EFFECT OF MOISTURE ON THE BREAKING CHARACTERISTICS OF POLYPROPYLENE TWISTED THREAD

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The effect of moisture on the properties of initial PP thread and finished sewing thread is investigated. Application of moisture on PP thread increases its strength by 8% on average and decreases the elongation due to the plasticizing effect of the moisture. The studies demonstrated the possibility of using articles made of PP, soft containers in particular, in shipping in different weather conditions.

Polypropylene (PP) fibres and thread have been widely used for both fabrication of industrial articles and for developing goods for mass consumption. This is due to the availability of the initial raw material, simplicity of the fibre and thread manufacturing technology, and good performance characteristics of articles made from them. In 2003, the increase in world production/consumption of PP fibres and thread in comparison to 2002 was 4% [1].

PP thread is used for manufacturing industrial fabrics, for sewing PP bags, sports knits, fabrics for work clothes, filter cloth, fabrics for bags, luggage, furniture upholstery, and automobile passenger compartments. All of these articles are subject to some degree of exposure to moisture during use, and it is important that they not lose their strength properties as a result.

A different assortment of PP sewing thread is used for sewing soft containers [2]: bags with a capacity of 50 kg are sewn with thread with a linear density of 90-120 tex, and soft containers with a high carrying capacity — “big bags” — are sewn with 250-450 tex thread.

We investigated the effect of moisture on the physicomechanical properties of PP thread of 33.3 tex×1×3 and 92.5 tex×1×3 structure. Initial 33.3 tex and 92.5 tex thread, 33.3 tex×1 and 92.5 tex×1 strands were also tested. PP twisted thread and sewing thread were made on modern domestic TKM-12 and TKM-21 doubler-twisters with parameters obtained as a result of multicriteria optimization of PP sewing thread processing technology. The tests were performed on thread samples made of domestic 33.3 tex (Krasnodar) and imported 92.5 tex (Slovakia) raw material.

The wet thread was tested from the same packages as the dry thread. A 1-m length of thread was unwound from the package and immersed in distilled water for 2 min. To eliminate excess moisture from the surface of the thread, it was placed on filter paper for 15 sec. Moisture of up to 40% of the weight of the dry thread remained on the thread. The thread was then loaded into the clamps of a tensile-testing machine.

The specific breaking load of the thread \( P_s \), cN/tex was calculated with the equation [3]

\[
P_s = \frac{P_{eW}}{T},
\]

where \( P_{eW} \) is the real breaking load of the wet thread, cN; \( T \) is the real linear density of the dry thread, tex.

The result of determining the basic physicomechanical properties of experimental samples of both wet and dry yarn, strands, and sewing thread are reported in Table 1. Diagrams were plotted with the results of the tests (Figs. 1-3).

The analysis of the diagrams shows that the absolute breaking load increases as follows for wet thread: by 3 and 9% for initial 33.3 and 92.5 tex complex thread, by 7 and 10% for strands of 33.3 tex×1 and 92.5 tex×1 structure, and by 9 and 10%, respectively, for 33.3 tex×1×3 and 92.5 tex×1×3 sewing thread.

The initial thread was twisted in fabrication of strands, which increased its strength.
TABLE 1. Physicomechanical Properties of Dry and Wet PP Thread, Strands, and Sewing Thread

<table>
<thead>
<tr>
<th>Structure of thread, strand, string</th>
<th>$T$, tex</th>
<th>$P$, H (Fig.1)</th>
<th>$\varepsilon$, % (Fig.2)</th>
<th>$P_s$, cN/tex (Fig.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33.3 tex</td>
<td>34</td>
<td>19.0/21.1</td>
<td>20.90/19.70</td>
<td>55.88/62.05</td>
</tr>
<tr>
<td>33.3 tex x 1</td>
<td>35</td>
<td>18.6/20.0</td>
<td>22.65/20.00</td>
<td>53.20/57.14</td>
</tr>
<tr>
<td>33.3 tex x 1 x 3</td>
<td>102</td>
<td>58.0/64.0</td>
<td>22.93/20.80</td>
<td>56.86/62.75</td>
</tr>
<tr>
<td>92.5 tex</td>
<td>93</td>
<td>63.0/65.0</td>
<td>24.26/19.20</td>
<td>67.74/69.89</td>
</tr>
<tr>
<td>92.5 tex x 1</td>
<td>96</td>
<td>63.0/70.0</td>
<td>23.90/22.30</td>
<td>65.65/72.92</td>
</tr>
<tr>
<td>92.5 tex x 1 x 3</td>
<td>283</td>
<td>182.5/202.0</td>
<td>26.23/22.50</td>
<td>64.49/71.38</td>
</tr>
</tbody>
</table>

**Note.** linear density ($T$) of dry thread, breaking load ($P$), elongation at break ($\varepsilon$), and specific breaking load ($P_s$) of dry (numerator) and wet (denominator) thread.

![Fig.1](image1.png) ![Fig.2](image2.png)

**Fig. 1.** Effect of moisture content on absolute breaking load: 1) dry thread; 2) wet thread.

**Fig. 2.** Effect of moisture content on elongation at break: 1) dry thread; 2) wet thread.

![Fig.3](image3.png)

**Fig. 3.** Effect of moisture content on specific breaking load: 1) dry thread; 2) wet thread.

The elongation at break of wet thread tended to decrease: by 6 and 20% for the initial thread, by 12 and 7% for strands, and by 9 and 14% for sewing thread at linear density of 33.3 and 92.5, respectively.

The effect of moisture on the specific breaking load of all samples of PP thread was similar to the effect on the absolute breaking load.

The increase in the strength of wet PP thread is due to the fact that the moisture has a plasticizing effect and reduces the probability of fibrillation of filaments, which in turn increases the breaking load and decreases the elongation at break. Materials