"EFFECT OF YARN COUNT & STITCH LENGTH ON SHRINKAGE, GSM AND SPIRALITY OF SINGLE JERSY COTTON KNIT FABRIC"

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Abstract

Single jersey cotton weft knitted fabrics tend to undergo a certain dimensional changes due to different yarn parameters and knitting parameters. The investigation was carried out to compare the effect of different yarn counts & stitch lengths on the spirality, GSM and shrinkage of knitted fabric. In this study the experimental results show that when yarn count is fixed, the increment of stitch length results decrement of spirality, increment of shrinkage and decrement of GSM. On the contrary, when stitch length is fixed, the increment of yarn count results increment of spirality, decrement of shrinkage and decrement of GSM. Some exceptions were also experienced.

Keywords: Spirality, GSM, Shrinkage, Single Jersey, Cotton Knit Fabrics, Count & Stitch length

Introduction

The knit structure is mostly used to make knitted garments. But there are some products which are not originally textiles but textile related, are also made using knitting basic rules. The most of the people of the whole world wear knit garments because of feeling more comfort as compared to woven fabrics. A lot of processing techniques are applied to produce a complete garment. But because of some faults like raw material fault, processing fault, mechanical fault, neglect of operator etc. in making garments, the products & product quality are greatly hampered. In this thesis, we shall try to represent a clear conception about a few terms of garments-GSM of fabrics (How to increase the GSM of fabrics, how to decrease the GSM of fabrics, In which way this is affected by knitting parameters & how this may be controlled), Spirality of fabric (Why this is formed in fabric & how it is controlled), Shrinkage of fabric (How this type of fault is formed in fabric & how it can be minimized(Technical Bulletin, 2002).

Literature review

Manufacturing of knitted fabrics involves intermeshing of yarn loops where one loop is drawn through another loop to form a stitch (Shah, 2003; Saufley, 1992). Since the last few years knitted fabrics are used in manufacturing of fashion garments and even it has the potential in the formal wear segments also. Shrinkage is one of the most serious problem of the fabric faults. Especially, it is obtained in single jersey knitted fabric. Because of different of both side of single jersey knit fabric & side (Face or back) of the single jersey always tends to create curling. Thus, shrinkage is formed in single jersey mostly, where the other fabric are not so affected greatly as compared with it. Shrinkage on fabric creates, stitching problem which resulting seam pucker problem. Human feels uncomfort due to wear of shrinked cloth.(Vishal Desale *et al*., 2008). Apart from this, spirality is another serious problem for single jersey knitted fabrics due to their asymmetrical loop formation. The fabric spirality is minimized up to 50% after the finishing process as compared to its gray stage spirality(Vishal Desale *et al*., 2008).

Many developments have taken place in the machinery for processing of knitted fabrics in both tubular process and open width forms. Specification methods of knitted fabrics, usually, include loop density, width of the fabric, weight per square meter and the loop length (Bourah, 2004). Flexibility exists at the various stages of wet processing in terms of process machinery and methods followed by calendaring or compacting which is often, the final operation prior to the packaging step (Tendulkar *et al*., 1994; Euscher *et al*., 1997).The level of shrinkage control needed, composition of yarn (100% cotton, blends) and type of chemicals applied to the fabric decide the final process, i.e., whether calendaring or compacting. Variable compactors are used to achieve specific stitch count and wet compacting is also carried out in certain cases (Baser *et al*., 1993). Yarns of different counts knitted to the same loop length display different physical properties such as drape, openness, permeability, handle and spirality etc. Başer and Çeken (Baser *et al*., 1993) produced knitted fabrics on hand knitting machines to research the effects of yarn properties on fabric spirality by using acrylic and cotton yarns with two different yarn counts and four different twist factors at different tightness factors. As a result the most important factor that affected the fabric spirality on acrylic and cotton knitted fabrics is observed as twist liveliness. It is observed that the angle of spirality is decreasing on knitted fabrics, when yarns are fixed with vapor. At the same time by using two-ply yarns, the spirality is prevented, because the twist direction of the two-ply yarn is opposite to the twist of one-ply yarn. On the other hand using fine yarns and slack fabrics, it is observed that on knitted fabrics the angle of spirality is very high. Araujo and Smith (De Araujo *et al*., 1989) investigated the spirality on single jersey fabrics, by usingCotton / Polyester yarns with different yarn counts and twist factors, which are produced with different spinning techniques. It is observed that the twist liveliness of 100 % cotton is higher than the 50/50 Co/PES knitted fabrics.They observed that, 50/50 Ring Co/PES yarns have higher twist factor than the 100 % Cotton yarns, for this reason the blended yarns have lower twist liveliness. 50/50 Co/PES yarns produced with open-end technique and air jet spun technique have lower twist factor than the 100 % Cotton yarns, so the fabrics with blended yarns have lower twist liveliness. In friction spinning 100% Cotton yarns' twist factor reaches its maximum value. Related with the spinning techniques, the angles of spirality from the biggest to the smallest values in 100 % cotton knitted fabrics are observed in friction spinning, ring, open-end and air jet spinning techniques respectively. The angles of spirality in 50/50 Co/PES knitted fabrics are observed as the smallest in air jet end open-end spinning techniques.Tao, Dhingra, Chan and Abbas (Tao *et al*., 1997) are investigated the spirality on single jersey fabrics. They used ring yarns with four different yarn counts and four different twist factors. Before knitting processes, they fixed yarn for 30 minutes with vapor. They observed a linear relation between the spirality and the twist factor. The fabrics which are knitted with high twisted yarns have great angles of spirality. At the same time they have high correlation coefficients between the spirality and the tightness factors. At different twist factors, the angles of spirality are getting lower when the tightness factor is getting higher. After wet relaxation state, the angles of spirality are increased, after washing and drying state the angles of spirality are increased more than the wet relaxation state.

From the above reveals as the literatures cited, it is evident that the effect of shrinkage, spirality, GSM etc. of knit fabric properties are sometimes fateful, and thus needs to be controlled. But the construction and processing parameters of the knit fabric are exclusively related with the properties. Within the parameters, yarn count and stitch length are the vital most, on which the till-dated works could not focus clearly. In this consequence, the present job is targetted in dealing with the following objectives:

i) To dig into the effect of yarn count on shrinkage, spirality and GSM, where stitch length is constant,

ii) To study the effect of stitch length on shrinkage, spirality and GSM,

where yarn count is constant.

Materials and methods

Raw materials

Fiber properties

In this study differently constructed cotton knit samples were tested . Yarn of different counts produced in Delta Spinning Mills ltd, yarn produced from 100% cotton fiber. The fiber having following parameters:

Micronaire value : 4.5 (From USTER report)
Staple length : 28.50mm

Fabric production

All the fabrics knitted are of single jersey type. Each yarn was used to knit a length of knitted fabric with a knitting machine having following specification.

Brand Name of Machine : JIUNN LONG.
Origin of machine : TAIWAN
Model no : JLS
MACHINE NO : 041012
Diameter of Machine : 23
Number of Feeder : 69
Number of Needle : 1740T
Machine Gauge : 24G
Machine Speed : 26 rpm

This parameter was employed for knitting 24^s&26^s yarn using positive feed device. Single jersey: Cam arrangement Needle Set out

K K K K	1
K K K K	2
K K K K	3
K K K K	4

Dyeing procedure

Pretreatment curve

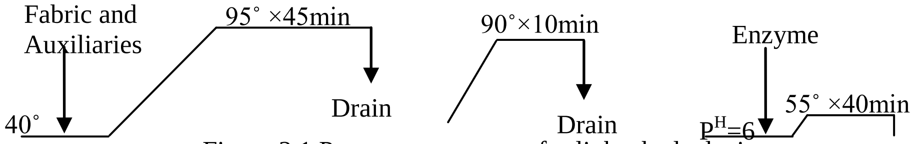


Figure 2.1 Pretreatment curves for light shade dyeing

Dyeing curve of reactive dyeing of cotton knit fabric

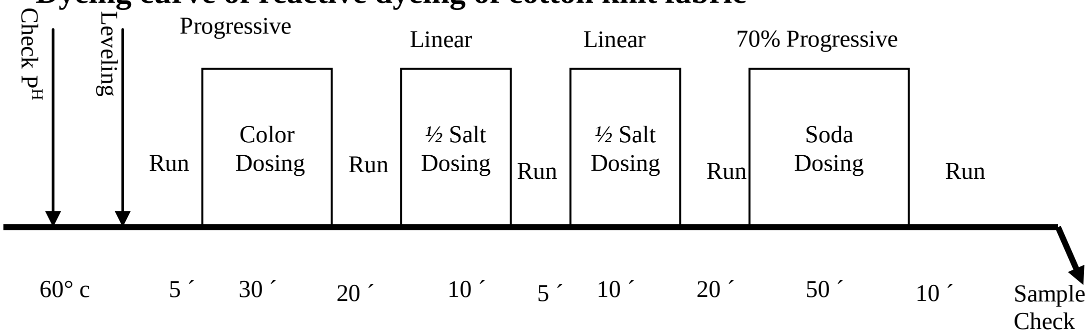


Figure 2.2 Dyeing curve

Finishing process

The finishing process designated slitting & dewatering on Blanco m/c, and then Stentering was done.

Stentering machine

The main mechanism of the Stentering machine, under feed roller to feed the fabric, over feed roller to increase and decrease GSM, spending roller to remove the crease mark, mahalo to adjust the bowing angle, Fabric wheel to stretch the fabric and contact with chain.

During Stentering following parameters were used.

Brand name of Machine : Unitech
Capacity of Machine : 10000 kg
Chamber : 8
Temperature : 150°c
Over feed : 70 %
Speed : 20 m/min
Set Dia : 127"
Squeezing roller Pressure: 3 bar

Fig.2.3

Function of compactor

- To Control the GSM.
- To Control the shrinkage
- To Control fabric diameter.
- To Control spirality.

Compacting m/c parameters:

Brand name of Machine : FERRARO
Compaction % : 2 %
Dia Setting : 50"
Over feed : 25 %
Speed : 25 m/min
Upper felt tension adjust : 4.75 bar

Fig 2.4 Compacting machine

Spirality testing

For measuring spirality, firstly, samples were collected from compacting machine. They were marked with two sets of marks in each direction (length and width), a minimum of 50 cm apart and at a distance of approximately 3 cm from the edge. It is recommended that, the samples should pre conditioned at standard textile testing atmosphere.

Purpose and scope

1. This test method determines change in skewness in woven and knitted fabrics or twist in garments when subjected to repeated automatic laundering procedures commonly used in the home. Washing and drying procedures used for shrinkage tests and other home laundering tests are specified for this method (Saville, 2004).

2. For some fabrics the degree of twist of fabric in garments is not solely dependent on its behavior in the unsewn state; it also may be dependent on the manner of garment assembly (Saville, 2004).

Principle

Change in skewness in fabric or twist in garment specimens resulting from procedures typical of home laundering practices is measured using bench marks applied to the specimens before laundering. (Saville, 2004).

Apparatus and materials

Indelible ink marker pen, Right triangle, L-square or marking template.

Tape or rule marked in millimeters, tenths of an inch or smaller increments.

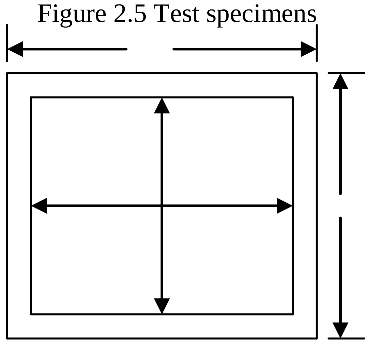
Automatic washing machine, ISO Standard Reference Detergent, Automatic, Tumble Dryer.

Test specimens

Sampling and preparation

Prior to marking, pr-condition and then condition test specimens as directed in ASTM Practice D 1776 Standard Practice for Conditioning and testing Textiles. Condition each specimen for at least 4 hrs in an atmosphere of 21 ±1˚C (70 ± 2˚C) and 65 ± 2% RH. Where possible, cut specimens from different areas of the fabric so that the each specimen will contain different groups of lengthwise and widthwise yarn. Identify fabric face; mark lengthwise direction on each specimen (Saville, 2004). Specimen Size 50cm × 50cm

Figure 2.5 Test specimens



Washing Condition

Detergent : 2 g/l
Temperature : 40˚c
Time : 45 min
Drying Condition: (Tumble Dry)
Temperature : 70˚c Time : 15-20 min

Evaluation

The dried specimens were subjected to condition and measured the spirality (%). Calculation of Spirality %:

$$Spirality\% = \frac{\frac{Left\ side\ +\ Right\ side}{2}}{Length} \times 100 \text{(i)}$$

Results and discussions

The objectives of this study were to evaluate the effect of yarn count & stitch length on Spirality, GSM & Shrinkage of single jersey cotton knit fabric. In this chapter, the effects of yarn count & stitch length were discussed separately and compared. For every experiment the same procedure was applied to produce fabric, dyeing and finishing. The measurements were also repeated after compacting with open width compactor machine. All measurements were performed under standard textile testing conditions of 21°C ± 1°C, and 65% ± 2% relative humidity. No tension was applied to samples during measuring spirality percentage. The influence of parameters linked to yarn, fabric structure and machine were studied. When studying one parameter the other ones were kept constant.

Fabric shrinkage with yarn count and stitch length

In this experiment samples knitted from 100% cotton were analyzed by keeping same count (24 Ne) but different stitch length (2.72mm & 2.75mm). Same experiment was conducted for count 26 Ne having stitch length (2.70 mm & 2.75mm). After compacting, the variation of shrinkage % in the length and width direction of fabric due to change stitch length was plotted into the chart. From figure 3.1 it is shown that for 24Ne cotton yarn the shrinkage % of fabric is increasing due to increase stitch length and the Shrinkage % value is -4.5 for 2.72 mm stitch length and it is -5.88 for 2.75mm stitch length. Also shown that for 26Ne cotton yarn the shrinkage % of fabric is decreasing due to increase stitch length and the shrinkage % value is -6% for 2.70 mm stitch length and it is -5.22% for 2.75mm stitch length. Again, it is shown that for 24 Ne & 26 Ne cotton yarn the Shrinkage % in the width direction of fabric is increasing due to increase yarn count and the Shrinkage % value is -8.5 for 24Ne and it is -9.55 for 26 Ne. The test results were tabulated in the figure 3.2.

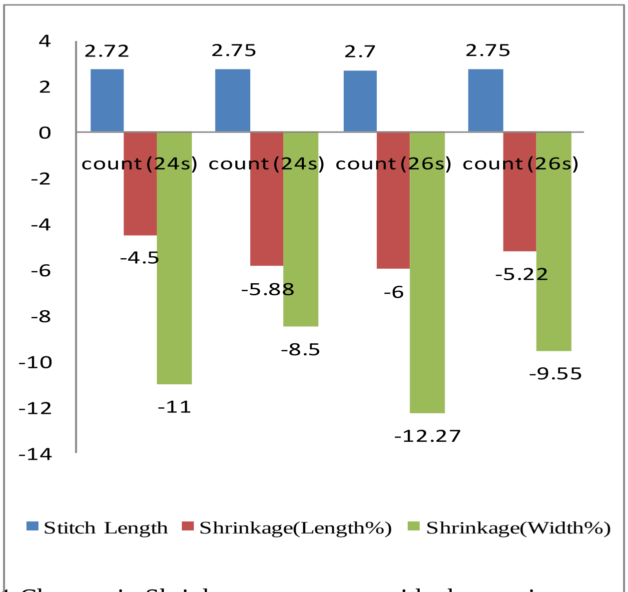


Figure 3.1 Changes in Shrinkage percentage with changes in count and stitch length

Changes in gsm with yarn count and stitch length

In this experiment samples knitted from 100% cotton were analyzed by keeping same count (24 Ne) but different stitch length (2.72mm & 2.75mm) and (26 Ne) having stitch length (2.70mm and 2.75mm) respectively. After compacting, the variations of GSM of fabric due to changes in stitch length were plotted into the chart. The test results were tabulated in the figure 3.2 it is shown that for 24 Ne cotton yarn the GSM is decreasing due to increase stitch length and the value of GSM of fabric is

160 whose stitch length is 2.72mm and it is 157 for the 2.75mm stitch length. Also it is shown that for 26 Ne cotton yarn the GSM of fabric is increasing due to increase stitch length and the GSM value is 136.11 for 2.70 mm stitch length and it is 156.55 for 2.75mm stitch length.

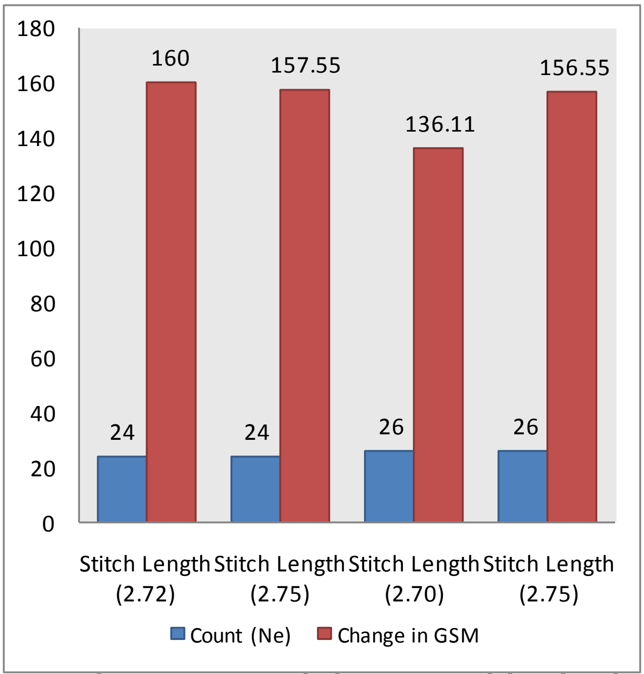


Figure 3.2 Changes in GSM with changes in stitch length and yarn count

Changes in spirality with yarn count and stitch length

In this experiment samples knitted from 100% cotton were analyzed by keeping same count (24 Ne) but different stitch length (2.72mm & 2.75mm) and for (26 Ne count) with stitch length (2.70mm and 2.75mm) respectively. After compacting the variations of spirality% of fabric due to change stitch. In figure 3.3 it is shown that for 24 Ne cotton yarn the spirality% of fabric is decreasing due to increase stitch length and the spirality% value is 2.39 for 2.72 mm stitch length and it is 1.54 for 2.75mm stitch length. And that for 26 Ne cotton yarn the Spirality% of fabric is decreasing due to increase stitch length and the Spirality % value is 2.92 for 2.70 mm stitch length and it is 2.33 for 2.75 mm stitch length. The results were plotted into the chart.

It is also found that for 24Ne & 26Ne cotton yarn the Spirality% of fabric is increasing due to increase yarn count and the Spirality% value is

1.54 for 24 Ne and it is 2.33 for 26 Ne.

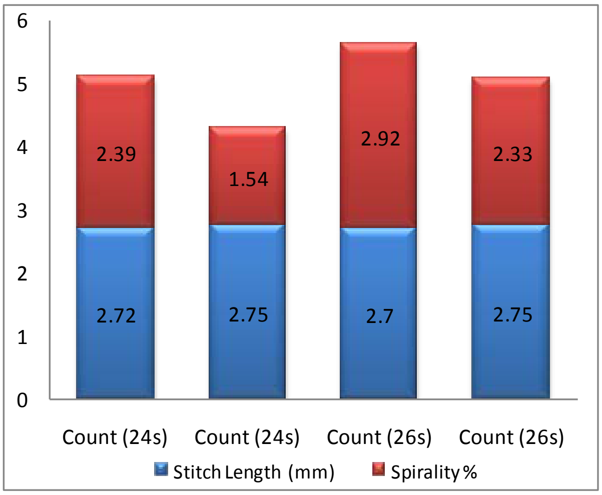


Figure 3.3 Changes in Spirality percentages with changes in yarn count and stitch length

Stitch length expresses the tightness of knitting construction. The fabric is tight as stitch length is low. The observed proportionality between fabric spirality and the stitch length can be explained by the fact that compared to tight fabrics, slack fabric have higher stitch length and then the yarn composing the loop has a higher tendency to rotate inside the fabric after relaxation. In a more tightly knitted fabric, the movement of a knitted loop is restricted, and thus spirality is reduced. The spirality of fabrics knitted with low tightness generally increases with yarn tex for a given twist factor. But for the tighter fabrics, there is no evidence of any systematic relationship between fabric spirality and yarn count (Tao *et al.*, 1997). Dimensional parameters of fully relaxed single jersey fabrics depend on the yarn linear density and tightness of construction. If diameter is reduced, its resistance to deformation is lowered. It indicates that, deformation of loop structure is influenced by yarn count. In other words, the finer the yarn, the more will be the spirality due to more twisting (Vishal *et al.*, 2008). In this study some experimental results shows that, spirality of knitted fabrics increase with increases in stitch length & yarn count. When yarn count increases spirality increases & vice versa. But when yarn count increases the GSM of fabric decreases. When GSM decreases spirality decreases and when yarn count increases the Shrinkage of fabric increases. But some experimental results shows unsymmetrical relation between spirality, stitch length & yarn count. Probable causes for unsymmetrical result require stitch length ranges for specific count were not used in every case. Diameter setting of different machine may not be sufficiently accurate. Dyeing tension for different sample may vary. Description of yarn for HVI report shows varied values of CV%, U%, and elongation properties etc. which affect the gradual values of spirality.

Conclusion

This study presents an experimental investigation of the effect of yarn count and stitch length on the Spirality, GSM, and Shrinkage of industry based produced cotton single-jersey fabric. In both ways the effects were investigated by keeping the yarn count and stitch length alternately fixed. At the same it is observed that the stitch length or loop length has the most significant effect on spirality & GSM of cotton single jersey fabric way the count of the yarn also influences the spirality & GSM of cotton single jersey fabric. In most cases, it is clear that spirality increases with the increment of stitch length as well as yarn count with some exceptions. When yarn count increases spirality increases & vice versa. But when yarn count increases the GSM of fabric decreases. When GSM decreases spirality decreases and when yarn count increases the Shrinkage of fabric increases. But some experimental results show unsymmetrical relation between spirality, stitch length & yarn count. Further study should be done for effect of yarn elongation TPI, TM, different construction on spirality of cotton knit fabric of different constructions.

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