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Review Article

Dyeing of Cotton-Silk Blended Greige Fabric with Reactive Dyes & Evaluation of Different Parameters

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Abstract

Physical properties like tearing strength, stiffness, drape of the silk-cotton blended fabric were determined. This blended fabric was dyed with anionic dyes like reactive dye & the fastness properties as well as the physical properties were also measured. At first, the greige fabric was pretreated & dyeing was carried out later. Dyed fabric quality was also satisfactory & free from any defect. Cost of silk fabric is high & if it is possible to get similar qualities to blend silk with cotton, it can be a good option to prepare blended fabric. In this research yarn of cotton (in the warp direction) and silk (In the weft direction) were taken for woven fabric manufacturing to test the different properties in greige & dyed fabric.

Keywords: blended fabric; reactive dye; strength; fastness.

Introduction

A textile fiber can be identified as a long thin object with a high ratio of length to thickness. It is distinguished by a high degree of fineness and outstanding flexibility. Moreover, it should have dimensional and thermal stability and minimum levels of strength and extensibility consistent with the end use [1]. Fibers have been defined by the Textile Institute as units of matter characterized by flexibility, fineness and a high ratio of length to thickness. To these features might be added, if the fiber is used to manufacture any cloth, a sufficiently high temperature stability and a certain minimum strength and moderate extensibility are required for general textile purposes [2].

Yarn is a long continuous length of interlocked fibers, suitable for use in the production of textile weaving, knitting, sewing etc [3]. According to Merriam-Webster 'A continuous often plied strand composed of either natural or man-made fibers or filaments and used in weaving and knitting to form cloth'. A continuous often plied strand composed of either natural or man-made fibers or filaments and used in weaving and knitting to form cloth. Except felt, Yarn is the basic unit of textile construction and every fabric is made with it. The desirable characteristics and properties of yarn are: its ply, tensile strength, weight, elasticity, and resistance to heat, water, and shrinkage. By changing these properties, a surprising array of fabric types can be produced, creating any number of textures and appearances.

Silk is very smooth and it has shiny appearance and feel. It is suitable for the skin when touched and provides a lot of comfort. The importance of blended silk fabric is increasing day by day, because of the gradual increasing price of silk fabric. Hence, latest technologies are needed to create textile materials with new advanced characteristics [4]. This would make the combination of silk and natural fabrics more popular and acceptable in the market [5]. Silk is a protein fibre which under theclass of natural polymers [6]. The crystallinityof Silk fiber is high and approximately 60-65%. It is choose able for its water absorbency, dye affinity, thermo tolerances, insulation properties, and luster [8]. Silk has the poor resistance to sunlight, perspiration, and chlorine bleach, absorbing body oils and grease stains, being affected by water spots, yellowing and fading with age, being subject to attack by carpet beetles unless treated, being affected by high temperatures, losing strength when wet, needing to be pressed with a press cloth, beingcolor damaged by hair spray, and being damaged by perfumes [10].

The protein fiber of silk is consisted mainly of fibroin and is produced by certain insect larvae to form cocoons [9]. The best-known silk is collected from the cocoons of the larvae of the mulberry silkworm Bombyxmori reared in captivity (sericulture). The shimmering appearance of silk is due to the triangular prism-like structure of the silk fiber, which permits silk cloth to refract incoming light at different angles, thus producing different colors [11].

The fibroin-heavy chain is formed mostly of beta-sheets, due to a 59-mer amino acid repeat sequence with some variations. The plain surfaces of the fibrils reflect light at many angles, giv-

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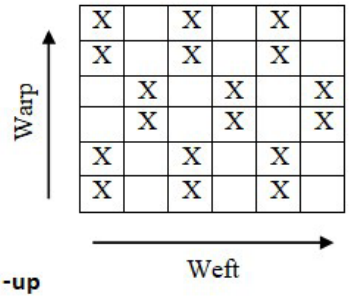

Figure 1: Weave plan of the fabric.

Figure 2: Grey fabric sample.

ing silk a natural sheen. Natural protein fibre like Silk is very soft, lustrous, smooth, strong, and durable than any natural or artificial fiber. The contribution of silk in industrial and commercial purposes has become pervasive in silkworm promotion all over the world especially in developing nation. Silk has a chemical composition of fibrion 72-81%, sericin 19-28%, water 11%, salts 1.5%, fat and wax 0.8-1.0%, coloring matters and ash 1.0-1.4%. Cotton fibre is one of the most valuable textile fibres collected from plant origin and accounts for about one third of the total world production of textile fibres. Cotton fibres grow on the surface of the seed of cotton plant .Cotton fibre contains 90–95% cellulose which is an organic compound with the general formula $(C_6H_{10}O_5)_n$. Cotton fibres also contain waxes, pectins, organic acids and inorganic substances which produce ash when fibre is burnt.Cotton is a natural fibre which is a moderately strong fibre having tenacity 26.5-44.1 cN/tex (3.0-5.0 g/den), it has many advantages, such as its ability to control moisture, insulate, provide comfort and it is durable fibre [7].

Cotton fibers grow first in length, then in thickness. The physical properties of the fiber and, therefore, its use value are determined by its length, fineness, and cell-wall construction, all of which are genetically controlled but are also subject to modifications by weather conditions during growth. Since fiber length is established before the cell walls thicken, length and cell-wall structure may be influenced independently.

The spinning quality of cotton is dependent upon a combination of fiber properties and upon the spinning technique used. In general, however, the size of yarn or thread made from cotton is dependent upon its fiber length. For a given length, fiber fineness, and even strength, may influence the maximum count to be expected. Strong yarns require relatively strong fiber for any given fiber length and fineness. Uniformity of fiber length undoubtedly influences the ease of manufacture and the percentage of waste to be expected from given cotton. Within a variety, however, growth conditions, ginning, and baling may affect the fiber-length uniformity enough to influence fiber property-yarn strength relationships. Since variety characteristics may be influenced by growth conditions, causing positive varietal relationships to reverse and become negative for environment, the analyses of data consisting of fiber properties and yarn strengths, except for very general treatments, will give more information if variety and environmental effects can be segregated.

Cotton which is a soft, fluffy staple fiber grows in a bowl, or protective case, around the seeds of the cotton plants of the genus Gossypium in the mallow family Malvaceae. The fiber is mostly pure cellulose and under natural conditions, the cotton bolls will increase the dispersal of the seeds.

The fiber is widely spun into yarn or thread and used to make a soft, breathable textile. The purpose of cotton for fabric is familiar to date to prehistoric times. Cotton has a chemical composition of cellulose 80-90%, water 6- 8%, protein, pectin &coloring mats 0-1.5%, ash 0-1%, oil & wax 0.5-1.0%, mineral matters 1-1.8%.

Fabric is known to us under several other names: textile, cloth, material, dry goods, and stuff. So a dictionary definition of a fabric or textile usually includes woven, warp and weft threads. Interlacements of these threads are occurred with one another according to the type of weave or design. The warp threads are those that run longitudinally together with the length of the fabric and the weft threads are those that run transversely across the fabric. For the sake of convenience, the warp threads are denoted as ends and the weft as picks or fillings.

Cotton and silk can be joined together to make a blended fabric. It is usually made as a primarily cotton combined. It is light in weight, absorbent and soft, though not as smooth as silk. The elasticity and feel of the fabric relies largely on the percentages used of each. Cotton combined with different yarn come in all types of clothing, furniture coverings and linens.

Silk-cotton fabric is a combined of both fibers, combining positive characteristics of each into a single textile which was also dyed & the physical, fastness properties were in satisfactory range.

Sample Making & Dyeing Procedure:

Weave plan of produced fabric

Fabric Specification

Material: Liquor = 1: 15

Warp count x Weft count = EPI X PPI

X Fabric width Amount of water = 40 ml

$$= \frac{16 \times 24}{10.28 \text{ Ne (cotton)} \times 42.94 \text{ Ne (silk)}} \quad X \quad 5.5$$

Silk and Cotton % Composition of Sample

EPI = 16 (all cotton)

PPI = 24 (silk and cotton at equal number) Percentage of silk in overall fabric =

{12/40}*100= 30%

Percentage of cotton in overall fabric = {28/40}*100 = 70%

Grey fabric which was prepared of above construction

Pretreatment of Grey Fabric

Table 1: Recipe for pretreatment of gray fabric.

Serial No.	Name of the Chemical	Quantity (gm)
01.	Detergent	0.04
02.	Sequestering agent	0.04
03.	Stabilizer	0.12
04.	Soda ash	0.20
05.	H_2O_2	0.40

Table 2: Recipe for Dyeing of Sample Fabric.

SL No.	Name of the Chemical	Quantity (gm)
01.	Sequestering agent	0.12
02.	Leveling agent	0.24
03.	Wetting agent	0.20
04.	Salt	1.80
05.	Soda ash	0.60
06.	Novacron Ocean SR	0.020
07.	NovacronTurquiose HGN	0.013
08.	Novacron Rubby S3B	0.002

Table 3: Recipe for Neutralization of Fabric.

SL No.	Name of the Chemical	Quantity (gm)
01.	CH_3COOH	0.04

Table 4: Recipe for Washing of Fabric.

SL No.	Name of the Chemical	Quantity (gm)
01.	Soaping chemical	0.04

Table 5: Tear resistance Test result of Gray fabric.

Observation No.	Tearing Strength	TearingStrength (average)
1	58 N	61 N
2	64 N	
3	61 N	

Table 6: Tear resistance Test result of Dyed fabric.

ObservationNo.	Tearing Strength	TearingStrength (average)
1	63 N	60 N
2	61 N	
3	57 N	

Table 7: Tensile Strength Test of Gray fabric.

No. of Observation	Tensile Strength	Tensile Strength(average)
1	351 N	387.33 N
2	399 N	
3	412 N	

Table 8: Tensile Strength Test of Dyed fabric.

No. of Observation	Tensile Strength	Tensile Strength (average)
1	348 N	384.66 N
2	397 N	
3	409 N	

Table 9: Static Drape Test of Gray fabric.

No. of observations	Static Drapecoefficient	Static Drapecoefficient (average)
01	22.11	49.82
02	70.60	
03	56.74	

Table 10: Dynamic Drape Test of Grey fabric.

No. of observations	DynamicDrapecoefficient	Dynamic Drapecoefficient (average)
01	66.57	54.78
02	35.49	
03	62.27	

Pretreatment is an important process to improve the water absorbency of the grey fabric and remove the natural yellowish color from the grey fabric. This pretreatment process makes the grey fabric for the next dyeing process by doing scouring and bleaching of the fabric.

Table 11: Static Drape Test of Dyed fabric.

No. of observations	Static Drapecoefficient	Static Drapecoefficient (average)
01	20.75	48.56
02	69.50	
03	55.44	

Table 12: Dynamic Drape Test of Dyed fabric.

No. of observations	DynamicDrape coefficient	Dynamic Drapecoefficient (average)
01	65.33	53.60
02	34.50	
03	60.98	

Table 13: Color Fastness to Rubbing Test result of the Dyed fabric.

No. of observations	Rubbing test	Value
01.	Dry	5
02.	Wet	4-5

Pretreatment of grey fabric was done and process is shown below:

Weight of the gray fabric = 2.6gm

Material: Liquor = 1: 15

Amount of water = 40 ml

Pretreatment Process

First 40ml water was taken in a container and all the necessary chemicals were added in the water at the room temperature. Then the grey fabric was added in the container and put in the pretreatment machine.

The process of pretreatment was carried out in the machine at 100°c for 40 minutes. After that the fabric was taken out and washed properly.

Sample of pretreated fabric is shown below:

Pretreatment process Curve

Dyeing of Pretreated Fabric

Dyeing is the next step of fabric processing after the pretreatment of the fabric. In this process pretreated fabric is dyed with dyeing chemicals. This process helps the fabric to gain it's artificial color and luster.

Dyeing of pretreated fabric was done and process is shown below:

Weight of the pretreated fabric = 2.5gm Material : Liquor = 1 : 15

Amount of water = 38 ml

Dyeing process

First 38ml water was taken in a container and all the necessary auxiliaries (Sequestering agent, Leveling agent and Wetting agent) and salt were added in the water. Then the container was put in the dyeing machine. The machine was running at 40°c for 15 minutes. After that dyes (Novacron Ocean SR, Novacron Turquiose HGN and Novacron Rubby S3B) were added in the solution. The dyeing machine ran again for 20 minutes after adding the dyes at 40°c temperature. Then the soda ash was added in the solution and again the machine ran at 40°c temperature for another 10 minutes.

Figure 3: Pretreated fabric.

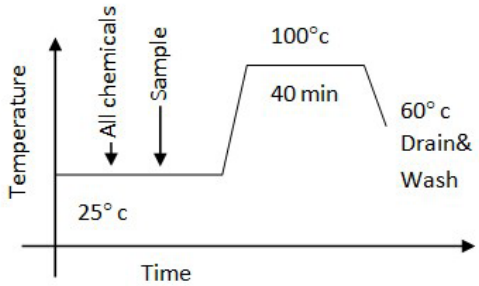

Figure 4: Pretreatment process Curve.

Figure 5: Dyed fabric.

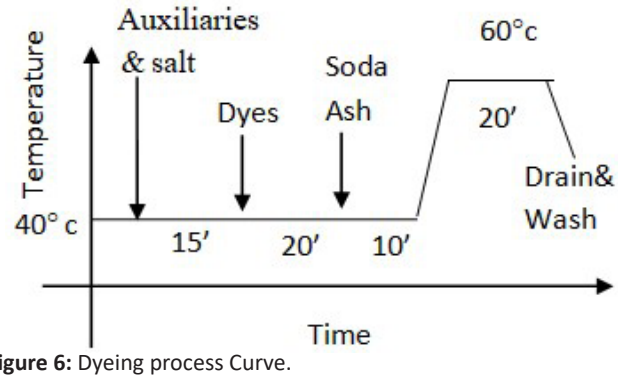

Figure 6: Dyeing process Curve.

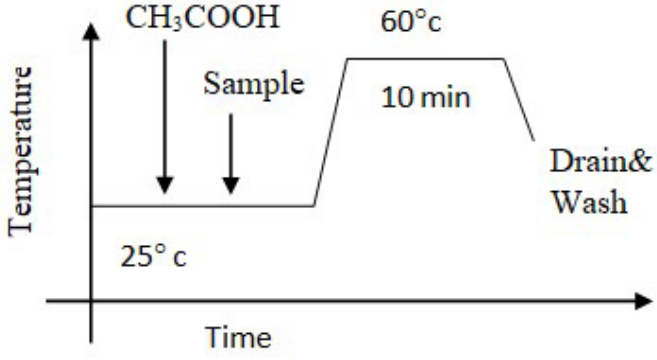

Figure 7: Neutralization process Curve.

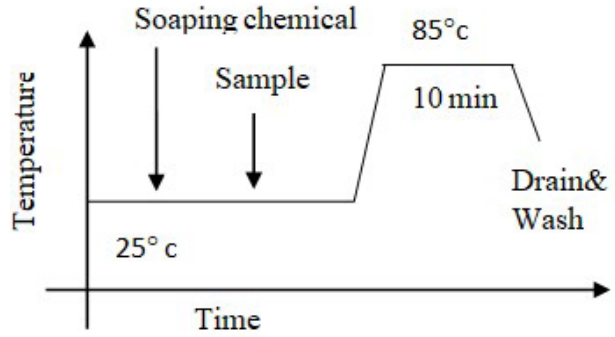

Figure 8: Washing process Curve.

Then the temperature was raised at 60°c and continued the process for another 20 minutes. At the end of the process the sample fabric was taken out and it was properly washed.

The Dyed fabric and the process curve of the dyeing process is show below:

Dyed Fabric Sample

Dyeing process Curve

After Treatment Process of Dyed Fabric

After the dyeing process, it is important to do the after treatment process of the fabric to improve the quality of the fabric.

In the after treatment process the neutralization and washing of the fabric was done properly.

Neutralization of fabric

Weight of the Dyed fabric = 2.6gm Material: Liquor = 1: 15 Amount of water = 40 ml

The process of neutralization was carried out for 10 minutes at 60°c temperature.

Process curve of neutralization is shown below:

Washing of the Fabric

Weight of the Neutralized fabric = 2.6 gm Material: Liquor = 1: 15

Amount of water = 40 ml

The process of washing of fabric was carried out for 10 minutes at 85°c temperature.

Process curve of neutralization is shown below:

Results & Discussion

GSM Determination

GSM stands at Gram per square meter. It is the weight of fabric in one gram per square meter. Its unit is gm/m2. So, the higher the GSM, the higher bulkier will be the fabric and vice versa, even they can be of same construction.

The GSM of the fabric sample is= 232 gm/m^2

Tear Resistance Test

Tear strength is the resistance of the fabric against tearing or force necessary to propagate the tear once it is initiated.

The Tear strength of fabric was tested according to ASTM Standard – D1424and the results are shown below:

Tensile Strength Test

Tensile strength is one of the most significant mechanical properties for fabrics. Tensile strength is the capability of a material to withstand a pulling (tensile) force. The tensile strength of fabric was tested according to ASTM E-4. Here UTM (Testometric) was used to calculate the tear strength of the fabric.

The tensile strength of fabric was measured and the results are shown below:

Drape of Fabric

Drape is the term which is used to depict the way a fabric hangs under its own weight. It has avital bearing on how good a garment looks in use. The draping qualities required from a fabric will differ totally depending on its end use, therefore a given value for drape cannot be classified as either good or bad. Woven fabrics are comparatively stiff when compared with knitted fabrics so that they are used in tailored clothing where the fabric hangs away from the body and disguises its contours.

The drape of fabric was measured and the results are shown below:

Color Fastness to Rubbing Test

Color fastness to rubbing test of the fabric was done for dry rubbing and wet rubbing. Crock cloth was compared with the Grey Scale (color change). The test results of color fastness to rubbing are shown below:

The visual assessment was done in a color matching cabinet under standard light D65 (artificial daylight).

Conclusion

The result of the taken samples are satisfactory both in greige& dyed stage. The cost of the samples become less for using cotton instead of silk and also the samples are quite suitable for using as wearable products as the result of tearing strength and tensile strength, stiffness were satisfactory. Drape properties and GSM are suitable for using. If the silk filament could be used in the weft direction, the blended fabric (cotton+silk) would be a good option considering the dyeing & physical parameters.

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