THE EFFECT OF CHANGING WEFT COUNTS & DENSITY FOR THE SAME WEIGHT PER UNIT AREA ON SOME PROPERTIES OF PRODUCED FABRIC

تأثير تغيير نمر وكثافات خيوط اللحمة لنفس وزن النسيج

على بعض خواص القماش الناتج

By

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The aim of this work is to fix the weight per unit area of the polyester fabrics. This is happens by changing the weft density according to it's count. Three weft counts were chosen for this study 100, 150, 300 denier twisted / untwisted polyester yarns, where the warp was constant in all cases. The results obtained showed that the finer weft counts (higher density) give higher crease recovery fabrics, where the thicker weft counts (lower density) give fabrics that have more strength, air permeability and thickness.

ABSTRACT:

INTRODUCTION:

The first use of polyester filaments was in knit shirts and blouses for women. The filaments were also used in glass curtains. Both smooth and textured filaments have had wide use in career apparel such as uniforms for nurses and waitresses. Where as the first use of staple polyester was in tropical suitting for men's summer suits. The suits were light in weight and machine washable. The very low absorbency of polyester fibres limited the comfort factors of these garments, a disadvantage that was overcome by blending with cotton and / or wool.

The polyester is noted for their ability to impart strength, wrinkle resistance, and ease of care to fabrics and garments. Strength and abrasion resistance of polyester are quite high and the wet strength is comparable to the dry strength. The high strength is developed by hot – drawing or stretching to develop crystallinity and also by increasing the molecular weight.

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A safe ironing temperature of 325° F may be used on filament polyester if the fabric has been properly heat-set. If the fabric is made of stable fibre, it should be pressed at lower temperature and the time of exposure and the pressure of the iron should be carefully controlled to prevent glazing or shining.

**MATERIALS & METHODS:**

Two different fabric constructions were chosen for this study: plain & satin 5, they manufactured with the same warp in the laboratories of Faculty of Engineering, Mansoura University, but the weft were 100, 150, 300 denier twisted & untwisted yarns. The density of the weft was chosen in order to keep the weight per unit area still constant and the fabric specifications were as follows:

<table>
<thead>
<tr>
<th>Fabric construction</th>
<th>Yarn count (Denier)</th>
<th>Yarn density (cm)</th>
<th>Weight per unit area (gm/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Warp</td>
<td>Weft</td>
<td>Warp</td>
</tr>
<tr>
<td><strong>PLAIN</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>100</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>150</td>
<td>150</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>150</td>
<td>300</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td><strong>SATIN 5</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>150</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>150</td>
<td>150</td>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

Theoretical weight per unit area was calculated as follows:

Warp weight = \((1 + 0.03) \times 25 \times 150 \times 100 / 9000\) gm/m²

= 43 gm/m² for fabric 1

Weft weight = \((1 + 0.05) \times 36 \times 100 \times 100 / 9000\) for fabric 2

= \((1 + 0.05) \times 24 \times 150 \times 100 / 9000\) for fabric 3

= 42 gm/m² for all fabrics.

Where Cw & Cf are the warp & weft crimp ratio, Dw & Df are the warp & weft counts in Denier, E.P.Cm. & P.P.Cm. are the warp & weft density per cm. respectively.

**EXPERIMENTAL WORK:**

The obtained fabrics were taken to the laboratories (Mansoura University), in order to investigate the following properties according to ASTM [1]: tensile strength & breaking elongation; bending length; fabric thickness; air permeability; crease resistance; fabric cover factor and the phase of fabric construction.
<table>
<thead>
<tr>
<th>YARN COUNT (DENIER)</th>
<th>CRIMP RATIO %</th>
<th>YARN DENSITY (YARNS/CM)</th>
<th>Yw</th>
<th>Yf</th>
<th>Hw</th>
<th>Hf</th>
<th>Kr</th>
<th>Fr</th>
</tr>
</thead>
<tbody>
<tr>
<td>WARP</td>
<td>WEFT</td>
<td>WARP</td>
<td>WEFT</td>
<td>WARP</td>
<td>WEFT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150 100</td>
<td>3 5</td>
<td>25 36</td>
<td>0.251</td>
<td>0.329</td>
<td>0.0697</td>
<td>0.1316</td>
<td>0.5296</td>
<td>3.77</td>
</tr>
<tr>
<td>150 150</td>
<td>3 5</td>
<td>25 24</td>
<td>0.251</td>
<td>0.329</td>
<td>0.1046</td>
<td>0.1316</td>
<td>0.7948</td>
<td>4.54</td>
</tr>
<tr>
<td>150 300</td>
<td>3 5</td>
<td>25 12</td>
<td>0.251</td>
<td>0.329</td>
<td>0.2092</td>
<td>0.1316</td>
<td>1.5897</td>
<td>5.91</td>
</tr>
</tbody>
</table>

Where:
- \( Yw \) & \( Yf \): empirical forms as a function in warp & weft crimp respectively;
- \( Hw \) & \( Hf \): empirical forms for calculating warp & weft height respectively;
- \( Kr \): empirical form as a percentage between warp & weft wave heights;
- \( Fr \): the phase of fabric construction. [2]

\[
Yw = \sqrt{Cw \left(200 - Cw\right)} / (100 - Cw) \quad Yf = \sqrt{Cf \left(200 - Cf\right)} / (100 - Cf)
\]

\[
Hw = 10 \frac{Yw}{P.P.Cm} \quad Hf = 10 \frac{Yf}{E.P.Cm}
\]

\[
Kr = Hw / Hf
\]

\[
Fr = \left(1 + 9 Kr\right) / \left(1 + Kr\right)
\]

### RESULTS & DISCUSSION:

The obtained fabrics were taken to investigate their properties [1, 3]: thickness, coefficient of crease resistance, tensile strength & extension and cloth cover factor. The figures (1-15) show the results obtained and trends of behavior for each sample.

**From the results obtained we notice that:**

- The fabric thickness increases by increasing the weft count / decreasing density, this is due to using coarser yarns. Coarser yarns leads to enlarge fabric thickness. This happens in cases of twisted / untwisted yarns. (fig. 1-2)

- The coefficient of crease resistance decreases by increasing the weft counts / decreasing density, this is due to using coarser yarns. This happens in cases of twisted / untwisted yarns. (fig. 3-4)

- By increasing the weft count / decreasing weft density, the fabric air permeability increases, while the fabric cover factor decreases. This is due to using coarser yarns. Using coarser yarns leads to enlarge yarn interspaces which leads to decrease fabric cover factor / increase air permeability. This happens in the cases of twisted / untwisted yarns. (fig. 5, 6, 17)
Fig (1) The relationship between fabric thickness & weft count / density for twisted yarns.

Fig (2) The relationship between fabric thickness & weft count / density for untwisted yarns.

Fig (3) The relationship between coefficient of crease resistance & weft count / density for twisted yarns.

Fig (4) The relationship between coefficient of crease resistance & weft count / density for untwisted yarns.
Fig (9) The relationship between fabric strength in weft direction & weft count/density for twisted yarns.

Fig (10) The relationship between fabric strength in weft direction & weft count/density for untwisted yarns.

Fig (11) The relationship between fabric breaking extension in warp direction & weft count/density for twisted yarns.

Fig (12) The relationship between fabric breaking extension in warp direction & weft count/density for untwisted yarns.
Fig. (13) The relationship between fabric breaking extension in weft direction & weft count / density for twisted yarns.

Fig. (14) The relationship between fabric breaking extension in weft direction & weft count / density for untwisted yarns.

Fig. (15) The relationship between the bending length in the warp direction & weft count / density for twisted yarns.

Fig. (16) The relationship between the bending length in the warp direction & weft count / density for un twisted yarns.
Fig (17) The relationship between fabric cover factor & weft count / density for twisted yarns
- the tensile strength in the warp direction increases by increasing the weft count / decreasing weft density for twisted yarns, but in case of untwisted yarns it decreases by increasing the weft count / decreasing density. (fig. 7, 8)

- the tensile strength in the weft direction increases by increasing the weft count / decreasing weft density. This happens in the cases of twisted / untwisted yarns. (fig. 9, 10)

- the breaking extension in the warp / weft direction increases by increasing the weft count / decreasing density, for the cases of twisted / untwisted yarns. (fig. 11-14)

- the bending length in the warp direction decreases by increasing the weft yarn count / decreasing density. The lower bending length means less stiffness for coarser yarn. More stiffness for higher density of yarns causing less mobility. This happens in the cases of twisted / untwisted yarns. (fig. 15-16)

- by increasing the weft count from 100 Denier to 300 Denier, the phase of fabric construction increases from 4th degree to 6th degree. This means that the degree of the displacement of warp & weft threads changes. And 5th degree is the optimum degree that gives more suitable fabric [4]. This happens in case of using weft count 150 Denier and weft density of 24 P.P.Cm.

**CONCLUSION:**

By increasing weft count from 100 Denier to 300 Denier (decreasing weft density from 36 to 12 P.P.Cm.), we notice that bending length, crease recovery or fabric cover factor decreases while fabric thickness, fabric strength in both direction and also extension increases.

So, in order to obtain fabrics that have a higher cover factor, crease recovery or stiffness we must use a lower weft counts 100 denier (higher weft density 36 p.p.cm). But in order to obtain fabrics that have more strength, air permeability or thickness, we must use a higher weft counts 300 denier (lower weft density 12 p.p.cm).

In order to obtain more regular fabric in the phase of it’s construction 5th degree we must use medium weft count 150 denier / medium density 24 p.p.cm.
REFERENCES:

1- ASTM. (D1175-64), (D1388-64),(D1424-63), (D1777-64)& (D1910-64); American Society For Testing Materials, Philadelphia, (1967).


3- J.E. Booth, Principles of textile testing, London. 1968.
