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An Investigation into the Dimensional Stability of 100% Cotton Fleece Knit Fabric

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Abstract

Fleece is one of the popular knit fabric structures and design which is still dominated vast acceptance in today's up-to-the-minute fashion thoughts. It has the distinctive characteristics for its structure to feel being warm, easy to handle, washable and hang to dry. The wide application includes outerwear, lining or insulation, mittens, socks, hats, scarf's, blankets and quills etc. Due to its market demand the fabric developments have been extensive worldwide. The combinations of different machine gauge, yarn types and blended yarns are used for knitting fleece fabric. The investigation of this research involved with dimensional stability of fleece fabric which are critical problem for getting quality fabric to make garment. The research area belongs to textile industry as well as consumers satisfaction regarding ready-made garment to wear comfortably. Dimensional instability of 100% cotton knitted fleece fabric is major problem to meet buyers and end user satisfaction in terms of quality and comfortability. Selection of right yarn count and adequate knitting parameters during knitting can minimize this problem.

Keywords: *Dimensional stability, shrinkage, spirality, bursting strength, weight loss, three thread fleece fabric*

1. Introduction

The dimensional stability of fabric denotes the changes of fabric dimensions whether it is used or reprocessed due to the properties of raw material and other responsible factors such as tightness of yarn, fabric structure, yarn tension and fabric take down tension during fabric manufacturing (Kumar and Sampath, 2013). Loop length, yarn count and machine gauge are other important factors to consider about dimensional stability of the fabric. The fabric with good dimensional stability could be worn and washed for many times. The fabric with poor shrinkage characteristics resulted inferior experience in sewing, ironing, washing and so on (Marmaralı, 2004).

The uniform tension during yarn feeding to produce knitted fabric has a significant role on fabric shrinkage. If the yarn feeding tension increases, the fiber deformation also increases. As a consequences internal stress and the slow elastic deformation increases which enhances the relaxation and retraction degree of the fabric increases after soaking. As a result, the shrinkage rate of the fabric increases. Beside this the shape of the loop changes due to the tensions applied to the knitted fabric during knitting. The forces are removed next to knitting process, the loops of the fabric tend to return their natural shape and make dimensional changes of it which is reflected on the knitted fabric till to finished readymade garment (Munden, 1959). Fabrics are needed to be relieved from internal tension and to prevent yarn swelling in wet treatment process (Çoban, 1999). In order to avoid dimensional instability, it is necessary to perform some proactive measures from the beginning of the fabric production and to control all the processes from the fabric manufacturing to garments making (Teli, Khare and Chakrabarti, 2008). Different types of fleece fabric can be knit such as one thread fleece, two thread fleece, three thread fleece, polar fleece and micro fleece. But in terms of knit fabric structures technically three-thread fleece is known as fleece fabric. Three sets of yarn are used to knit three thread fleece fabric, i.e., one yarn is to knit ground fabric, another is to make pile and other yarn which is known as binder yarn used to bind these two set of yarns (Yesmin, 2014). Different raw materials of fabrics will affect shrinkage rate varies from fabrics density, the thickness of yarns, knitting, dyeing and finishing process. Mercerization can reduce shrinkage rate. Shrinkage rate means to the percentage of that particular fabrics' size presents shrink when washed or soaked, which is also an indicator of measuring the degree of fabric shrinkage. The paper includes the study on the dimensional stability of fleece fabrics made from different yarn count with different linear density and twist factors and having variation in stitch length (Spencer, 2001).

2. Objective

The major objective of the current study is to investigate the dimensional behavior of 100% cotton fleece knit fabric.

3. Literature Review

Three thread fleece fabric is produced by following needle and cam arrangement

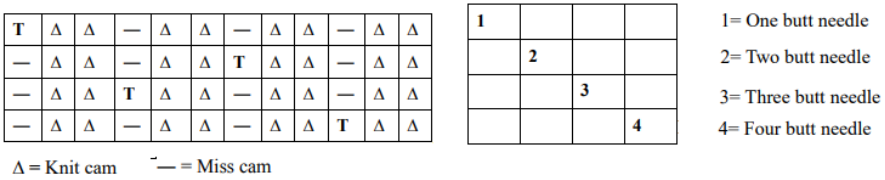


Figure 1: Needle and CAM arrangement of three thread fleece fabric

The flowchart for producing three thread fleece fabric are as below:

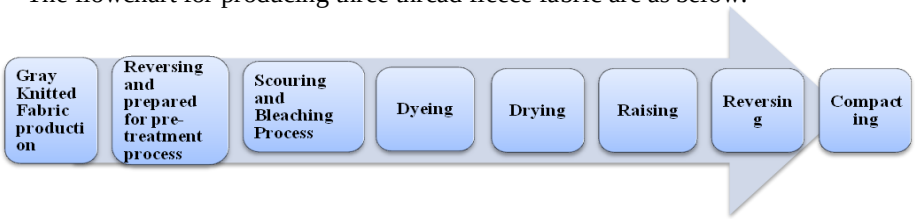


Figure 2: Process flowchart to produce three thread fleece fabric

In order to determine lengthwise and width-wise shrinkage or elongation after the finishing process, shrinkage test was applied to the specimens. After finishing process, the dimensional change was measured. Fabrics were drawn on the dimensional pattern (50cm x 50cm) using a permanent marker. Then dimensional change was measured with the help of shrinkage scale and measurements were taken inner borders of the first drawn line on the ruler (35x35 cm) (Prakash and Thangamani, 2010). Shrinkage in each direction was calculated by the following formula:

$$\text{Shrinkage percentage} = \frac{Original\ Measurement - Final\ Measurement}{Original\ Measurement} x\ 100$$

Spirality was measured using AATCC pillow case method, two specimens were sewed from three sides and other side was kept open. After repeated washing the sewing line inclination was measured from the following equation:

$$\text{Spirality} = \frac{Distortion}{Length} x\ 100\%$$

Bursting strength was tested on "BURSTMATIC" 338E instrument, as per ISO 13938-2 at head speed of 100 millimeters per minute. Bursting height and bursting pressure were attributed to the measure of strength. For this, force was applied for 20 seconds that the rupture of textile materials takes place within this time (Sitotaw, 2017). Machine parameters for the "Bursting strength" test is as below:

Test Area	**50 centimeters**
Clamping	6 Bar
Pressure rate	10 kPa/s
Pressure drop	10 kPa
Diaphragm	1.0 mm
Correction rate	2 kPa/s
Correction	35.2 kPa @46.1mm

4. Methodology

4.1. Materials

The research was conducted at Nadeem Textile Mills Ltd., Narayanganj during the year of February, 2018 to June, 2019. In this study 100% cotton yarn were taken in different yarn count and was knitted on 18-gauge knitting machine with 24-inch diameter using 30 Ne as ground yarn. Three different branded knitting machines were investigated with same diameter and machine gauge. Following machines were used for the investigation:

Machine No.	Machine Name	Gauge	Diameter	Feeds per inch	Yarn Count
7	Pailung	18	24	3.0	G 30s, B 16s, F 10s
19	Fukuhara	18	24	3.0	G 30s, B 20s, F 20s
41	Pailung	18	24	3.0	G 30s, B 30s, F 12s
46	Pailung	18	24	3.0	G 30s, B 30s, F 10s
52	Fukuhara	18	24	3.0	G 30s, B 16s, F 12s

Table 1: yarn selection in different counts to knit three thread fleece fabric
(G- ground yarn, B-Binding yarn and F- Fleecy yarn)

4.2. Methods

The influence of the fiber properties for the ground yarn, binding yarn and fleecy yarns of the three-thread fleece fabric shrinkage test, spirality and bursting strength was calculated for the significance of this study.

4.2.1. Fabric manufacture

In order to produce fabric needle and cams were arranged to ensure quality production. Stitch length, greige GSM and other knitting parameters were checked carefully in order to ensure dimensional stability of the fabric. Yarn twist and machine rotation was under considered before creeling. Each and every fabric roll was undergoing for quality parameters testing process.

4.2.2. Shrinkage and Spirality Tests

The sample which was knitted placed for shrinkage test. At first that was spread on the table. Then a square size glass template was put on sample fabric. There were six mark on glass template and distance between two mark was 35 cm. Then sample is sewn and was ready for washing. Washing is done at 60˚c temperature for 90 minutes. After washing the fabric was taken out. Then drying the sample takes place by Line Dry or Flat Dry or Tumble Dry. Spirality test was done by cut a fabric sample in a rectangle shape of a particular dimension. Then fabric was fold and joined at their two ends by over edge stitch. Then appropriate marking is done on the fabric. Sample was then wash in washing machine and tumble dry is done. Sample fabric was spread on the flat table and measured displacement of perpendicular line.

4.2.3. Weight Loss Percentages

In total 15 replications for 5 different samples were made to determine weight loss percentage. All the specimens before proceed to finishing stage were undergo 500 cycles, 1000 cycles and 1500 cycles respectively to compare the weight loss percentage.

	Weight loss percentage after 500 cycle	Weight loss percentage after 1000 cycle	Weight loss percentage after 1500 cycle
G 30s, B 16s, F 10s	1.93	2.19	2.34
G 30s, B 20s, F 20s	1.95	2.18	2.3
G 30s, B 30s, F 12s	1.85	2.08	2.27
G 30s, B 30s, F 10s	1.89	2.14	2.32
G 30s, B 16s, F 12s	1.92	2.17	2.31

Table 2: weight loss percentage of three thread fleece fabric

5. Findings and Discussions

5.1. Fabric Shrinkage

Fleece fabric shrinkage percentage increases as binding yarn count increases and for coarser count shrinkage percentage decreases.

In this study, it was observed that for ground yarn count 30/Ne with binding yarn count 30/Ne shrinkage percentage in lengthwise and widthwise is greater compared to ground yarn count 30/Ne with binding yarn count 20/Ne and 16/Ne.

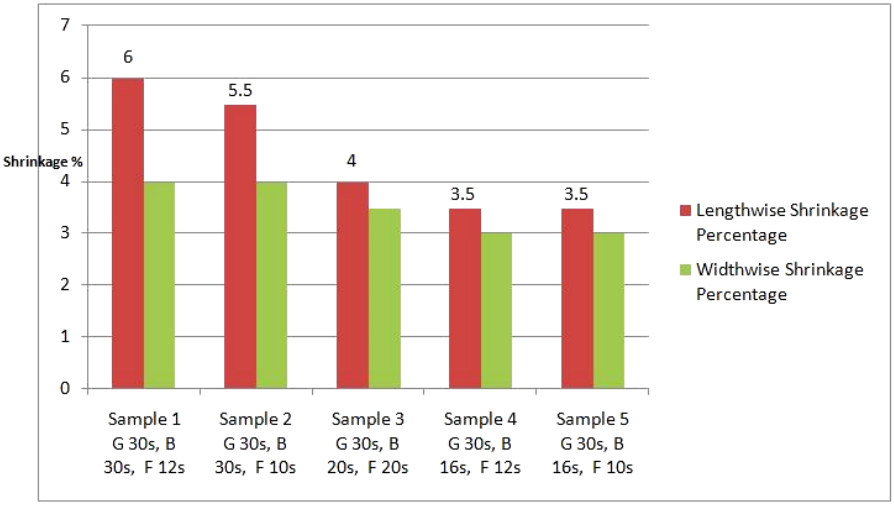


Figure 3: Shrinkage percentage in lengthwise and width-wise

In this investigation, fleece fabric spirality percentage increases as binding yarn count increases and for coarser count spirality percentage decreases. In this study, it was observed that for ground yarn count 30/s Ne with binding yarn count 30/s Ne spirality percentage is greater compared to ground yarn count 30/s Ne with binding yarn count 20/s Ne and 16/s Ne.

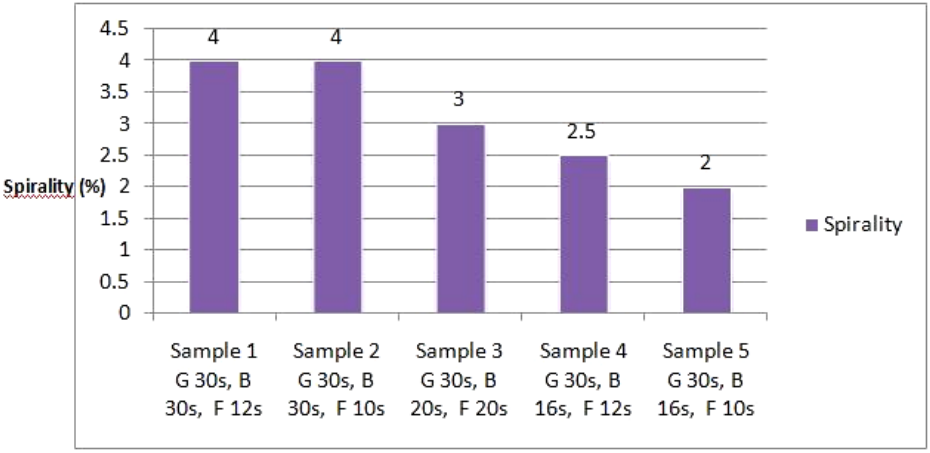


Figure 4: Spirality percentage results

5.2. Bursting Strength

Strength is an important parameter for any types of textile structure. The strength of three thread fleece knitted fabrics was measured by bursting strength test method where the vertical pressure was applied to the fabric. As a consequence, the effect on pressure to the fabric and the diaphragm were stretched up to extreme dimension and the loops brake at the

point which belongs to the lowest strength of the yarns. Bursting strength average test results were examined and illustrated as a graph in Figure 3.

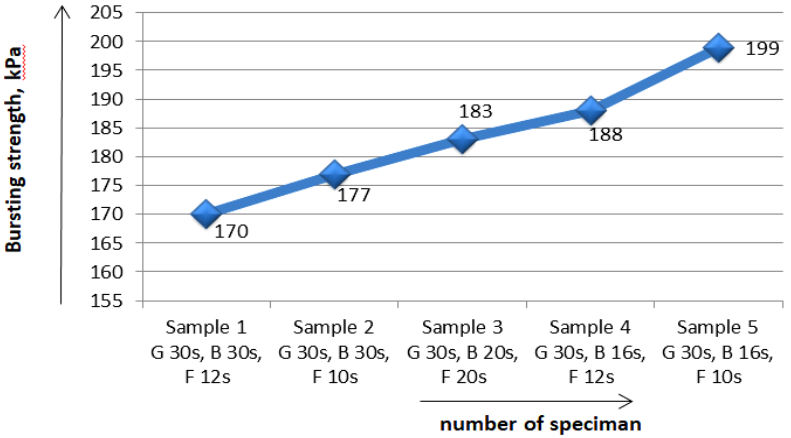


Figure 5: Bursting strength test results

According to this figure the bursting strength values of the samples were not closer to each other. Here it was observed that as binding yarn count were getting coarser than bursting strength was increased and in sample 4 and sample 5, binding yarn count was coarser as well as fleecy yarn count was also coarser. As a result, bursting strength was increased.

5.3. Weight Loss Percentages

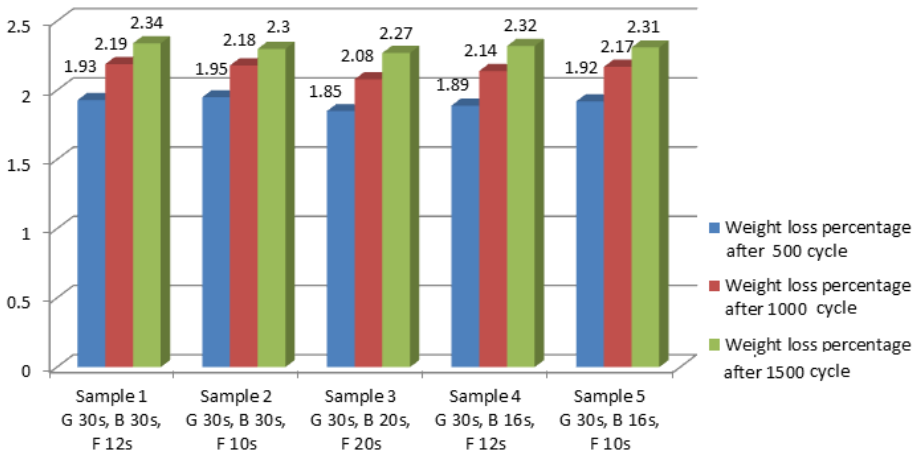


Figure 6: Weight loss percentage results

In this study it was noticed that increasing English yarn count in binding yarn results more weight loss and weight loss decreased as English yarn count decreases in binding yarn (Kotb and Megeid, 2011). Weight loss percentage of fleece fabric is increased with the increase of cycle number. After 500 cycles to 1000 cycles and 1000 cycles to 1500 cycles it was found that after 1000 cycles and 1500 cycles results were very similar in their values. A

significant change in the rate of weight loss percentage was found in between 500 to 1000 cycles.

6. Conclusion

The aim of the study was to find out the dimensional behavior of fleece knit fabric. Bursting strength of fleece knitted fabric is depends on fabric structure, fiber types and blend of yarns. These factors are the main factors in which bursting strength of knitted fabrics is dependent. Dimensional behavior of the fleece knitted fabric is influenced by fabric strength. So, bursting strength play a distinctive role in dimensional changes. Shrinkage and spirality percentage increases as binding yarn count increases. Weight loss percentage of fleece fabric is increased with the increase of cycle number. It was also found that after 1000 cycles and 1500 cycles result shows very closer values. A notable change in the rate of weight loss percentage increase is found in between 500 to 1000 cycles. The summary of this investigation was that the deterioration effect on the fabric surface as well as dimensional changes increased due to raise of the higher number of cycles. Finally, the paper concludes saying that future work needs to consider the modification in ground yarn count and binding yarn count to explore other factor regarding dimensional stability of three thread fleece fabric.

7. Acknowledgement

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