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Effect of Relaxation on Properties of Silk Acrylic Knitted Fabrics

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Abstract

In this study, effect of relaxation on the properties of acrylic- silk blended fabrics has been examined. The effect of wet relaxation as well as full relaxation has been examined. Bulk in the silk yarn was produced by blending shrinkable acrylic fibre with silk with varying blend percentage. Single jersey weft knitted fabrics were prepared from acrylic silk blended yarns such as 100% shrinkable acrylic A10, 80% shrinkable acrylic and 20% silk (A8S2), A6S4, A5S5, A4S6, A2S8 and 100% silk S10. It was found that after wet and full relaxation the course/cm, wales/cm, stitch density, thickness and bulk of acrylic/silk fabrics increased whereas stitch length reduced. After wet and full relaxation the increase in the values of course/cm, wales/cm was observed due to shrinkage in the fabrics. Reduction in the value of stitch length has been observed due to change in the shape of the loop. The change in the shape of the loop results in increase in values of loop shape factor and tightness factor. Shrinkage in the knitted fabrics after full relaxation is greater than after wet relaxation. This is due to tumble drying during full relaxation. The skewness of the silk rich knitted fabrics after full relaxation is greater than after wet relaxation.

Thickness, weight per unit area and fabric bulk of acrylic silk weft knitted fabrics has increased after wet and full relaxation due to shrinkage in the fabrics. Thickness, weight and fabric bulk was found maximum at 50/50 acrylic/ silk level. This is due to maximum bulk level of silk- acrylic yarn at 50/50 level.

Keywords: Silk Acrylic Blend, Shrinkage In Knitted Fabric, Wet Relaxation, Full Relaxation.

Introduction

Knitting was done manually by hands in the early days. The properties of the knitted fabrics were entirely dependent upon ability and skill of the knitter. These days knitting operation is done with the help of machines and efficient knitting machines are available. After knitting, all types of knitted fabrics are prone to shrinkage in the dry relaxed state of the knitted fabrics. Further shrinkage is observed in the wet relaxation during finishing processes and full relaxation during customer usage. During wet and full relaxation the properties of the fabrics changes due to shrinkage. These properties are course/cm, wales/cm, stitch length, stitch density, shape of the loop, tightness factor, thickness and weight of the fabric. Hence it is necessary to study effect of various relaxation processes on the properties of knitted fabrics. After shrinkage the stitch length and shape of the loop also changes. Hence it is necessary to study, effect of relaxation processes like wet, full relaxation on the properties of knitted fabrics.

In textiles, the properties of the fabrics depend upon raw material, spinning parameter, method of fabric preparation, finishing and processing parameters. The parameters chosen during these processes affect fabric properties. During relaxation, these internal stresses stored during various processes like spinning and knitting are relieved during processing and fabric attains relaxed state. During shrinkage internal stresses are relieved and properties of the knitted fabric changes.

In the present study, effect of wet and full relaxation on the properties of weft knitted acrylic silk blended knitted fabrics at various blend levels, has been examined. The properties studied are course/cm, wales/cm, stitch length, stitch density, shape of the loop, tightness factor, thickness and weight of the fabric. For

comparison purpose cotton fabric of same construction was also manufactured so that properties of different blends can be compared with very common and popular cotton knitted fabric.

Review of Literature

Lot of studies has been done in the field of shrinkage in warp, weft knitted fabrics. Eleonora G.[1] has studied dependence of dry, wet and washing relaxation on knitted structure and fabric parameters. In this study, it has been shown that relaxation processes is related to the percentages of stitches, tucks, and floats in weft knitted structures. Relaxation process is correlated to stitch density. Mukherjee S. et al[2] have studied non- dimensional parameters of rib fabric produced on circular bed double jersey knitting machine using ultrasonic technique. In this study non- dimensional parameters such as course constant, wale constant, stitch density and loop shape factor of the knitted fabric were studied. It is observed that new relaxation technique produces similar dimensional and non-dimensional parameters of the fabrics as obtained with conventional relaxation techniques. Cuden A.P. et al[3] have studied impact of material, knitted structure and relaxation process parametres on loop length. Knitted fabrics produced from elasticized and non- elasticized yarn, fabric density and relaxation process influence the loop length most of all. Herath Chathura and Kang Bok Choon[4] have studied dimensional stability of core- spun cotton/ spandex single jersey fabrics under relaxation. In this study dimensional stability of core- spun cotton/ spandex single jersey structure with high, medium and low tightness factors were experimented under dry, wet and full relaxation conditions. From these experiments, it was confirmed that yarns with elastomeric components increase tightness factors. Mohamadi V.[5] has studied dimensional stabilization of cotton plain knitted fabric by using ultrasonic waves. Cotton knitted fabric with plain structure has been subjected to relaxation treatment using mechanical energy of ultrasonic waves to reach maximum shrinkage. It is observed that this method of relaxation is more effective than conventional method. Onal Levent[6] has studied contribution of fabric characteristic and laundering to shrinkage of weft knitted fabrics. In this work, three different single jersey knits with varying fabric tightnesses, yarn types and fibre blends are selected for their characteristics. The contribution of each characteristic to shrinkage behavior is presented. Mukhopadhyay A. and Kaushik R.C.D.[7] have studied bulk characteristics of air-jet textured yarn knitted fabrics. In this study the thickness and specific volume of knitted fabric have been analyzed in relation to yarn type, stitch length and relaxation treatment. Kaushik R.C.D. et al[8] have analysed effect of steam relaxation treatment on characteristics of Acrylic viscose rotor spun yarns. The steam- relaxation treatment of acrylic- viscose rotor spun yarns decreased their tenacity significantly but increased breaking extension. Acrylic majority yarns exhibited higher bulk and residual shrinkage. Sharma I. C. et al[9] have studied dimensional and physical characteristics of single jersey fabrics. An account is given of the dimensional changes of plain weft knitted fabrics made from 12^s, 16^s and 22^s grasicrimp yarn, brought about by various processes of relaxation. Sharma I.C. et al[10] have studied dimensional stability of Plain weft knitted fabrics. The dimensional stability of plain weft knitted fabrics made from grasi crimp and acrylic yarns have been investigated under three different conditions of relaxation- dry relaxation, wet relaxation and tumble drying.

In the previous study, Kumar R.[11], it was found that after steaming the increase in yarn diameter is maximum for acrylic- silk 50/50 blend. Lot of references are available for knitted fabrics but effect of blend percentage on the properties of knitted fabrics are few.

Aim of the Study

The aim of the study is,

1. To study effect of wet relaxation on the properties of acrylic/silk blended single jersey weft knitted fabrics at different blend levels.
2. To study effect of full relaxation on the properties of bulk silk weft knitted single jersey acrylic/silk blended knitted fabrics at different blend levels.
3. To study effect of shrinkage on the properties of acrylic/silk blended weft knitted single jersey knitted fabrics like course/cm, wales/cm, stitch length, stitch density, shape of the loop, tightness factor, thickness and weight of the fabric, at different blend levels.
4. To study effect of shrinkage on the skewness, weight, and fabric bulk of acrylic/silk blended weft knitted single jersey knitted fabrics at different blend levels.

Material and Methods

Acrylic-silk yarns in different blend proportions were prepared of 30^s N_e and Twist multiplier 2.7 (T.p.i 14.8). For comparison of acrylic-silk blended yarns and fabrics with equivalent cotton yarn and fabric, 100% cotton yarn of 30^s N_e and Twist multiplier 2.7 (T.p.i 14.8) was also prepared. All silk-acrylic blended fabrics, 100% silk and cotton fabrics were knitted on single jersey, 24 feeder circular knitting machine having 12 inches diameter, total numbers of needles 886 and 24 gauge. All the fabric samples were knitted at the same time one by one with same cam setting.

Dry Relaxation

Fabrics knitted in tubular form were laid free from constraints for 24 hours on a flat surface to facilitate recovery from the stresses imposed during knitting in standard atmospheric conditions (65% $\pm$ 2% RH and $27^0C \pm 2^0C$).

Wet Relaxation

Fabric samples were put into a large stainless steel tub containing water and 0.1% wetting

agent maintained at a constant temperature of 40^0C. The samples remained in this container for 24 hours before being lifted out, then allowed to dry naturally for at least 3 days. After drying, the fabric samples were brought back to the standard conditions (65% ± 2% RH and 27^0C ± 2^0C).

Full Relaxation

Knitted samples were put into a large stainless steel tub containing water and 0.1% wetting agent maintained at a constant temperature of 40^0C. The samples were wetted thoroughly for 24 hours, washed thoroughly, then briefly hydroextracted and tumble-dried for 90 minutes at 70^0C. The samples were laid on a flat surface for 24 hours in standard atmospheric conditions of 65% ± 2% RH and 27^0C ± 2^0C.

Course and wale density of the fabrics was measured with thread counting glass. Stitch length of the knitted fabric was measured according to British Standards. The stitch density was obtained by multiplying wales/cm and course/cm. The knitting constant were calculated from the following equations

K_C = Course/cm × Stitch length

K_w = Wales/cm × Stitch length

$K_s = K_c \times K_w$

Loop shape factor, tightness factor and fabric bulk were calculated by following formulas

Loop shape factor = K_C / K_w

Tightness factor = $\frac{\sqrt{T}}{l}$ where T is tex of yarn and l is loop length.

Fabric bulk (cc/g) = Thickness (cm)/ Weight of fabric (g/cm^2)

Thickness of the fabric was measured on Prolific thickness tester at a foot pressure of 20 gf/cm^2. Skewness of the fabric was measured according to ASTM standards.

Results & Discussion

The properties of dry relaxed fabrics have been shown in Table 1.These values will be compared with the values after wet and full relaxation.

Table 1 Properties of Acrylic-Silk Blended Dry Relaxed Knitted Fabrics

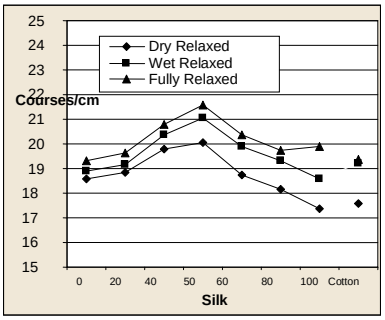
	Acrylic	A8S2	A6S4	A5S5	A4S6	A2S8	Silk	Cotton
Yarn linear density (tex)	19.9	19.9	19.5	19.5	19.9	19.5	20.3	20.2
	(3.1)	(2.5)	(3.7)	(2.7)	(2.1)	(2.6)	(3.8)	(3.6)
Course/cm	18.6	18.8	19.8	20.1	18.8	18.1	17.4	17.6
	(1.4)	(1.2)	(1.3)	(1.4)	(1.2)	(1.2)	(1.3)	(0.9)
Wales/cm	13.5	13.4	13.1	13.1	13.4	13.5	13.9	13.9
	(1.2)	(0.9)	(1.1)	(1.2)	(1.2)	(1.3)	(0.9)	(1.2)
Stitch density/cm^2	251.1	251.9	259.4	263.3	251.9	244.4	241.9	244.6
Stitch length (mm)	2.79	2.78	2.73	2.71	2.88	2.97	3.09	3.03
	(2.9)	(2.1)	(3.1)	(2.4)	(3.4)	(2.7)	(2.1)	(3.6)
Kc	5.19	5.23	5.41	5.45	5.41	5.38	5.38	5.33
Kw	3.77	3.73	3.58	3.55	3.86	4.01	4.30	4.21
Ks	19.5	19.5	19.3	19.3	20.9	21.6	23.1	22.5
Loop shape factor	1.38	1.40	1.51	1.53	1.40	1.34	1.25	1.27
Tightness factor	16.0	16.0	16.2	16.3	15.5	14.9	14.6	14.8
Thickness (mm)	0.57	0.6	0.63	0.64	0.58	0.52	0.45	0.5
	(1.5)	(1.7)	(1.4)	(1.3)	(1.3)	(1.6)	(1.8)	(1.9)
Skewness (%)	1	1.4	1.5	2	2.6	2.8	3	16.5
Weight (gm/m^2)	155.3	160.9	165.2	165.9	152.2	143.5	140.5	142.6
Fabric bulk (cc/g)	3.67	3.73	3.81	3.86	3.81	3.62	3.20	3.51

(Figures in parenthesis represent CV %)

Properties of Wet Relaxed fabrics

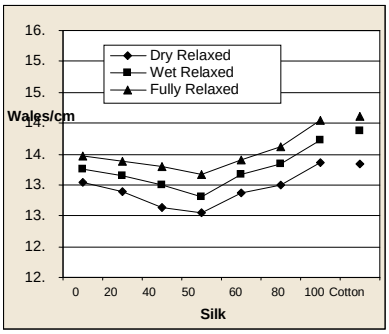
The properties of wet relaxed acrylic silk blended knitted fabrics are shown in Table 2. It has been noted from Table 2 that shrinkage in acrylic rich blended knitted fabric is lesser than silk and cotton knitted fabrics of similar construction. Shrinkage in the knitted fabrics has occurred as the fabric recovers from strains imposed by knitting machine in lengthwise and widthwise direction.

Fig.1 Effect of Relaxation on Course/cm



During wet relaxation, water molecules penetrates the inter yarn spacing and behaves like a lubricant. The major part of the inter yarn friction is lost and yarn movement is eased. Thus yarn occupies a new configuration within the space available.

Fig.2 Effect of Relaxation on Wales/cm



Hence the values of courses/cm and wales/cm have increased according to the shrinkage in the fabric as shown in Fig.1 and Fig.2.

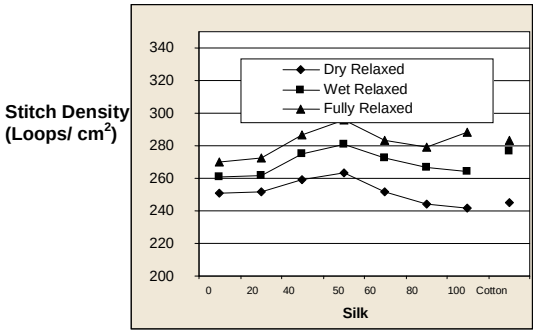
Table 2 Properties of Acrylic-Silk Blended Wet Relaxed Knitted Fabrics

	Acrylic	A8S2	A6S4	A5S5	A4S6	A2S8	Silk	Cotton
Yarn linear density (tex)	19.9	19.9	19.5	19.5	19.9	19.5	20.3	20.2
	(3.1)	(2.5)	(3.7)	(2.7)	(2.1)	(2.6)	(3.8)	(3.6)
Course/cm	18.9	19.1	20.4	21.1	19.9	19.3	18.6	19.2
	(1.5)	(1.1)	(1.4)	(1.5)	(1.4)	(1.3)	(0.9)	(1.2)
Wales/cm	13.8	13.7	13.5	13.3	13.7	13.8	14.2	14.4
	(1.2)	(1.3)	(1.2)	(1.3)	(1.2)	(1.2)	(1.1)	(1.1)
Stitch density/cm^2	260.8	261.7	275.4	280.6	272.6	266.3	264.1	276.5
Stitch length (mm)	2.69	2.69	2.62	2.6	2.75	2.83	2.94	2.89
	(2.4)	(2.7)	(2.1)	(2.6)	(2.7)	(2.8)	(3.7)	(2.7)
Kc	5.08	5.14	5.34	5.49	5.47	5.46	5.47	5.55
Kw	3.71	3.69	3.54	3.46	3.77	3.91	4.17	4.16
Ks	18.9	18.9	18.9	19.0	20.6	21.3	22.8	23.1
Loop shape factor	1.37	1.39	1.51	1.59	1.45	1.40	1.31	1.33
Tightness factor	16.6	16.6	16.9	17.0	16.2	15.6	15.3	15.6
Thickness (mm)	0.63	0.66	0.69	0.71	0.64	0.57	0.48	0.56
	(1.1)	(1.3)	(1.2)	(1.3)	(1.4)	(1.2)	(1.5)	(1.9)
Skewness (%)	1.25	1.75	2	2.75	3	4.5	4.7	17.3
Weight (gm/m^2)	161.9	166.8	167.4	168.2	155.2	146.2	143.8	146.9
Fabric bulk (cc/g)	3.89	3.96	4.12	4.22	4.12	3.90	3.34	3.81
Lengthwise Shrinkage %)	1.5	2	2.25	2.25	3.5	3.5	4	5
Widthwise Shrinkage (%)	0.6	1.5	1.75	2	2.5	2.75	3	4
Area wise Shrinkage (%)	2.1	3.5	4.0	4.2	5.9	6.2	6.9	8.8

(Figures in parenthesis represent CV %)

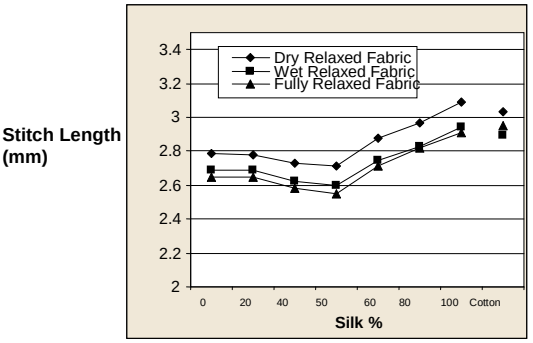
Due to shrinkage in the fabric the stitch density has also increased as shown in Fig.3. Fig.3 shows increase in values of stitch density after wet and full relaxation due to the shrinkage in the fabric.

Fig.3 Effect of Relaxation on Stitch Density



Due to shrinkage in the fabric the stitch length has reduced Fig.4. Shape of the loop has changed and the change in the shape of the loops is reflected from the values of loop shape factor Fig.5. After wet relaxation the reduction in the values of stitch length has been observed and increase in values of loop shape factor (Fig.6).

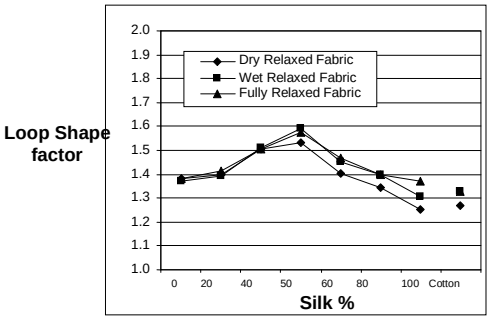
Fig.4 Effect of Relaxation on Stitch Length



Loop shape factor first increases and maximum value is observed at acrylic/ silk 50/50 level.

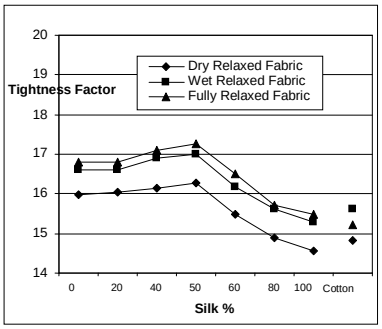
After this, value of loop shape factor decreases. As the blend of acrylic/silk changes the shape of loop also changes.

Fig.5 Effect of Relaxation on Loop Shape Factor



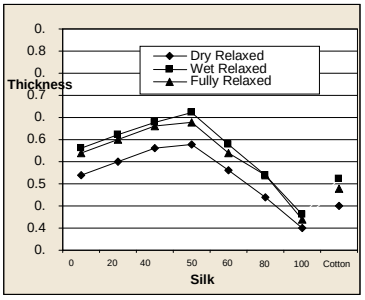
The change in value of tightness factor is shown in Fig.6. The tightness factor of A5S5 fabric is maximum due to minimum stitch length of this fabric.

Fig.6 Effect of Relaxation on Tightness Factor



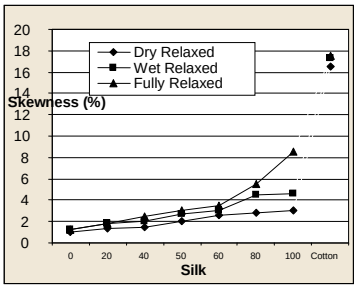
Thickness of the fabrics is shown in Fig.7. Thickness of acrylic/silk blended fabric has increased after wet relaxation due to yarn swelling.

Fig.7 Effect of Relaxation on Thickness



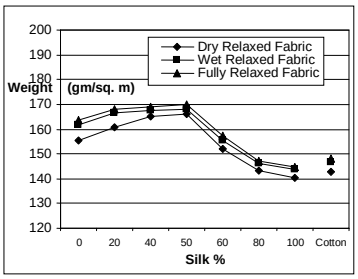
From Fig.8 it is clear that skewness has increased after wet relaxation in case of acrylic/silk blends. This is due to relieving of the torques imposed during spinning and knitting.

Fig.8 Effect of Relaxation on Skewness



The weight of the fabrics is shown in Fig.9. Due to shrinkage, the weight of the fabric has increased after wet relaxation.

Fig. 9 Effect of Relaxation on Weight of Fabric



Due to yarn swelling, the fabric bulk has increased. This is shown clearly in Fig.10.

Fig.10 Effect of Relaxation on Fabric Bulk

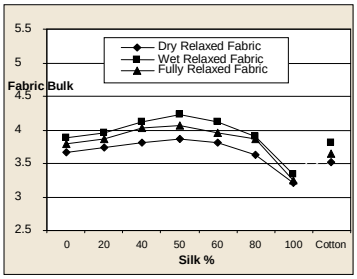


Table 3 Properties of Silk Acrylic Blended Fully Relaxed Knitted Fabrics

	Acrylic	A8S2	A6S4	A5S5	A4S6	A2S8	Silk	Cotton
Yarn linear density (tex)	19.9	19.9	19.5	19.5	19.9	19.5	20.3	20.2
	(3.1)	(2.5)	(3.7)	(2.7)	(2.1)	(2.6)	(3.8)	(3.6)
Course/cm	19.3	19.6	20.8	21.6	20.4	19.8	19.9	19.4
	(1.2)	(1.1)	(1.2)	(1.3)	(1.2)	(1.2)	(1.1)	(1.1)
Wales/cm	14	13.9	13.8	13.7	13.9	14.1	14.5	14.6
	(1.1)	(0.9)	(1.1)	(1.2)	(1.3)	(1.1)	(1.0)	(1.0)
Stitch density/cm^2	270.2	272.4	287.0	295.9	283.6	279.2	288.6	283.2
Stitch length (mm)	2.65	2.65	2.58	2.55	2.71	2.82	2.91	2.95
	(2.4)	(2.1)	(1.9)	(2.1)	(1.9)	(2.1)	(2.9)	(2.7)
Kc	5.11	5.19	5.37	5.51	5.53	5.58	5.79	5.72
Kw	3.71	3.68	3.56	3.49	3.77	3.98	4.22	4.31
Ks	19.0	19.1	19.1	19.2	20.8	22.2	24.4	24.6
Loop shape factor	1.38	1.41	1.51	1.58	1.47	1.40	1.37	1.33
Tightness factor	16.8	16.8	17.1	17.3	16.5	15.7	15.5	15.2
Thickness (mm)	0.62	0.65	0.68	0.69	0.62	0.57	0.47	0.54

	(1.3)	(1.1)	(1.2)	(1.1)	(1.5)	(1.3)	(1.3)	(1.4)
Skewness (%)	1.25	1.75	2.5	3	3.5	5.5	8.5	17.5
Weight (gm/m^2)	163.4	167.8	168.9	169.8	157.1	147.1	144.9	147.9
Fabric bulk (cc/g)	3.79	3.87	4.03	4.06	3.95	3.87	3.24	3.65
Lengthwise Shrinkage %)	3	3.25	3.6	3.75	4.25	4.5	4.6	6.5
Widthwise Shrinkage (%)	2	2.75	3	3.25	3.4	3.5	3.5	5.25
Areawise Shrinkage (%)	4.9	5.9	6.5	6.9	7.5	7.8	7.9	11.4

(Figures in parenthesis represent CV %)

Properties of Fully Relaxed fabrics

It has been observed from Table 3 that shrinkage in the knitted fabrics after full relaxation is greater than after wet relaxation. This is due to the fact while tumble drying during full relaxation, the penetration of molecules of water is further quickened and quantitative lubrication is also more, resulting in higher value of shrinkage as compared to wet relaxation treatment. The values of course/cm, wales/cm, and stitch density have increased after full relaxation whereas the values of stitch length have reduced. This is due to change in the shape of the loops as it is evident from Fig. 5.

The increase in tightness factor of the knitted fabrics after full relaxation can be attributed to the reduction in value of loop length. It is also evident from Fig. 7 that increase in value of thickness after full relaxation is lesser as compared to wet relaxation. This may be ascribed to tumble drying of the fabrics at 70^0C. The skewness of the silk rich knitted fabrics after full relaxation is greater than after wet relaxation (Fig. 8). Due to tumble drying of the samples at an elevated temperature, the extent of inter-yarn lubrication is more which helps the fabric to shrink to a greater extent. Weight/m^2 of the fabric has increased according to the amount of shrinkage in fabric. The fabric bulk depends upon thickness and weight/unit area of the fabric, hence the fabric bulk has changed according to the changes in the values of thickness and weight/unit area of the fabrics.

Conclusion

The results of the study are as follows

1. After wet and full relaxation the course/cm, wales/cm, stitch density, thickness and bulk of acrylic/silk fabrics increases due to shrinkage in the fabric.
2. After wet and full relaxation the reduction in the values of stitch length has been observed due to change in the shape of the loop.
3. Change in the shape of the loop results in increase in values of loop shape factor and tightness factor.
4. Shrinkage in the knitted fabrics after full relaxation is greater than after wet relaxation. This is due to tumble drying during full relaxation.
5. The skewness of the silk rich knitted fabrics after full relaxation is greater than after wet relaxation

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