INTERNAL STRUCTURE AND STRENGTH OF COTTON YARNS

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1. Introduction

The main aim of this work is description of yarn production technology influence on the cotton yarn internal structure and selected mechanical properties. Three types of yarn production technology are selected. The internal structure is characterized from yarn cross-sections and longitudinal views. The hairiness is evaluated by the new method based on the image analysis. The influence of yarn internal structure on the ultimate tensile mechanical characteristics is discussed.

2. Experimental part

The yarns from the same material were spun under comparable technological conditions. Three technologies namely **ring, rotor** and **new pilot plant** one having improved hairiness (denoted as experimental yarn) was selected. The yarn fineness was 10, 20 and 29.5 tex. The yarn twist was selected in accordance with requirement of the same twist coefficient for the same fineness. In practice is common to use higher twist coefficient for rotor yarns (leading to the higher strength). There were problems with spinning ability of 10 tex rotor yarn. For this fineness were therefore fabricated the ring and experimental yarns only. For 10 tex yarns the combed technology (finer, longer and stronger fibers) was used. The 20 and 29.5 tex yarns were prepared by carded technology.

The yarn structure was evaluated from cross sections and longitudinal views. The special software for data treatment has been created.

The yarns structural parameters were measured according to internal standards of Textile Research Center [1]. The ultimate mechanical properties were measured according to ISO standards.

The radial analysis of cross sections was made by the Secant method [1-3]. The number of fibers, radial packing density trace, effective packing density and effective yarn diameter were evaluated as mean characteristics from 40 cross sections.

Experimental evaluation of radial packing density trace was based on the division of yarn cross section to the radial system of annual rings and computation of relative portion of fiber areas to the ring area [1].

The yarn diameter is usually replaced by the diameter of equivalent cylinder containing majority of fibers. Effective yarn diameter was evaluated as value corresponding to the mean radial packing density 0.15.

The measuring the yarn hairiness from longitudinal views was based on analysis of yarn images [4]. Black and white pixels were obtained after binary segmentation. The relative frequency of the black pixels on each distance from fiber axis (from 800 images) was used for creation of so called the <u>blackness or hairiness function</u>. The effective yarn diameter D was defined as distance corresponding to 50% of blackness function. The value of hairiness has been expressed as the area under this curve in the interval $<D; 3D>$. There are close connection between this hairiness and hairiness evaluated from Uster Tester 4 [4].

3. Results and discussion

The differences in radial packing density trace between yarn production technologies were statistically insignificant. Higher values in the fiber axis vicinity for ring yarn fineness 10 tex were due to higher twist level. This observation is in accordance with practical experience. The dependence of yarn hairiness on the yarn fineness is shown on the fig.1. Lowest hairiness and highest diameter have rotor yarns. Ring yarns have lowest diameter and moderate hairiness. Experimental yarns have moderate diameter and highest hairiness

Fig. 1 Yarn hairiness [-]

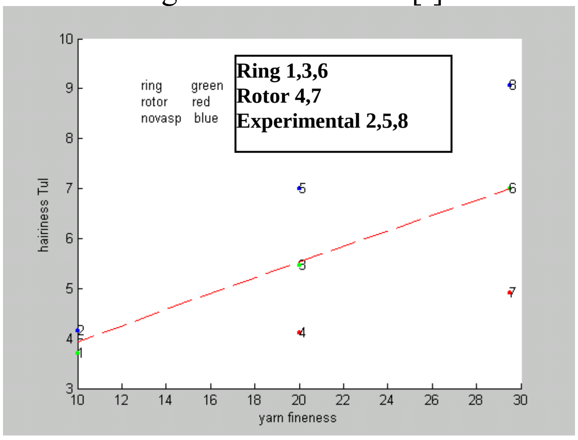
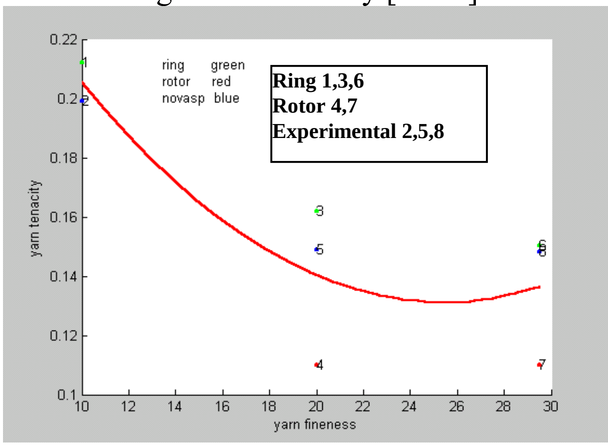


Fig.2 Yarn tenacity [N/tex]



Yarn strength is a result of many variables as fiber parameters; including strength and surface characteristics, yarn specifications, resulting in yarn packing density, the technology applied and machine setting. The dependence of yarn strength on the yarn fineness is shown on the fig. 2.There is visible that higher yarn count leads to decreasing of yarn strength. For the same yarn fineness is smallest yarn strength for rotor yarn in comparison with ring and experimental ones. This result is due to highly disordered structure of rotor yarn.

4. Conclusions

The technology of yarn production leads to the following differences in yarn structure and properties:

- Rotor yarn has characteristic closed structure with tips. This yarn has smallest hairiness. Disordered internal structure leads to the smallest strength.
- The ring yarn has more arranged structure with higher hairiness and maximal strength.
- The experimental yarns have similar internal structure as ring one. The main differences are in hairiness and looser arrangements in subsurface layers. Result is slightly lower strength.

It is therefore possible to select right technology from point of view of desired properties and production economy.

AKNOWLEDGEMENTS:

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5. References

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