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EFFECT OF WASHING AND DRYING TECHNIQUES ON THE DIMENSIONAL STABILITY OF WEFT KNITTED FABRIC

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Abstract

The different washing and drying techniques greatly influences the dimensional stability of weft knitted fabrics. There are various dimensional changes on fabric such as shrinkage, spirality, fabric width, fabric thickness and loop shape factor. Basically the research work is carried out on 100% cotton weft knitted fabric's shrinkage behavior of specified sample (single jersey fabric GSM 147 and 1×1 Rib fabric, GSM 147). This work investigated that the effect of washing with detergent as opposed to water, and tumble drying against line drying. The main aim of this work was to find out the best washing and drying method on dimensional stability of weft knitted fabrics. The work demonstrated that changes occurring after washing and drying were largely caused due to the agitation during tumble drying. The widthwise shrinkage of 1x1 rib fabric was more than single jersey fabric due to the higher potential relaxation tendency specially for detergent wash with tumble drying. The detergent-tumble regime were more responsible for shrinkage contrary to the water-line regime. Finally this work illustrated that water wash with line drying was the best method.

Keywords: Washing, Lline drying, Tumble drying, Shrinkage

Introduction

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)

It is well known that weft knitted fabrics tend to undergo large changes in dimensions and are often prone to distortion upon repeated laundering. A large number of factors are responsible for causing these undesirable effects in knitted structures; these are all associated with the yarn, knitting, finishing and making-up of the fabrics. 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.

Knitted cotton fabrics possess certain qualities to allow garments to fit closely and snugly, making them ideal for next-to-skin wear (Munden, 1959). However, knitted fabrics are prone to stretching and mechanical deformations (Zanaroli, 1990), this is due

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to the fact that the yarns are put under a high stress factor whilst the fabric is being produced and finished. These torsion forces within the yarns are present when the fabric is taken off the machine and the fabric is left in a highly distorted state (Hepworth, 1989). 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 (Munshi, V.G et al.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)

The prediction of washing performance is therefore an enormous task. 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 aim of this research is to find out dimensional changes of weft knitted fabrics due to different washing techniques.

Materials and Method

Materials

Two fabrics were selected for measuring dimensional stability i.e. single jersey and 1×1 rib fabric.The yarn count of single jersey is 30's and 1×1 rib is 40's. The color of both fabrics are white and finished gsm are same (147).we took four sample separately from each fabric for this test.

Materials for Shrinkage test

- Template
- Scissor
- Sewing machine
- Washing machine
- Washing Chemicals
- Dryer
- Tape

Standard testing condition:

Fabrics were fully conditioned for 48 hours in a standard testing atmosphere of 20 ± 2 °C temperature and 65 ± 2% relative humidity. The whole washing was done by the ISO:6330 method.

Method

Here two fabrics are tested i.e. single jersey & 1×1 Rib .We had taken four sample fabric from the same fabric each. At first it was washed without detergent and then washed with detergent. The whole washing was done by the ISO: 6330 Method .We had to wash those sample fabrics at 40°C for 18 min and four times rinse had done here. Line and tumble drying were done for drying that sample. The washing and drying specifications (Anand et al. 2002) are described in table -1:

Table 1. Washing and drying specifications are

REGIME	CODE
1) Water wash with line drying	WL
2) Detergent wash with line drying	DL
3) Water wash with tumble drying	WT
4) Detergent wash with tumble drying	DT

Washing Recipe for measuring shrinkage of weft knitted fabric (with detergent):

1. Liquor Ratio : 1:50
2. Temperature : 40°C
3. Detergent(Jet washing powder) 0.5% on the weight of the weft knitted sample.
4. Sample size : 50 x 50 cm.
5. Marking area 35 x 35 cm (mark with marking scale).
6. Washing Time : 18 min at 40°C
7. Rinse & spin
8. Drying with tumble or line

Washing recipe for measuring shrinkage of weft knitted fabric (without detergent):

1. Liquor Ratio : 1:50
2. Temperature : 40°C
3. Use water for washing.
4. Sample size : 50 x 50 cm.
5. Marking area 35 x 35 cm (mark with marking scale).
6 . Washing time : 18 min at 40°C
7. Rinse & spin
8. Drying with tumble or line

The rinse process are carried out according to ISO: 6330 method

Rinse Process

In this method four times rinse had been done for single jersey and 1×1 rib. Both types of washing (with detergent and without detergent) had been done for this method.

Rinse -1
Liquor level: 13cm (in machine)
Rinse time: 3 min

Rinse -2
Liquor level: 13cm (in machine)
Rinse time : 3 min

Rinse -3
Liquor level : 13 cm (in machine)
Rinse: 3 min

Rinse-4
Liquor level: 13 cm (in machine)
Rinse time : 2 min , Spin time : 5 min

Drying System

After washing we took eight sample for drying. Both single jersey & 1×1 Rib fabric samples were dried with line and tumble system. For line and tumble drying we had to dry those sample fabrics for 4 hours at room temperature and 30 min at 60°C temperature respectively

Calculation of Shrinkage: The specimens are then allowed to cool, preconditioned and then conditioned for another 24hour to bring them into the same state they were in when they were marked. They are then remeasured on a flat smooth surface and the percentage dimensional change calculated.

$$\text{Shrinkage} = \frac{\text{original measurement} - \text{final measurement}}{\text{original measurement}} \times 100\% \text{ (Savile, 1999)}$$

Results and Discussion

After washed and dried the samples were prepared and tested. By testing (stitch length ,wpi, cpi, shrinkage percentage) the following tested results are given below:

Table 2. Variation of stitch length due to washing

Type of Fabric	S.L (Before Wash) mm	S.L (After Wash) mm	Type of Wash	Type of Drying
Single jersey	2.75	2.77	Water	Line
Single jersey	2.75	2.74	Water	Tumble
Single jersey	2.75	2.77	Detergent	Line
Single jersey	2.75	2.73	Detergent	Tumble
1×1 Rib	2.5	2.52	Water	Line
1×1 Rib	2.5	2.51	Water	Tumble
1×1 Rib	2.5	2.52	Detergent	Line
1×1 Rib	2.5	2.50	Detergent	Tumble

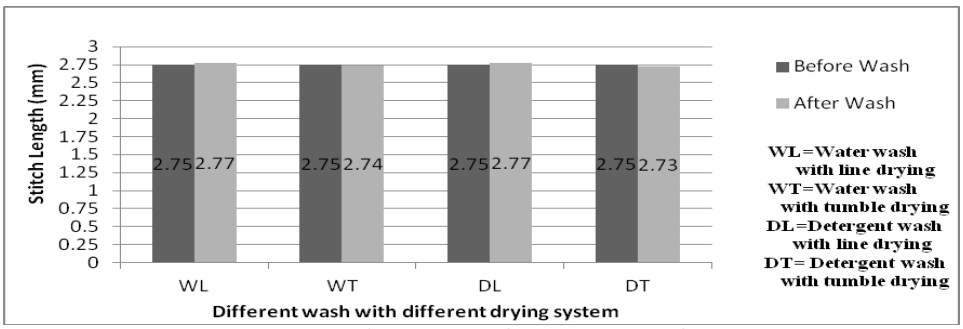

Fig. 1. The change of stitch length for Single jersey after washing

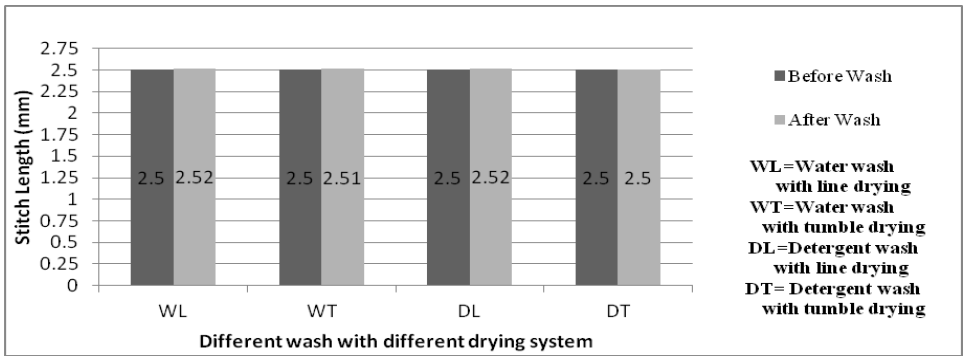

Fig. 2. The change of stitch length for 1×1 Rib due to different washing

Table 3. CPI&WPI variation due to washing and drying

Fabric Type	Courses Per Inch (CPI)		Wales per inch (WPI)		Loop shape factor (CPI/WPI)	Loop shape factor (CPI/WPI)	Stitch density CPI×WPI (stitches/inch)	Type of Wash	Type of Drying
	Be fore wash	After wash	Before wash	After wash	Before wash	After wash	After wash		
Single jersey	54	53	38	35	1.42	1.51	1855	water	Line
Single jersey	54	54	38	40	1.42	1.35	2160	water	Tumble
Single jersey	54	53	38	36	1.42	1.47	1908	Detergent	Line
Single jersey	54	55	38	39	1.42	1.41	2145	Detergent	Tumble
1×1 Rib	44	48	64	64	0.69	0.75	3072	Water	Line
1×1 Rib	44	46	64	68	0.69	0.68	3128	Water	Tumble
1×1 Rib	44	49	64	66	0.69	0.74	3234	Detergent	Line
1×1 Rib	44	49	64	68	0.69	0.72	3332	Detergent	Tumble

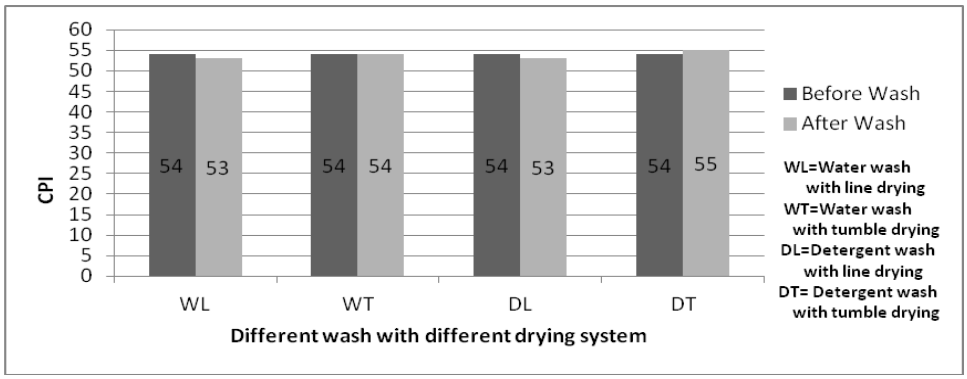

Fig. 3. Variation of CPI for Single jersey due to different washing

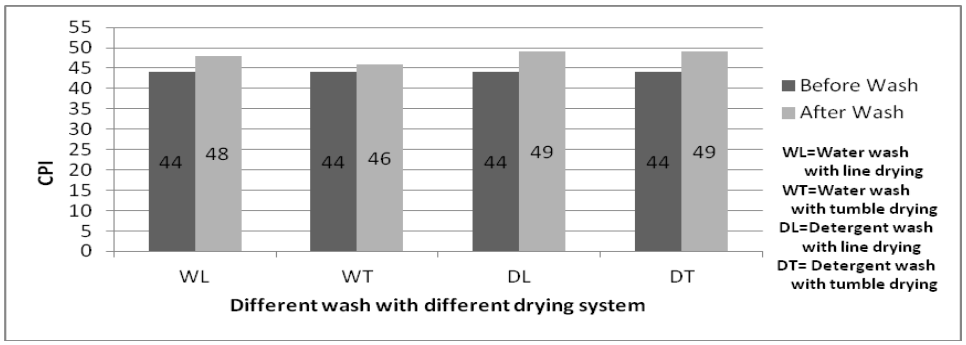

Fig. 4. Variation of CPI for 1×1 Rib due to different washing

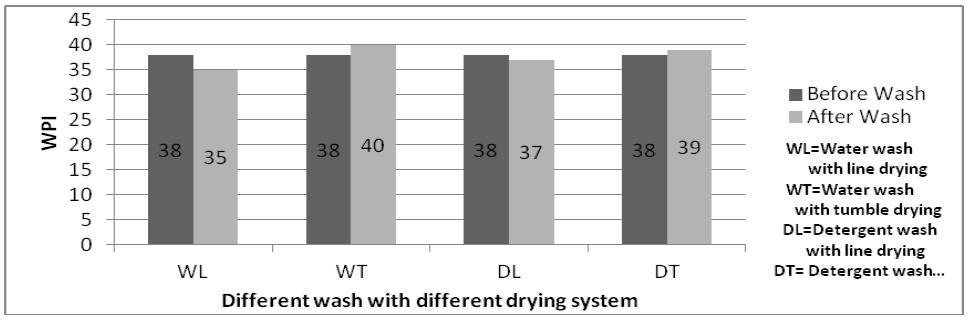

Fig. 5. Variation of WPI for Single jersey due to different washing

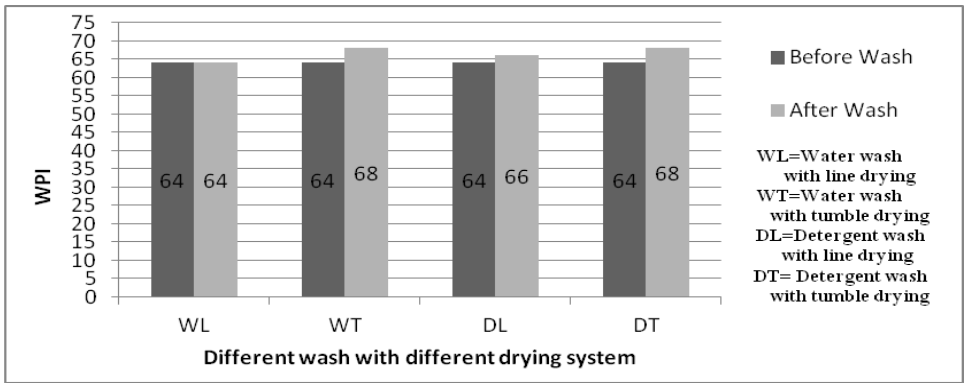

Fig. 6. Variation of WPI for 1×1Rib due to different washing

Table 4. Variation of shrinkage% due to washing

Fabric type	Shrinkage%		Wash	Drying
	Length	Width		
Single jersey	+3.6	-4.7	water	Line
Single jersey	-0.9	-6.66	water	Tumble
Single jersey	+3.9	-3.52	Detergent	Line
Single jersey	+1.4	-6.28	Detergent	Tumble
1×1 Rib	-1.6	-1.33	Water	Line
1×1 Rib	-5.14	-6.76	Water	Tumble
1×1 Rib	-3.3	-1.52	Detergent	Line
1×1 Rib	-7.42	-5.42	Detergent	Tumble

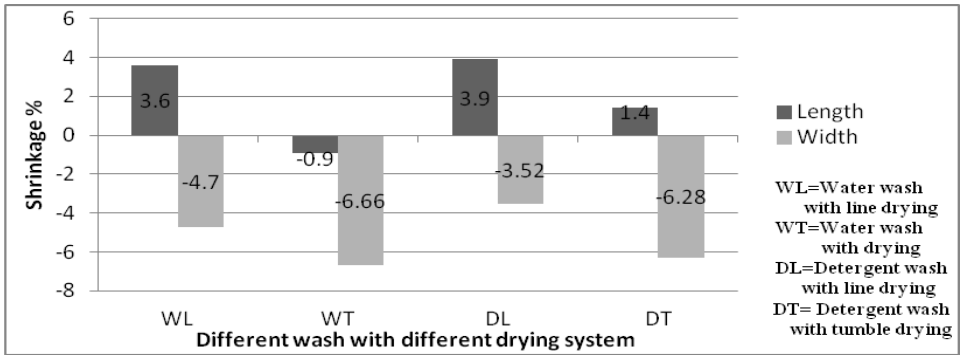

Fig. 7. Lengthwise & widthwise shrinkage% of Single jersey at different washing

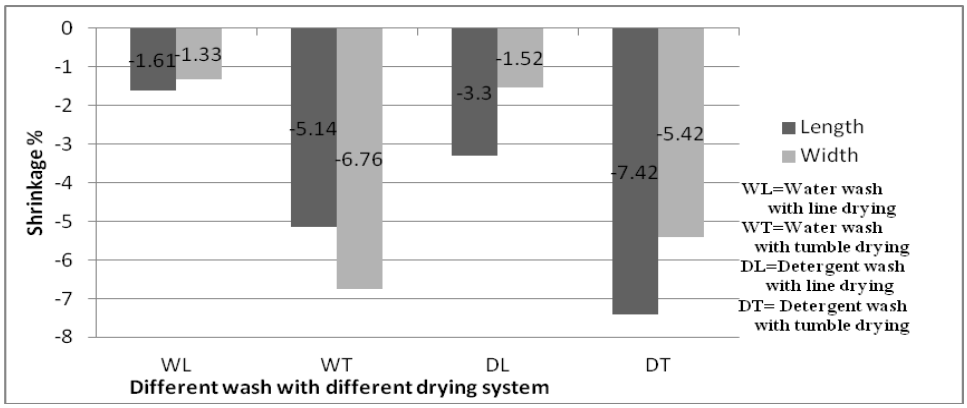

Fig. 8. Lengthwise & widthwise shrinkage% of 1×1 Rib at different washing

It was expected that the results obtained for the dimensional stability tests carried out would be significantly different for two fabric structures, due to the distinct nature of each structure. A positive value indicates extension of tested fabrics and negative value represents shrinkage. The results obtained for the single jersey fabric specimens in Table

4 indicated that there was a significant difference between line drying and tumble drying for single-jersey. The line-drying regime caused more extension in length direction than the tumble drying regime, whereas tumble drying tend to produce higher shrinkage at widthwise direction. It would therefore appear that washing with water and detergent by tumble caused higher shrinkage in the fabric length and width direction than line drying.

The dimensional stability tests carried out in the length and width direction for the 1×1 rib fabric samples showed tumble drying regime caused more shrinkage than line drying regime.

From the above experiment we observed that among different washing & drying systems(WL,DL,WT&DT), the shrinkage for WL(wash with line drying), is better compared with the other washing and drying system because here CPI,WPI and the change of Stitch length after washing is very slight.

But water wash in tumble drying shrinkage% of length and width is more than -5%(both Single jersey & 1×1 Rib). and detergent wash in Single jersey & 1×1 Rib ,drying with line or tumble, here shrinkage is not good because CPI,WPI and Stitch length change after washing is more than water wash. Tumble drying system, fabric may be shrunk more due to pressure and temperature, revolving cylinder.

So we can take decision about this thesis for achieving acceptable shrinkage that water wash with line drying should be done.

Conclusion

Length stability results for the two structures indicated that there a significant difference between tumble and line drying. The tumble-dried specimens were found to shrink to a greater extent. Line drying caused actual length extension in plain single-jersey fabrics due to the mass of the fabric causing the fabric to be drawn downwards. Two structures displayed similar trends for the dimensional stability tests in the length direction; therefore it would appear that two fabrics were susceptible to length shrinkage. The 1x1 rib structure results for dimensional stability in width indicated more variation due to the higher potential relaxation possible in the width direction. The detergent-tumble regime caused the most shrinkage, whereas the water-line regime caused extension in the width. Overall, it can be concluded that the plain single-jersey requires more attention when laundering. It would appear that the structure is so unbalanced, it would be unwise to launder the fabric under the same conditions as those applied to the 1x1 rib structures. It would therefore necessary to investigate the conditions under which single-jersey fabrics can be laundered so that the dimensional changes kept to a minimum. The effect of tumble-drying was evident throughout the investigation. It would appear that this method of fabric drying tends to cause the most dimensional changes in the fabric, due to a combination of pressure and temperature. So from this thesis it can be said that we get acceptable shrinkage incase of water wash with line drying.

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