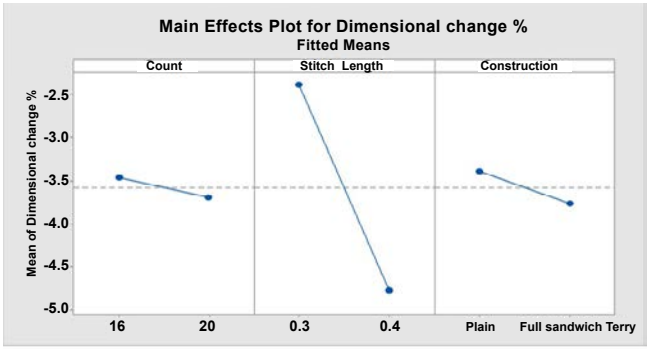

Figure 1: Main effect plot for dimensional stability.

in processing as compared to 16/1. It may be due to the fact that finer count swells more as compared to coarse count due to which it offers more shrinkage.

Conclusion

The effect of three different parameters viz. count, loop length and construction was compared on dimensional stability of 100% cotton socks during wet processing. It was found that the loop length has the significant inverse effect on the dimensional stability of sock during processing. Count of the yarn and construction also contribute to dimensional stability but their effect was found significant. So, the final specification and dimensional stability of the 100% cotton socks can be predicted and control by adjusting the parameters viz. count, loop length and construction.

References

1. Morris MA, Prato HH, White NL (1984) Relationship of fiber content and fabric properties to comfort of socks. Cloth Text Res J 3: 14-19.
2. Nishimatsu T, Ohmura K, Sekiguchi S, Toba E, Shoh K (1998) Comfort Pressure Evaluation of Men's Socks Using an Elastic Optical Fiber 68: 435-440.
3. Tsujisaka T, Azuma Y, Matsumoto YI, Morooka H (2004) Comfort Pressure of the Top Part of Men's Socks. Text Res J 7: 598-602.
4. Munden DL (1959) 26-The Geometry and Dimensional Properties of Plain-Knit Fabrics. J Text Inst Trans 50: T448-T471.
5. Hurd JCH, Doyle PJ (1953) Fundamental Aspects of the Design of Knitted Fabric. J Text Inst Proc 44: P561-P578.
6. Knapton JJF, Ahrens FJ, Ingenthron WW, Fong W (1967) The dimensional properties of knitted wool fabrics Part1: The plain-knitted structure Textile Research Journal: 999-1012.
7. Herath CN, Kang BC (2008) Dimensional Stability of Core Spun Cotton/ Spandex Single Jersey Fabrics under Relaxation. Text Res J 78: 209-216.
8. Srinivasan JG, Ramakrishnan S, Mukhopadhyay, Manoharan S (2010) A study of knitted fabrics from polyester microdenier fibres. J Text Inst 98: 31-35.
9. Kreze T, Malej S (2003) Structural Characteristics of New and Conventional Regenerated Cellulosic Fibers. Text Res J 73: 675-684.
10. Anand SC, Brown KSM, Higgins LG, Holmes DA, Hall ME, et al. (2002) Effect of laundering on the dimensional stability and distortion of knitted fabrics. Autex Res J 2: 85-100.
11. Rahman H, Karim R, Mitra BK, Science MB (1902) Study on the Spirality and Shrinkage of Weft Knitted Fabric: An Impact of Tumble Drying and Line drying 1: 143-152.
12. Fletcher HM, Roberts SH (1953) Distortion in Knit Fabrics and Its Relation to Shrinkage in Laundering. Text Res J 23: 37-42.
13. Textile KV (2006) ProKNIT system a study on the theoretical and practical application of predicting the fabric mass per unit area for weft single and double knitted structures efthymios gravas.
14. Gokarneshan N, Viswanath SR, Nagarajan VB, Veeraprabhakar J (2014) Dimensional characteristics of cotton and viscose weft knits 3: 84-103.