Faculty of Engineering

Department of Textile Engineering

Effect of Burn out print on physical and mechanical properties of knit fabrics.

Course Code: TE-4214 Course Title: Project (Thesis)

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A thesis submitted in partial fulfillment of the requirements for the degree of

Bachelor of Science in Textile Engineering

Advance Apparel Manufacturing Technology

August, 2020

ACKNOWLEDGEMENT

Very first we would like to express our heartiest thank and gratefulness to almighty Allah.

We would like to express a sense of gratitude to our beloved parents for all types of supports.

Daffodil International University gave the platform to prepare our thesis paper.

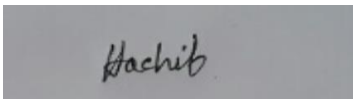
We would also like to express our regards and gratitude to the management of the Concept Knitting Ltd. for giving us the opportunity to complete the industrial training. Our deepest gratitude goes to general manager, HR, Admin & Compliance of Concept Knitting Ltd. for their permission to conduct our industrial training and for providing all types of materials necessary to prepare our thesis paper without which it would be impossible. Their generous support is greatly appreciated.

We are also grateful to Mr Shihab Uddin, Department of Planning, Concept Knitting Ltd. for his support & guidance throughout the training period. We are also thankful to all the employees of Concept Knitting Ltd. for their co-operation, support & valuable advice.

We also like to express our gratitude to our supervising teacher Sharmin Akter, Lecturer, Daffodil International University for helping us throughout this thesis paper. Thanks to her precise guidance we could able to complete the paper. Finally we would like to acknowledge that we are responsible for every incompetence and omission, which doubtlessly remain.

DECLARATION

We hereby declare that, this thesis paper has been done by us under the supervision of Sharmin Akter, Lecturer, Faculty of Engineering, Department of Textile Engineering, Daffodil International University. We also declare that, neither this thesis paper nor any part of this thesis paper had been submitted elsewhere for the award of any degree or diploma.



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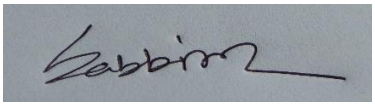

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ABSTRACT

This paper is an experimental investigation of the effect of Burn out print on physical and mechanical properties of knit fabrics. In this work two different colored fabrics with same fabric structure and composition were printed by Burn out printing method to investigate and determine the effect of Burn out printing on their physical and mechanical properties such as GSM, CPI & WPI, stitch length, water absorbency, dimensional properties, color fastness, pilling resistance, abrasion resistance, bursting strength and tensile properties. In this study, Sangria and Thai Curry colored of 50% Polyester and 50% Cotton blended Single Jersey knitted outerwear fabrics were taken. After Burn out printing both fabrics were tested and investigated to determine and compare their properties. Typical printing and testing methods were followed and then physical and mechanical properties were analyzed under standard condition. It is observed that fabrics weight (GSM) is decreased from 170 to 140 after Burn out print. Fabrics CPI, WPI, stitch length and water absorbency property are also decreased after Burn out print. Burn out print has also impact on fabrics dimensional property.

Chapter-1: Introduction

At present, fashionable and comfortable textile products have become very popular among the customers worldwide. Especially ladies and baby wear should be more comfortable and fashionable. That's why, textile manufacturers and companies are developing enormous methods to improve the design and comfort ability of textile products.

At present printing is a very important technique for textile sector to make a cloth more lucrative. Day by day printing sector is expanding with fashion trend. Print technology is now boosting with garments industry. Now a days maximum cloths must have any print on it because it makes a dress more attractive and salable. "There are many types of printing technology we can apply on garments. Burn out print technology is one of them. It is a rare and quality print. It is also very expensive but lucrative with nice feelings. Burnout printing technology is used to develop designs on the fabrics surface. We can apply this print only on some selected fabrics. It is applied on fabrics with at least two different fiber contents i.e. Polyester-Cotton, Rayon-Silk etc. Here one fiber component is being dissolved through chemical reactions while the other content remains unabated. Polyester portion should be either dyed or printed and when cotton burns down dyed polyester portion gives full shade and vacant spaces" [1]. "The printing factory does this type of print with the flat bed printing machine. The process of this print is like as a normal flatbed print but for this printers have to use acid type chemicals instead of color. Burn out printing is usually done on flat bed rotary machine. Print screen is required to develop and then chemical is applied on the fabric like rotary print. In this process the design is not visible much. Only after curing process it can be visible in light brown color. The important fact is that the adjustment of temperature during curing process. If the temperature is excessive then the fabric can be damaged.

And if sufficient heat is not applied then burn out will not be properly done. Curing time and temperature are needed to be pre tested. Sometimes while using light blends, Polyester portion also get damaged along with Cotton portion. And the result is that, we will not get properly printed fabrics. If one selects 160°C temperature for curing the fabric then he will need to do it for five minutes. And if he selects 180°C temperature then he will need to do it for two minutes. Or if he selects 200°C temperature then he will need to do it for one minute" [2].

Chapter-2: Literature Review

“The process loss of Burn out print is very high and it may be 35% to 40%. So before fabric booking careful consumption is needed. Process loss depends on burn out design area. Less design area requires less process loss and more design area requires more process loss. Burn out print decreases productivity during sewing because of its uneven surface. For this reason operator needs to take extra care during sewing the garment. Another big problem for burn out printed fabric is shrinkage. So precautionary action must be taken to control shrinkage level” [2]. “Burnout print is not possible on 100% cotton fabric. The best composition for this print is 60% polyester and 40% cotton fabric. This print is also possible on 60% cotton and 40% polyester fabric. Single jersey construction is the best construction for Burnout print. And if we need the finished fabric with 120 to 130 GSM then we should knit the fabric with 160 to 170 GSM” [3]. “‘GSM’ means ‘Gram per square meter’ which indicates the weight of fabric in gram per one square meter. By this property of fabric we can compare which is heavier and which is lighter. The GSM of fabric is one kind of specification of fabric which is very important for understanding and production of fabric and garments” [4]. “In fabric structure it is very crucial to know, how much yarn is in length wise and width wise? To know the number of yarn in a specific fabric CPI and WPI are counted for this. And it is counted in course and Wales direction. CPI means yarn is in course per inch and WPI means Wales per inch” [5]. “Stitch length is the length of yarn in a knitted loop” [6]. “Shrinkage is a parameter of testing textile fabrics to measure changes in length and width after washing or any treatment of fabrics. Shrinkage failing materials are dimensionally unstable and they can cause deforming of the garments or products made out of those materials. Shrinkage is tested at various stages, but most importantly before cutting the fabric into further sewn products and after cutting

and sewing prior to supplying the products to buyers and end users. It is a required parameter of quality control to ensure the sizes of the products to avoid any complaints regarding deformation or change in dimensions after domestic laundry" [7]. Water absorbency or wicking property of knit fabrics has a great impact on the comfort ability of garments. "Abrasion resistance and pilling are two of the most important mechanical characteristics of fabrics. The resistance of a fabric against the force of friction is known as the abrasion resistance. In general, pilling is a fabric defect observed as small fibre ball or a group consisting of intervened fibres that are attached to the fabric surface by one or more fibres. There are many factors which affect the abrasion resistance and pilling performance of fabric, such as the yarn spinning system, quality of fibre to produce yarn, fabric construction and finishing operation. The abrasion resistance and pilling performance of knit fabrics can be developed by taking certain precautionary steps" [8]. "Colour fastness is a term used in the textile industry to describe the resistance of a fabric against colour fading or colour transfer. There are different colour fastness tests, among them rubbing fastness test is one of the important test. Colour fastness to rubbing/crocking is a basic test used to determine the quality of a coloured fabric. This test is designed to determine the degree of colour that may transfer from the coloured textiles to other surfaces by rubbing. Crocking means the transfer of colour from one fabric onto another by rubbing. A fabric with poor colour fastness would transfer its colour easily onto other fabrics, especially to white colour fabrics" [9]. "Colour fastness to washing is one of the most important and common quality parameter from the point of view of consumers. Besides, colour fastness to wash is very important for Lab-dip. We can define colour fastness to wash, a specimen of textile in contact with pieces of specified adjacent fabrics is agitated in a soap or soap-soda solution. The change in colour of the specimen and the staining of the adjacent fabrics are assessed with the grey scale. The resistance to the loss of colour of any dyed or printed material to

washing is preferred to as its wash fastness. If dye molecules have not penetrate inside the inter polymer chain space of fibre or have not attached to the fibre with strong attractive force, poor washing fastness result. This test determines the loss and change of colour in the washing process by a consumer and the possible staining of other garments or lighter portion that may be washed with it" [10]. "Bursting strength of a fabric is the distending force, which is applied at right angles to the plane of the fabric, under specified conditions, which will result in the rupture of a fabric. Bursting strength test is an alternative method of measuring strength in which the material is stressed in all direction at a time" [11]. "Fabrics tensile strength is also called breaking strength, which refers to as the maximum tensile force when the specimen is stretched to break. It is one of the main standards to assess the inherent quality of textiles. The unit of fabric breaking strength is "Newton (N)" and it is used to evaluate the capability of the fabric to resist to tensile damage. Tensile strength test is used to determine the breaking strength and elongation of most textile fabrics. The common testing methods of breaking strength include revelled-strip method, grab method and shear strip method. For the testing of woven fabrics, the revelled-strip method is used frequently. For some fabrics that can't be easily removed the edge, such as knitted fabrics, nonwoven fabrics, coated fabrics, etc., they can be tested by shear strip method. The width of the sample must be strictly controlled, otherwise it will greatly disturb the testing results" [12].

Chapter-3: Materials and Methods

3.1 Materials:

3.1.1 Fabrics properties: Two weft knitted single jersey fabrics were taken in this study. They are Thai Curry and Sangria colored of 50% Polyester and 50% Cotton blended knitted outerwear fabrics. The fabric parameters are given in Table 1.

Table 1. Fabrics properties.

SL NO.	Color	GSM	Yarn count (Ne)	CPI	WPI	Stitch Length (mm)
01	Sangria	170		56	36	1.9
02	Thai Curry	170		58	35	1.95

3.1.2 Burn out printing recipe: Recipe to prepare 1 kg stock paste for printing is given in Table 2.

Table 2. Burn out printing recipe.

Chemical	Dosing (gram)
Thickener (Guar gum)	48
Ethanol	50
Emulsifying agent	20
Humectant (Glycerin)	100

Anionic water	20
Aluminum Sulfate	85
Water	677
Total	1000

3.2 Methods:

3.2.1 Burn out printing process:

First step: First of all the fabric was dyed by two different colours. One is Sangria and the other is Thai Curry.

Second step: Print pest was prepared according to aforementioned recipe.

Third step: Print pest was applied on the dyed fabrics with the flat bed printing machine. Here, the cotton portion was destroyed by chemical reactions but the polyester portion remained unabated.

Sangria colored fabric:

Figure 1: before printing

Figure 2: After printing

Thai Curry colored fabric:

Figure 3: Before printing

Figure 4: After printing

3.2.2 Fabrics weight (GSM) measurement process: Fabric weight was measured according to ASTM D 3776 method [12].

Table 3. Effect of Burn out printing on fabrics weight.

Fabrics color	Fabrics weight (GSM) before printing	Fabrics weight (GSM) after printing
Sangria	170	140
Thai Curry	170	140

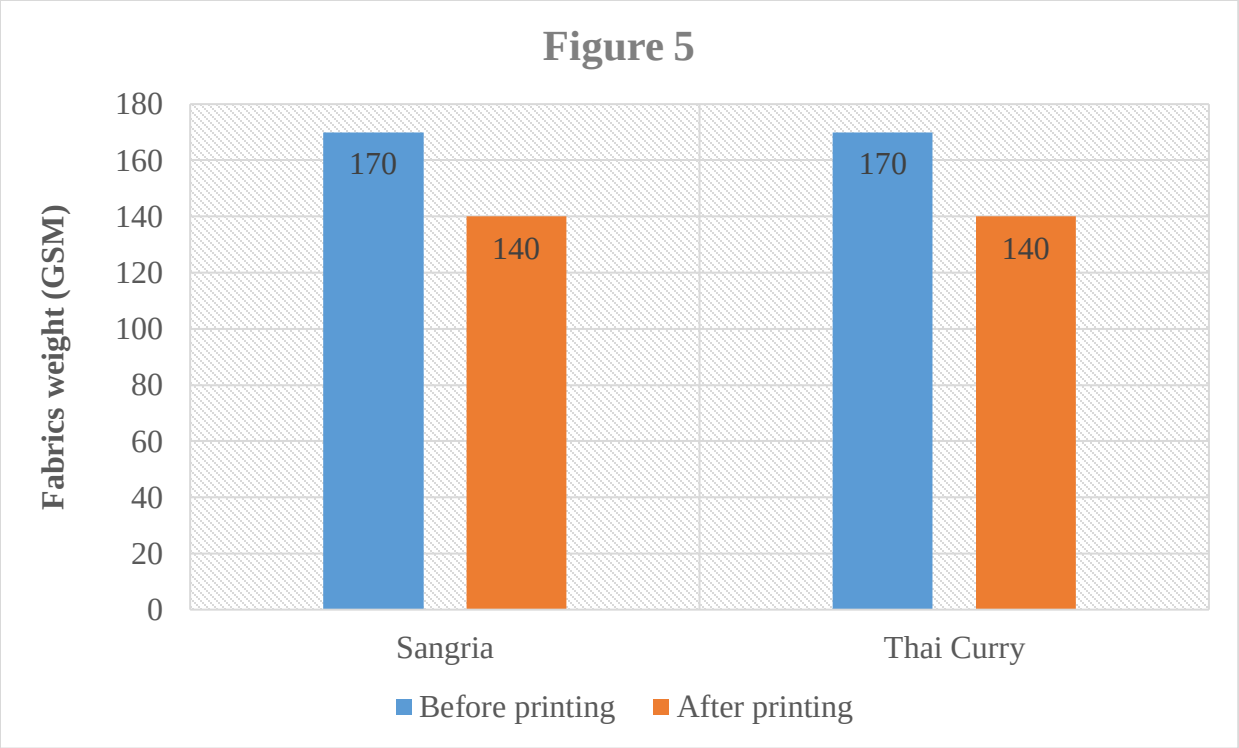

Figure 5: Effect of Burn out printing on fabrics weight.

3.2.3 Fabrics CPI and WPI measurement process: CPI and WPI of the fabrics were calculated by counting the number of the Coarses and wales contents in 1 inch of the fabric. IS 1963 method was used for this measurement process [13].

Table 4. Effect of Burn out printing on fabrics CPI and WPI.

Fabrics color		**Before printing**	**After printing**
Sangria	**CPI**	56	58
	WPI	36	40
Thai Curry	**CPI**	58	53
	WPI	35	38

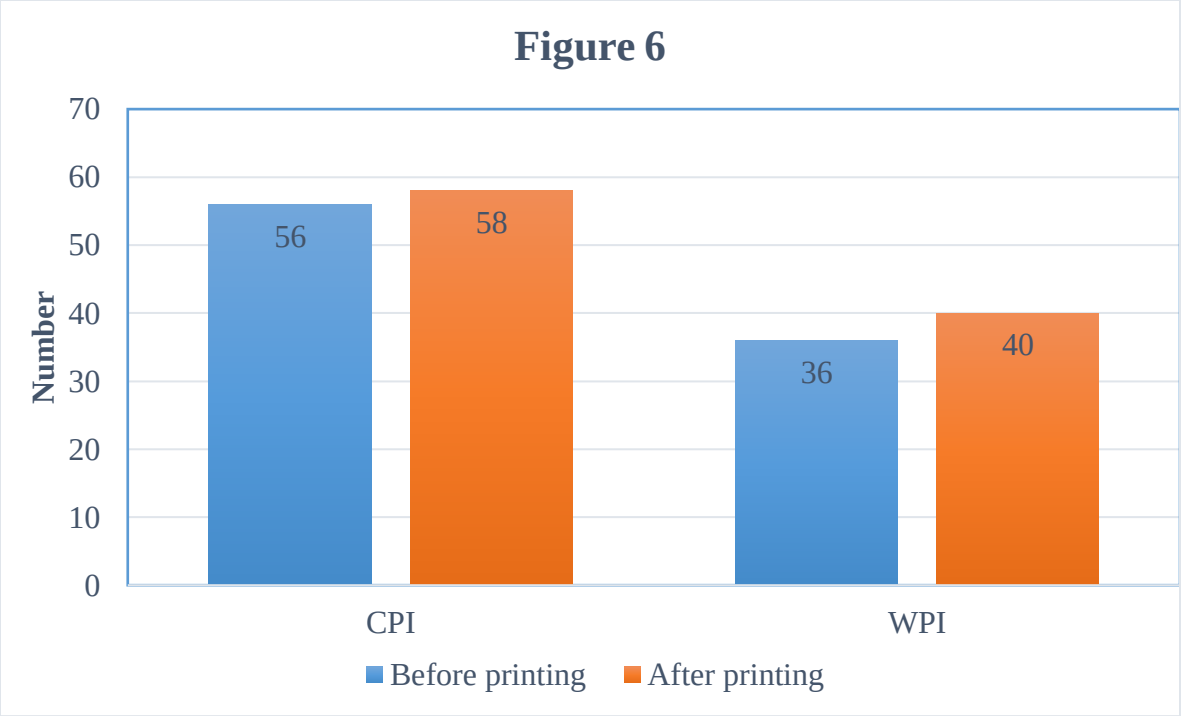

Figure 6: Effect of Burn out printing on Sangria colored fabrics CPI and WPI.

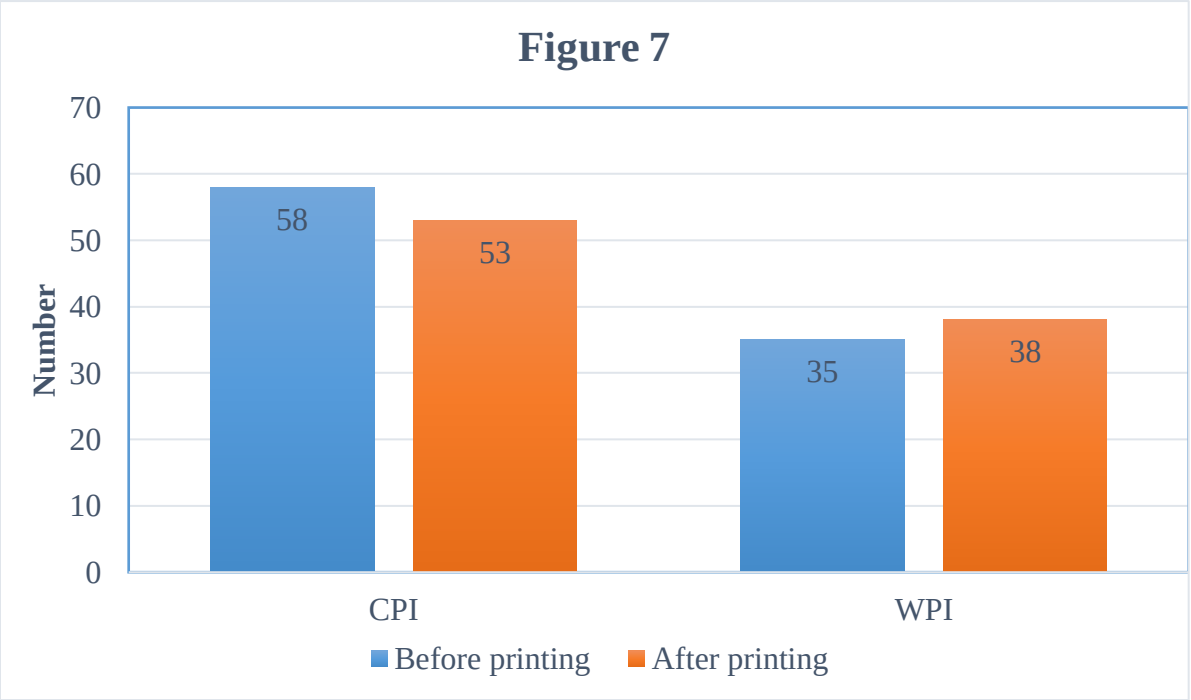

Figure 7: Effect of Burn out printing on Thai Curry colored fabrics CPI and WPI.

3.2.4 Fabrics Stitch Length measurement process: Fabrics stitch length was measured according to BS EN 14970-2006 method [14].

Table 5. Effect of Burn out printing on fabrics stitch length.

Fabrics color	Stitch length (mm)		Changing rate (%)
	Before printing	After printing	
Sangria	1.9	1.5	-21
Thai Curry	1.95	1.6	-17.95

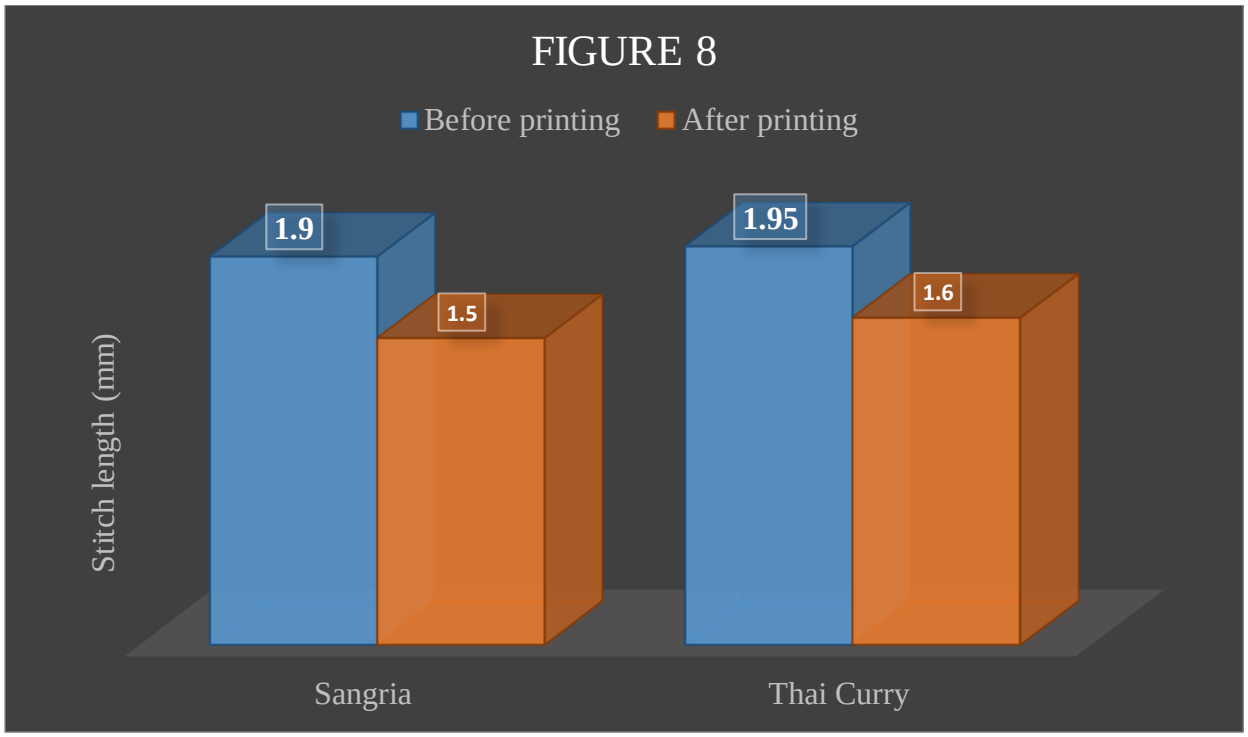

Figure 8. Effect of Burn out printing on fabrics stitch length.

3.2.5 Fabrics shrinkage measurement process: According to AATCC Test Method 96 (2009) shrinkage of the fabrics was tested [15].

Table 6. Effect of Burn out printing on fabrics dimension.

Fabrics color		Before printing (cm)	After printing (cm)	Shrinkage %
Sangria	**Lengthwise**	74.0	73.0	-1.35
	Widthwise	50.0	49.0	-2.00
Thai Curry	**Lengthwise**	74.0	75.0	1.35
	Widthwise	50.0	49.0	-2.00

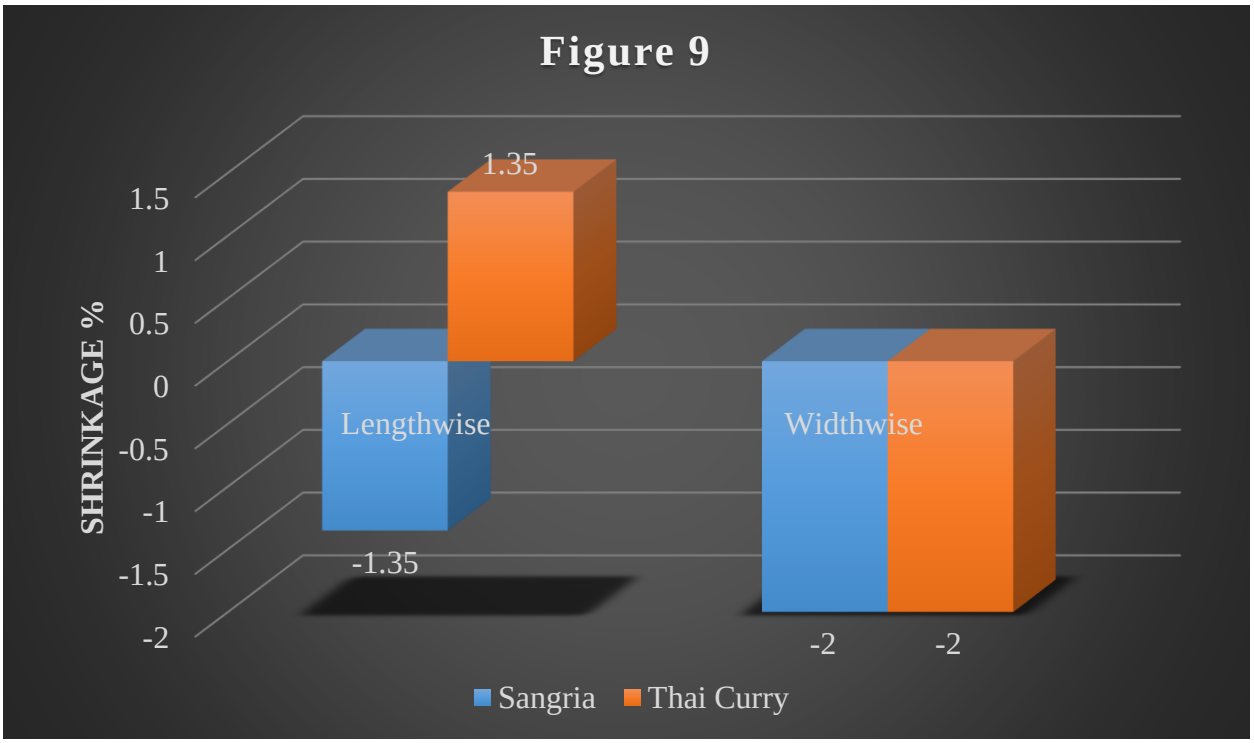

Figure 9: Effect of Burn out printing on fabrics dimension.

3.2.6 Fabrics water absorbency measurement process: Vertical wicking test method was applied here to determine water absorbency property of fabrics.

1. Five specimens in each direction were cut, all measuring (100 mm * 25 mm).

2. Each specimen was folded and secured it on a pen by stitching.

3. The pen was placed over the opening of a glass; so that, the test specimen was hung in the glass without touching the glass.

4. Then the glass was filled up with water till the test specimen was submersed 20 mm in the water and was kept for 30 minutes.

5. After 30 minutes the measurement was taken how high the water had uplifted, starting 20mm from the edge [16].

Figure 10: Vertical wicking test of Sangria colored fabric.

Figure 11: Vertical wicking test of Thai Curry colored fabric.

Table 7. Effect of Burn out printing on fabrics water absorbency property.

Fabrics color	**Direction**	**Before printing (mm)**	**After printing (mm)**
Sangria	**Coarse wise**	2	1
	Wale wise	1	1
Thai Curry	**Coarse wise**	2	1
	Wale wise	1	1

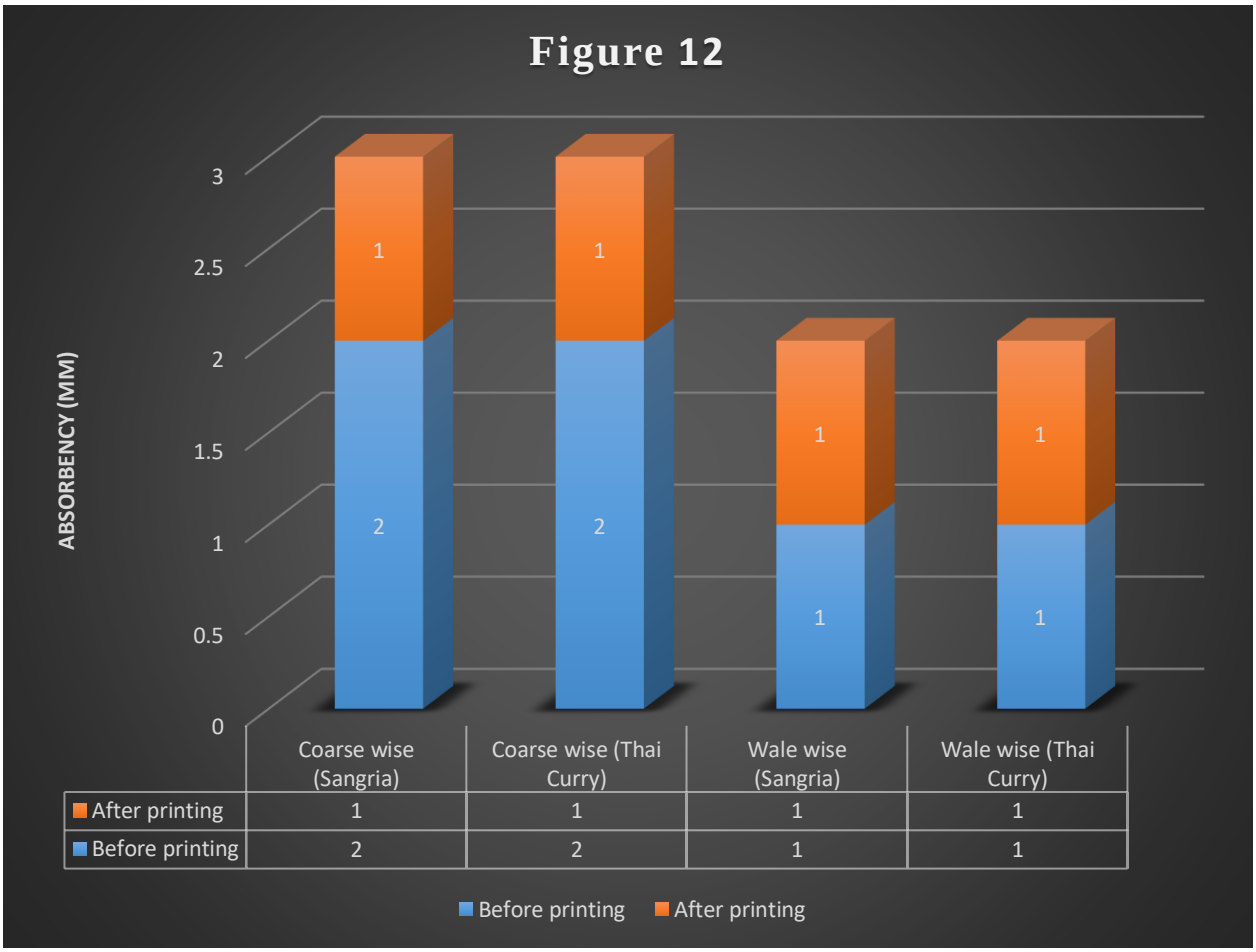

Figure 12. Effect of Burn out printing on fabrics water absorbency property.

3.2.7 Fabrics abrasion resistance measurement process: Martindale abrasion tester was used in this process and fabric specimens were rubbed against canvas fabric. Abrasion was performed on the face side of the fabrics.

1. At first, we cut the fabrics by GSM cutter according to the measurement of the instrument.

2. Then, we took the weight of test specimens by electrical balance.

3. After that, we placed those test specimens under 12 Kpa. Load as supplied in the instrument.

4. Then, we started the machines and observed the number of cycles.

5. After completing 600 cycles, we brought ought one sample from each condition leaving another sample from each condition.

6. Then, we took the weight and observer thread breakage.

7. After completing 900 cycles, we brought ought the remaining samples and also took the weight and observer thread breakage.

8. After that, by taking the values of weight and thread breakage before and after rubbing we calculated the abrasion resistance property of fabrics.

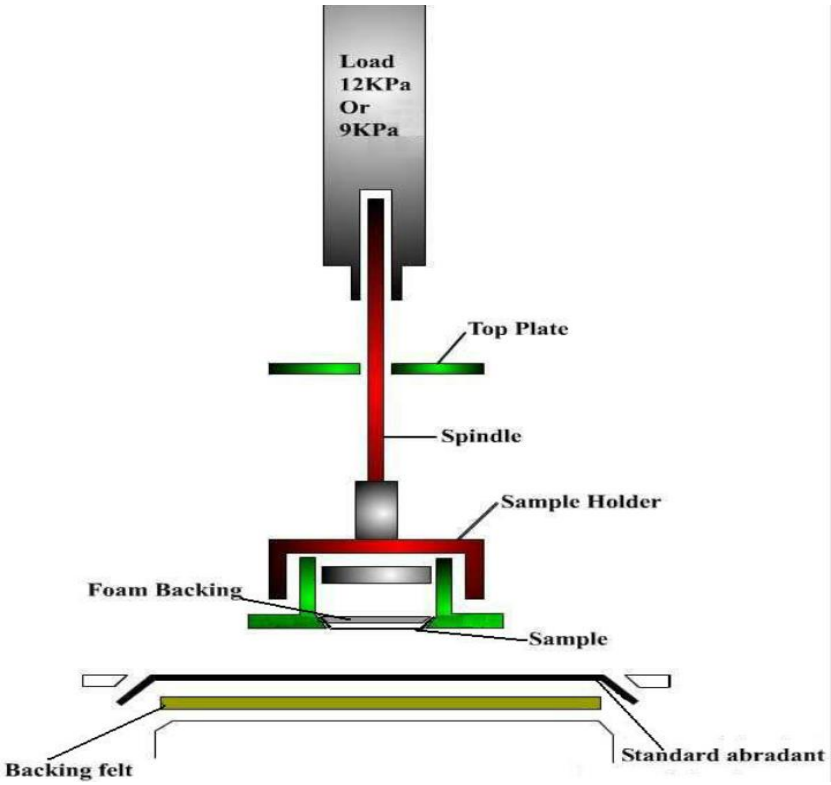

Figure 13. Schematic diagram of Martindale abrasion tester.

Table 8. Abrasion resistance property of test specimens before printing.

Fabrics color	Observation number	Initial weight (gm.)	Number of cycle	Final weight (gm.)	Weight loss (gm.)	Percentage of weight loss	Thread breakage (Y/N)
Sangria	01		600				
	02		900				
Thai Curry	01		600				
	02		900				

Table 9. Abrasion resistance property of test specimens after printing.

Fabrics color	Observation number	Initial weight (gm.)	Number of cycle	Final weight (gm.)	Weight loss (gm.)	Percentage of weight loss	Thread breakage (Y/N)
Sangria	01		600				
	02		900				
Thai Curry	01		600				
	02		900				

3.2.8 Fabrics pilling resistance measurement process: Martindale abrasion tester was used in this process and fabric specimens were rubbed against canvas fabric. The test was done on the face and back sides of the fabrics.

1. At first, we cut the fabrics by GSM cutter according to the measurement of the instrument.

2. Then, we took the weight of test specimens by electrical balance.

3. After that, we placed those test specimens under 12 Kpa. Load as supplied in the instrument.

4. Then, we started the machines and observed the number of cycles.

5. After completing 600 cycles, we brought out one sample from each condition and then after completing 900 cycles we brought ought the remaining samples.

6. After that, we counted the number of pills by counting glass and calculated the pilling resistance property of fabrics.

Table 10. Effect of Burn out printing on fabrics (face side) pilling resistance property.

Fabrics color	**Observation number**	**Number of cycle**	**Number of pills**		**Rating by standard photographs**	
			Before printing	**After printing**	**Before printing**	**After printing**
Sangria	01	600				
	02	900				
Thai Curry	01	600				
	02	900				

Table 11. Effect of Burn out printing on fabrics (back side) pilling resistance property.

Fabrics color	Observation number	Number of cycle	Number of pills		Rating by standard photographs	
			Before printing	After printing	Before printing	After printing
Sangria	01	600				
	02	900				
Thai Curry	01	600				
	02	900				

3.2.9 Fabrics color fastness to rubbing measurement process:

Color fastness to rubbing was determined according to ISO 105-E01: 2013 Textiles test method [17]. Color fastness to rubbing test (dry and wet) was done by crock meter and assessed by Grey scale. The test was done on the face sides of the fabrics.

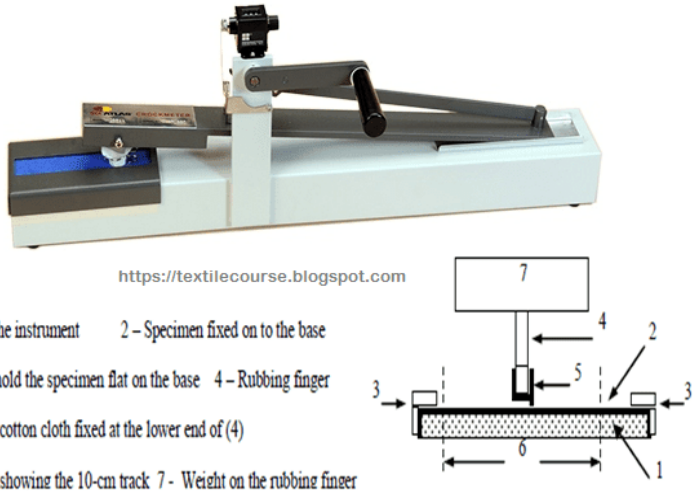

Figure 14: Crock meter and schematic diagram of crock meter.

Table 12. Effect of Burn out printing on fabrics color fastness to rubbing.

Fabrics color	Dry condition		Wet condition	
	Fastness rating		Fastness rating	
	Before printing	After printing	Before printing	After printing
Sangria				
Thai Curry				

3.2.10 Fabrics color fastness to washing measurement process: Color

fastness to washing was determined according to ISO Textiles test method [10]. The test was done by Rotawash colour fastness tester and assessed by Grey scale. And it was done on the face side of the fabrics.

Table 13. Effect of Burn out printing on fabrics color fastness to washing property.

Fabrics color	Fastness rating	
	Before printing	After printing
Sangria		
Thai Curry		

3.2.11 Fabrics bursting strength measurement process: Bursting strength of test specimens was measured by Ball bursting strength tester.

"This method is used to determine the force required to rupture textile fabric by forcing a steel ball through the fabric. Fabrics having more extension that cannot be checked by diaphragm bursting strength test. This method is used for knitted fabric, non-woven fabric, coated fabric etc. Using a circular template 12.5 cm in diameter, samples of the fabric were marked and cut out from random areas so as to be representative of the entire sample. No sample was taken nearer than 20 cm from the edge of the fabrics roll. The test was carried out using an attachment on standard tensile testing machine. The sample was placed in the ring clamp as flat as possible with no wrinkles or tension and tightened the clamp. In the test, the steel ball was pushed through the stretched fabric. By the steel ball downward force was applied at constant rate until the sample break and the force required to do so was recorded" [18].

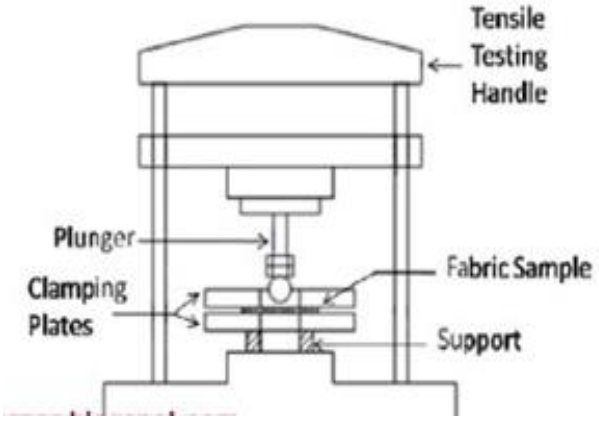

Figure 15. Schematic diagram of ball bursting strength tester.

Table 14. Effect of Burn out printing on fabrics bursting strength.

Fabrics color	Bursting Strength (KPa.)	
	Before printing	After printing
Sangria		
Thai Curry		

3.2.12 Fabrics tensile property measurement process: Tensile property of test specimens was measured according to Strip Test (British Standard) method.

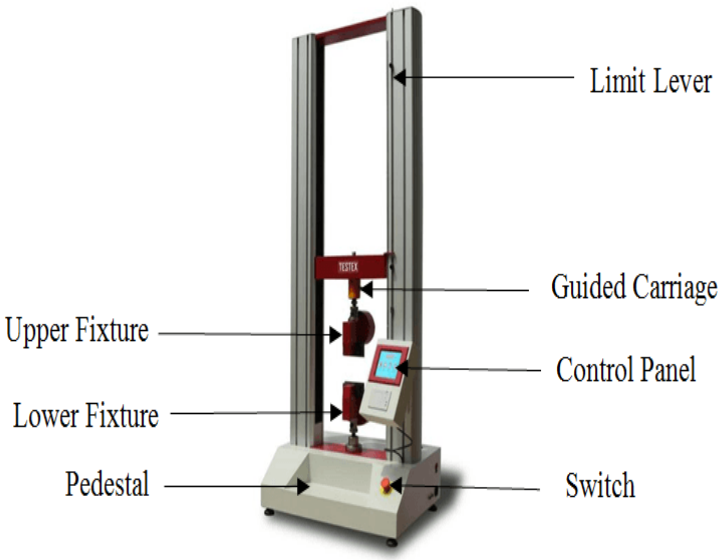

Figure 16. Tensile property testing machine.

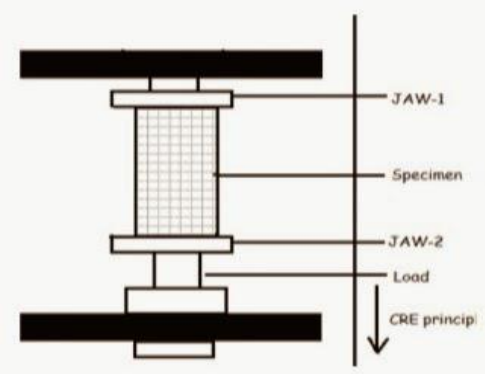

*Figure 17. Schematic diagram of sheer strip test***.**

Table 15. Effect of Burn out printing on fabrics (coarse wise) tensile property.

Fabrics colour	**Tensile speed (mm/ minute)**	**Max. breaking force (N)**		**Elongation (%) at break**	
		Before printing	**After printing**	**Before printing**	**After printing**
Sangria					
Thai Curry					

Table 16. Effect of Burn out printing on fabrics (wales wise) tensile property.

Fabrics colour	**Tensile speed (mm/ minute)**	**Max. breaking force (N)**		**Elongation (%) at break**	
		Before printing	**After printing**	**Before printing**	**After printing**
Sangria					
Thai Curry					

Chapter-4: Discussion of Results

Fabric weight: The variance of the result of fabrics GSM test reveals that Burn out print has a great impact on fabrics weight. In our investigation, Burn out print reduces fabrics weight (GSM) from 170 to 140. The changed amount is significant. It is further noted that, fabrics colour has no impact on the changing rate of fabrics weight. In our experiment, we had two different coloured fabrics. But their impact is unnoticeable.

Course per Inch and wales per Inch: The variance of the result of fabrics CPI and WPI test reveals that, the impact of Burn out print on fabrics CPI and WPI is highly significant. The Course per Inch and wales per Inch of printed specimens differ significantly from the specimens without print. In maximum cases the value of CPI and WPI is increased.

Fabrics Stitch Length: Burn out print has significant impact on fabrics stitch length. It reduces fabrics stitch length. For sangria coloured fabric 21% stitch length is reduced and for Thai Curry coloured fabric 17.95% stitch length is reduced. So fabrics dyed with different colour or treated with different chemicals at different conditions may influence to create this variance.

Shrinkage: The variance of the result of fabrics shrinkage test reveals that, Burn out print has significant impact on fabrics dimension. For Sangria coloured fabric, length wise 1.35% and width wise 2.00% shrinkage is occurred. And for Thai Curry coloured fabric, length wise 1.35% fabric is elongated and width wise 2.00% shrinkage is occurred.

Water absorbency:

Burn out print has also significant impact on fabrics water absorbency property. It reduces fabrics water absorbency property.

Abrasion resistance:

Pilling resistance:

Color fastness to rubbing:

Color fastness to washing:

Bursting strength:

Tensile property:

Chapter-5: Conclusions

The effect of Burn out print on the physical and mechanical properties of knit fabric can be realized by comparing the physical and mechanical properties: namely GSM, CPI & WPI, stitch length, water absorbency, dimensional properties, color fastness, pilling resistance, abrasion resistance, bursting strength and tensile properties. It is noticeable that Burn out print has a great impact on fabrics weight. It reduces fabric weight by destroying a certain portion of fabric. It also has impact on fabrics dimension. It reduces stitch length but increases the value of CPI and WPI. It is further noted that, printed fabrics are almost smoother, softer and less water absorbent than the fabrics without burn out print.

Limitations of the study:

In this study, we could manage to get only two different colored test specimens. More specimens could help to get more precise results. We also could not conduct six types of mechanical property tests, because of the impact of pandemic Coronavirus. That's why, we could not able to accomplish our thesis paper.

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