ISSN 1392–1320 MATERIALS SCIENCE (MEDŽIAGOTYRA). Vol. 13, No. 4. 2007

Control of Fabric End Use Properties Based on the Principle of Restricted Pulling Through a Nozzle

Diana GRINEVIČIŪTĖ[1*], Gailutė KAZAKEVIČIŪTĖ[1], Aušra ABRAITIENĖ[1], Dainora TRUNCYTĖ[2], Matas GUTAUSKAS[2]

[1]*Lithuanian Textile Institute, Demokratu 53, LT-58584 Kaunas, Lithuania*
[2]*Department of Clothing and Polymer Products Technology, Kaunas University of Technology, Studentu 56, LT-51424 Kaunas, Lithuania*

Received 05 September 2007; accepted 09 October 2007

In this work, investigation of hand parameters' extent of polyester and blended cotton/bamboo fabrics was performed. It was established that tenuous specific differences, which depend on fabric end finish, could be determined using KTU-Griff-Tester. It was revealed that bamboo fiber interblended into cotton fabric basically changed the scale of main hand parameters as well as their extent that was influenced by fabric washing and chemical treatment processes. As in other cases, the most sensitive hand parameter, i. e. complex hand rate *Q,* was established. If compared to analogous parameters of control specimens, its extent (with alternating finishing conditions) as often as not reached 5 times.
Keywords: materials science, textile, cotton, bamboo, hand, chemical softening.

INTRODUCTION

Emergence of new fibrous materials and changing technological processes in their manufacture lead to a new relevant materials science problem related that is to control of mechanical parameters of new materials. In the majority of cases, conventional methods, which define determination of strength and other standardized parameters, do not allow detecting significant differences between separate fabrics after different finishing, washing, softening and other processes that vary for several times during garment wear period.

Research of the recent years has shown that one of the most sensitive and most perspective control methods of textile garments' end use properties may be punching (extraction) of a disc-shaped specimen through a nozzle [1 – 7]. It was established that applying the method and the adequate device created at KTU, it is possible to determine fabric hand parameters' extent after different wear care processes [8 – 12].

The aim of this work was to determine the influence of bamboo fiber on fabric hand parameters' scale as well as their extent, influenced by fabric washing and chemical softening.

MATERIALS AND METHODS

Selected objects of investigation included thin lining polyester fabric (P-X and P-Y) and several groups of cotton, bamboo and blended cotton/bamboo fabrics for special purposes (Table 1).

Determination of fabric hand parameters was performed using KTU-Griff-Tester and applying earlier developed and published methodology [8 – 10]. Four hand parameters were identified from the extraction curve *H-P*: P_{max} – maximal extraction force, tgα – initial slope angle, A – pulling work. The primary hand parameters were expressed by one numeric value – the complex hand parameter Q – area of a polygon in a polar chart.

Part of the investigated objects was soaked in industrial softeners: non-ionogenic "Viskosil PSN" ("BOME") and cationogenic "Belfasin SI" ("COGNIS"). Textile fabrics' treatment was performed periodically using 5 % of softener from fabric weight, modulus 1 : 50, temperature 40 °C, duration – 20 min. After treatment, fabrics were squeezed and dried in a horizontal position. In comparison, fabrics of the same structure were soaked in pure water in the same conditions, then squeezed and dried. Number of specimens in each group varied from 5 to 8.

RESULTS AND DISCUSSIONS

Analysis of polyester lining fabrics showed that initial parameters of P-X and P-Y fabrics, which were produced in the same technical conditions by different companies X and Y, were identical (Table 1).

Hand parameters of these fabrics were also similar (Table 2). However, some differences appeared in peak areas of fabric extraction curves (Fig. 1). The peak point P_{max} of fabric P-X curve *H-P* has a shape of knife-edge followed by an instant decrease of extraction force *P*. Part of the peak of fabric's P-Y curve *H-P*, however, is obtuse, with multiplex zigzag oscillation. This means that fabrics' behaviour during the extraction process is slightly different, i. e. they fold differently between limiting plates [12]. Current observation seems to be related to the peculiarities of technological finishing, which determine fabrics' surface parameters. This comparison of *H-P* curves' peaks may be effective when analyzing subtle differences in textile finishing.

Interesting scientific results were obtained when investigating hand parameters of cotton fabrics interblended with bamboo fiber.

In case of raw fabric (plain weave), increase of bamboo fiber quantity in the fabric led to decrease of the main hand parameters tgα and Q (that characterize fabric softness)

*Corresponding author. Tel.: +370-37-313432; fax.: +370-37-314423.
E-mail address: *asta.sileikaite@stud.ktu.lt* (A. Šileikaitė)

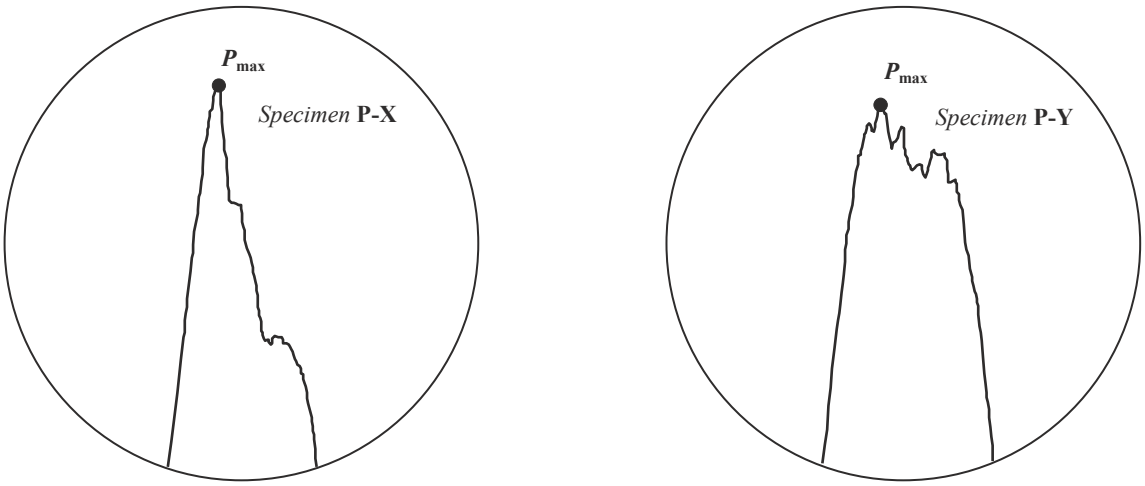
(Table 3). When cotton was totally substituted by bamboo, decrease of tgα reached 0.74, and Q – 0.91 (parameters of the initial specimens were equal to 1.0). Due to fabric shrinkage, values of P_{max} and A parameters tend to vary.

After treatment, fabrics become uniform according to their thickness and other characteristics. In this case it was also noticed that the increase of bamboo fiber quantity in blended cotton/bamboo fabric (twill weave) from 0 % to 55 %, led to decrease of hand parameters (improvement) as well: tgα – up to 0.84, A – up to 0.85, Q – up to 0.73. Only the parameter P_{max} slightly increased. When bamboo quantity composed 55 %, P_{max} decreased to 0.82.

Table 1. Objects of investigation

Fabric	Composition	Weave	Density (Warp/Weft), cm^{-1}	Area density, g/m^2	Thickness, mm
Lining fabrics					
P-X	PES 100 %	Plain	46/22	60	0.11
P-Y	PES 100 %	Plain	46/22	60	0.11
Raw fabrics					
C-1	Cotton 100 %	Plain	24/19.4	144	0.37
CB-1	Cotton 55%, bamboo 45 %	Plain	24/19.4	141	0.34
B-1	Bamboo 100 %	Plain	24/19.4	142	0.33
Finished fabrics					
C-2	Cotton 100%	Twill	36/19	241	0.47
CB-21	Cotton 85 %, bamboo 15 %	Twill	36/19	241	0.49
CB-22	Cotton 75 %, bamboo 25 %	Twill	36/19	241	0.49
CB-23	Cotton 65 %, bamboo 35 %	Twill	36/19	244	0.48
CB-24	Cotton 45 %, bamboo 55 %	Twill	36/19	238	0.48

Note: P – polyester; C – cotton; B – bamboo; CB – cotton + bamboo.



a b

Fig. 1. Illustration of the peak areas of polyester fabrics' P-X (a) and P-Y (b) extraction curves *H-P*

Table 2. Hand parameters of P-X and P-Y fabrics

Fabric	P_{max}, N	tgα	A, Ncm	Q
P-X	14.7±0.3	10.13±0.51	48.8±2.9	0.0172
P-Y	14.4±0.3	10.33±0.32	53.0±3.1	0.0177

Table 3. Influence of fabric composition, weave and finishing on hand parameters

Composition	Weave	P_{max}, N	tgα	A, Ncm	Q
Raw fabrics					
C – 100 %	Plain	9.9	10.43	36.7	0.0139
C– 55 % + B – 45 %	Plain	10.2	9.48	38.8	0.0137
B – 100 %	Plain	10.7	7.67	38.7	0.0127
Finished fabrics					
C – 100 %	Twill	96.6	66.35	301.2	0.2707
C – 85 % + B – 15 %	Twill	107.4	66.70	358.3	0.3211
C – 75 % + B – 25 %	Twill	110.2	66.80	353.9	0.3228
C – 65 % + B – 35 %	Twill	101.5	61.7	338.8	0.2907
C – 45 % + B – 55 %	Twill	78.8	55.6	255.3	0.1979

Note: C – cotton; B – bamboo.

Table 4. Relative change of fabrics' hand parameters after washing and chemical treatment, compared to initial specimens (which parameters were equal to 1.0)

Pro0cess	ΔP_{max}	$\Delta tg\alpha$	ΔA	ΔQ
Raw fabrics				
Cotton – 100 %, plain weave				
Washing	1.10	0.79	1.04	0.96
Softening "V"	0.98	0.75	0.95	0.87
Softening "B"	0.96	0.75	0.89	0.86
Bamboo – 100 %, plain weave				
Washing	0.81	0.75	0.76	0.80
Softening "V"	0.51	0.52	0.49	0.62
Softening "B"	0.41	0.51	0.40	0.54
Finished fabrics				
Cotton – 45 % + bamboo – 55 %, twill weave				
Washing	0.93	0.78	0.92	0.80
Softening "V"	0.33	0.33	0.35	0.18
Softening "B"	0.37	0.36	0.39	0.21
Cotton – 100 %, twill weave				
Washing	0.94	0.74	0.99	0.82
Softening "V"	0.49	0.46	0.53	0.30
Softening "B"	0.53	0.52	0.60	0.36

Note: "V" – softener "Viskozil PSN"; B – softener "Belfasin Si".

Analysis of blended cotton/bamboo fabrics' hand parameters extent after soaking (washing) and chemical softening revealed that fabrics' soaking in water (washing imitation) and in chemical softeners decreased (improved) hand parameters in all cases (Table 4). Only in rear instances parameters P_{max} and A insignificantly increased (raw cotton fabric of plain weave).

Chemical softeners improved hand parameters of all fabrics, but in case of raw fabrics – only up to 0.75 – 0.96 of the level of initial specimens, and for finished fabrics – up to 0.21 – 0.36. The influence of both "V" and "B" softeners was very similar. The most significant improvement, which was dependent on chemical softening, was determined for blended fabric (C – 45 % + B – 55 %). Softener "V" decreased all hand parameters of this fabric from 1.0 to 0.35 – 0.18, which means that hand has been improved by 3 – 5 times. It should be noted that the influence of softener "V" was more significant on cotton fabrics, and the influence of softener "B" – on bamboo ones.

It should be also noted that in all cases the most sensitive hand parameter was complex rate Q. Its variation (having different finishing conditions) often reached 5 times, when compared to corresponding parameters of initial specimens.

CONCLUSIONS

Analysis of specimen extraction through a nozzle curve *H-P* peak's zone may be useful for investigation of specific textile fabric attributes, related to finishing peculiarities.

Addition of bamboo fiber into cotton fabric improves its hand parameters. Increase of bamboo fiber quantity leads to more significant improvement of fabric hand.

Efficiency of chemical softeners "Viskozil PSN" and "Belfasin Si" is very similar when softening cotton – bamboo fiber fabrics. The most significant changes, caused by chemical softening, are inherent to blended fabric (C – 45 % + B – 55 %). Softener "Viskozil PSN" improved all hand parameters of this fabric from 3 to 5 times.

REFERENCES

1. **Grover, G., Sultan, M. A., Spivak, S. M.** A Screening Technique for Fabric Handle *Journal of the Textile Institute ISSN 0040-5167* 23 (3) 1993: pp. 486 – 494.
2. **Henrich, L., Seidel, A., Rieder, O.** Griffprüfung von Maschenwaren *Maschen-Industrie* 7 1999: pp. 46 – 47 (in German).
3. **Seidel, A.** Griffbewertung von Strumpfwaren mit dem JTV-Griff-Tester *Melliand Textilberichte ISSN 0341-0781* 6 2001: pp. 491 – 494 (in German).
4. **Martišiūtė, G., Gutauskas, M.** Būdas ir įtaisas tekstilės grifui nustatyti (Method and Device for Textile Hand Evaluation). LT pat. 5050, 2001.
5. **Truncytė, D., Gutauskas, M.** Prietaisas tekstilės grifui nustatyti (Device for Textile Hand Evaluation). LT pat. 5293, 2005.
6. **Martišiūtė, G., Gutauskas, M.** A New Approach to Evaluation of Textile Fabric Handle *Materials Science* (*Medžiagotyra*) *ISSN 1392-1320* 7 (3) 2001: pp. 186 – 190.
7. **Strazdienė, E., Daukantienė, V., Gutauskas, M.** Bagging of Thin Polymer Materials: Geometry, Resistance and Application *Materials Science* (*Medžiagotyra*) *ISSN 1392-1320* 9 (3) 2003: pp. 262 – 265.
8. **Grinevičiūtė, D., Papreckienė, L., Gutauskas, M.** The Optimization of Complex Hand Rate Determination *Materials Science* (*Medžiagotyra*) *ISSN 1392-1320* 12 (1) 2006: pp. 79 – 83.
9. **Strazdienė, E., Gutauskas, M.** The Peculiarities of Textile Hand Evaluation Method *Fibers and Polymers ISSN 1229-9197* 7 (4) 2006: pp. 414 – 419.
10. **Daukantienė, V., Bernotienė, B., Gutauskas, M.** Kontrola opipa tekstila korištenjem uredaja KTU-Griff-Tester *Tekstil ISSN 0492-5882* 53 (7) 2004: pp. 356 – 360 (in Croatian).
11. **Daukantienė, V., Zmailaitė, E., Gutauskas, M.** Influence of Concentrated Liquid Softeners on Textile Hand *Indian Journal of Fibre and Textile Research ISSN 0971-0426* 30(3) 2005: pp. 200 – 203.
12. **Truncytė, D., Papreckienė, L., Gutauskas, M.** Behaviour of Textile Membrane while Being Pulling Through a Hole by the Constrained Method *Fibres and Textiles in Eastern Europe ISSN 1230-3666* 15 (1) 2007: pp. 50 – 54.

Presented at the National Conference "Materials Engineering'2007" (*Kaunas, Lithuania, November 16, 2007*)