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Performance of Dyeing and Printing of Polyester / Viscose Yarns Blends for Clothing use

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ABSTRACT – This study highlights the effects of the dyeing and printing processes on the tensile strength of blended suiting fabrics (65% polyester : 35% viscose) as compared to grey blended fabrics. The obtained results showed negative effects of dying and printing applications on the strength of the produced fabrics. Also, there were positive effects of dying and printing applications on the elasticity of produced fabrics. The strength of the printed fabric along the warp direction was found to be greater than that of the dyed. As well the strength of the dyed fabric along the weft direction was found to be greater than that of the printed. It was found that the elongation of the printed fabric along the warp direction was greater than that of the dyed.

Keywords: T*ensile strength, elongation, blended yarn, grey fabric, warp direction, weft direction*

المستخلص – هذه الدراسة سلطت الضوء علي اثر عمليات الطباعة والصباغة علي متانة قماش منتج من خيط مخلوط بنسبة (65% بولستر : 35% فسكوز) علي التوالي مقارنة بمتانة القماش الأسمر المنتج من هذا الخيط. أثبتت النتائج إن عمليات الصباغة والطباعة لهما تأثيرات سلبية علي متانة القماش مقارنه بمتانة القماش الاسمر. هنالك تأثيرات ايجابية لعمليات الطباعة والصباغة علي مطاطية القماش. متانة القماش المطبوع في اتجاه خيوط اللحمة اقل من متانة القماش المصبوغ هذا بالاضافة الي ان امتطاطية القماش المطبوع في اتجاه خيوط السداة أكبر من امتطاطية القماش المصبوغ للاتجاه ذاته.

INTRODUCTION

Dyeing is distinguished from printing as that it only allows one shade to be produced all over the yarn or fabric unless two different fibers are present. Dyeing is employed to give solid shades, whilst printing used to produce patterns that may contain up to fourteen different colors. The simplest form that dyeing can take place is that the textile material is immersed into the dyeing liquor. The dye is attracted to the material and the dye liquor gradually loses its colors whilst the fabric becomes more deeply dyed [1].

The prime function of a thickening agent in textile printing is to enable the dyestuff or pigment to be transferred easily to the fabric at the printing stage. Following the printing stages the thickening agent must contain the dye within the printed area during drying. Furthermore, the thickening agent must be completely removed from the fabric during the washing-off treatment given to the dyestuff [2]. Polyester shrinks about 7% in boiling water and even more at higher temperatures and to avoid this, heat setting is desirable before dyeing . Dry-heat setting is carried out at 200o to 230oC for periods of 30 to 60 seconds. This will stabilize materials which may be ironed domestically.

MODELING OF INDUCTION MOTOR

Four air jet looms were selected from the production line installed in Al-Hudhud textile factory (Khartoum North) to produce the fabric sample. The looms specifications are given in Table 1. The looms were adjusted in order to produce fabrics having the same characteristics.

Table .1: Loom specifications

Loom type	Air jet
Brand name	Nissan
Model number	LA40A
Place of origin	Japan
Reed width	170 cm
Speed	550 picks /min
Year	1994

Grey fabrics were woven on the selected looms. Samples from the produced grey fabric were taken as reference sample. The mechanical properties of the grey fabric were firstly determined [3]. The rest of the grey fabric was then divided into two batches (batch A for the dyeing treatments and batch B for the printing treatments. Due to the differences in the chemical structure of the molecules forming the fibre chains, each type of textile fibers require different dyeing and printing treatment. Therefore, in this work, the viscose and polyester fibers constituting the yarn used to produce the fabric were dyed and printed using different dyeing and printing bath as described in the next sections.

Batch - A (dyeing processes)

The dyeing process carried out in two stages:

a) Dyeing of Viscose Portion (35%):

Dispersed dyes were used for dyeing the viscose fibers. The recipe was composed of 2% blue dye, 0.8% black dye, 0.008% red dye, acetic acid 1cc/L. Dispersed agent 1 c c / L The liquor ratio was 1:7 and the dying temperature was 130 oC. The fabric was fed to the dying machine in a rope form and the duration of the treatment was 30 minutes [4].

b) Dyeing of Polyester Portion (65%)

Insoluble vat dyes were used for dyeing the polyester fibers. The recipe was composed of 1% dark blue dye, reduction material, caustic soda 8 g/L, sodium hydro-sulphate (12 g/L). The liquor ratio was 1:3. A jigger dyeing machine was used and and the fabric was fed in an open form. The temperature was adjusted to 60 ºC and the treatment period was 45 minutes. At the end of the dying process, the dyeing liquor was drained and the fabric was subjected to an oxidizing treatment using 10 ml/L hydrogen peroxide (H_2O_2) at a temperature of 50 ºC. The treatment period was 10 minutes [4].

Batch -B (printing processes):

The printing processes carried out in two stages as follows:

a) Dyeing of Fabric Background:

The fabric (batch B) was dyed by a dispersed dye for a colored background. The recipe was composed of 0.189% blue dye, 0.0079 red dye, acetic acid 1cc/L, disperse agent 1cc/L and the liquor ratio 1:7. The liquor was transferred to the jet dyeing machine and the fabric was fed into a rope form. The temperature was adjusted at 130ºc for duration of 30 minutes. Since the fabric was in a rope form, the fabric was passed through the stenter machine for shrinkage removal and preparation for the subsequent processes [2].

b) Printing Processes:

Pigments were used for printing the fabric. The paste was composed of poly acetate (ammonia salt) 1g/Kg, PH8, 150 g/Kg binder acetate base, softener, fixing agent, emulsifier and 50 g/Kg pigment dye. The fabric was passed through the printing flat machine to print the selected design and finally passed through a drying calendar which is attached to the flat printing machine at a temperature of 130ºc and the fabric was then taken to the stenter machine for color fixation at 180ºc for duration of 1-2 minutes.

The finishing processes were completed by immersing the printed fabric into a bath containing 10 g/L softener to obtain smooth surface. The fabric was then passed through the stenter machine for drying to obtain the fabric final width (150 cm) [5].

Table .2: Uster settings

Module	Fabric Tensile
Jaw Separation	200.00mm
Pretension	2.00N
Rate of Extension	20mm/min
Break Detection	%5.00
Maximum Load	3000.00N
Specimens (Warp & Weft)	5

Table .3: Tensile strength in warp direction of the grey fabric

Specimen	Max. Force (Kgf)	Extension (%)
1	162.67	33.64
2	161.00	33.23
3	167.96	33.96
4	160.11	33.13
5	163.49	33.82
Mean	163.05	33.56
Maximum	167.96	33.96
Minimum	160.11	33.13
Range	7.85	0.83
Median	162.67	33.64
Std. Dev.	3.05	0.36
Conf. Limits	+166.83	34.01
Conf. Limits	-159.26	33.11
Coefficient of Variation	1.87%	1.08%

SIMULATION RESULTS

The tensile strength in both warp and weft directions of the grey, dyed and printed samples was obtained using a computerized Uster installed in Sour factory for military clothes laboratory The Uster tester was adjusted as shown in Table 2 [3]. For the grey fabric (reference sample), the mean tensile strength in warp direction was 163.05 Kgf and the extension percentage was 33.56 whereas in weft direction, the tensile strength was 115.07 and the extension was 22.37%. The results are given in Tables 3 and 4 and plotted in Figures 1 and 2. These results were taken as a reference specification.

Table.4: Tensile strength in weft direction of the grey fabric

Specimen	Max. Force (Kgf)	Extension (%)
1	113.54	21.77
2	116.00	22.30
3	117.68	23.12
4	116.42	22.95
5	111.71	21.73
Mean	115.07	22.37
Maximum	117.68	23.12
Minimum	111.71	21.73
Range	5.97	1.39
Median	116.00	22.30
Std. Dev.	2.40	0.65
Conf. Limits	+118.05	23.18
Conf. Limits	-112.09	21.57
Coefficient of Variation	2.09%	2.89%

a) Effect of Dyeing

The mean tensile strength in warp direction for the dyed fabric was 141.66 kgf and the extension percentage was 37.97. In weft direction however, the mean tensile strength was 112.02 Kgf and the extension percentage was 22.47. The results are plotted in Figures 3 and 4. Compared to the results obtained in warp direction in the case of gray fabric, it can be seen that after dying the tensile strength decreased by 13.1% while the extension increased by 13.1%. On the other hand, results obtained when testing was carried out in the weft direction, showed a decrease in the tensile strength by 2.7% and an increase in the extension by 0.4%.

The slight decrease in the yarn tenacity after the dyeing process was expected. This fall in tenacity arose from the fact that especially viscose fibers and partly PES fibres get slightly damaged during reductive washing with NaOH [6].

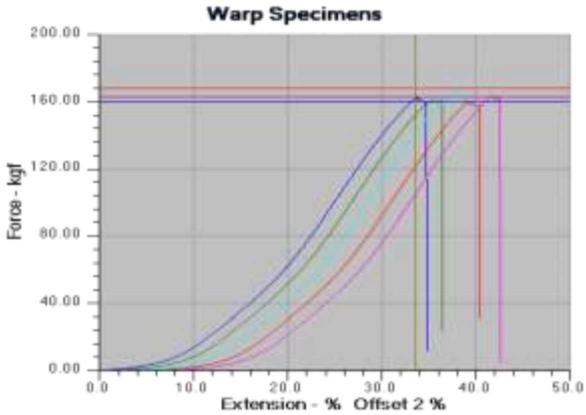

Figure 1: Tensile strength curves in warp direction (grey fabric)

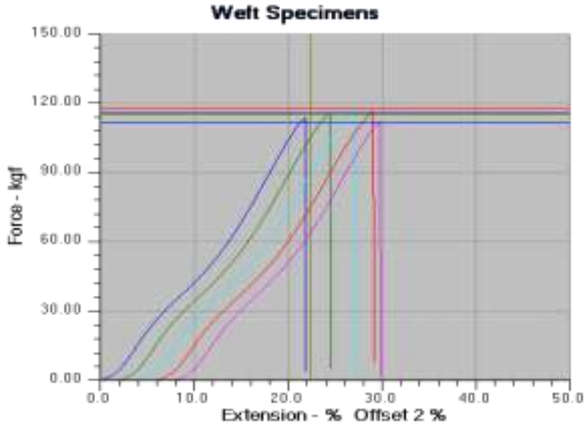

Figure 2: Tensile strength curves in weft direction (grey fabric)

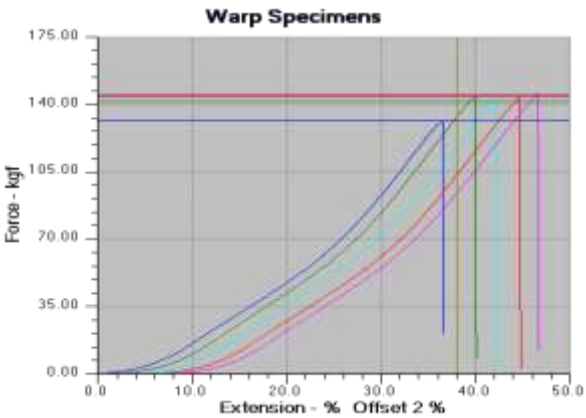

Figure 3: Tensile strength curves in warp direction (dyed sample)

b) Effect of Printing

The mean tensile strength in warp direction for the printed sample was 151.19 kgf and the extension percentage was 36.77 while in weft direction, the tensile strength was 109.54 kgf and the extension percentage was 22.75. The results obtained are shown in Figures 5 and 6.

For warp direction, these results show that the tensile strength decreases by 7.3% and the extension increases by 9.6% compared to the results obtained in the case of grey sample. In weft direction however, there was a decrease in the tensile strength amount to 4.8% and an increase in the extension by 1.7%.

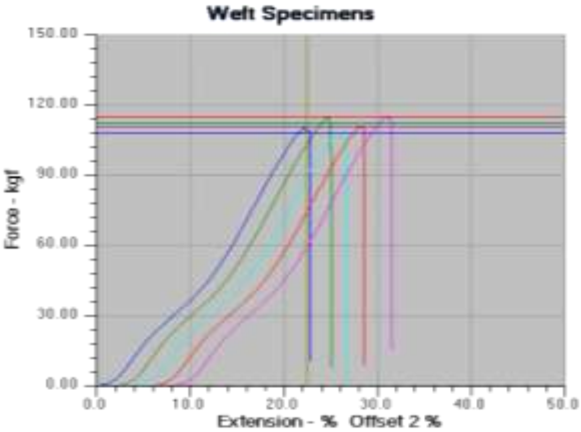

Figure 4: Tensile strength curves in weft direction (dyed sample)

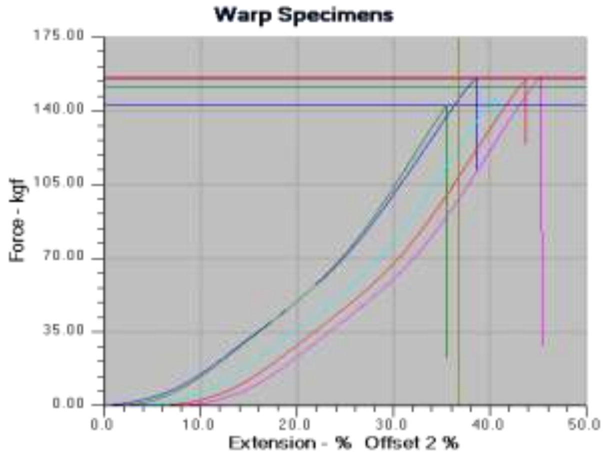

Figure 5: Tensile strength curves in warp direction (printed sample)

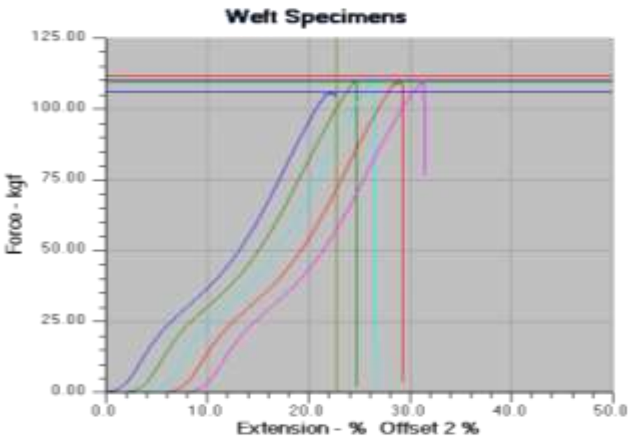

Figure 6: Tensile strength curves in weft direction (printed sample)

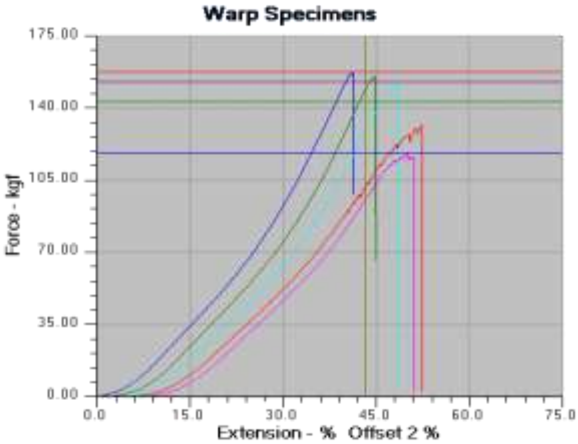

Figure 6: Tensile strength curves in warp direction (Finished sample)

c) Effect of finishing process:

After finishing, the mean tensile strength in warp direction was found to be 143.12 Kgf and the extension was 43.38 %. The results are plotted in Figure 6. For weft direction, the mean tensile strength was 108.42 kgf and the extension was 19.09 %. The results are shown Figure 7.

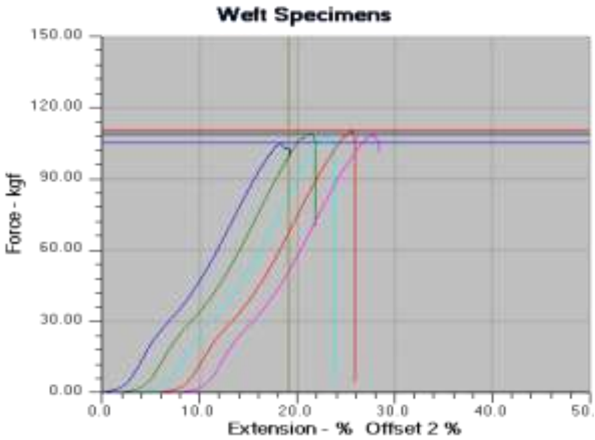

Figure 7: Tensile strength curves in weft direction (Finished sample)

The results obtained showed that in warp direction, finishing treatment decreases the tensile strength by 12.2% and increases the extension by 29.1%. In weft direction however, the finishing treatment decreases the tensile strength and extension by 5.8% and 14.7% respectively.

The heat-setting processes increased the values of yarn elongation within the range of 5.4% and 8.7%. Since cellulose macromolecules, which form regenerated cellulose fibres, are short, the attraction between these macromolecules was not very strong. Therefore, when a force parallel to the fiber axis was applied to the regenerated cellulose fibers, bonds between the macromolecules weakened, causing the fibers to break. Breakages of wet regenerated fibres took place more easily because of the swelling and sliding effects of water [7].

The results obtained showed that dying and printing treatments affect the fabric strength and extension. This may be attributed to the macromolecular interactions that take place during the dyeing and printing processes between the fibres constituting the weft and warp yarns in the fabric and the surface agents of constituting the dyeing and printing liquor. Furthermore, during stentering and drying processes, the fabric is subjected to a high tension and temperature that may also affects its properties.

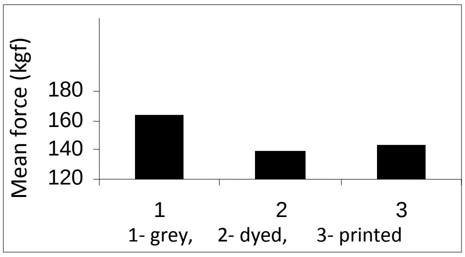

Figure 8: The Effect of Coloration on Fabric Strength (Warp direction).

A comparison was made between the results obtained in the case of gray, dyed and printed samples in warp and weft directions and the results are shown in Figures 8 – 11. A summary of the results are given in Table 5.

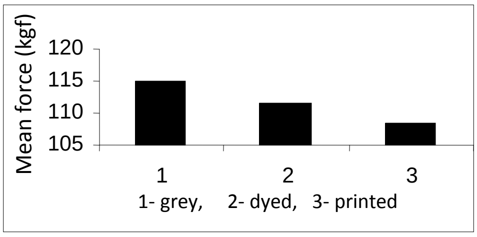

Figure 9: The Effect of Coloration on Fabric Strength (Weft direction)

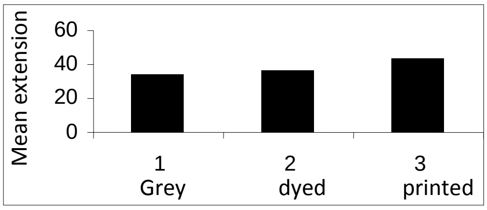

Figure 10: The Effect of Coloration on Fabric Extension (Warp direction)

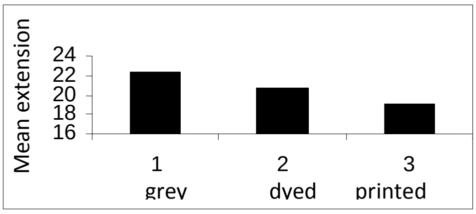

Figure 11: The Effect of Coloration on Fabric Extension (Weft direction)

Table 5: Changes in yarn tensile strength after dying, printing and finishing process

Parameters	Fabric properties											
	dyed fabric		Batch A				Batch B					
			dyed fabric (viscose portion)		dyed fabric		Dyed fabric (background)		printed fabric (before finishing)		Printed fabric	
	warp	weft	warp	Weft	warp	Weft	Warp	Weft	Warp	Weft	warp	Weft
Force (Kgf)	163.05	115.07	141.66	112.02	139.26	111.60	152.01	114.55	151.19	109.54	143.12	108.42
Extension (%)	33.56	22.37	37.97	22.47	35.94	20.75	37.30	23.76	36.77	22.75	43.33	19.09

CONCLUSIONS

From the results obtained in this work, it can be concluded that:

- Dying and printing treatments improve fabric extensibility due to the effect of wet treatment processes.
- Printed fabric strength at warp direction was greater than that of dyed fabric due to the printing thickener presence at fabric surface.
- Printed fabric strength at weft direction was less than that of dyed fabric due to the passage of printed fabric over Stenter machine many times.
- Printed fabric elongation at warp direction was greater than that of dyed fabric due to the effect of wet processes.
- Printed fabric extensibility in weft direction was less than that of dyed fabric due to the passage of printed fabric over Stenter machine many times.

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