Egyptian Journal of Chemistry

http://ejchem.journals.ekb.eg/

Study the weft circular knitted fabrics behaviour with Repeated laundering cycles

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In Loving Memory of Late Professor Doctor ""Mohamed Refaat Hussein Mahran""

Abstract

Weft knitted fabrics are instability fabrics due to easy changes in its dimension and surface shape, this behavior is one of its common defects which will cause dimensional distortion in the produced garment from it. In this study it will be measured the skewness and dimension stability of different weft circular knitted fabrics at both fabric directions wales and courses. The samples were different in structure which was single jersey and rib, also different in weight per unit area. The tested properties were measured after each home laundering cycle up to 7 cycles. The data are statistical analyzed. It was found that the knitted fabric parameters did not alter significantly upon repeated laundering. Therefore, this confirms that any dimensional changes that occurred during the washing this changes become little or stable after the 5th cycle. It was recommended that the cotton knitted fabrics must be washed at least three times and exposed to heat setting before manufacturing to minimize clothes distortion.

Keywords: dimension stability; laundering cycles; knitted fabric; skewness; spirality; weft circular knitting.

Introduction

In general, the knitted fabrics have more stretchable property compared to the woven fabrics , there for it will cause dimension changes. This may be caused disadvantages in garment specially in weft circular knit fabrics [1, 2]. The variables of Clothing processes from weft circular knitted fabrics are predicted to impact on dimensional changes. So the pre-study of these variables will help in solving technical problems and satisfying consumer requirements [3].

The knitting fabric are mainly divided into two major sections warp and weft knitting, each of them have own characteristics [4]. Rib fabrics have less troubles in manufacturing and more stable than plain knit fabrics [5].

Another work has been done on the factors Impacting on knitwear shrinkage. They found that the stitching parameters affect significantly on knitwear's shrinkage. So, it was recommended to developed the patterns for the cutting of knitted fabrics to avoid unexpected changes in garment shape to achieve good quality for knitwear [6] .

Skewing means wales have torsion from a perpendicular line to the right or left side, also courses are inclined up or down. Skewness is considered one of the weft circular knitted fabrics common defects, usually this is formed during processing and we can't avoid it. So the fabrics must be treated in final fabric finishing to avoid waste during dressing stage. Skewing creates fabric distortion, which causes bad clothes drapability, bad appearance, also less comfortable in wearing. The lighter weight knitted fabrics are more chances of skewing than heavier fabrics. Also, the yarn count has an effect on skewing where finer yarns have more skewness more than coarser yarn count [7].

plain knitted fabrics are the most common used in knitted garments, but they have some problems due to asymmetric loops [8]. Spirality is The most important problem in plain fabrics. Figure 1 clears the distortion in both Wale and Course directions. Fabric finishing and dyeing processes prevent skewness problem but after washing the problem is occurred again. Selection of yarn twist direction and use of plied yams can be reduced spirality.

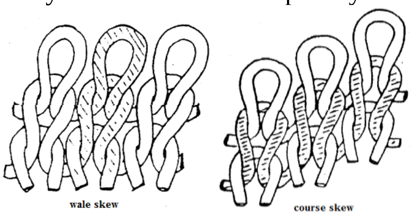

Figure 1: wale and course skew

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Receive Date: 24 December 2023 , Revise Date: 13 January 2024, Accept Date: 28 January 2024

DOI:10.21608/ejchem.2024.257701.9042

Spirality is a common problem in weft and warp knitted fabric can be minimized in but cannot be removed. Generally fabric compactness, yarn elongation, yarn twist, tightness factor reduced the spirality in single jersey knitted fabrics [9].

Another study found that spirality increases strongly due to increase of stitch l ength when count of yarn is fixed and if fixed stitch length spirality increases with the increment of yarn count[10].

Weft knitted fabrics are closed related to various forms of dimensional changes. In this study it has been studied distortion and Inclination in loops during knitted manufacturing. She Causes the reasons to the residual torque in the yarn, and knitting process with multiple feeders on the circular knitting machine. It was used a new Models for spirality and skewness explanation and predicting the loop distortion [11].

The incorrect selection of yarn count and stitch length, will produce unsuitable fabric weight (GSM), and this will create some troubles in knit fabrics like shrinkage, spirality. They produce different single jersey knit fabrics with different yarn count (Ne) and stitch length, then studied the effect on fabric GSM , shrinkage and spirality. It was found that increasing in yarn count(Ne) decreases the GSM. Also higher count and smaller loop length improve shrinkage and spirality. This experiment tried to find the adjustable points in fabric production to give the suitable GSM with less Spirality and Shrinkage [12].

An investigation studied the impact of stitch length and knit constructions on the dimensional and mechanical properties of knitted fabrics. The experiment was applied on three knitted fabric structures single jersey, single lacoste and double pique fabrics from cotton yarn 28 Ne, and with five level of stitch length. They found that the impact of stitch length and fabric structure on the knitted fabric properties is significant. Maximum shrinkage appeared in width direction and Higher spirality percentage in single jersey fabrics than other samples [13].

Another work was aimed to investigate the effect of the variables of washing and drying on distortion and the dimensional changes, The work was carried on three different structures of 100% cotton weft knitted fabrics(plain single-jersey, 1x1 rib and interlock) after five cycles. Also, they proved that larger distortion occurring after laundering which caused 34% of the changes due to changes in the loop shape, and this change caused by agitation during tumble drying because of heat. But, The fabrics was fully relaxed dimensions after five wash and dry cycles [14].

The main requirements in the clothing industry are durability and stability. One of searches is concerned with study of home laundering on seam performance of the garment from two plain cotton fabrics. The tested properties were measured before and after laundering. It was found that laundering has a significant effect on seam performance besides the another tested factors[15].

Nowadays Industrial knit garments washing by using different techniques like using enzymes, softener, Silicone, pigment are used to improve the physical and mechanical properties[16]. It was studied three types of washing (enzyme, softener, Silicone) effects on 100% cotton Single Jersey T-shirt. Shrinkage and spirality have little changes in Garment after all washes types in different ratios spirality, shrinkage properties and fabric GSM were analyzed for different gauges of single jersey circular knitting machine. It was measured the tested properties for both grey and finished fabrics. The results prove that spirality and shrinkage properties of the finished fabrics were much acceptable in case of 24 gauge machine rather than other gauges [17].

knitted single jersey garment from cotton combed ring spun yarn affected on the dimensional stability. Also, sewing stitch type, stitch density, type of sewing thread and washing method will have significant effect [18].

Dimensional stability is considered a critical problem affects the quality of knitwear. This paper investigated the impact of stitching parameters and wash types on the dimensional stability of pique knitted garment. The measurements were taken at body width, sleeve length, body length and across shoulder before and after laundering process. It was found that the stitching parameters affect significantly on knitwear's shrinkage. Thus, this results will be helpful in patterns development and in the cutting step of fabric, expected shrinkage ratio which known as residual shrinkage, must be considered in measurements to avoid undesirable changes in clothing shape [19].

2. Experimental

Four different circular knitted fabrics from 100 % Egyptian cotton are tested for this work, it was used two different structures single jersey and rib with two different weights for each one. It was studied the effect of two parameters X1 (Fabric variables), X2 (No. of cycles) on the knitted fabric properties like skewness, dimensional changes, bursting strength, air permeability. Table (1) illustrates the tested Fabrics Specification, and Table (2) shows the Sample coding

2.1 Samples preparation

Samples were fully relaxed for 24 hours before any fabric testing or analysis in a standard atmosphere of 20 ±2 C^o and 65% relative humidity.
2 % relative humidity. For calculating the shrinkage and spirality samples were cut into 35 cm × 35 cm, then it was marked a rectangular area 30 cm × 30 cm on each sample.

Table 1. tested Fabrics Specification

Samples	Structure	Weight (g/m^2)	Thickness(mm)	Wales/cm	Courses/cm	Stitch density
S1	Single jersey	132	0.42	13	15	195
S2		190	0.6	17	22	374
R1	1× 1 rib	192	0.67	15	22	330
R2		220	0.73	19	27	513

Table 2. Sample coding

Sample No.	Sample code	Sample specification	
1	S1	single jersey	Light
2	S2	single jersey	Heavy
3	R1	1× 1 rib	Light
4	R2	1× 1 rib	Heavy

The specimen were exposed to repeated laundering by using automatic washing machine with detergent for 7 cycles, after the end of each cycle the specimen was exposed to line drying (by putting it on flat surface without any tension in the open air up to full drying without hanging). All tested results were registered after selected cycles of laundering and drying which are (1, 3, 5, 7) in the wales and courses direction.

2.2 test methods

Dimensional stability

The tested specimens for dimensional stability and skewness were tested according to the AATCC 135 [20], and AATCC 179 [21]. Once the laundering and drying cycled had been ended, the samples were again conditioned and relaxed for 24 hours. Then, the tested properties were measured which were :

Thickness

The thickness test of the sample was performed according to ASTM D1777-96, [22].

Mass per Unit Area

Mass per unit area is the key parameter of the knitted fabric for the negotiation between supplier and buyer. Therefore, it is very important to control it through various possible parameters. The GSM cutter method was used to calculate the mass per unit area of the fabric according to ASTM-D-3776 [23]. The weight of the cut fabric sample was done through

Stitch density

It was measured wales/cm and courses/cm by using textile analysis glasses referring to BS EN 14970 [24].

Bursting strength

The samples were Bursting strength tested refers to the standard test method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method ASTM-D-3786 [25]. the sample was cut to the size of 112 mm2.

Air permeability

The air permeability of the samples was tested according to ASTM D 737 [26].

Results and Discussion

Table (3) illustrate the tested parameters for the factorial design.

Table (3); tested parameters

Parameters	levels			
X1 (Fabric variables)	S1	S2	R1	R2
X2 (No. of laundering cycles)	1	3	5	7

Table (4) illustrate the results of the tested properties Bursting and Air permeability before laundering, after the 1st cycle, and after the 7th cycle.

Table (5) shows the Results of Skewing angle and Dimensions changes in wales (w), and courses (c) direction after the selected laundering and drying cycles for the different tested specimens. The illustrated values in table (5) were the average of six readings.

The results data were analyzed by regression (two factors with replicate) at confidence limit 95 %.

Table (6) illustrate the p-values of regression in wales and courses direction for the tested properties:

Skewness, Dimensions changes, Bursting and Air permeability,

The relations between tested properties and parameters are plotted in figures 1-6

Fig (1) illustrate the plotting of the number of washes (X2), against skewness in wales direction at different fabric variables (X1)

Table (4) Fabric properties

Samples	Before laundering		After the 1st cycle		After the 7th cycle	
	Bursting	Air permeability	Bursting	Air permeability	Bursting	Air permeability
1	6.6	122.2	6.3	74.96	5.97	81.73
2	7.6	62.6	7.2	68.5	6.82	46.7
3	5.5	133.6	5.4	112.4	5.47	123.95
4	5.9	101.2	5.6	93.78	5.35	105.14

Table (5); Results of Skewing angle and Dimensions changes

Samples	Skewing angle		Dimensions		Cycle No.
	W	C	W	C	
S1	91	85.5	28.25	29.25	1
	91.66	87,66	28.98	28.2	3
	91.16	85.16	29.18	28.5	5
	91.16	84.8	28.55	29.16	7
S2	92.85	84	29.6	28.5	1
	93.16	84,66	29.7	28.25	3
	94	83.16	29.91	28.18	5
	94.3	81.3	29.9	28.25	7
R1	91.5	87.5	31.85	27.6	1
	91	85	32.55	27.1	3
	89.3	86.16	32.71	27.31	5
	90.66	84.3	34.15	27.08	7
R2	90.5	85	31.55	28.2	1
	91.16	84.33	32.45	28.06	3
	93.83	85.1	33	28	5
	89.3	85	34.3	27.01	7

Where ; w -----wales / cm - C ----- courses / cm

Table (6): p- values

Property	**fabric Direction**	**Variables**	p- values
Skewing angle	Wales	X1 (Fabric structure)	0,914293 **
		X2 (No. of cycles)	0,176473 **
	courses	X1 (Fabric structure)	0,104082 **
		X2 (No. of cycles)	0,128222 **
Dimensions changes	Wales	X1 (Fabric structure)	0,454926 **
		X2 (No. of cycles)	0,208597 **
	courses	X1 (Fabric structure)	4,93E-07 *
		X2 (No. of cycles)	5,53E-32 *
Bursting	--------	X1 (Fabric structure)	0,015064 *
		X2 (No. of cycles)	4,64E-05 *
Air permeability	--------	X1 (Fabric structure)	0,219693 **
		X2 (No. of cycles)	0,007009*

* p- value ≤ 0.05 is significant at confidence limit 95 %
** insignificant

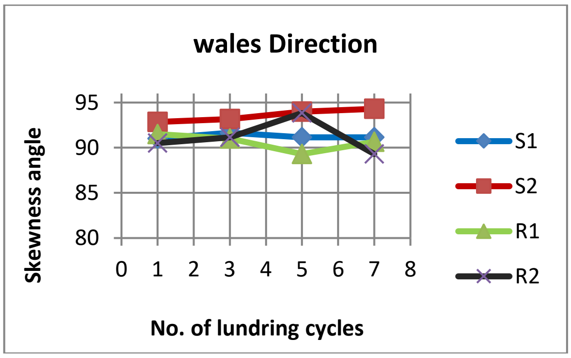

Fig1, the effect of no. of laundering cycles on fabric skewness in wale direction at the different tested fabric variables.

It was clear from fig. (1) that the skewness in the heavy weight fabrics have increased with the increasing in washing cycles in positive direction, but the rib fabric decrease after the7th cycle in the negative direction. Also the fig shows that the change in skewness in light fabrics is the same behaviour for both fabrics single jersey and rib where they have little increase up to the 3 rd cycle then decrease after 5th one, after that returned to stable values at 7 th cycle. Also, it was clear that light fabrics was less than heavy fabrics in distortion this may be due to less fabric density which gives stitches free movement to relaxed.

Fig. (2) show the relation between of the number of washes (X2), against skewness in courses direction at different fabric variables (X1)

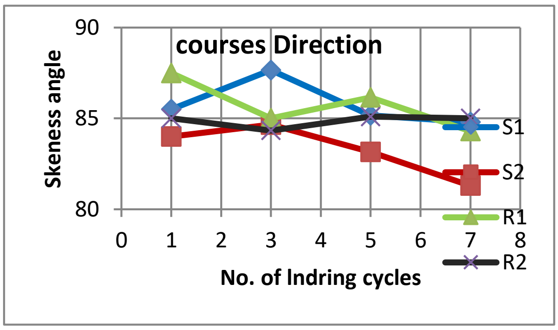

Fig 2, the effect of no. of laundering cycles on fabric skewness in course direction at the different tested fabric variables

Fig. (2) exhibited lower values of skewness in heavy samples than light one, so the behaviour in course direction is opposite in wales direction. Also, the values in rib are less than single jersey for light weight, but it is more in heavy weight of single jersey than rib fabrics.

Fig (3) illustrate the relation between the number of washes (X2), against dimensional changes in wales direction at different fabric variables (X1)

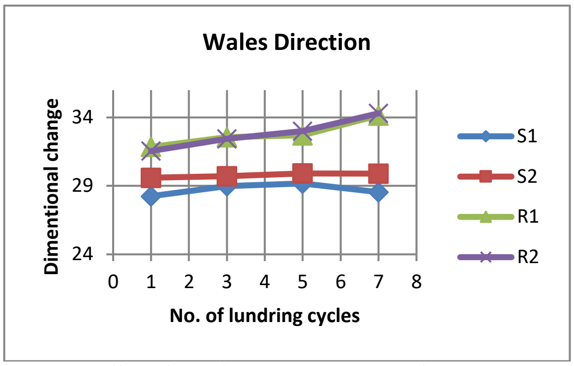

Fig 3, the effect of no. of laundering cycles on fabric dimensions Changes in wales direction at the different tested fabric variables

Fig (3) indicates that the plotting trend is similar for the two rib specimens where they have increasing in extension up to the 7th cycle , but for higher single jersey sample exposed to little shrinkage then balanced after the 3th cycle. but for the light weight sample which has more shrinkage after the 1st cycle, then decrease after 3rd cycle, after that stable after the 5th , increase in wale direction.

Fig (4) shows the relation between the numbers of washes (X2), against dimensional changes in courses direction at different fabric variables (X1)

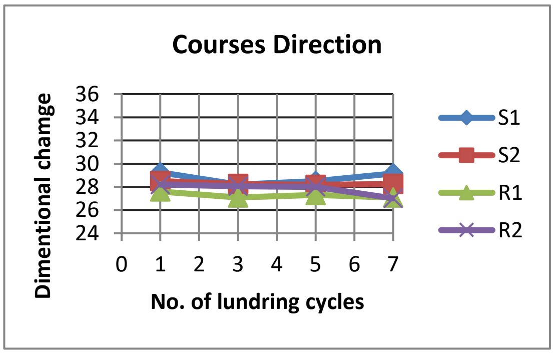

Fig 4, The effect of fabric structure and no. of laundering cycles on fabric dimensions changes in courses direction

From fig. (4) it was demonstrated that all tested samples were perfectly similar in behavior, All samples were exposed to shrinkage in course direction its values increase then nearly be stable after the 5th laundering cycle.

and produced low of shrinkage in courses direction

From fig, 5 it as clear that bursting strength decrease by little values after the 1st cycle that is due to fabric compactness after the 1st cycle , then become stable up to the 7th cycle. That is mean bursting strength not affected by no. of cycles. Also it is clear that all samples are similar

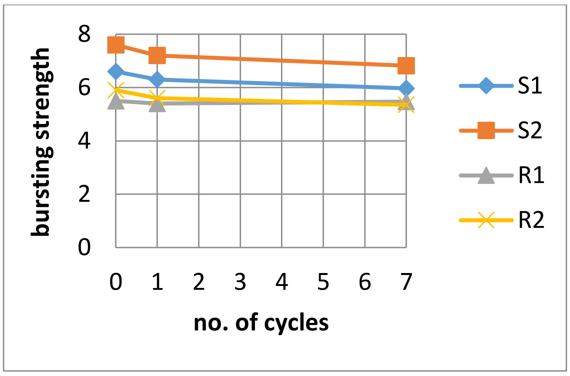

Fig (5) illustrate the relation between the number of washes (X2), against bursting strength at different fabric variables (X1)

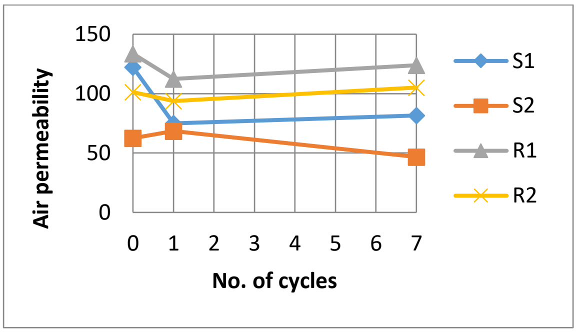

Fig (6) illustrate the relation between the number of washes (X2), against air permeability at different fabric variables (X1)

From fig. 6 it is noticed that all samples except S2 the air permeability values decreased after the 1st Cycle, then little increase up to the 7th cycle for all specimen. In sample S2 the opposite behavior.

Conclusion

The results demonstrated that the knitted fabric parameters did not alter significantly upon repeated laundering. Therefore, this confirms that any dimensional changes that occurred only according to stitches movement due to washing., This changes become little or stable after the 5th cycle. The distortion(skewness and dimensional changes) in wales direction is opposite in values and direction in courses direction

This conclusion also confirmed that the correct conditions appropriate to the cotton fibre type were used during laundering. Also the number of cycles insignificantly effect on fabric distortion.

So, we can recommended that the cotton knitted fabrics must be washed and dried at least three times and exposed to heat setting before manufacturing to minimize clothes distortion, also we have to pay attention carefully to plain knitted clothes at laundering and drying.

Conflicts of interest

There are no conflicts to declare.

Formatting of funding sources

This research has no funding from any sources. It is self-funded from the researchers.

Acknowledgments

The authors would like to acknowledge Everyone who contributed to this work or provided raw materials, Also our Appreciation for the editors.

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