YARNS QUALITY ASSURANCE DEPENDING ON THE SPINNING SYSTEMS (I)

BY

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Abstract. This paper deals with two of the leading topics of the yarn quality characteristics: the consistency (by mean of evenness) and the yarn surface integrity (by mean of the hairiness). Part I of this paper will be describing the interpretation of the USTER® TESTER 4 report and available graphical representations in order to evaluate yarn quality and to prevent misunderstandings that can result in wrong decisions in knitting.

Key words: yarn, ring- spinning, rotor– spinning, consistency, surface integrity.

1. Introduction

Assessment of the yarn quality is still based on the off-line technique measurements - through laboratory data systems, which contribute to the automatic and integrated data control in spinning mills [1].

The yarn’s proper quality can be reached only if the quality of the raw material, the high performance of the processing equipment, the quality of the labor and the overall management allow it. Every quality issue referable to the spinning has side consequences in fabrics and also, on the customer feedback [2], [3].

Having in account the revolutionary manufacturing in the spinning mills, for long lasting supply, it was redefined the yarn quality as a combination of four basic elements: the consistency (yarn evenness and appearance integrity by mean thick places, thin places and neps), the bulk integrity (count, density and twist), the surface integrity (hairiness, diameter and shape) and finally but not less important, the purity (foreign fibers, seed coat, trash and dust) [4],…,[ 6].
From the above characteristics that can affect the appearance of fabrics, were selected for this paper the yarn evenness (as mass variation) and the hairiness. The effect of the yarn unevenness on the knitwear appearance is important because the overall mass variation can lead to inadequate texture with many faults, which can be facility detected [6], [7].

The effects of the yarn hairiness on the knitting operation following after spinning and its influence on the fabrics features, have led to its measurement, too. In spinning, the overall processing purpose is to produce even hairiness because, hairiness which is strictly dependent to the end use is not necessarily a quality deficiency, but the uneven hairiness is [5], [6].

In this paper (Part I) will be describing the interpretation of the USTER® TESTER 4 report and available graphical representations for the overall quality assurance in spinning mill, regardless of the spinning system.

2. Exposition

2.1. Reference Values in Yarn Testing

In the permanently race for improvement of the yarn’s quality, the textile industry faced with many challenges in order to compete in a “world-class manufacturing program”. For that, the benchmarks with the USTER® STATISTICS assure the top values as reference points needed to correspond with the requirements of spinning processing and the fabric’s appearance, but always by knowing the requirements of the customers [7].

Table 1 shows the top values reached by 5% of all random samples measured for the USTER® STATISTICS (referred usually as Uster Statistics Percentile and written as 5% USP) and the low values reached by 95% of all random samples measured for the USTER® STATISTICS (95% USP) for the two yarn quality characteristics: mass variation and the hairiness. These will be the useful for the experimental part of paper (Part II).

<table>
<thead>
<tr>
<th>Spinning system</th>
<th>Quality characteristics</th>
<th>Ring spinning</th>
<th>Rotor spinning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Top values, 5% USP₀₁</td>
<td>Low values, 95% USP₀₁</td>
</tr>
<tr>
<td>Mass variation</td>
<td>CVₘ [%]</td>
<td>12.3</td>
<td>17.2</td>
</tr>
<tr>
<td>Hairiness</td>
<td>H</td>
<td>4.7</td>
<td>8.3</td>
</tr>
<tr>
<td>Standard deviation Hairiness</td>
<td>sH</td>
<td>1.19</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Table 1
Top and Low Values of Mass Variation and Hairiness-24 Ne (25 Tex) Yarns, Designed for Knitting
In Table 1, the benchmarking was achieved in USTER® STATISTICS published in 2001, [8] for 24 Ne (25 Tex) ring-spun and rotor–spun yarns, processed from 100% carded cotton, designed to knitting. Actually, the USP values range can be between 5% (the best possible) to 95% (the worst possible). Since the raw material in a spinning mill account for 50÷60% of the total manufacturing costs, it is important to set the quality characteristics limits (for yarns benchmarking) according to customer demands. In this point, it must be specified that 5% USP for yarns means a very good quality but also, very expensive ones.

2.2. Interpretation of the USTER® TESTER 4 Report

USTER® TESTER 4 is advanced testing equipment that offers a wide range of test results and information. One test report consists of text, table and graphs that needed to be interpreted in the right way in order to prevent any misunderstandings and resulting in wrong decisions.

The report achieved on USTER® TESTER 4 (UT4) contains main quality parameters of the experimental yarn and statistical data also, that is necessary for the reproducibility of a test. The specification of the measurement also, is very important as other settings can influence the results and thus make impossible a comparison between suppliers or between testing equipments. Therefore, for the accurately testing and results, it is important to start by selecting the test job editor: raw material type; fiber blend percentage; nominal yarn count and nominal twist, spinning system (e.g. ring/open end) and yarn destination [6], [9].

Usually the UT 4's report editor can be setting to include one or several yarn quality parameters because with this system is possible to determine different characteristics depending on the range of sensors for analysis. Besides of already known consistency characteristics (mass variation, thin places, thick places and neps), others characteristics referred in this paper as the surface integrity (hairiness, diameter and shape), the bulk integrity (count and density) and the purity (foreign fibers, seed coat, trash and dust), can be evaluated.

Currently, the routine report includes the following statistical parameters:

− mean values: arithmetic average of test series;
− CV% between samples (the lower the CVb, [%], the better the end results);
− Q95% confidence limits (indicates a range within a test's mean value result would come to lie again with 95% probability, if the test must be repeated using samples from the same batch of the tested yarn);
− Max. and Min. sample values (can be used to check which values are furthest from the mean value);
− USP_{01} or USP_{07} (indicates the percentage where the mean value of a test series would be located on USTER® STATISTICS chart published in 2001 or in 2007).
For the quality assurance in spinning mills, the assessment of the yarn quality is still based on numerical values but also, on graphic representations (diagrams and spectrograms). These are very helpful especially, when there is not available USTER® STATISTICS PERCENTILE to be selected for a certain raw material. As well, diagrams and spectrograms can be tools for the status assessment of spinning process in mills.

The yarn quality evaluation is improved with the make-up of the spectrogram and diagram of mass variation and respectively of the hairiness, because:

- the diagram of mass variation shows if there are any significant random mass deviations along the tested yarn and also contains all information from which is derived the spectrogram;
- the spectrogram of mass variation indicates periodic faults (periodic yarn mass variation) both, the tolerable faults and the severe ones;
- the diagram of hairiness shows the hairiness variations along the tested yarn and the diagram width is related on the degree of the standard deviation of the hairiness;
- the spectrogram of hairiness shows the periodic variation of hairiness and a high standard deviation of hairiness typify at least an indication on the hairiness periodicities presence.

2.3. Interpretation of the USTER® TESTER 4 Additional Graphics for the Quality Assurance

1) USTER® TESTER 4 system determines besides of the already known graphic representations, the quality profile in a circular chart; that is possible to be achieve like a graphic representations of the test values with simultaneous automatic classification and color-coding. Again, even without numerical values, USTER® QUALIPROFILE (UQP) provide simple and comprehensive information about the produced yarn quality and is possible to recognize immediately if the quality characteristics agreed with customers demands (nominal values) are exceeded [9].

Color code and symbols in this circular diagram, are the following:

a) The thick and dotted lines in the diagram symbolize the different USP values (if they are available):
   a₁) the first thick ring around the center means the 5% USP and the outermost thick stands for 95% USP; the gradations follow the usual division into 25%, 50% and 75% USP;
   a₂) when the USP are not available for evaluation, the thick and dotted lines are not shown;

b) the thick blue rings shown in the graphic representation indicate the set limits or control limits that have to be defined by the customer;

b) Different shades of green, indicate even smaller differences in the good range of the yarn quality (“go or keep going”); red means “stop or intervention” and for the yellow, it is up to the user to either “going or to stop”.
c) Additional circles of different colors in the individual green sectors have the same meaning as with mean values parameters; for example, a red circle also represents an inadequate variation between tested yarn bobbins.

2) Classification criteria used with the USTER® QUALIPROFILE is based on a given limit value as specified and can be done as follows: “very good”, “good, “adequate”, “questionable” (this level represents a quality limit that, when reached, requires appropriate action to keep the yarn quality under control), “inadequate” (the yarn not meet the specifications and problem-solving interventions in the raw material or the production process are necessary) and finally, “poor” (yarns are far from meeting the required specifications).

3) In addition or not with the quality profile, the tested yarn can be displayed as a taper board or as fabrics (woven or knitted) on the screen of the UT4 system, in order to be able to evaluate the appearance of the yarn faults in the fabrics. The fabric simulations are generated by the USTER® TESTER 4 software, by using the test results data of mass variation, yarn imperfections and of the spectrograms. Simulations of the denim fabric in addition with single jersey knitted fabric make it possible to predict the yarn’s appearances in a finished product. This way, it is possible also to dispense with the time consuming for the weaving or knitting of fabric samples for quality assurance planning.

3. Conclusions

The paper issue was to explain the meaning of the overall analysis achieved with USTER® TESTER 4 laboratory system in order to prevent misunderstandings that can result in wrong decisions, equally for the suppliers and for the customers.

Further, in Part II will be describing the actual USTER® TESTER 4 reports and the available graphical evaluations for 24 Ne (25 Tex) yarn spun by both, ring and open end spinning systems from 100% carded cotton, designed for knitwear.

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REFERENCES

Această lucrare abordează două dintre subiectele cele mai importante legate de caracteristicile calitative ale firelor: structura (prin uniformitatea densității de lungime) și aspectul (prin pilozitate). În această parte a lucrării vor fi descrise interpretarea unui raport de testare obținut pe sistemul USTER® TESTER 4 și a reprezentărilor grafice disponibile pentru a evalua calitatea firului și pentru a preveni interpretările greșite care pot să duce la decizii greșite în tricotarea acestuia.