A STUDY ON CHANGES OF DIMENSIONAL PROPERTIES OF GREY KNIT FABRIC DUE TO WET PROCESS

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Abstract

Intension of this work was to find out the changes those occur in knit fabric due to wet-process. To study this four single jersey grey knit fabric samples were taken and the properties courses per cm, wales per cm, stitch density, stitch length, tightness factor and G.S.M. were measured. Then they were subjected to go through a full wet-process cycle which is practiced in knit dyeing factories, i.e.; scouring-bleaching, enzyme process, dyeing, wash-off and finishing with softener were done. The samples were then dried and properties courses per cm, wales per cm, stitch density, stitch length, tightness factor and G.S.M. were measured. Finally they were compared with the properties of their respected grey samples. It is very difficult to predict the properties of a knit fabric before they are produced or received a wet-process treatment. Which leads to difficulties between two sections namely, the knitting section and the finishing section. The authors hope that this work will increase the understandings between the two sections.

Keywords: Dimensional properties, courses per cm, wales per cm, stitch density, stitch length, tightness factor, G.S.M., wet-process, scouring-bleaching, enzyme process, dyeing, wash-off, finishing with softener

1. Introduction:

This paper accumulated the changes of properties of grey knit fabric after it has gone through the wet processing stages. For this study fabric samples were collected in two stages. First sample was collected just after knitting and the second sample was collected after it has undergone the wet processing stages. The fabric samples were conditioned for 24 hours and then properties were studied. Then the values of the properties were graphically represented to compare them. This study was carried-out collecting knit fabric samples from a knit-dyeing factory of Bangladesh. In this work the dimensional properties of knit fabric (like; courses/ cm, wales/ cm, stitch density, stitch length, tightness factor and GSM) were studied.

2. Literature review:

The smallest dimensionally stable unit of all knitted fabrics is the stitch. It consists of a yarn loop, which is held together by being intermeshed with another stitch or other loops. A stitch is composed of head (part of needle loop), two side limbs or legs (shanks) and feet (part of sinker loops). [2]

Stitch lengths combine in the form of course lengths. Stitch length influence fabric dimensions and other properties including weight. Variations in course length between on garment and another can produce size variations while course length variations within structures (particularly when using continuous filament yarns) can produce horizontal barriness and impair the appearance of the fabric. [1]

Doyle showed that for a range of dry, relaxed, plain weft knitted fabrics, stitch density could be obtained using the formula $S = k_s / l^2$, where S is stitch density, l is loop length and k_s is a constant independent of yarn and machine variables. In 1959 with experimental results Munden indicated that the linear dimensions as well as the stitch density for a wide range of thoroughly relaxed, plain knitted, worsted yarn fabrics were uniquely determined by their stitch length and all other variables influenced dimensions only by changing this variable. He suggested that, in a relaxed condition the dimensions of a plain knitted fabric are given by the formulae;

$Cpi = k_c / l$ and $wpi = k_w / l$;

$S = k_s / l^2$ [1]

By knowing the stitch density (loops per sq.m), loop length (mm) and yarn linear density, the areal density of the knitted fabric can be calculated as,

Arel density = $S \times l \times tex \times 10^{-6}$ grams / m^2 (1 km = 10^{-6} mm)

Also $S = k_s / l^2$

Therefore,

$$\text{Areal density} = k_s / l^2 \times \frac{l \times tex}{100} = \frac{ks \times tex}{100\, l} \text{ g / m}^2$$ [3]

3. Experimental Details:

3.1 Sample collection: Yarn of 24 English count and 24 gauge, 30 inch diameter single jersey knitting machine were used to produce the knit fabric samples.

The first fabric set of samples (4 grey samples) were collected just after knitting the fabric in a single jersey knitting machine. The second set of samples (4 samples after wet-process) was collected after the samples have gone through full wet-process cycle. First grey sample was dyed with 0.06% shade, second grey sample was dyed with 0.356% shade, third grey sample was dyed with 0.5738% shade and fourth sample was dyed with 0.774% shade.

Grey Fabric **(First sample)** → Demineralization → one stage Scouring and bleaching → hot wash → Treatment with per oxide killer → Neutralization → Enzyme treatment → dyeing → neutralization → Wash-off → Finishing with softener. **(Second sample)**.

By this process we got total 8 samples. (4 grey knit fabric and 4 knit fabric samples after wet-process). The second set of sample was then dried. Both the 8 samples were then conditioned.

3.2 Test method: Different dimensional properties were measured from the first (grey) and second (final sample after wet-process) samples. The properties are; course per cm, wales per cm, stitch density, stitch length, tightness factor, G.S.M.

3.2.1 Course per cm: A course is a predominantly horizontal row of loops produced by the adjacent needles during the same knitting cycle. In a brief, course is row of loops across the length of the fabric. It is measured along the wales direction by needle and counting glass. 10 readings were taken for course per cm from each sample. They were then averaged to get the final data.

3.2.2 Wales per cm: A Wale is a vertical column of intermeshed needle loops produced by the same needles knitting at successive knitting cycle. In a brief, wale is column of loops across the width of the fabric. It is measured along the course direction by needle and counting glass. 10 readings were taken for wales per cm. They were then averaged to get the final data.

3.2.3 Stitch density: Stitch density means the total number of loops in a measured area of fabric. (Square inch or square centimeter) It is obtained by counting number of courses per cm and number of wales per cm, then multiplying them. In this way 10 readings were taken for stitch density from each sample. They were then averaged to get the final data.

3.2.4 Stitch length: Stitch length is the length of yarn knitted into a complete stitch. A stitch is comprises of a needle loop and half of two sinker loops. To determine the stitch length the following procedure was followed:

1. 50 loops were counted at the edge of the fabric, across the course direction.
2. Start and the end point of the 50 loops were marked on yarn which is bent into loops.
3. The loops were then unraveled and straitened to yarn.
4. The distance between the start and end marks on the yarn were measured in mm.
5. Finally, the lengths measured in mm, were divided by 50 (number of loops) to obtain the stitch length. In this way 10 readings were taken for stitch length from each sample. They were then averaged to get the final data.

3.2.5 Tightness factor: Tightness factor indicates the tightness or looseness of a knitted fabric. Tightness factor is the ratio of the area covered by the yarn in one loop to the area occupied by that loop. It is determined by the following equation: Tightness factor = $\frac{\sqrt{\text{tex}}}{l}$ Where l = stitch length in mm.

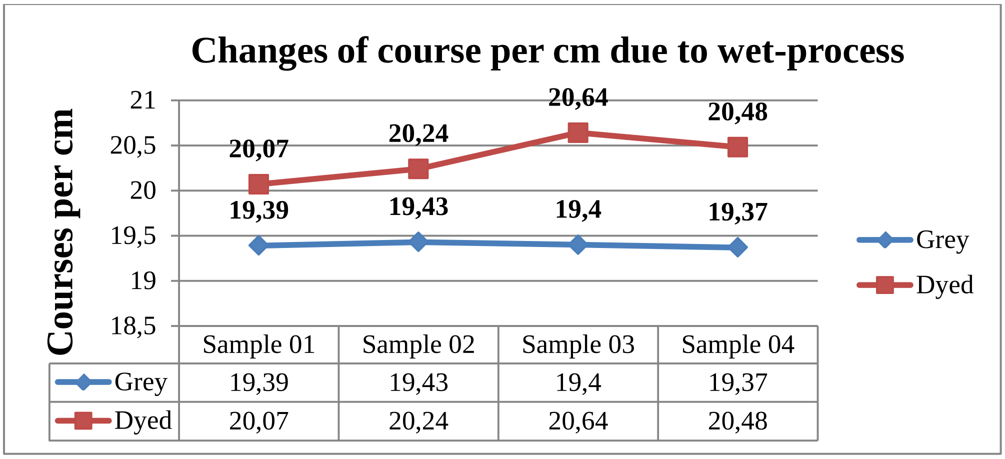
3.2.6 Grams per square meter (G.S.M.): The property is self explanatory which indicates the weight in grams, of one square meter fabric. The G.S.M. of the fabric is directly related to the yarn count and stitch length. The fabric was cut by template (G.S.M. cutter) and weighted to measure the G.S.M.

4. Results and discussion:

The values of the properties found are summarized in the following table. The property-wise values were used to construct graphs. Only the average of values of the properties are shown here.

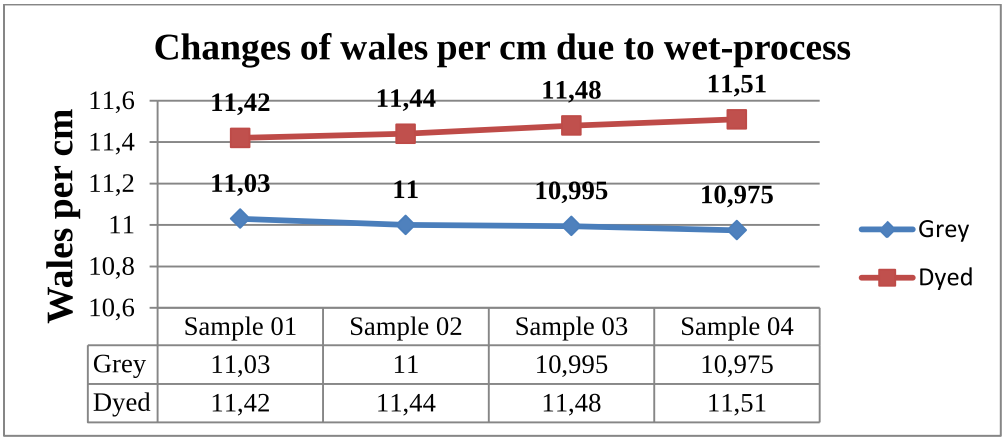
Table: Changes of properties of knit fabric due to wet-process.

Dimensional Property	Sample 01 (Shade % 0.06)		Sample 02 (Shade % 0.356)		Sample 03 (Shade % 0.573)		Sample 04 (Shade % 0.774)	
	Grey	Dyed	Grey	Dyed	Grey	Dyed	Grey	Dyed
Course per cm	19.39	20.07	19.43	20.24	19.4	20.64	19.37	20.48
Wales per cm	11.03	11.42	11	11.44	10.995	11.48	10.975	11.51
Stitches per square cm	219.11	229.19	213.73	231	213.3	233.5	212.56	235.72
Stitch length	2.833	2.8	2.832	2.795	2.829	2.795	2.83	2.789
Tightness factor	1.57	1.59	1.5748	1.595	1.5765	1.5957	1.5759	1.5991
Gram per square meter	176.3	185.4	174.91	191.15	176.5	199.06	175.77	202.78



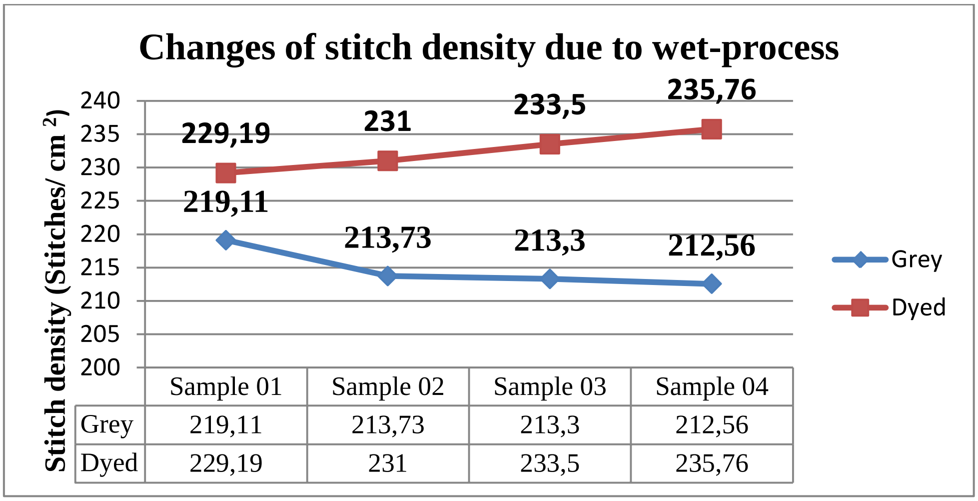
	Sample 01	Sample 02	Sample 03	Sample 04
Grey	19,39	19,43	19,4	19,37
Dyed	20,07	20,24	20,64	20,48

Figure 1: Changes of courses per cm due to wet-process.



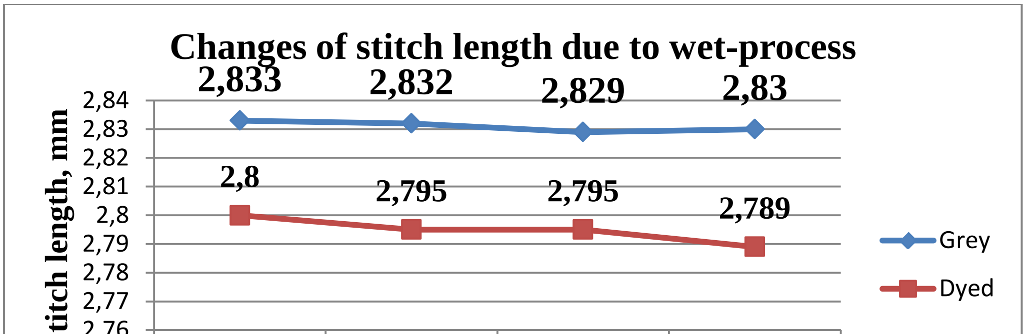
	Sample 01	Sample 02	Sample 03	Sample 04
Grey	11,03	11	10,995	10,975
Dyed	11,42	11,44	11,48	11,51

Figure 2: Changes of wales per cm due to wet-process.



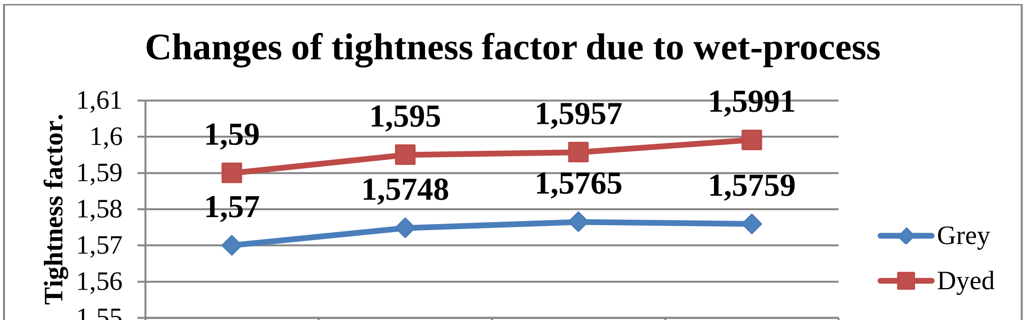
	Sample 01	Sample 02	Sample 03	Sample 04
Grey	219,11	213,73	213,3	212,56
Dyed	229,19	231	233,5	235,76

Figure 3: Changes of stitch density due to wet-process.



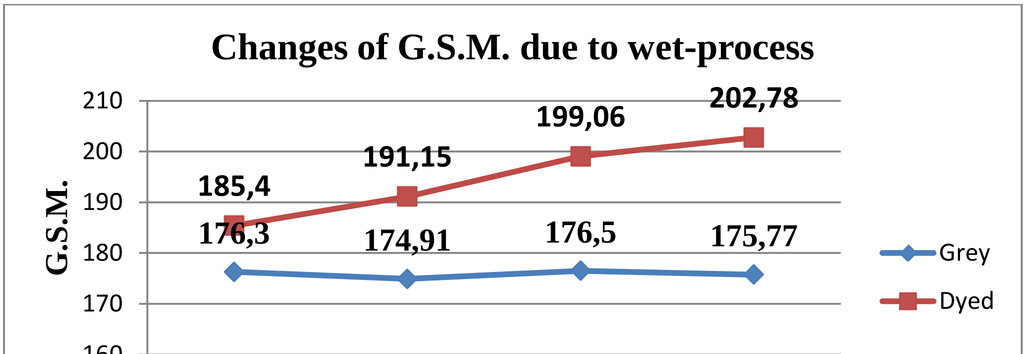
	Sample 01	Sample 02	Sample 03	Sample 04
Grey	2,833	2,832	2,829	2,83
Dyed	2,8	2,795	2,795	2,789

Figure 4: Changes of Stitch length (mm) due to wet-process.



	Sample 01	Sample 02	Sample 03	Sample 04
Grey	1,57	1,5748	1,5765	1,5759
Dyed	1,59	1,595	1,5957	1,5991

Figure 5: Changes of tightness factor due to wet-process.



	Sample 01	Sample 02	Sample 03	Sample 04
Grey	176,3	174,91	176,5	175,77
Dyed	185,4	191,15	199,06	202,78

Figure 6: Changes of G.S.M. due to wet-process.

From the table and graphs we can see that,

1. The courses per cm have increased after wet-process in each sample.
2. The wales per cm have increased after wet-process in each sample.
3. The Stitch density (stitches per cm^2) has increased after wet-process in each sample.
4. The stitch length (mm) has decreased after wet-process in each sample.
5. The tightness factor has increased after wet-process in each sample.
6. The G.S.M. has increased after wet-process in each sample.

We can see from graphs that the courses per cm, wales per cm, stitch density, tightness factor and G.S.M. of knit fabric increased after wet-process. While the stitch length decreased after wet-process.

The main reason behind the decrease in stitch length after wet-process is yarn shrinkage. In the scouring-bleaching process cotton fiber swells. For this the diameter of fiber increases which causes length-wise shrinkage of yarn. This results in decrease in stitch lengths.

We know that with the change of stitch length, other properties like courses per cm, wales per cm, stitch density, tightness factor and G.S.M. changes as they are dependent on it. If stitch length decreases then more number of stitches can be accommodated in a square area. The reason for increasing number of courses per cm, wales per square cm and stitch density is that the stitch length has decreased due to wet-process. Again as the stitch length is reciprocal of G.S.M. so the G.S.M. increased due to stitch length decreased. Finally the tightness factor increased due to decrease in stitch length. We can see from the equation (Tightness factor = $\frac{\sqrt{\text{tex}}}{l}$) that the stitch length is the denominator of the equation so as the stitch length decreased, the tightness factor increased.

Though some weight is lost due to scouring-bleaching process but in course of other processes like, dyeing and finishing with softener, some weight is gained due to addition of dyes and softener. Again due to enzyme process to reduce hairiness of fabric causes weight-loss in fabric. But we can see that the final resultant weight (G.S.M.) has increased due to shrinkage, addition of dye and softener.

5. Conclusion:

From the table and graphs it is seen that after wet process cycle the stitch length has decreased. With the decrease in stitch length other dimensional properties course per centimeter, wales per centimeter, stitch density, tightness factor and G.S.M. have increased. There are some weight loses in scouring-bleaching and enzyme process but the resultant weight has increased due to shrinkage and addition of dye and softener.

References:

[1]. Spencer, David J., “Knitting Technology”, Third Edition, 2001, WOODHEAD PUBLISHING LIMITED, Cambridge, England.

[2]. Iyer, Mammel, and Schach, “Circular Knitting”, Second Edition, 2004, Meisenbach GmbH, Bamberg, Germany.

[3]. Ambumani N., “Knitting Fundamentals, Machines, Structures and Developments”, FirstEdition, 2007, NEW AGE INTERNATIONAL PUBLISHERS, New Delhi, India.

[4]. Bernard P. Corbman, Textiles Fiber to Fabric, McGraw-Hill International Editions, Sixth Edition, 1983.