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The Influence of Compacting on Constructional Properties of Knitted Fabric

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ABSTRACT

Shrinkage from washing has always been considered a serious problem for cotton knitted fabrics and even today a high level of shrinkage in fabrics and garments remains an enigma to many people. However, the performance characteristics of cotton knit fabrics as related to its dimensional structure and therefore shrinkage are as basic and predictable as any other mathematical or physical model. Shrinkage arises mainly due to the harsh treatment given to the fabric while wet processing and drying, which results in elongation in the knitted fabric. The fabric relaxes during washing and therefore shrinkage occurs. The technique of compacting is used to achieve a natural relaxed state of the knit loop and thereby the fabric displays minimal shrinkage within acceptable levels.

Keywords: Cotton; Durability; Fabric; Shrinkage; Wales.

INTRODUCTION

One of the foremost problems that confront a knitter or garment manufacture is shrinkage. Many institutes have devoted large amounts of time and money to study this problem. Shrinkage of a fabric means change in dimensions of the fabric: it could be reduction in length or width, often with a corresponding elongation in the other direction (Padaki *et al.*, 2006; Lomov *et al.*, 2013). Shrinkage of a fabric is nowadays one of the major deciding factors for the consumer, whether the product is for export or for sale in the local market. This clearly indicates the vital role that shrinkage of a fabric plays in its ultimate end use performance. Many export orders are rejected only on the grounds of unacceptable shrinkage. Cotton garments are well known to have low durability compared with synthetic apparel (Kamiya *et al.*, 2000). Therefore, until and unless proper shrinkage control processes are employed, knitted cotton garments will lose out on the serviceability factor. Shrinkage of fabric occurs due to various factors.

Also, different types of shrinkage take place, e.g. residual shrinkage, cover factor shrinkage and process shrinkage (Chen and Chou, 2009). Among these, process shrinkage results in high shrinkage percentage. So this study takes only the process shrinkage into account. Process shrinkage is mainly caused by processes wherein excessive tension is used, e.g. the take-up device in a knitting machine (Han *et al.*, 2010). Stretching of the fabric in a width-wise direction for extended periods of time during processing will obviously lead to shortage of the fabric.

Most of the export houses in India are using the compacting process to control shrinkage. In this process, the principle of "controlled compressive shrinkage" is utilised. In a compacting machine, the fabric being processed is subjected in a relaxed state to the action of steam (Saunders *et al.*, 2008; Ranganathan *et al.*, 2010). Due to the combined action of steam and overfeed of the fabric, an environment is created whereby the stresses and strains imposed in the fabric during processing are released. This method is most effective, as almost all the residual forces are removed and any persisting ones result in marginal shrinkage within accepted limits (Venner *et al.*, 2002).

There are also other variations of the compacting machine where, instead of direct steam, the manufacturer adopts the use of a steam-heated cylinder or a heated shoe. Many people have studied knitted fabric shrinkage and have found that shrinkage can be controlled. They have shown that the residual fabric shrinkage can be maintained to as low a value as 1% upon compacting. However, there is little information about the change in fabric parameters like courses per inch, wales per inch, stitch length, GSM and thickness due to the imposed mechanical shrinkage (Gutowski and Dillon, 2007). This paper thus focuses on the effects of compacting on shrinkage as well as other structural characteristics of the knitted fabric.
This study focuses on the change in other parameters of knitted fabric like course per inch, wales per inch, stitch length, GSM and thickness that result from shrinkage. The results of the investigation are reported here along with recommendations for industry.

METHODOLOGY

For this study, the following types of machine-state knitted fabric samples were obtained from compacting units in Tirupur.

1. Single jersey
2. Rib
3. Interlock
4. Airtex

Shrinkage tests were carried out on five specimens for each of the fabrics before and after compacting. The values wales per inch (WPI), courses per inch (CPI), grams per square metre (GSM), stitch length and thickness for each sample before and after compacting were also evaluated. Standard methods of test were used to evaluate all of the above properties (Suh, 2007).

RESULTS AND DISCUSSIONS

The shrinkage values of five specimens each of the fabrics under study, before and after compacting, are shown in Table 1. According to accepted reporting norms, a reduction in dimension is taken as positive shrinkage, while an increase is shown with a negative sign (Keshkari, 2012).

Table 1: Shrinkage of the Fabrics before and after Compacting

S. No.	SINGLE JERSEY				RIB				INTER LOCK				AIRTEX			
	Longitudinal Shrinkage		Transverse Shrinkage		Longitudinal Shrinkage		Transverse Shrinkage		Longitudinal Shrinkage		Transverse Shrinkage		Longitudinal Shrinkage		Transverse Shrinkage	
	BC	AC	BC	AC	BC	AC	BC	AC	BC	AC	BC	AC	BC	AC	BC	AC
1	–9	–1	NIL	–4	–10	NIL	4	–3	–19	–3	12	–4	–17	1	4	–4
2	–6	NIL	5	–3	–8	2	5	–3	–10	1	14	–1	–16	–3	4	–2
3	–8	4	–2	–4	–12	–2	6	–2	–11	–4	4	NIL	–11	4	4	–1
4	–6	NIL	4	–1	–9	3	3	–3	–13	1	8	–3	–17	NIL	9	–4
5	–8	1	6	–4	–7	1	4	–1	–12	2	6	–2	–13	–3	4	–3
Mean	**– 7.4**	**0.8**	**2.6**	**–3.2**	**–9.2**	**0.8**	**4.4**	**–2.4**	**–16.2**	**–0.6**	**8.8**	**–2.0**	**–14.8**	**–0.2**	**4.8**	**–2.8**

BC – Before Compacting AC – After Compacting

Table 2: Wales per inch and Courses per inch of the Compacted Fabrics

S. No.	SINGLE JERSEY						RIB						INTERLOCK						AIRTEX					
	Wales per inch			Course per inch			Wales per inch			Course per inch			Wales per inch			Course per inch			Wales per inch			Course per inch		
	BC	AC	% Change in WPI	BC	AC	% Change in CPI	BC	AC	% Change in WPI	BC	AC	% Change in CPI	BC	AC	% Change in WPI	BC	AC	% Change in CPI	BC	AC	% Change in WPI	BC	AC	% Change in CPI
1	38.5	38	-1.29	45	46	2.22	26	27	3.3	47	48	4.12	40	41	2.5	76	77	1.31	30	31	3.33	37	37	NIL
2	33	32	-3.03	46	46	NIL	25	24	- 4	41	42	2.4	38	39	2.6	35	36	2.8	27	28	3.7	37	38	2.7
3	45	45	NIL	49	50	2.5	31	31	NIL	33	34	4.03	35	36	2.8	38	38	NIL	29	30	3.44	36	37	2.7
4	40	41	2.5	55	56	1.8	25	26	4	39	41	5.12	36	36	NIL	52	53	1.92	31	32	3.22	29	30	3.44
5	39	40	2.5	67	68	1.49	33	32	-4	41	42	2.43	40	41	2.5	43	44	2.32	28	29	3.57	34	35	2.9

BC- Before Compacting AC- After Compacting

It is clear from results which is mention in Table 1 that the machine-state knitted fabrics investigated display mean shrinkage values in the range –7.4 to –19 % in the longitudinal direction and 2 to 14 in the transverse direction. In a knitting machine, the fabric is under great longitudinal tension due to the take-up device (Sharma *et al.*, 2005). There is also some imposed lateral stress due to the machine diameter. The shrinkage results agree with the behaviour of the fabric when it is taken off the machine, i.e. it will shrink in the width-way direction and considerably increase in length. However, upon compacting the fabrics, the longitudinal shrinkage is on an average –14.2 to 0.8 % while the mean transverse shrinkage changes from –8.8 to 5 %. These results are also in keeping with the principle of a compacting machine, where the knitted fabric is given a compressive mechanical shrinkage treatment. Therefore, clearly, the length-wise shrinkage is virtually disappears with a residual shrinkage of only 0.8 %. The width-wise shrinkage, on the other hand, increases to an average value of –3.2% due to compacting (David, 2004). It may therefore be concluded that the shrinkage in length is almost eliminated with the fabric showing only negative transverse shrinkage, an observation that may be ascribed to the width-wise stretching of the fabric for the compacting process to meet the width specified by the garment maker (Onal and Candan, 2013).

The wales and courses per inch of the fabrics are shown in Table 2, GSM in Table 3, thickness in Table 3 and stitch length in Table 4.

It can be observed from Table 2 that there is an increase in the values of wales and courses per inch in the fabrics due to compacting.

- The compacted single jersey fabric has wales per inch varying from 0 % to 3 % (average 1.86 %) and courses per inch from 0 % to 2.5 % (average 1.6%).
- In the compacted rib fabric, the wales per inch varies from 0 % to 4 % (average 2.46 %) and courses per inch from 2.4 % to 5.1 % (average 3.54%).
- In the interlock fabric, compacting results in the wales per inch varying from 0 % to 2.8 % (average 1.18%) while the courses per inch varies from 0 % to 2.8 % (average 1.67%).
- The compacted airtex fabric has wales per inch varying between 0% and 3.2% (average 1.72%) and courses per inch varying from 0 % to 1.7 % (average 0.9%).

Wales and courses per inch do not seem to be affected appreciably due to compacting (Hazel *et al.*, 2013).

The following observations may be discerned from the compacted fabric GSM values shown in Table 3.

- Increase in the GSM of the single jersey fabric due to compacting is in the range 0.6 to 30.6 % (average 10.69 %).
- In case of the rib fabric, increase in GSM is between 2.4 and 14.5 % (average 6.42 %).
- The interlock fabric shows an increase in GSM in the range 0.5 to 2.5 % (average 1.4 %).
- In the airtex fabric the GSM increases from 4.2 to 25.7 % (average 13.8 %).

Compacting thus results in a considerable increase in fabric GSM.

From the thickness values of the fabrics before and after compacting shown in Table 4, the following observations emerge.

- In single jersey fabric, thickness of the single jersey fabric shows an increase between 2.9 and 5.3 % (average 4.26 %).
- For the rib fabric, increase in thickness is between 3.3 and 7.4 % (average 5.4 %).
- The interlock fabric increases in thickness from 4.4 to 11.76 % (average 7.31 %).
- In the case of the airtex fabric, the thickness increase due to compacting is from 3.8 to 10.35 % (average 7 %).

Table 3: GSM of the Compacted Fabrics

S. No.	SINGLE JERSEY			RIB			INTERLOCK			AIRTEX		
	GSM			GSM			GSM			GSM		
	Before Compacting	After Compacting	% Change in GSM	Before Compacting	After Compacting	% Change in GSM	Before Compacting	After Compacting	% Change in GSM	Before Compacting	After Compacting	% Change in GSM
1	145	150	+3.4	207	226	+9.2	180	184	+2.2	172	188	+9.3
2	195	205	+5.1	228	195	-14.2	219	220	+0.5	182	190	+4.2
3	150	196	+30.6	250	256	+2.4	215	216	+0.5	203	254	+25.3
4	170	171	+0.6	226	232	+2.7	205	208	+1.4	187	235	+25.7
5	199	226	+13.5	210	217	+3.3	192	197	+2.5	222	232	+4.5

Table 4: Thickness of the Compacted Fabrics

S. No.	SINGLE JERSEY			RIB			INTERLOCK			AIRTEX		
	THICKNESS (mm)			THICKNESS (mm)			THICKNESS (mm)			THICKNESS (mm)		
	Before Compacting	After Compacting	% Change in thickness	Before Compacting	After Compacting	% Change in thickness	Before Compacting	After Compacting	% Change in thickness	Before Compacting	After Compacting	% Change in thickness
1	0.486	0.512	+5.3	0.862	0.798	-7.4	0.714	0.798	+11.76	0.734	0.810	+10.35
2	0.552	0.524	+5.07	0.776	0.716	-7.7	0.720	0.752	+4.44	0.746	0.802	+7.51
3	0.532	0.554	+4.13	0.854	0.826	-3.3	0.75	0.82	+9.33	0.840	0.890	+5.95
4	0.544	0.528	-2.9	0.856	0.818	-4.4	0.81	0.85	+5.18	0.704	0.756	+7.38
5	0.538	0.516	-4.08	0.743	0.710	-4.4	0.75	0.79	+5.85	0.792	0.822	+3.78

Table 5: Stitch Length of the Compacted Fabrics

S. No.	SINGLE JERSEY			RIB			INTERLOCK			AIRTEX		
	Stitch Length (cm)			Stitch Length (cm)			Stitch Length (cm)			Stitch Length (cm)		
	Before Compacting	After Compacting	% Change in Stitch Length	Before Compacting	After Compacting	% Change in Stitch Length	Before Compacting	After Compacting	% Change in Stitch Length	Before Compacting	After Compacting	% Change in Stitch Length
1	0.2633	0.2724	+3.45	0.2794	0.2916	+4.36	0.2272	0.2394	+5.36	0.2316	0.2461	+6.26
2	0.2667	0.2761	+3.33	0.2683	0.2857	+6.48	0.2236	0.2373	+6.12	0.2412	0.2544	+5.48
3	0.2653	0.2750	+3.69	0.2742	0.2911	+6.16	0.2356	0.2498	+6.03	0.2237	0.2409	+7.68
4	0.2712	0.2813	+3.72	0.2736	0.2903	+6.1	0.2328	0.2456	+5.49	0.2362	0.2558	+8.29
5	0.2642	0.2729	+3.29	0.2785	0.2957	+6.17	0.2291	0.2437	+6.37	0.2379	0.2533	+6.473

There is thus a moderate increase in the thickness of knitted fabric due to compacting.
The following observations may be inferred from Table 5, which depicts the stitch length of the fabrics under investigation as a result of compacting (Oinuma, 2006).

- The single jersey fabric displays an increase in stitch length in the range 0.0081 to 0.0101 cm (average 0.0093 cm).
- In the case of the rib fabric the stitch length increase is between 0.0122 and 0.0174 cm (average 0.0161 cm).
- For the interlock fabric, the increase in stitch length is in the range 0.0122 to 0.0146 cm (average 0.0135 cm).
- In air tex, the stitch length increase is between 0.0132 and 0.0196 cm (average 0.0159 cm).

The above details clearly lead to the conclusion that there is only a marginal increase in stitch length due to compacting, the maximum increase being 6.8 % for the different kinds of knitted fabrics in this study.

CONCLUSIONS

It is concluding that the shrinkage tests conducted on knitted fabric before and after compacting, it may be concluded that shrinkage is eliminated to a considerable extent. The residual shrinkage is well within the required limits. Compacting results in an appreciable increase in GSM, while the increase in thickness is nominal. Changes in WPI, CPI and stitch length are negligible.

REFERENCE

Chen, B., and T.W. Chou. 2009 Compaction of woven-fabric performs in liquid composite molding processes: single-layer deformation, *Compos. Sci. Technol.* 59:1519–1526.

David, H. 2004 Black Shrinkage Control for Cotton and Cotton Blend Knitted Fabrics *Tex. Res. J.* 44:606-612.

Gutowski, T.G., and G. Dillon. 2007 The elastic deformation of fibre bundles. In: Gutowski, T.G. (ed.), Advanced Composites Manufacturing, Wiley, New York, pp:115–156.

Han, K., W. Lee, and B. Rice. 2010. Measurements of the permeability of fibre preforms and applications, *Compos. Sci. Technol.* 60:2435–2441.

Hazel, M., M. Fletcher, S.H. Roberts. 2013 Distortion in Knit Fabrics and Its Relation to Shrinkage in Laundering. *Tex. Res. J.* 23:37-45.

Kamiya, R., B.A. Cheeseman, P. Popper, and T.W. Chou. 2000 Some recent advances in fabrication and design of three-dimensional textile preforms: A review. *Compos. Sci. Technol.* 60(1):33–47.

Keshkari, K.R. 2012 Effect of yarn feed length on cotton weft knitted fabrics. *The Indian Tex. J.* 4:131 – 136.

Lomov, S.V., I. Verpoest, M. Barburski, and J. Laperre. 2013 Carbon Composites Based on Multiaxial Multiply Stitched Preforms. Part 2: KES-F characterisation of the deformability of the preforms at low loads. *Composites Part A.* 34:359-370.

Oinuma, R. 2006 Factors Affecting Dimensional Properties of Cotton Plain –Jersey. *Fabrics, Jo Tex. Mach. So. Japan*. 39(1):401-406.

Onal, L., and C. Candan. 2013 Contribution of Fabric Characteristics and Laundering to Shrinkage of Weft Knitted Fabrics. *Tex. Res. J.* 73:187-192.

Padaki, N.V., R. Alagirusamy, and B.S. Sugun. 2006 Knitted preforms for composite applications. *J. Ind. Text.* 35:295–321.

Ranganathan, S., R.G. Easterling, S.G. Advani, and F.R. Phelan. 2010 Effect of microstructure variations on the permeability of preform materials. *Polym. Compos.* 6(2):63–73.

Saunders, R.A., C. Lekakou, and M.G. Bader. 2008 Compression and microstructure of fibre plain woven cloths in the processing of composites, *Compos. Pt A.* 29:443–454.

Sharma, I.C., S. Ghosh, and N.K. Gupta. 2005 Dimensional and Physical Characteristics of Single Jersey Fabrics. *Tex. Res. Jo.* 55:149-160.

Suh, M.W. 2007 A study of the shrinkage of plain knitted fabric, Based on the structural changes of the loop geometry due to yarn swelling and deswelling. *Tex. Res. J.* 67:417 – 431.

Venner, C.H., and A.A. Lubrecht. 2002. Multi-Level Methods in Lubrication. *Tribology Series* Elsevier. 37, Elsevier.