Measurement of slub yarns with the USTER® TESTER 4
Contents

1 Introduction ........................................................................................................ 5

2 Determination of mass variations ................................................................. 5
   2.1 Numerical values .............................................................................. 5
   2.2 The diagram ................................................................................ 5
   2.3 Counting the number of thick places per unit length ..................... 7
   2.4 The spectrogram ....................................................................... 8

3 High-speed strength testing ...................................................................... 9

4 Summary .................................................................................................. 10

Important notice

All the evenness measurements in this paper were carried out with the USTER® TESTER 4. However, it is also possible to perform the same tests with the USTER® TESTER 3 with 2 exceptions:

- The minimum speed of the USTER® TESTER 3 is 25 m/min
  (USTER® TESTER 4: 10 m/min)

- The diagram of the USTER® TESTER 3 can be selected as follows:
  -100% / +200% or +400% (USTER® TESTER 4: -100% / +200% or 500%)
1 Introduction

If the quality characteristics of slub yarns have to be measured in the textile laboratory the following options are available:

- The USTER® TESTER 4 serves for the determination of the mass variation, the number of produced thick places per 1000 m, the diagram and the spectrogram.
- The USTER® TENSOJET determines the mean force and elongation, the distribution of force and elongation and the isolated weak places.

2 Determination of mass variations

2.1 Numerical values

The measurement of the mass variations indicates the size of the thick places as well as the number of thick places per 1000 m.

<table>
<thead>
<tr>
<th>Nr</th>
<th>U%</th>
<th>CVm</th>
<th>Thin +40%</th>
<th>Thick +35%</th>
<th>Thick +50%</th>
<th>Thick +100%</th>
<th>Neps +150%</th>
<th>Neps +200%</th>
<th>H</th>
<th>sh</th>
<th>Count</th>
<th>Usp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25.33</td>
<td>32.17</td>
<td>2730</td>
<td>240.0</td>
<td>3140</td>
<td>2630</td>
<td>630.0</td>
<td>60.0</td>
<td>0.0</td>
<td>7.71</td>
<td>2.54</td>
<td>7.81</td>
</tr>
<tr>
<td>2</td>
<td>25.02</td>
<td>31.87</td>
<td>2546</td>
<td>140.0</td>
<td>3060</td>
<td>2390</td>
<td>350.0</td>
<td>30.0</td>
<td>0.0</td>
<td>7.65</td>
<td>2.23</td>
<td>7.84</td>
</tr>
<tr>
<td>3</td>
<td>25.24</td>
<td>32.10</td>
<td>2460</td>
<td>170.0</td>
<td>3080</td>
<td>2400</td>
<td>370.0</td>
<td>40.0</td>
<td>10.0</td>
<td>7.85</td>
<td>2.44</td>
<td>7.82</td>
</tr>
<tr>
<td>4</td>
<td>24.97</td>
<td>31.77</td>
<td>2460</td>
<td>140.0</td>
<td>3140</td>
<td>2460</td>
<td>380.0</td>
<td>50.0</td>
<td>10.0</td>
<td>7.62</td>
<td>2.33</td>
<td>7.83</td>
</tr>
</tbody>
</table>

The most important values for slub yarns are the coefficient of variation CV_m, the number of thick places per 1000 m (Thick +35%) and the count. The value CV_m is equal to the standard deviation divided by the mean. This value is a measure of the size of the thick places.

2.2 The diagram

In order to evaluate an individual thick place the slub yarn can be measured at lowermost speed which is 10 m/min with the USTER® TESTER 4. At this drawing-off speed the diagram shows all the details of a thick place (Fig. 1). The USTER® TESTER determines several data points per millimeter at a speed of 10 m per minute.

The diagram scale was selected such that thick places of +200% can easily be interpreted (-100% to +200%).
The mass variation of the yarn is calculated by measuring all the mass deviations referred to the average value. Therefore, when selecting the "fancy yarn mode" the USTER® TESTER 4 first calculates the mean value. This value is equal to the zero line. It can be recognized that the diagram trace of the yarn between two thick places is below the zero line. The areas, therefore, below and above the zero line are equal:

Red area = blue area (Fig. 2)
2.3 Counting the number of thick places per unit length

In order to measure the number of thick places per 1000 m the thick place sensitivity +35% has to be selected. With this setting the evenness tester does not miss the small thick places (Table 2).

Average distance between the thick places:

\[ l_T = \frac{1000 \text{ [m]}}{n_T} = \frac{1000}{3100} = 0.32 \text{ [m]} \]

\[ n_T = \text{Number of thick places per 1000 m. Setting of thick place threshold: +35\%.} \]

The diagram can demonstrate the size of the thick places as well as the size variation. It also shows the length of the thick places and the periodicity (Fig. 3).
The USTER® TESTER 4 has a particular setting for slub yarns where the zero line of the diagram is displaced to the lower side. This shift is required to show the thick places in full size, because the produced thick places are mostly larger than +100%.

The diagram of Fig. 1 shows the distance between the thick places and the size and the size variation of the thick places.

2.4 The spectrogram

The spectrogram can particularly determine the periodicity of the thick places.

Fig. 4 shows a real spectrogram of a normal cotton ring-spun yarn. The fiber length influences considerably the shape of the spectrogram at the wavelengths from 2 cm to 50 cm. The maximum occurs at a wavelength of 2.82 • mean fiber length.

Fig. 5 shows the spectrogram of an slub yarn. The spectrogram differs considerably from Fig. 4. Particularly in the range of 13 to 42 cm the spectrogram has a completely different shape.

If the thick places have a perfect random distribution, the spectrogram of Fig. 5 would not differ from Fig. 4. A perfect random distribution of the thick places means that every channel of the electronic system which calculates the spectrogram would be triggered regularly. This, however, is not the case in Fig. 5. They are some dominant frequencies in Fig. 5 within the wavelength range of 13 to 42 cm with a peak at 32 cm. Table 2 shows that the number of thick places per 1000 m is 3100 which is an average distance of 32 cm between the thick places. At this distance Fig. 5 also shows the highest peak.
This indicates that the thick places do not occur randomly, but with preferred repetition rates. The most frequent distances between the thick places are in the range of 13 to 42 cm.

![Spectrogram MassCV%](image1)

Fig. 6 represents the same spectrogram as shown in Fig. 5. However, the red line represents the ideal spectrogram. Therefore, the deviation from the red line indicates events which are periodic or nearly periodic. The basic spectrogram of cotton is automatically adapted in size (compared to Fig. 4) in order to demonstrate the entire deviations.

3 High-speed strength testing

There is a high probability that slub yarns contain isolated thin places if the forming of thick places is not under control.

Fig. 7 shows a scatter plot of a high-speed strength tester (USTER® TENSOFJET). This instrument is able to produce 30'000 breaks per hour. Each dot of the scatter plot of this slub yarn is one test value. Therefore, it is possible to identify the number and size of the weak places on the left hand side of the scatter plot.

![Scatter plot of high-speed strength test](image2)
Table 3 shows the numerical values for this strength test. The mean value of strength is 162.7 cN, the mean value of elongation was 4.49%.

However, there are a few isolated weak places. In this printout 5 out of 10'000 tests have resulted in strength values below 46.59 cN and elongation values below 1.63%.

![Table 3](image)

### 4 Summary

With the USTER\textsuperscript{®} TESTER and the USTER\textsuperscript{®} TENSOJET it is possible to carry out various tests to assess the quality of slub yarns. The evaluation has shown that the yarn has the expected number of thick places per unit length. In addition, the diagram demonstrates the variation of the size and the distances of the thick places. The spectrogram unveils that the most frequent distance between the thick places vary between 13 and 42 cm. Care must be taken that dominant frequencies of thick places do not occur in order to avoid the formation of disturbing patterns in the fabric. The scatter plot of the Strength Tester indicates a few isolated weak places. The number of these weak places must be kept under control to avoid too many end breaks on the weaving machine.