Changes of Cotton Fiber Linear Density and Maturity During the Spinning Process

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ABSTRACT

The AFIS system enables the measurement of different cotton fiber parameters in raw material and intermediate products in the successive stages of processing. In this investigation, particular attention was paid to such fiber parameters as maturity (MR, IFC) and fineness. The values of these parameters were analyzed in different stages of processing. In addition, the quality of rotor yarns produced from chosen raw material and the quality of dyed knitted samples were assessed. A slight improvement in maturity during the spinning process was observed but in designing fabric, the maturity of the raw material is of prime importance.

Introduction

Information from the AFIS system on fiber parameters in raw materials and intermediate products can be applied to:

- raw material assessment in the trading purpose,
- assessment of changes of spinning parameters during processing,
- analysis of the operation and adjustment of spinning machinery,
- explanation of problems during the technological process,
- and finally, for optimization of technological process and blend settings.

Our investigations were carried out under industrial conditions. Cotton fineness and maturity parameter changes were considered in spinning carded and combed yarns. The changes of mean degree of maturity and share of mature and immature fibers in the sliver from the second drawing frame (finisher) in relation to the raw material were analyzed by Jeżewska (1991). Slight differences in Micronaire (IM) and degree of maturity were analyzed with the polarized light method.

Yankey and Qaud (1995) analyzed changes of fiber maturity in the opening/blending and carding processes using the AFIS system. No differences were detected in the former, but a slight increase of immature fiber content (IFC) was observed for the latter. The age and type of carding machine influence the maturity distribution. The higher speed of carding machine causes the increase of IFC.

The range of measurement and methodology

The cotton fiber properties were measured in each laydown of bales and in the intermediate spinning products for the successive stages of processing, starting from the scutching lap (or cardmat) and ending according to Żurek *et al.* (1997) coarser fibers are removed from the sliver to the noils after the combing process. Consequently, very precise analyses of on sliver from the second drawing frame (finisher) or in some cases on roving. Raw material and half-product fiber characteristics were determined on the AFIS system. In each case five samples of mass 500 mg were taken for the AFIS measurement. Cotton was processed by combing (five blends) and carding (two blends).

The full analysis was conducted on:

- length and its distribution,
- short fiber content,
- fineness and its distribution in mtex,
- maturity and its distribution and immature fiber content,
- nep content and distribution of their size,
- trash and dust content as well as distribution of their size.

This paper analyses the distributions obtained for cotton fiber fineness and maturity.

Analysis of changes of mean cotton fiber fineness and maturity during processing

Figures 1 and 2 present changes in mean fiber linear density in the successive stages of technological processes for combed and carded yarns. The increase of mean fiber linear density was observed between the raw material and sliver from the second drawing frame (finisher) of about 10% in the combed process and 5-6% in the carded one for all analyzed samples. This suggests that thin fibers (probably immature) are removed in the noils during the process. This was confirmed in further investigations.

The fiber linear density increases monotonically but more violent increase is observed after the carding and combing processes. It should be pointed out that

distributions of linear density and maturity for fibers from combed sliver and noils were performed. Table 1 summarizes the results of these analyses.

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Figures 3 and 4 show changes of Maturity Ratio (MR) and immature fiber content (IFC) for the successive technological stages. In all analyzed samples of raw material, the maturity level was similar (MR = 0.89 ÷ 0.98) and corresponding to the class "mature". IFC was in the range 4.2% ÷ 6.7%, which is "very mature" according to the Uster Zellweger`s classification.

On the basis these results the following trends were observed (Table 2).

1. The systematic increase of MR and decrease of IFC in the successive stages of spinning process.
2. The size of changes depends on the kind of the technological process. The bigger decrease of IFC was observed in the combed process.
3. For the combed process, the increase of MR for sliver from the second drawing frame (finisher) in relation to the raw material from the bale ranged from 6 ÷ 14% with an analogous decrease in the absolute value of the IFC of 0.3 ÷ 0.5%.
4. In the carded process these changes were 6 ÷ 7% for MR and 0.2 ÷ 0.3% for IFC.

Changes of cotton fiber linear density should be taken into consideration while engineering yarn design, especially with regard to fine rotor yarns where the number of fibers in the yarn cross-section is a very important factor that influences machine settings and yarn strength.

Slight changes of cotton maturity and IFC indicate that from the material engineering point of view the choice of raw material of appropriate maturity is the most important problem because the technological process does not assure removing the significant fraction of immature fibers.

Conclusions

An increase of mean fiber linear density in the technological process of about 10% for the combed spinning system and about 5 % for the carded yarns was observed. It should be taken into consideration during when designing the yarn, especially in the case of fine rotor yarns were the number of fibers in the yarn cross-section is critical.

Slight positive changes of MR and IFC during the technological process were observed (increase of MR and decrease of IFC).

Slight changes of mean maturity and immature fiber content indicate that from the point of view of designing a textile product, the choice of raw material of appropriate maturity is a very important factor because the technological process will not assure significant removal of the immature fiber.

References

Jeżewska E. (1991): Maturity of cotton in raw material. (In Polish) Technik Włókienniczy. SIGMA-NOT, Sp.z.o.o (Ed) 4:89-92.

Yankey, J.M. and M. Qaud. (1995): Applications of Single Fiber Cotton Maturity, Uster Solutions No 2 September.

Żurek W., M. Greszta, I. Frydrych and G. Balcar. (1997): Changes of fiber characteristies during the spinning process. In: Proc. 5th Cotton International Conference, Gdynia. Edited and Distributed by Gdynia Cotton Assoc. Pp. 152-167.

Watson M.D. (1992): Measurement and evaluation of dye resistant neps and immature fibers. In: Proc. 21st Intl. Cotton Conf. Bremen. H. Harig and S.A.Heap (Ed). Faserinstitut, Bremen. Pp 159-163.

Ghorashi H.M. (1996): New developments in fiber testing. In: Proc. 26th Intl. Cotton Conf. Bremen. H. Harig and S.A.Heap (Ed). Faserinstitut, Bremen. Pp.55-65.

Table 1. Comparison of maturity and linear density parameters in the sliver from the combing frame and in noils.

Lp	Parameters	Sliver		Noils	
		X	$X_{min} – X_{max}$	X	$X_{min} – X_{max}$
	Maturity				
1.	Maturity Ratio [-]	0.98	0.97 - 1.00	0.90	0.88 – 0.91
2.	IFC [%]	4.26	3.4 – 5.3	3.98	3.1 – 5.0
3.	Share in [%] of fibers characterized by circularity coefficient:				
	1.00 ÷ 0.75	14.0	13.0 – 15.9	5.46	4.7 – 6.1
	0.75 ÷ 0.25	81.74	80.7 – 82.9	90.56	89.2 – 91.8
	0.75 ÷ 0.50	46.6	45.8 – 48.2	38.96	35.7 – 40.4
4.	Mediana of MR (according to 3 the most frequent classes) [-]	0.545	0.525 – 0.575	0.455	0.425 – 0.475
5.	Share in [%] of 3 the most frequent classes)	32.04	30.9 – 33.3	38.70	37.2 – 41.0
	Linear density				
6.	Mean linear density [mtex]	183	182 – 184	167	164 – 170
7.	Share in [%] of fibers of linear density:				
	>300 mtex	5.4	4.5 – 6.8	2.72	2.2 – 3.0
	300 ÷ 200 mtex	27.4	26.3 – 28.4	22.52	20.9 – 23.6
	<125 mtex	18.56	17.4 – 19.4	26.54	24.9 – 28.2
8.	Share in [%] of 3 the most frequent classes	48.52	47.0 – 49.8	48.48	45.7 – 49.4
9.	Mediana (according to 3 the most frequent classes) [mtex]	162.5	162.5	152.5	137.5 – 162.5

Table 2. Changes of cotton linear density and maturity during the spinning process.

Parameter	Combed process	Carded process
Linear density Tt	Increase about 10 - 11%	Increase about 5 - 6%
Maturity RM	Increase about 6 - 14%	Increase 6 - 7%
Immature Fiber Content IFC	Decrease 0.3 - 0.5% (of absolute value)	Decrease 0.2 - 0.3% (of absolute value)

Figure 1. Changes of linear density in combed process.

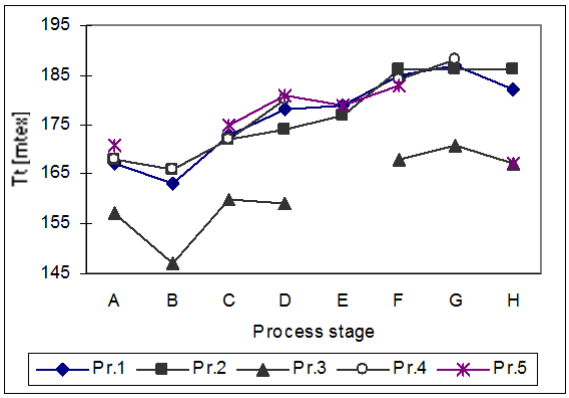

Figure 2. Changes of linear density in carded process.

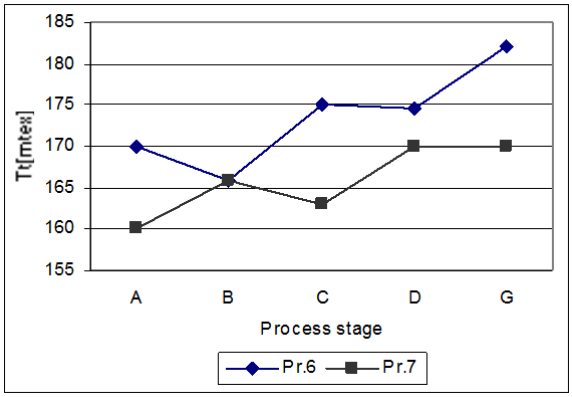

Figure 3a. Changes of maturity MR in combed process.

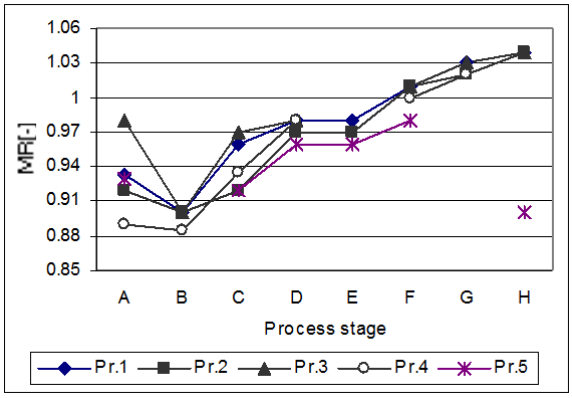

Figure 3b. Changes in IFC in combed process.

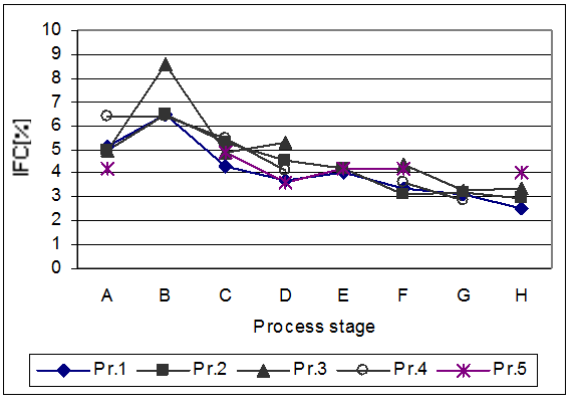

Figure 4a. Changes of maturity MR in carded process.

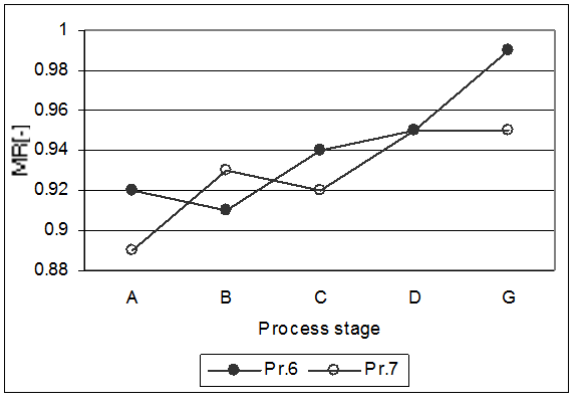

Figure 4b. Changes of IFC in carded process.