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Spirality in Single Jersey Knit Fabrics

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ABSTRACT: Spirality of knitted garments is related to change in shape over the time. This becomes drawback of knitted goods and is studied by many researchers. The article is related to review of several research activities. The spirality is introduced in knitted fabrics because of various factors like fibre, yarn, fabric, knitting machine and relaxation processes. Many parameters influencing spirality are compared to arrive at some conclusion which can be used as guideline to control the dimensional stability of knitted fabric and garments.

KEYWORDS: Spir.ality, garment,dimensions, knitted fabrics.

I. INTRODUCTION

Today knit-wares have become popular than apparels made from woven fabrics, 45% of global demand of clothing is met by knit goods. This can be gauged from the fact that one sixth of yarn production is consumed by this industry alone. Knitting industry in India is more than hundred years old and has significant contribution of about 50% to textile export. Further of total knit-ware production, single jerseyknitted fabric contributes around 55%.

Knitted fabrics and garments are more comfortable, have very good flexibility over wide range of fabric designs at economic price. On the other side these garments lose their original shape in shorter span of time and there is recurring complaint that knitted goods are not dimensionally stable and durable like woven apparels.

Knitting is process of manufacturing fabric by intermeshing of yarn loops. When one loop is drawn through another loop a stitch is formed. Stitches can be formed horizontally, called as weft knitting or in vertical way termed as warp knitting.

In weft knitting loops are formed horizontally using single yarn and intermeshing of loops take place in circular or flat form on course wise basis. In this method one or more yarns are fed one at a time to a multiplicity of knitting needles placed in either lateral or circular fashion. Weft knits are made on both flat and circular knitting machines. Here three basic types of stitches are used such as plain, rib and interlock stitches. Plain stitch is most basic structure and its one of the variation is single jersey while rib stitch, interlock stitch and purl stitch are double jersey structures.

In warp knitted fabrics loops are made in vertical manner along length of fabric from each warp yarn and intermeshing of loops take place in flat form on length way basis. Numerous ends of yarn are being fed simultaneously to indivisual needles arranged in lateral manner. Mostly flat knits are made on flat bed knitting machines and structures produced by warp knitting are Tricot, Raschel, special types like Milanese and weft in lay knit. Tricot is used for finer fabrics of high gauge while Raschel and Milanese are used for heavier coarse knitted fabrics with low gauge. Weft in lay are used for making fabrics like woven structure and for industrial uses.

Spirality of knitted fabrics:

Dimensional stability and change in shape are main issues associated with knitted fabrics and here spirality plays important role.

Spirality of a single jersey knitted fabric is a condition in which the loops lean over, so that wales are not perpendicular to courses (9) and causes serious problems when knitted fabrics are made up in to gaements.

Spirality is defined as ' In a relaxed state of single jersey fabric made from single yarns, the wales instead of being at right angles to courses. show a pronounced inclination towards left or right, following spiral path around the axis of fabric.'

Knitted fabric structure contains spaces in construction and hence it is referred as series of holes fastened together. Because of this looseness in structure yarn in loops has tendency to untwist and release built in torsional strain so as to acquire natural configuration of minnimum energy state.

Spirality is a serious problem in case of single jersey knitted fabric due to asymmetric loops (27) resulting in to shifting of seams, mis-matched pattern and sewing difficulties. Such problems are often corrected by finishing steps like setting

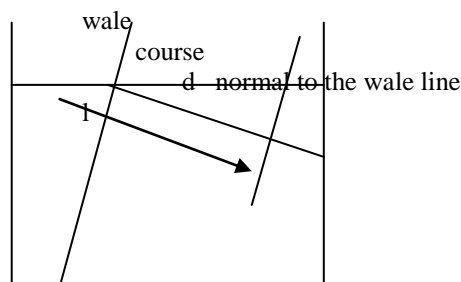
with resins, heat and steam. However these settings are not durable, after several washes spirality recurs. It affects aesthetic and functional performance of knit wares.

Measurement of Spirality:

The magnitude of spirality (4) is measured by using the following formula:

$$\text{Degree of spirality } \theta = \tan^{-1}(d/l)$$

Where, d=displacement of the course from a normal line to the wales of the fabric measured at a distance 'l' from the identified wale line.



Hepworth (9) mentioned that Angle of spirality defined as the angle between the direction of the wales and a perpendicular to the line of the courses.

Spirality occurs in knitted fabric because all loops tend to distort, thus throwing the fabric wales and courses into an angular relationship other than 90 degree. Garments cut from such fabric show obvious distortion and are worthless.

Factors Influencing on Fabric Spirality:

The magnitude of the spirality (4) depends on a combination of fiber, yarn, and knitting factors. Fibre factors include the modulus and cross sectional shape.

Yarn factors include structure and residual strain. Geometric properties and physical properties of yarns vary considerably with spinning technology. The arrangement of fibers in the yarn affects the twist imparted to yarn and thus its tendency to snarl.

Fabric properties course per inch, stitch length, stitch density, tightness factor, shape factor have impact on spirality. Also relaxation of fabric, twist setting and yarn conditioning process show their effect on spirality of knitted fabric.

Knitting factors (4) are machine related and have a significant influence on fabric spirality. With Multi Feeder circular knitting machines, course inclination will be more, thus giving rise to the spirality. The direction of spirality (1) depends on the rotation direction of the knitting machine.

II. INFLUENCE OF YARN PROPERTIES ON FABRIC SPIRALITY

a. Yarn Count:

Degrees of freedom of yarn movement in fabric structure contribute to significant rise (1,15) in spirality of fabric. The slackness can be adjusted either by changing tightness factor or by yarn linear density. Dimensional parameters of fully relaxed single jersey fabric (10) are governed by tightness factor and yarn linear density as well. Finer yarn has lower resistance to deformation.

Generally on particular knitting machine only certain range of yarn count can be knitted. Higher operating speed, timing and setting motions of knitting elements tend to reduce maximum denier or count of yarn recommended (28) on given gauge.

b. Yarn Twist:

It is chief parameter affecting spirality of knitted fabric. Twisted yarns have tendency to get untwisted to attain equilibrium state with minimum energy. Higher the twist in the yarn, higher is the tendency of untwisting i.e. twist liveliness.

Twist liveliness is dependent on twist multiplier / twist factor, count, type of fiber, and extent of relaxation. (9,14)

Fabric spirality is also dependent on direction of twist (1) S or Z, torsional rigidity and torsional buckling of fibers.

Usually in knitting low twisted yarns are used, twistless yarns (14) were found to produce fabric with little spirality.

c.Blended yarn:

Polyester cotton (50/50) blends have shown lower tendency to produce spirality in fabric than 100% cotton yarn.

III. INFLUENCE OF FABRIC PROPERTIES ON FABRIC SPIRALITY

It is concluded by P.K. Banerjee and Aliaban (11) that spirality of wale line exercises significant impact on stable fabric dimensions due to assymmetric loops. Spirality of wale line increases with twist liveliness of the yarn, slackness of construction and coarseness of machine gauge.

a.Fabric course per inch:

Course per inch or centimeter decide helical deposition of courses and ultimately course skew in single jersey fabric.

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b.Fabric stitch length :

Dimensional parameters of fully relaxed single jersey fabric depend on loop length, machine gauge and yarn count. Knitted fabric geometry relationship (15) indicates that stitch density and fabric dimensions in relaxed state are unaffected by change in yarn count if stitch length is maintained constant.

fabric dimensions may considerably get affected by change in yarn count, owing to its extensional properties and recovers to similar dimensions if knitted with same stitch length. (18)

Knitting quality is therefore measured using stitch length since it is unaffected by longitudinal and lateral strains.(20)

c.Fabric stitch density:

Stitch density or number of loops per unit area of fabric is used as reliable fabric parameter(15) for linear measurement as it is less affected by distortion. If length increases by longitudinal stress, there is decrease in width by compensation.

If twist in yarn increases stitch length increases and result in change in stitch density (14). Shape of loop also changes with stitch density, leading to more lively yarn and more yarn is required to form the loop.

d.Fabric tightness factor:

It is defined as ratio of square root of yarn count to loop length (4, 6, 12) and provides measure of freedom of loop movement in knitted fabric construction and significantly affect spirality.Higher value of tightness factor allows less space availability and hence spirality is less. Buchler (16) expressed that spirality of wale lines depends upon fabric tightness factor and Banerjee (10) said that dimensional parameters of fully relaxed single jersey fabric depend on tightness of construction.

e.Fabric shape factor:

Loop shape factor (12) is ratio of wale to course spacing along the plane of symmetry of fabric. The loop has a three dimensional structure and shape factor considers only two dimensions. Researchers therefore considered ratio of fabric thickness to yarn diameter (t/d) for expression of loop shape of three dimensional configuration.

Spirality (11) influences shape of loop, spirality of wale line could be traced as tendency and ability of sinker loops to rotate about its axis of symmetry. It is governed by space availability and ultimately on shape factor. Loop shape factor (12) depends on tightness factor, machine gauge and yarn linear density.

g.Relaxation:

RELAXATION AND YARN CONDITIONING:

Relaxation :

Relaxation of fabric (8) is change in dimensions occurring when it returns to its steady state i.e. any distortion away from steady state of loop results in inbuilt tendency of structure to return back to its stable form. Relaxation is greater in knitted fabric than woven fabrics, as knitted structure has a property to ease of tension. Relaxation can be in dry state or wet state. It is a state of minimum energy which can be reached by wet relaxing, heating, washing and agitating followed by tumble drying. A single jersey fabric can remain distorted for considerable time even if longitudinal or lateral stresses (14) are removed.

Dry Relaxation :

Relaxation treatment can remove knitting tension and relieve residual yarn torque as a result of changes in molecular structure of fabric and increase yarn mobility. This phenomenon promotes higher spirality. Lord Mohammad and Ajgaonkar (14) noted that dry relaxation causes progressive change in angle of spirality with time elapsed. In dry relaxation fabrics are subjected to treatment by laying them free on flat surface without any constraint to allow conditioning for at least 72 hours in conditioned atmosphere.

Wet Relaxation :

In wet relaxation treatment (9) fabric is treated with static wetting agent followed by gentle agitation in heated water and kept at 40° C for 1 hour, excess water is then hydro-extracted and fabric is allowed to dry lying flat in trays and at end it is conditioned.

Wet relaxation process causes change in shape of loop to minimum energy state (6) and also steady state of fabric. (17)

In case of 100% cotton single jersey fabric 10-20 % extension in length (15) is retained.

During relaxation yarn diameter changes due to shrinkage.

Fabric mercerisation causes large reduction in loop asymmetry than yarn mercerisation though the treatment is same.

Relaxation helps the yarn to get relieved from longitudinal and lateral strains and reach to minimum energy state.

INFLUENCE OF YARN CONDITIONING :

Earlier 'Twist Setting' was the treatment given at yarn stage to fix the twist and relaxing strains in yarn.

In twist setting treatment the yarn packages are stored at adequately high temperature in a enclosed chamber and humid air (hot air and moisture or steam) is forced in to chamber for specific period of time. It was found that twist set yarns perform better duringknitting along with improvement in mechanical stability (5,23) and have reduced yarn hairiness.

This conventional method has two main drawbacks, 1 Penetration of steam was not uniform, it differs from surface to interior of package and 2 It was causing fungal growth due to wetness and it was more time consuming process.

Modern yarn conditioning system (26,29) involves vacuumisation, injection of saturated steam, removal of Oxygen and thermal conditioning of yarn in about 1hour.

It provides many advantages like -

- a) Uniform conditioning and twist setting.
- b) Reduces snarling, increases strength and elongation.
- c) Reduced fly fluff generation.
- e) Reduced wear and tear of needles and end breaks at knitting.
- f) Increased softness of cloth.
- g) Oxidation is prevented.

Yarn Conditioning process helps to reduce spirality of single jersey fabrics.

IV. INFLUENCE OF MACHINE PARAMETERS ON FABRIC SPIRALITY

a. Number of feeders:

Number of feeders (2) in knitting machine affect angle of spirality, if multi feeder circular knitting machine is used course inclination will be more giving rise to spirality.

b.Direction of Machine rotation:

Direction of machine rotation itself influences spirality, clockwise rotation of machine causes wales to incline to left producing S spirality.(3)

In order to minimisespirality Z twist yarns should be knitted on machine that rotates clockwise and S twist yarns on knitting machine that rotates anti clockwise manner.

Direction of inclination of drop depends upon (15) direction of revolving cam box or rotating cylinder, inclination of drop and spirality contribute to total spirality of fabric.

c.Knitting tensions:

It was found that knitting tension do not have specific consistent trend about effect on fabric spirality.

V. CONCLUSION

As per review of cited literature, it can be said that 'Spirality of knitted goods' is an important quality parameter. It affects dimensional stability of knitted garments which are popular in these days. It is dependent on various factors like fibre and yarn properties, fabric properties, knitting parameters, their optimisation and relaxation and is vital for better quality knitted garments.

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