A Study on Spirality of Single Jersey Knitted Fabric

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Abstract

Spirality is particularly serious problem for single jersey knitted fabrics due to their asymmetrical loop formation. This paper focuses on spirality of the single jersey knitted fabrics as key aspects. This paper investigates the different studies such as effect of Yarn tension, No. of feeders and Stitch length on the spirality of single jersey knitted fabrics. The paper also explicitly determined the theoretically approach of the causes and remedies of spirality. The paper also focuses on the effect of fabric weight on the spirality of single jersey fabrics at both stages i.e. gray and finished state. The results of this study have concluded that the spirality is increases strongly when increasing the no. of working feeders with constant machine diameter. The result also concludes that the stitch length and yarn tension is also influences on fabric spirality. There is direct relationship of fabric spirality and yarn tension is observed by keeping other factors are constant. The study also concludes that stitch length is inversely proportional to fabric spirality. The fabric spirality is minimized up to 50% after the finishing process as compared to its gray stage spirality.

Key words

Single jersey, Spirality, Twist factor, GSM, Stitch length, knitting tension

Introduction

The ever increasing demand of knitted apparels has attracted attention in global niche market. In comparison to woven garment, around 50% of the clothing needs are met by the knitted goods. It is well known that weft knitted fabrics tend to undergo certain dimensional changes that causes distortion in which there is a tendency of the knitted loops to bend over, causing the wales to be at diagonal instead of perpendicular to the courses.

Spirality of knitted fabric is obtained when the wale is not perpendicular to the course, forming an angle of spirality with vertical direction of the fabric. It affects particularly single jersey fabrics and presents a serious problem during garment confection and use. The t-shirt production, for example, suffers from many quality problems linked to fabric spirality such as mismatched patterns, sewing difficulties, displacement of side seam to the back and front of the body and garment distortion. Spirality has an evident influence on garment aesthetics. The spirality phenomenon concerns essentially unbalanced structures such as single jersey fabrics. The symmetry of rib structures reduces considerably the spirality. Unset yarns under low tensile loads have a tendency to return to their untwisted state.[1]

This project proposed to measure spirality angle of cotton plain knitted fabric by manually technique with protector at both stages i.e. grey and finished. This project work have also

investigate the effect of fabric and machine parameters such as Yarn tension, loop length and no. of feeder of knitting machine on fabric spirality. In this project the influence of the finishing process on spirality behavior of commercially produced fabrics was also investigate. We have taken three reading of each type of sample for calculating the C.V% of the spirality angle. From these three reading we have calculated the mean and take it as the spirality angle of that sample. One of the main disadvantage of the manually measurement of spirality angle is that the higher CV% of spirality angle which is happened due to improper handling of material and also due to distortion of the sample measurement, it is also vary from checker to checker.

Review of literature

Cause & Effect Analysis of Fabric Spirality

The ultimate benefit of studying the spirality phenomenon is to understand the various factors influencing the dimensional stability of knit fabrics, particularly fabric spirality so that ways to select appropriate levels of these factors that result in optimum dimensional stability can be established. This can be achieved through a cause and effect analysis of the various potential factors influencing fabric spirality. The importance of cause and effect analysis stems from the fact that several theoretical approaches were taken to analyze the spirality phenomenon, yet because of the complexity of the phenomenon, each study focused on a limited number of factors, either for the sake of simplifying the analysis, or due to limited ability to verify the theory using experimental approaches. Other studies dealt with the analysis of spirality from strictly experimental view by examining the effects of a number of factors some of which were machine-related and others were fabric-related on the extent of spirality of knit structures. Obviously, these approaches resulted in many common causes and effects of this critical phenomenon. However, these were scattered in the bulk of literatures presented to such an extent that makes it difficult for researchers to have a complete view of all factors that can potentially result in an increase or a reduction in knit fabric spirality. It was important, therefore to perform this analysis in this study by examining causes and effects of fabric spirality on the basis of observations obtained in this study as well as the findings of the massive literatures available. Figure shows the various causes of fabric spirality and they are divided into four main categories: yarn causes, knit causes, fiber causes, and finishing causes.[1]

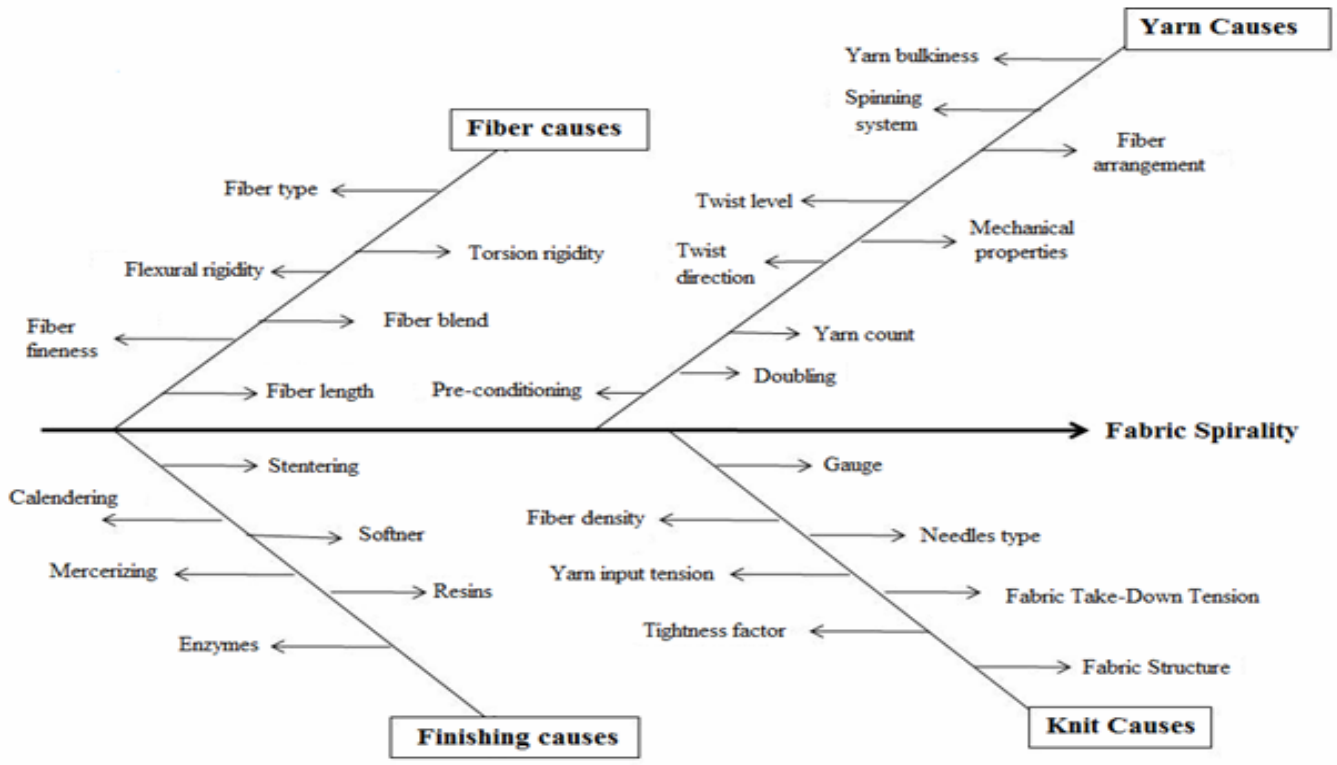


Figure 1: Causes and Effect Diagram of Fabric Spirality

Knitting related Causes

Influence of fabric properties

a) Fabric stitch length

This is the length of one loop in knitted fabric. Spirality increases with the length of loop. Fabric structure: More spirality in single jersey due to non-arrest of loops. By adding moisture to such a structure, the twist will try to revert as it swells, that distorts the shape of the loop. In double jersey, the effect of spirality is nullified. Pique and honey comb also show spirality even if sometimes two beds are used. Spirality can be noticed in certain jacquard structures. In stripe pattern, it increases with the size. No appreciable problem of spirality is there in ribs and interlocks.

b) Tightness

Slack fabric presents higher spirality angle compared to tightly knitted fabrics. At each level of yarn twist factor, the degree of spirality decreases linearly with fabric tightness factor.

c) Fabric relaxation

Fabric relaxation (dry and wet) treatment removes the residual knitting tension in the yarn introduced during the knitting process. The relaxation treatment relieves the residual yarn torque as a result of changes in the molecular structure and increasing yarn mobility.

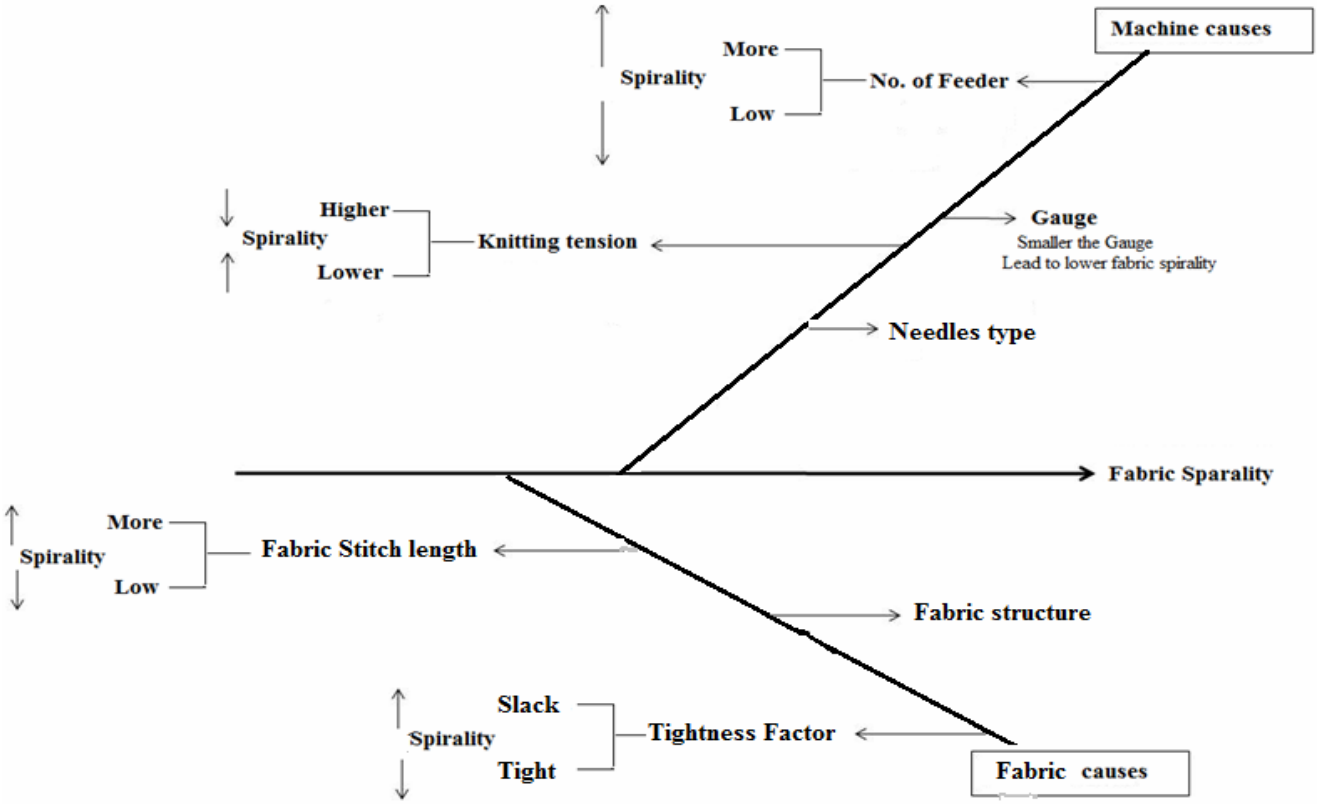


Figure 2: knitting parameter influencing fabric spirality

Influence of machine parameters

Figure 8 shows the cause and effect diagram of fabric & machine related causes of fabric spirality. Discussions of these causes are presented below.

1) Number of feeders

The number of feeders in a circular knitting machine also influences the angle of spirality. Due to more course inclination, spirality will be more.

2) Direction of machine rotation

The direction of machine rotation has influence on spirality. For Z twist yarns, the wales go to the right and thus, giving Z skew and S twist yarns makes the wales go to the left, giving S skew to the fabric. With multi feed machines, the fabric is created in helix, which gives rise to course inclination and consequently wale spirality. Direction of spirality depends on the rotational

direction of the knitting machine. Earlier research work revealed that, for a clockwise rotating machine, the wale would be inclined towards the left, thus producing the S spirality.

3) Gauge

In knitting terminology, number of needles per inch is called the gauge. Smaller the gauge, lesser will be the spirality keeping other parameters constant. A proper combination of linear density and gauge is required to reduce spirality e.g. torque can be controlled in 20 gauge and 40s count.

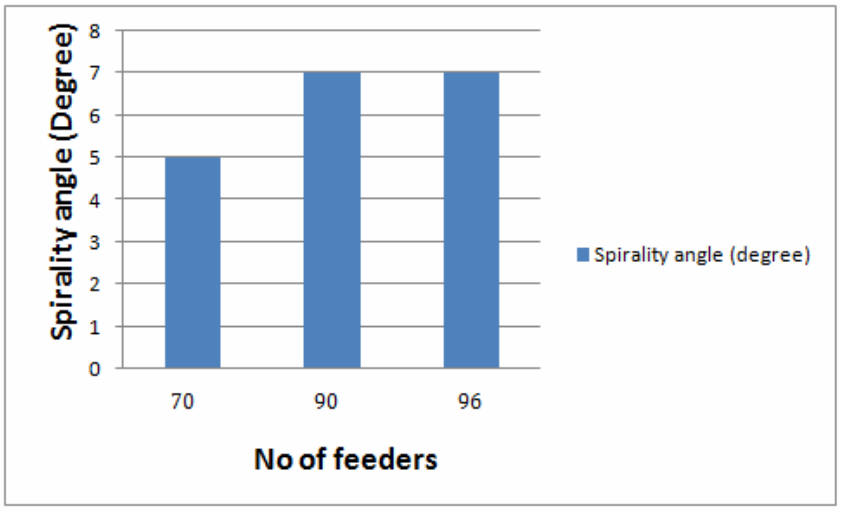
4) Knitting tension

The effects of various knitting tensions including the whole process of loop formation on fabric spirality had been could not establish consistent trends with respect to variations in fabric quality with knitting tensions. The twist factors of ply and single yarn, loop length, and fiber diameter have significant effects on the angle of spirality, while yarn linear density and fabric tightness factor have comparatively lesser effect. So that it is clearly show that the spirality angle is reduced to a certain level with the other parameters are keep constant.

Impact of no of feeders on Spirality angle

No. of Feeders	Stitch Length (mm)	Yarn Tension(CN)	Spirality Angle (degree)
70	3	6	5
90	3	6	7
96	3	6	7

Table 1: Impact of no of feeders on Spirality angle



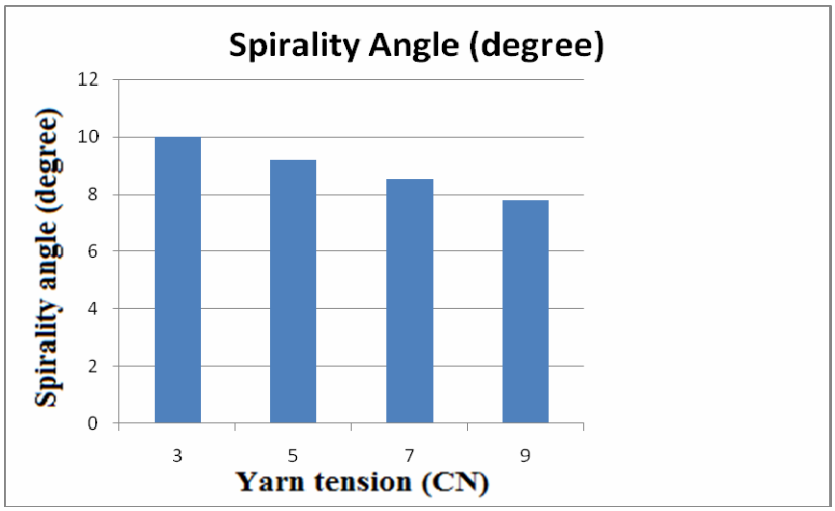
Graph 1: Graphical relationship between no. of feeders and Spirality angle

The observed increase of fabric spirality with the number of knitting feeders at a constant machine diameter is due to the nature of weft circular knitting. A fabric course knitted in a given feeder has to be inclined with a certain angle in order to permit the knock over of the row of stitches knitted in the following feeder. This angle depends on the number of feeders per machine diameter. This confirms the results obtained with simulations using manually measurement for spirality angle. The increase of the feeder density in circular knitting machines is the subject of high competition between machines manufacturers because of its impact on machines productivity. Mayer & Cie holds the record in this matter with the single jersey machine Relanit 4.0 which has 4 feeders per inch of machine diameter. These technological advances will certainly increase the importance of fabric quality problems linked to spirality.

The above graph shows the influence of the number of feeders and fabric spirality. Linear correlation cannot be tested in this case since the number of feeders is not a continuous variable, but spirality increases strongly when increasing the number of working feeders on the machine.

Yarn Tension (CN)	Stitch Length (mm)	No. of Feeders	Spirality Angle (degree)
3	3	70	10
5	3	70	9.20
7	3	70	8.55
9	3	70	7.80

Table 2: Impact of yarn tension on Spirality angle



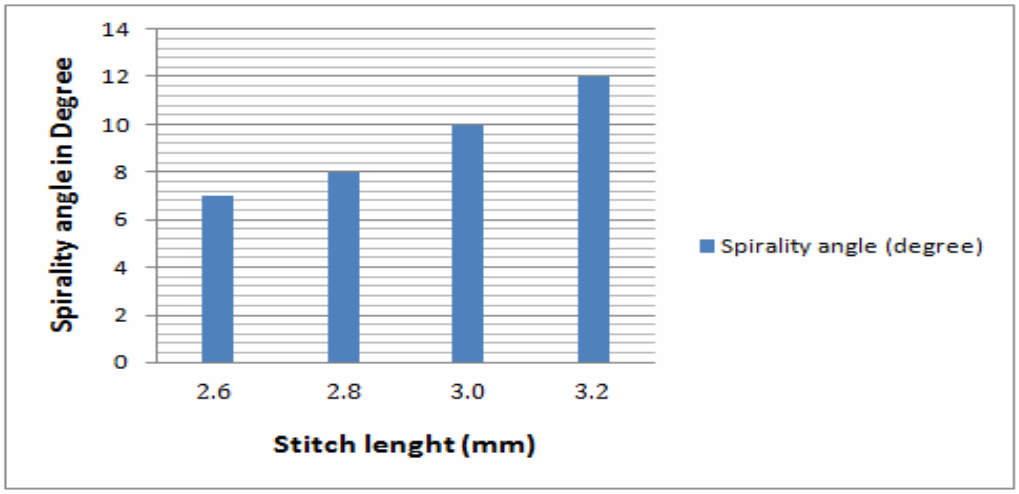
Graph 2: Graphical relationships between yarn tension and spirality angle

In this literature influence of yarn tension during knitting on fabric spirality has been studied for only range of tension which widely used in industries. The observed linear dependence between these two parameters is linked to yarn deformation. During knitting, yarn undergoes an important tension. At high tensions, the viscoelastic nature of the yarn causes yarn fibers to slip inside the structure. This slippage straightens fibers and reduces yarn twist and then yarn tendency to rotate inside the fabric after relaxation. This explains why at high yarn tensions, the fabric spirality is reduced.

Relationship between fabric spirality and yarn tension during knitting is shown in above graph Fabric spirality decreases linearly with yarn tension with a quite strong.

Stitch Length(mm)	Yarn Tension (CN)	No. of Feeders	Spirality Angle (degree)
2.6	6	70	7
2.8	6	70	8
3	6	70	10
3.2	6	70	12

Table 3: Impact of stitch length on Spirality angle



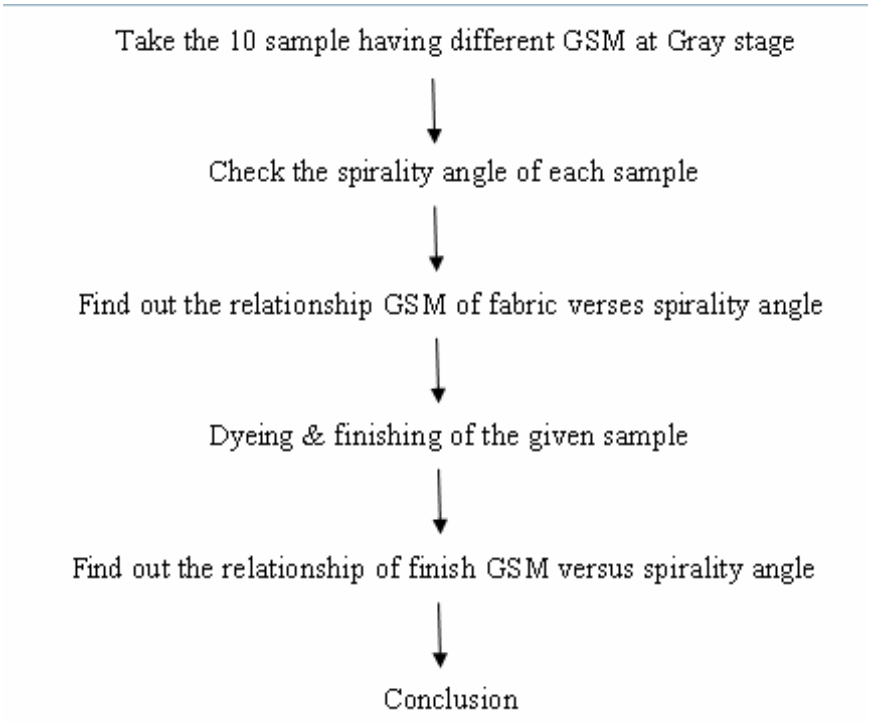
Graph: 3 Graphical relationships between stitch length and Spirality angle

Stitch length expresses the tightness of knitting construction. The fabric is as tight as stitch length is low. The observed proportionality between fabric spirality and stitch length can be explained by the fact that compared to tight fabrics, slack fabrics 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.

Above graph shows plot of averages spirality angle versus stitch length. The degree of fabric spirality increases linearly with stitch length. The relationship between fabric spirality and stitch length is strong

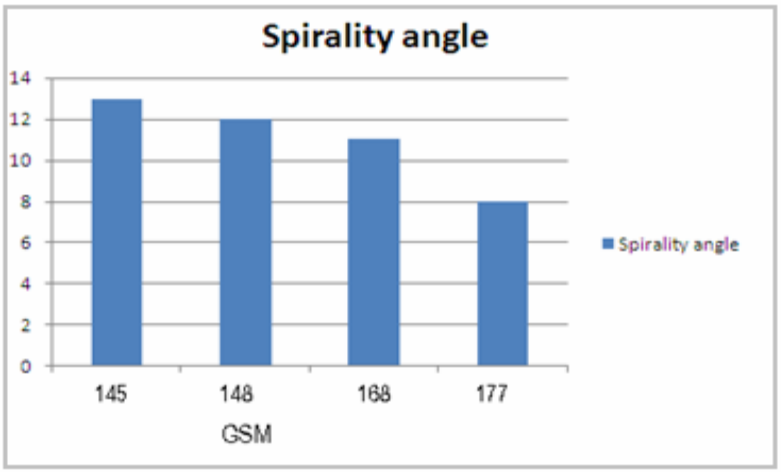
Plan of work for work done at dyeing

Relationship between weight of the fabrics verses spirality angle:



Sr. no	COUNT	STITCH LENGTH	M/C NO.	DIA/GG	GREY GSM	FINISH GSM
1	20 COMBED	3.18	ST	26/24	177	200
2	24 COMBED	2.83	ST10	30/24	168	180
3	26 COMBED	2.83	ST005	26/24	148	160
4	30 COMBED	2.65	SO006	30/24	145	150

Table 4: GSM Value for Gray and Dyed Sample



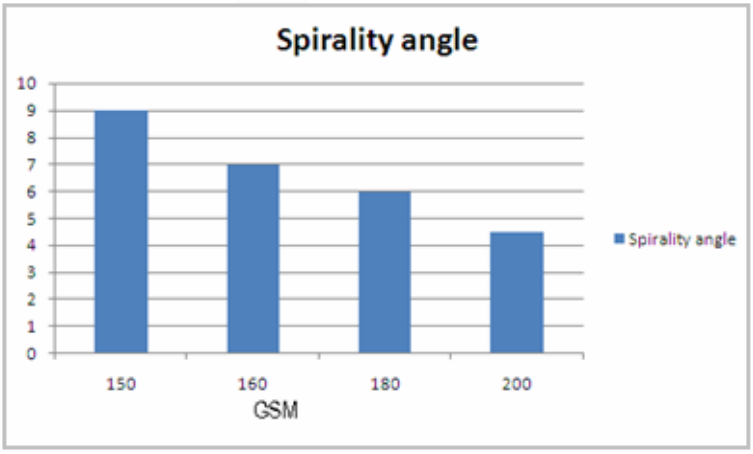
Graph 4: Spirality of grey fabrics versus fabric weight

Grey GSM	Spirality angle
145	13
148	12
168	11
177	8

Table 5: GSM of grey Fabric

Finish GSM	Spirality angle
150	9
160	7
180	6
200	4.5

Table 6: GSM of Finished Fabric



Graph 5: Spirality of dyed fabrics versus fabric weight

Effect of dyed fabric weight on spirality according to yarn production technology:

In gray fabrics, the spirality decreases when the fabric weight increases. The only result that can be obtained from the data is that the spirality decreases by half after the dyeing process.

Results

Varied parameters	Stitch length	Yarn tension	Number of feeder	Spirality angle	
				Mean (degree)	CV%
Stitch length	2.6	6	70	7	30.28
	2.8			8	20.41
	3.0			10	19.26
	3.2			12	20.41
Yarn Tension	3	3	70	10	18.70
		5		9.20	17.56
		7		8.55	22.58
		9		7.80	26.35
Number of feeders	3	6	70	5	24.49
			90	7	17.49
			96	7	26.72

Table 7: effect of the different knitting parameter on spirality of single jersey fabric

From the above table, it is clear that the effect of the different knitting parameter on spirality of single jersey fabric while other parameter are constant.

Spirality angles for finishing and unfinished fabrics	
Stage	**Mean (degree)**
Before finishing	8
After finishing	4.5

Table 8: Spirality for finishing and unfinished fabrics

The table shows that the corresponding average spirality angle. It is easily observe that finishing reduces fabric spirality. The fabric shrank and stitch wales were straightened.

Conclusion

After getting the result it has been concluded that,

1. The degree of fabric Spirality increases linearly with stitch length by keeping all other parameter as constant that is yarn tension, no. of feeders, stitch length and yarn TPM.
2. The tension on yarn during knitting as quite strongly affect on Spirality decreases linearly with yarn tension with quite strong.
3. The linear correlation cannot be met in this case since the no. of feeders is not a continuous variable, but Spirality increases when increasing the number of working feeders with constant diameter of machine.
4. Proper Finishing also helps to reduce the Spirality, only results that can be obtained from data is that the Spirality decreases by half after dyeing process.

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