Experimental Analysis in Knitted Fabrics GSM Calculation Performed With Heat Treatment Process

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Abstract- *This Project deals with the changes of GSM (Gram per Square meter) of grey knitted fabrics from pretreatment to finishing, which helps a greater extent to know about the thermal properties of the Lycra fabrics. A fabric with better GSM variation gives profit to the industries. So finding the optimum fabric is the ultimate aim. The experimental process were carried out by considering the factors such as yarn count and loop length. The selected raw materials are Lycra Loop knit, Lycra Airtex and Lycra viscose which were undergone various heat treatment process such as Heat setting, Fabric Dyeing and Compacting. The previous work had proved that Lycra Jersey is the most suitable fabric which was compared with Lycra Durby and Lycra Rib fabrics.*

Finally the collected data were accumulated and put in a table. The fabric which responds the heat treatment process effectively in the sense of GSM variation is found by comparing it with Lycra Jersey fabric's result.

I. INTRODUCTION

KNITTED FABRIC:

Knitting can be referred as the construction of the elastic, porous fabric, created by interlocking yarns by means of needles. Knitted fabrics process is simpler as can be made much more quickly and easily than woven fabrics at comparatively less cost.

FABRICS USED:

- Lycra Airtex
- Lycra Loop knit
- Lycra Viscose

II. LITERATURE REVIEW

In this chapter the literature review about the previous works regarding GSM variation in knitted fabrics, analysis of heat treatment process, research on textile characteristics such as yarn count and tear strength of the fabrics done by other researchers which has been used as a reference sources are mentioned.

K. M. FaridulHasanhas studied on the changes of GSM (gm/m2) of grey knitted fabric from pretreatment to finishing for finding the change of GSM in different levels of fabric processing. This work helps to a greater extent to know about the whole procedures of knitted fabrics GSM change from pretreatment to finishing and compare with the theoretical and calculated values of GSM change and to take necessary initiatives against it. For this process the researcher had to collect the sample of each and every processes for GSM measurement. In some fabrics more than two samples had taken for accuracy of the result.

Santanu Das, Monoroma Hossain, Md. Shakhawat Hossain Rony were analyzed technical relationships among GSM, count and stitch length of (1x1) rib and (1x1) grey interlock fabric. This work focused on rib and interlock knit fabric structures which detected relationships among the GSM (Gram per square meter), count and stitch length. This study is about (1x1) rib and (1x1) interlock fabric and from the analysis to find the complete idea about selection of GSM, count and stitch length which is important when producing rib and interlock fabric in industries.

Ahsan Nazirhas done modelling heat setting of cotton/ elastane knitted fabrics for optimum dimensional stability and this work concluded that fabrics with more heat setting time will increase the width of the fabric and spirality of the fabric. This work proved that increase in fabric width extension at higher fabric overfeed results in decrease of fabric length shrinkage and better stability of fabric density during laundering.

Shahjalal Khandaker reviewed the scope of polyester cotton blended single jersey knit fabric finishing without heat setting in that, the properties of polyester cotton blended fabric were compared after finishing with heat setting and without heat setting. The tear strength of without heat set fabric was slightly higher than the heat set polyester cotton blended fabric and the findings of this work suggest that, single jersey pc

fabric could be finished of that composition without heat set process to save time and utility cost as well as to increase production in a dyeing finishing unit.

N Besler, Y S Gloy and **T Gries** were done the analysis of the heat setting process. In this work the influence of heat setting on the textile characteristics of a polyester single jersey structure are analysed. The shrinkage is slightly increasing with increasing temperature (max. 200 °C) and increasing dwell time (max. 36 sec.). The mesh density and tensile strength in all direction are increasing. For modelling the heat setting process further data has to be collected to improve and verify obtained models.

N. Avcioglu Kalebek and **O Babaarslan** has briefly explained the effect of Heat Setting process for polymers. This chapter aimed to investigate the effect of heat setting on the structure and properties of industrially produced heat set polymer yarns. The increase of temperature from 100°C to 140°C caused a decrease in the strength and elongation values of the polymer yarns and an increase in the shrinkage and yarn linear density values.

Mohammad Naim Hassan and **Moni Sankar Mondol** were analyzed effect of yarn count on Single Jersey Knitted Fabric Properties means higher yarn count and higher GSM give more stiffness , more tear strength , more breaking force in case of using 100% cotton yarn for single jersey weft knitted fabrics.

III. FABRIC GSM AND MEASUREMENTS

GSM:

GSM means Gram per square meter. It is an essential property for knitted fabric. Due to fabric GSM the knitted fabric may be heavier or lighter. GSM varies from fabric to fabric, especially with the count and stitch length off abric. GSM is changed in pretreatment, dyeing and finishing to a greater extent. During these processes GSM change depends on the types of chemicals and dyes used and also with the processes used.

GSM CUTTER:

The GSM cutter is a textile testing instrument which is used for measuring fabric GSM with the aid of a weighing scale and GSM pad. The GSM cutter is a circular fabric sample cutter. With this instrument, a uniform circular fabric is cut without measuring. Area of the fabric specimen cut by GSM cutter is 100 square centimeter areas. The instrument is equipped with a set of four replaceable blades and normal cutting pads.

The formula for measuring fabric GSM with this GSM cutter:
Grams per square meter (GSM) = (Specimen weight in grams * 100)

GSM BALANCE:

The weight of the circular fabric specimen is in grams. The resulted weight (grams) of the specimen is multiplied by 100 to get the weight in grams per square meter (GSM).

IV. HEAT SETTING

Heat setting is an expensive and energy elaborative textile process. Heat setting is necessary to guarantee size accuracy and dimensional stability for textile materials. Depending on the material different heat setting methods such as saturated steam or hot air are used for the fixation.In the described experimental design up to a temperature of 200 °C and a dwell time of 36 seconds the material shrinkage of polyester is increasing with increasing temperature and dwell time. Shrinkage in wales direction is higher than in course direction. After heat-setting process, air permeability and compressibility values increases while mass per unit area and compression set values decreases.

HEAT SETTING MACHINE:

In this project for heat setting the fabrics the Taiwan made tubular heat setting machine named ASKME is used.

Key Features of ASKME

- Hot air circulation system.
- Individually driven with inverter controller both for entry and exit sections ensured an accurate overfeeding process.
- Setting chamber length: 2200 mm.
- Machine speed: 1-20 m/min.
- Design temperature: Max. 220℃.

Table 1: ASKME design for number of treatment

Roller Width (mm)	Width of the working fabric (inch) x Number of Treatment		Overall Length (mm)
2430	40" x 2	27" x3	3750
2800	32" x 3	48" x2	4100
3000	35" x 3	54" x2	4300

As per the ASKME tubular heat setting machine the number of treatment of knitted fabrics can be heat treated has shown in the above table. The roller width and the overall length of the heat setting chamber are mentioned in terms of millimeter. The width of the working fabric has mentioned in terms of inches.

According the width of the fabric, the number of treatment is changing can be absorbed by the table. The number of treatment also depends on the roller width of the ASKME tubular heat setting machine.

DYEING:

Dyeing in textiles is a process in which color is transferred to a finished textile or textile material (like fibers and yarns) to add permanent and long-lasting color. It can be done by hand or by machine. Dyes can come as powders, crystals, pastes, or liquid dispersions and they dissolve completely in an aqueous solution like water. When the textile and the dye come into contact, the textile is completely saturated by the dye and colored.

COMPACTING:

Compacting is a process used in textile finishing of knitted fabrics. The compactor is used for controlling shrinkage of fabric, GSM control and make compaction the fabric in length wise direction to provide over feed to the fabric while processing in presence of steam and able to control the shrinkage. The text compactor is used as finishing machine after dyeing. Open width compactor is used after stenter machine and tubular compactor machine is used after industrial dryer machine.

V. EXPERIMENTATION

The experimentation process has done with three fabrics which are lycraairtex, lycra loop knit and lycra viscose as mentioned early. There are four process in the experimentation step. They are fabric knitting, fabric heat setting, fabric dyeing and fabric compacting. In those except fabric knitting other three are heat treatment process.

Fabric Knitting:

In fabric knitting process the parameters such as knitting and initial diameter, GSM of the fabrics are observed. All the three fabrics are selected in grey colour. The knitting diameter of the lycraairtex is 32 inches, for lycra loop knit and lycra viscose the knitting diameter is 36 inches. The initial GSM of the fabrics are mentioned in the table 2.

Table 2: Fabric Knitting Process

S.NO	Fabric	Knitting Diameter (Inch)	Initial Diameter (Inch)	GSM (g)	Colour
1	Lycra Airtex	32	39	160	Grey
2	Lycra Loop knit	36	44	230	Grey
3	Lycra Viscose	36	34	185	Grey

Fabric Heat setting:

In fabric heat setting process the kniited fabrics are heat treated in 200^{o}C with various heat setting diameters. The heat setting diameters and GSM are shown in table 3.

Table 3: Fabric Heat Setting Process

S. NO	Fabric	Diameter (Inch)	GSM (g)	Temp (ºC)	Time (Sec)	Colour
1	Lycra Airtex	44	135	200	36	Grey
2	Lycra Loop knit	48	190	200	36	Grey
3	Lycra Viscose	38	155	200	36	Grey

Fabric Dyeing:

After completion of heat setting process the fabrics undergone fabric dyeing process. The GSM value of the fabrics are increased due to the addition of colours. The duration for dyeing process for each fabric is 5 hours. Due to the shrinkage effect the diameters of the fabrics are getting decreased. The parameters observed during the dyeing process are mentioned in table 4.

Table 4: Fabric Dyeing Process

S.NO	Fabric	Diameter (Inch)	GSM (g)	Temp (°C)	Time (Hrs)	Colour
1	Lycra Airtex	40	160	68	5	Purple
2	Lycra Loop knit	44	250	68	5	White
3	Lycra Viscose	34	200	68	5	Black

Fabric Compacting:

The compacting process of fabrics taken place after the completion of fabric dyeing. Similar to dyeing process, GSM of the fabrics increased in compacting also. The fabrics are processed in various speed. Lycra airtex and lycra loop knit are running in 32 rpm and 34 rpm respectively. Comparing the other two fabrics lycra viscose running in 30 rpm. Diameter increased one unit for one unit for each fabrics. The increased GSM and diameter values are shown in table 6.

Table 6: Fabric Compacting Process

S.NO	Fabric	Dia meter (Inch)	GSM (g)	Temp (°C)	Speed (RPM)	Colour
1	Lycra Airtex	41	170	160	32	Purple
2	Lycra Loop knit	45	260	160	34	White
3	Lycra Viscose	35	220	160	30	Black

The figure 1 used to identify the GSM value of the lycraairtex fabric in various diameters used in each process. The figure shows highest GSM value of 170 in 41 inches diameter of the fabric.

Figure 1: GSM VS Diameter of LYCRA AIRTEX fabric

The figure 2 explains the variations of GSM values of lycra loop knit fabric in various diameter which is need to be considered.

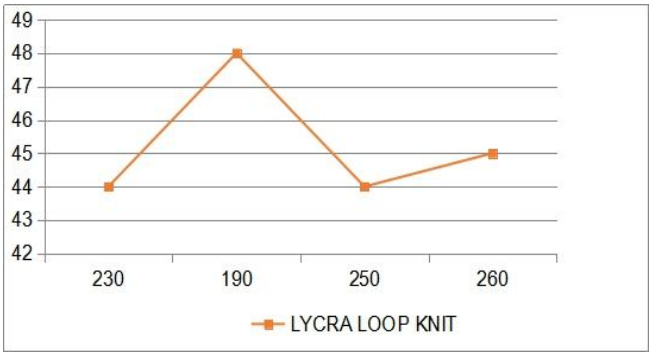

Figure 2: GSM VS Diameter of LYCRA LOOP KNIT fabric

The figure 3 shows the comparative study between the diameter of fabric in various stages of process and the GSM variation of lycra viscose fabric. The highest diameter of the fabric is 44 inches which is observed in heat setting process.

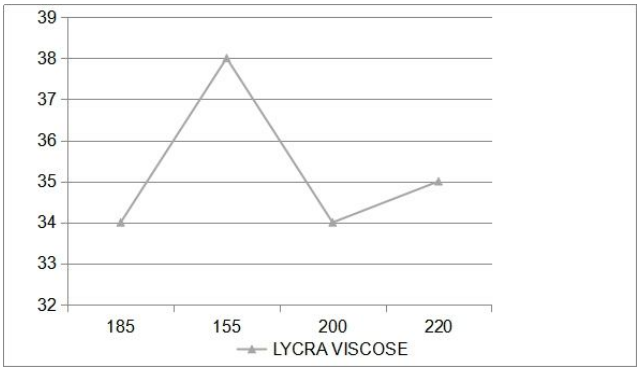

Figure 3: GSM VS Diameter of LYCRA VISCOSE fabric

VI. CALCULATION

HEAT SETTING:

The GSM variation calculation of the fabrics are done by using data observed in during heat setting process.

Lycra Airtex:

GSM before Heat setting = 160 g
GSM after Heat setting = 135 g
% of GSM variation = (135/160)*100 - 100
= 84.37-100
% of GSM variation = 15.63% (Loss)

Lycra Loop knit:

GSM before Heat setting = 230 g
GSM after Heat setting = 190 g
% of GSM variation = (190/230)*100 - 100
= 82.61-100
% of GSM variation = 17.39% (Loss)

Lycra Viscose:

GSM before Heat setting = 185 g
GSM after Heat setting = 155 g
% of GSM variation = (155/185)*100 - 100
= 83.78 - 100
% of GSM variation = 16.22% (Loss)
So, the percentage of GSM gets losing for all the fabrics in heat setting process.

DYEING:

Using the data collected during fabric dyeing process, the percentage of GSM variation has been calculated.

Lycra Airtex:

GSM before dyeing = 135 g
GSM after dyeing = 160 g
% of GSM variation = (160/135)*100 - 100
= 118.52 - 100
% of GSM variation = 18.52% (Gain)

Lycra Loop knit:

GSM before dyeing = 190 g
GSM after dyeing = 250 g
% of GSM variation = (250/190)*100 -100
= 131.58 - 100
% of GSM variation = 31.58% (Gain)

Lycra Viscose:

GSM before dyeing = 155 g
GSM after dyeing = 200 g
% of GSM variation = (200/155)*100 – 100
= 129.03 – 100
% of GSM variation = 29.03% (Gain)

Unlike heat setting process, the percentage of GSM variation gets gain for all three fabrics.

COMPACTING:

The percentage of GSM variation for the fabrics have been calculated as much as similar to the other two process using the data observed in compacting process.

Lycra Airtex:

GSM before dyeing = 160 g
GSM after dyeing = 170 g
% of GSM variation = (170/160)*100 - 100
= 106.25 - 100
% of GSM variation = 6.25% (Gain)

Lycra Loop knit:

GSM before compacting = 250 g
GSM after compacting = 260 g
% of GSM variation = (260/250)*100 - 100
= 104 - 100
% of GSM variation = 4% (Gain)

Lycra Viscose:
GSM before compacting = 200 g
GSM after compacting = 220 g
% of GSM variation = (220/200)*100 - 100
= 110 - 100
% of GSM variation = 10% (Gain)

So the percentage of GSM variation gets increased because of the compacting process in which saturated steam is used.

The figure 4 shows the relation between the percentage of GSM variation and the heat treatment process for the all three fabrics. By studying the figure the highest percentage of GSM variation is achieved by lycra loop knit in the dyeing process. The value is 31.58% which is the highest in the whole process.

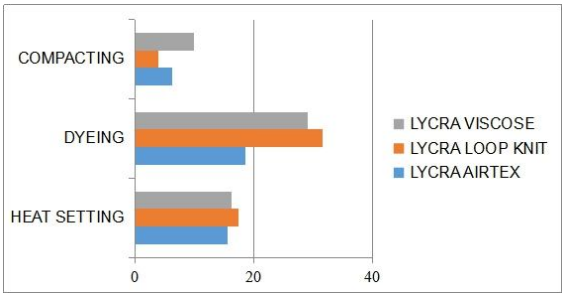

Figure 4: % of GSM variation VS heat treatment process

OVERALL GSM VARIATION:

The overall GSM variation of the fabrics are calculated by using the knitting and the compacting GSM values.

Lycra Airtex:

Initial fabric GSM = 160 g
Final fabric GSM = 170 g
% of GSM variation = (170/160)*100 - 100
= 106.25 - 100
% of GSM variation = 6.25% (Gain)

The percentage of GSM variation of the lycraairtex fabric has shown in figure 9.2 as per the changes in respective diameter of the fabric in each process. The maximum GSM change occurred between heat setting and dyeing process of the fabric.

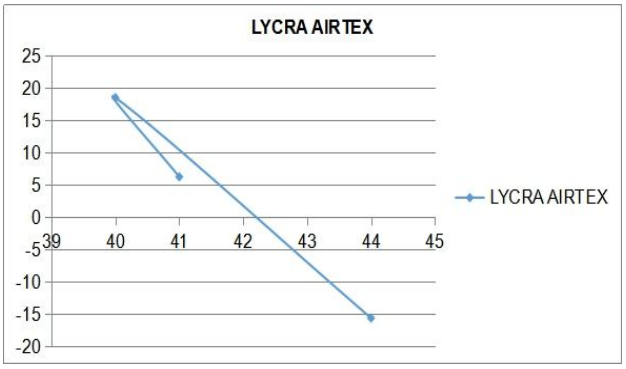

Figure 5: Diameter VS % of GSM variation of LYCRA AIRTEX

Lycra Loop knit:

Initial fabric GSM = 230 g
Final fabric GSM = 260 g
% of GSM variation = (260/230)*100 - 100
= 113.04 - 100
% of GSM variation = 13.04% (Gain)

By referring the figure 6 the percentage of GSM variation can be verified for various diameters of the fabric in different heat treatment process. The maximum diameter for the fabric is 48 inches in heat setting process with 190 GSM.

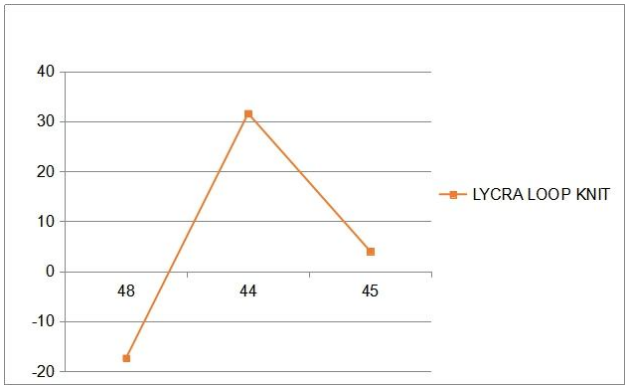

Figure 6: Diameter VS % of GSM variation of LYCRA LOOP KNIT

The final product of the lycra loop knit fabric,

Lycra Viscose:

Initial fabric GSM = 185 g
Final fabric GSM = 220 g
% of GSM variation = (220/185)*100 - 100
= 118.92 - 100
% of GSM variation = 18.92% (Gain)

The figure 7 clearly showing the percentage of GSM variation of lycra viscose for every diameter change in each heat treatment process. The highest diameter of the fabric is 38 inches in heat setting process.

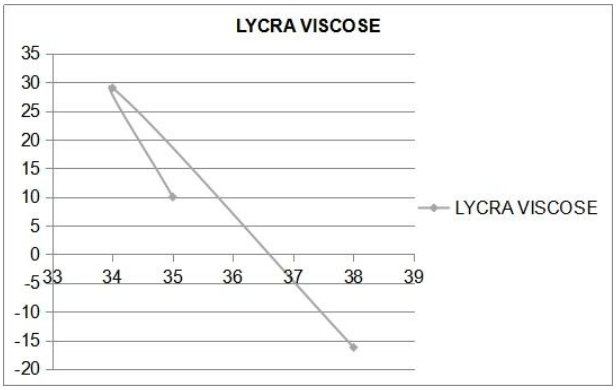

Figure 7: Diameter VS % of GSM variation of LYCRA VISCOSE

And also Lycra Jersey result need to be mentioned.
So,

Lycra Jersey:

Initial Grey GSM = 153 g
Final Grey GSM = 136 g
% of GSM variation = (136/153)*100 – 100
= 88.88 – 100
% of GSM variation = -11.11%

Here, the % of GSM variation is in negative side. So that the value also can be considered as GSM loss percentage.
So, % of GSM Loss = 11.11%

The figure 8 explains overall percentage of GSM variation of fabrics lycraairtex, lycra loop knit, lycra viscose and lycra jersey. Except other three fabrics, lycra jersey decreases the fabric weight can be observed by referring the figure.

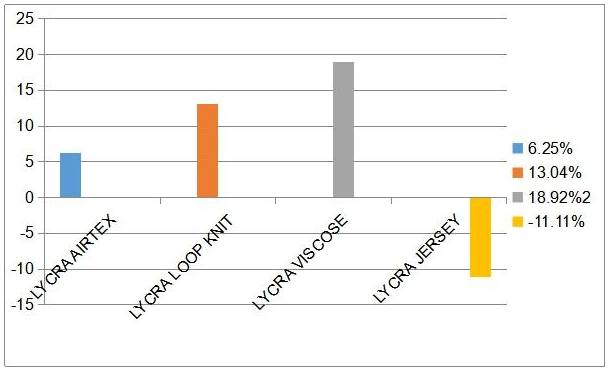

Figure 8: Overall % of GSM variation with Lycra Jersey

VII. RESULT

Lycra airtex fabric slightly gets increased the GSM from the initial value by 6.25%. It can be considered as usable fabric among the other two fabrics.

But comparing with lycra jersey fabric, it is not optimum selection for the heat treatment process which is already shown the GSM variation of 11.11% which is the decreased value from its initial value.

So, **LYCRA JERSEY** is the optimum fabric for heat treatment as well as commercial usage.

Lycra Airtex:

% of GSM variation =**6.25% (Gain)**

Lycra Loop knit:

% of GSM variation = 13.02% (Gain)

Lycra Viscose:

% of GSM variation = 18.92% (Gain)

Lycra Jersey:

% of GSM variation = **11.11% (Loss)**

VIII. CONCLUSION

In this work three fabrics were subjected to the heat treatment process and then processed in dyeing and compacting unit. In the heat setting process GSM values of all three fabrics was reduced. Especially, lycra loop knit was lost its weight by 17.39%. During the dyeing process, based on the weight of material colour weight was added so that its GSM value is slightly increased. In compacting process usage of saturated steam increased the density of the fabrics that resulting the increasing the weight of the fabrics. By observing the three fabrics lycraairtex is the best fabric for overall GSM controlling using the all three process.

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