Study on the Spirality and Shrinkage of Weft Knitted Fabric: An Impact of Tumble Drying and Line drying

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Abstract

Spirality and shrinkage are the most common problems for knitted fabric due to their asymmetrical loop formation. Spirality is a dimensional distortion in circular knitted fabrics and has an obvious influence on the aesthetic and functional performance. Shrinkage is the process in which a fabric becomes smaller than its original size while washing and drying. This study explicitly determined the theoretically approach of the causes and remedies of spirality and shrinkage and the main difference between tumble and line drying. The tumble drying was more responsible for shrinkage contrary to the line drying. Among the samples the full feeder lycra single jersey shows the best result in shrinkage and spirality and double pique shows the worst result due to more tuck loop in its structure. Finally, this study illustrated that line drying was the best for using the garments with assured quality and dimensional stability.

Keywords: Line Drying, Tumble Drying, Spirality, Shrinkage, Weft Knitted Fabric etc.

1.0. Introduction

The ever-increasing demand of knitted apparels has attracted attention in global niche market. Knitted fabrics are used in manufacturing of fashion garments and even it has the potential in the formal wear segments also (Afroz, 2012). The dimensional stability of knitted fabrics is an important factor of the knitting industry (Hossain, 2012). On the knitted fabric, it is necessary that the wale be perpendicular to the course, but Weft knitted fabrics tend to undergo certain dimensional change that causes distortion in which there is a tendency of the knitted loops to bend over, causing the wales to be at diagonal in-stead of perpendicular to the courses. However, the wales are not always perpendicular to the course and skew to the right or left, forming a spirality angle which creates a serious problem, especially in the apparel industry (Afroz, 2012). It is well known that weft knitted fabrics tend to undergo large changes in dimensions such as spirality and shrinkage. This often directed to distortion upon repeated washing. A large number of factors are responsible for causing these dimensional changes in weft knitted fabric structures; these are all associated with the yarn twist and hardness, knitting, finishing and making-up of the knitted fabrics. The residual torque in the component yarn caused due to bending and twisting is the most important phenomenon contributing to spirality. The residual torque is shown by its twist liveliness. Hence the greater the twist liveliness, the greater is the spirality. Twist liveliness of yarn is affected by the twist factor or twist multiple. Besides the torque, spirality is also governed by fibre parameters, cross-section, yarn formation system, yarn geometry, knit structure and fabric finishing. Machine parameters do contribute to spirality. For instance, with multi-feeder circular knitting machines, course inclination will be more, thus exhibit spirality. It affects the garments as the displacement of the side seams and this causes an important quality problem. This problem is prevented during the finishing and dyeing processes by different methods, however these preventions are temporary and after washing processes, on the clothes the displacement of side seam is occurred. Spirality depends on feed density, machine cut, and loop shape, but the magnitude of spirality can be offset by the selection of yarn twist direction. In addition, reduction in yam "torque" can only partially reduce fabric spirality, but the use of plied yams and plaiting techniques may completely eliminate it (Araujo, 1989). It is also a fact that consumers are becoming increasingly concerned and aware of fabric quality and expect higher standards of performance than ever before, even after a number of wash and dry cycles. A tumble dryer is a powered household appliance that is used to remove moisture from a load of clothing and other textiles, usually shortly after they are washed in a washing machine. Clothes may also be dried by natural evaporation and, if available, sunlight on an outdoor or indoor clothes line or clothes horse. Many dryers consist of a rotating drum called a "tumbler" through which heated air is circulated to evaporate the moisture, while the tumbler is rotated to maintain air space between the articles. Using these machines may cause clothes to shrink or become less soft (due to loss of short soft fibers/lint). A simpler non-rotating machine called a "drying cabinet" may be used for delicate fabrics and other items not suitable for a tumble dryer. A clothes line or washing line is any type of rope, cord, or twine that has been stretched between two points (e.g. two sticks) outside or indoors, above the level of the ground. Clothing that has recently been washed is hung along the line to dry, using clothes pegs or clothespins. Washing lines are attached either from a post or a wall, and are frequently located in back gardens, or on balconies (Wikipedia, 2016). The dimensional stability of knitted fabrics is an important area of the knitted industry. Fabric shrinkage is the ultimate problem if the dimensional stability of the knitted fabrics is not properly taken care. There are various factors influencing the dimensional stability as well as the shrinkage of the knitted fabrics.

Though the factors such as fibre characteristics, stitch length, machine gauge, yarn twist, knitting tension causes dimensional variations, the factor mostly responsible is relaxation of internal stress and the swelling of the yarn (Anbumani, 2007). Knitted fabrics often never fully recover from these strains and have to withstand the considerable wear and tear due to everyday use and laundering processes. To meet the demands of an increasing market, knitters have called for increased research into the dimensional stability of knitted cotton goods. With the rising popularity of cotton, greater demands in terms of quality were required as the customer became more aware of the negative properties, e.g. shrinkage from laundering (Munsi, 1993). The properties of cotton are limited due to its natural origins, therefore, if the consumer continues to expect higher quality and dimensionally stable garments, the actual construction of the fabric needs to be investigated. Another problem manufacturers have to contend with is the factors affecting variability in customer washing processes (Thomas, 1994). When the cotton yarn and the lycra yarn are knitted parallel or side-by-side in every course, with the lycra yarn always kept on one side of the cotton yarn, the method is classified as "full plating or full feeder". When the Lycra is placed in alternating courses, the method is classified as "half plating or half feeder" (Sadek, 2012). The effect of lycra fibre on the extension-at-peak load, immediate recovery, delayed recovery, permanent set and resiliency of cotton-lycra blended knitted fabric. It was observed that the immediate recovery, extension and resiliency of lycra fabric are higher than 100% cotton fabric (Mukhopadhyay). Washing and drying technique are the most important task in weft knitted fabric finishing. It requires an in-depth knowledge of the geometry, stability and forces held within the fabric. The main aim of this work was to systematically investigate the effect of the washing and drying variables on the dimensional stability and distortion of knitted fabrics. The work demonstrated that changes occurring after laundering were largely due to alterations in the loop shape, rather than loop length. The fabrics had taken up their fully relaxed state and appropriate conditions for laundering. The major aims of this study are to find out dimensional changes of weft knitted fabrics due to different washing techniques.

2.0. Materials and Method

For this study seven types of fabric have been produced from the same yarn of count and same lot. Yarn from the same lot is placed in the creels carefully for knitting with single jersey machine specification given (Table 1). The fabrics were produced by using the parameters (Table 2) and the yarn specification has been mentioned (Table 3). After knitting 2kg of each seven samples were taken and then swung to make rope form for scouring, bleaching and dyeing. The fabric was pre-treated and dyed in Fong's sample dyeing machine (Actual capacity up to 18kg). The name of chemicals and dyes were used in scouring, bleaching and dyeing mentioned separately (Table 4). Then washed at 40°C for 18 min. The whole washing was done by the ISO: 6330 method. Then the

Table 1. Knitting machine specification.

Brand name of machine	Jiung Long
Origin of machine	Taiwan
Model	JSL
Diameter of machine	26"
Number of feeder	60
Number of needle	1960T
Machine gauge	E-24G
Machine speed	23 RPM

Table 2. Description of different fabric with yarn.

Fabric Type	Combed Yarn count (Ne)	GSM	Stitch length (mm)
Plain S/J	30/1	115	2.80
Plain S/J (Lycra 4%: full feeder)	30/1 with 40D Lycra	220	2.55
Plain S/J (Lycra 2%: half feeder)	30/1 with 40D Lycra	200	2.62
Single lacoste	30/1	140	2.74
Double lacoste	30/1	160	2.65
Single pique	30/1	120	2.75
Double pique	30/1	155	2.70

Table 3. Yarn specification Ne 30/1 combed yarn used in the fabric manufacturing process.

Properties	Test results
Twist factor	3.60
Tenacity (mN/tex)	169
Elongation at break (%)	4.2
Unevenness (U%)	10
Thick place/1000m (+50%)	23
Thin place/1000m (-50%)	1
Neps/1000m (200%)	40

Table 4. Chemicals and dyes were used in scouring, bleaching and dyeing.

Chemicals for scouring and bleaching		Chemicals and dyes for dyeing	
Name	Amount	Name	Amount
Wetting agent	1 gm/L	Glauber salt	40 gm/L
Sequestering agent	1 gm/L	Soda ash	10 gm/L
Detergent	1 gm/L	Acetic acid	1 gm/L
Caustic soda	5 gm/L	JintexalateEco SQ- 1175CA (R/D*)	1 gm/L
Hydrogen per oxide	6 gm/L	Jinlev-CL 225 (R/D*)	1 gm/L
Stabilizer	2 gm/L	pH	8.5
Temperature	90°C	Temperature	Up to 110°C
Time	1 hour	Time	1.5 hour

samples were dried with line and tumble system for 4 hours at room temperature and 30 min at 60 °C temperature respectively (Anand, 2002). After that the samples were fully conditioned for 48 hours in a standard atmosphere of 20 ± 2 °C temperature and 65 ± 2% relative humidity. Then those samples were tested to measure the dimensional stability or shrinkage and spirality percentage by ISO:16322 method. Thus, all the experimental data has been derived and discussed consecutively.

3.0. Measurement of Shrinkage and Spirality

3.1. Materials

Template, Scissor, sewing machine, washing machine, washing Chemicals, dryer, tape.

3.2. Procedure

For calculating the shrinkage percentage samples were cut into 20 cm × 20 cm, then a rectangular area was marked 15 cm × 15 cm on each. Then the fabric is treated with 0.5% owf wetting agent for 2 hours at 30 to 35°C with a liquor ratio of 1:50. Then after drying the fabric the distance of the mark length and width are measured and shrinkage percentage is calculated by the following formula:

Shrinkage % = [100 x (a-b)]/a

where, a = Distance between two ends before treatment,

b = Distance between two ends after treatment (Islam, 2014).

In this way both the lengthwise and widthwise shrinkage percentage is calculated and they are shown in the Table 4. Spirality or twisting in a garment is appeared after washing. As a result, one of the side seams comes at front of the garment when wearer wears it. Spirality percentage depends on fabric torque and garment structure.

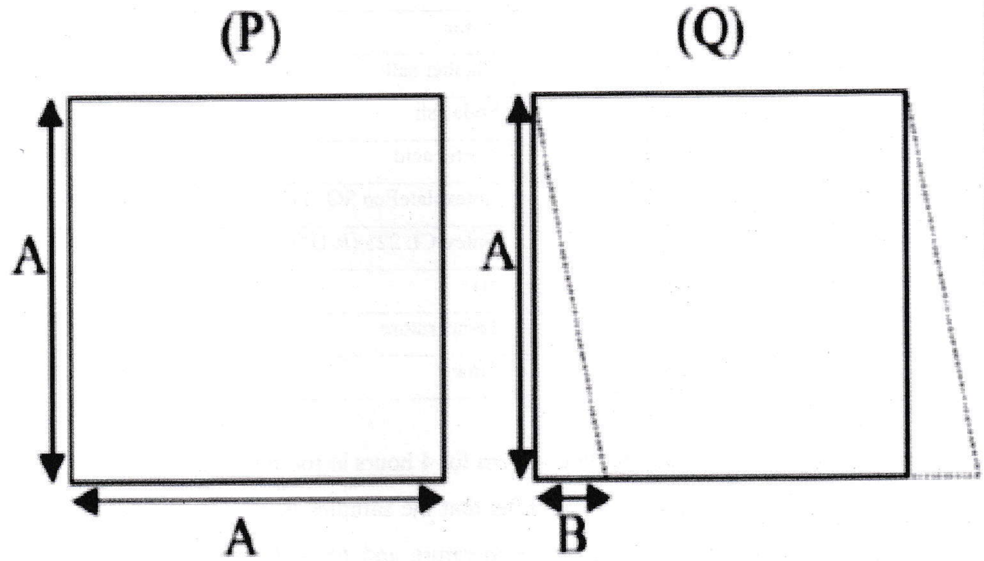

Fig. 1. (P) Before wash sample, (Q) After wash sample.

For spirality check, two fabric samples are taken which are 30 cm×30cm in dimension. They are stitched at three sides and one side is open. Then the fabric is washed in a washing machine and after that dried both in line and tumbler.

Then the Spirality of fabric is measured using the formula- Spirality% = 100* B/ A

Where, B= Displacement of side seam at bottom after wash

A= Side seam length (Islam, 2014).

The results obtained from this experiment are shown in Table 4.

4.0. Result and discussion

By testing spirality and shrinkage percentage of the samples according to the mentioned procedure and formula results are presented in Table 5. It was expected that the results obtained for the dimensional stability tests carried out would be significantly different for the fabric structures, due to the distinct nature of each structure. A positive value indicates extension of tested fabrics and negative value represents shrinkage.

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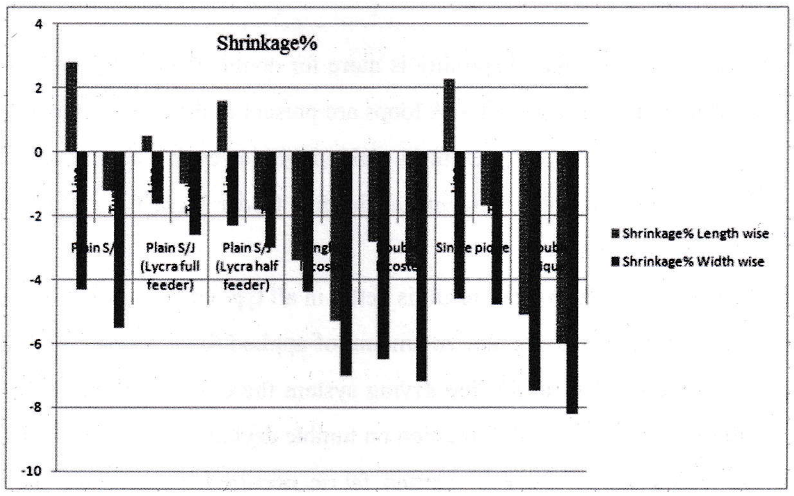
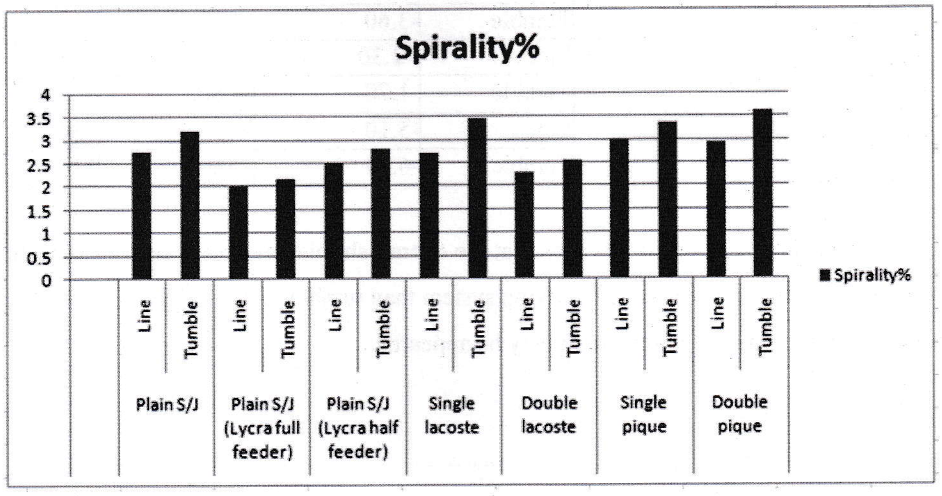
Table 5. Tested results of shrinkage and spirality percentage of fabric samples.

Fabric Type	Drying	Shrinkage%		Spirality%
		Length wise	Width wise	
Plain S/J	Line	+2.80	-4.30	2.75
	Tumble	-1.20	-5.50	3.20
Plain S/J (Lycra 4%: full feeder)	Line	+0.50	-1.60	2.00
	Tumble	-1.00	-2.60	2.15
Plain S/J (Lycra 2%: half feeder)	Line	+1.60	-2.30	2.50
	Tumble	-1.80	-3.00	2.80
Single lacoste	Line	-3.40	-4.40	2.70
	Tumble	-5.30	-7.00	3.45
Double lacoste	Line	-2.80	-6.50	2.30
	Tumble	-3.60	-7.20	2.55
Single pique	Line	+2.30	-4.60	3.00
	Tumble	-1.70	-4.80	3.35
Double pique	Line	-5.10	-7.50	2.95
	Tumble	-6.00	-8.20	3.60

From the above test result it is seen that the overall shrinkage and spirality percentage of the fabric samples were better in case of line drying system than tumble drying. If we separate the results and placed in graph of the following graph may be appeared.



From the graph of shrinkage percentage test result, it's clear that there only length wise positive shrinkage or extension has occurred in case of plain single jersey, single pique and plain single jersey with half Feeder lycra fabric samples for line drying and the rest of shows the negative value. Among these the double pique, double lacoste and single lacoste has the worst shrinkage to with wise in case of tumble drying. This is the result of presence of tuck loop in fabric structure. In the fabric structure of plain single jersey has the greater number of knit loop which is comparatively more stable or uniform in structure thus it shows the positive result. Additionally, the present of more lycra in fabric structure the amount of shrinkage percentage lower this is the result for elastic behavior of lycra which tends to recover it's original position after releasing applied force due to line or tumble drying system



It is seen that the percentage of spirality is more for double pique, single lacoste and single pique consecutively due to more number of tuck loops are present in the fabric structure. These loops are less stable than knit loop which are present in plain single jersey fabric structure. Additionally, the lycra fabric has the lower spirality percentage, the full feeder lycra fabric has lower spirality percentage than half feeder lycra fabric.

Finally, it is noted that the overall result is better in all type of fabric structure in case of line drying technique than the tumble drying due to amount of applied force for machine spin in tumble drying is more and on the other hand for line drying system there is not needed to apply force for fabric drying. For this reason, the loop deformation on tumble drying system is more than line drying and the course and wales displacement of knitted fabric occurred more. Thus, the spirality and shrinkage percentage is more in tumble drying system.

5.0. Conclusion

This study illustrated that the effect of various drying system used on garments washing made of weft knitted fabric of different structure. It is observed that the line drying system shows overall better result in case of spirality and shrinkage percentage of the dimensional stability of knitted fabric. The knitted structure of different loops such as knit and tuck have also a great effect on fabric spirality and shrinkage. More number of tuck loop present in fabric structure shows worse result in case of pique fabric. There is a slight impact of lycra percentage on spirality and shrinkage of weft knitted fabric. The larger amount of lycra prevent in fabric shows better result on spirality and shrinkage though fabric structure is same of single jersey plain fabric. So, the designer of garments manufacturer of knitted fabric should be informed that the accurate selection of definite structured fabric may help a lot to design the garments for specific purpose while need to wash for further use. The users also need to wash their garments and should prefer to dry in line drying system. Dimensional stability of knitted fabric results for the various structures indicated that there was a significant difference between tumble and line drying. The tumble-dried samples were found to shrink and spiral of loops (course and wales) to a greater extent. The effect of tumble drying was evident throughout the investigation. It would appear that this method of fabric drying tends to cause the most displacement of courses and wales change in the fabric due to a combination of knit and tuck loops along with lycra. So, from this study it can be noted that to get acceptable shrinkage and spirality wash with line drying is better than tumble drying system.

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