Research Paper Engineering

Assess the Performance of Linen Fabrics Treated Finishing Nano-Modifiers

* Tanska B. ** Nowalinska M. *** Hernik T.

* Institute of Natural Fibres & Medicinal Plants, 60-630 Poznan, ul. Wojska Polskiego 71 B, Poland.
* Institute of Natural Fibres & Medicinal Plants, 60-630 Poznan, ul. Wojska Polskiego 71 B, Poland.

* Institute of Natural Fibres & Medicinal Plants, 60-630 Poznan, ul. Wojska Polskiego 71 B, Poland.

ABSTRACT

The aim of this study was to improve the properties of linen fabrics by using nanomodifiers in refining processes. In the research linen fabrics made of yarns of different thickness, both bleached and dyed were used. During the study the composition of finishing baths containing standard components (reactive formaldehyde-free rasins) and nanomodifiers was developed. Comparative laboratorial tests were carried out. During each test the concentration of conventional aperture agents, polyurethane nanoadditives, silicone nanosofteners and auxiliaries for examined fabrics were changed. The parameters such as: bending stiffness, resistance to crease and colorimetric analysis were the basis to choose optimal variants of finishing bath.

It was found that, in the application of nanomodifiers in refining linen fabrics results in many positive properties without the shortcomings of side effects.

Keywords : nano-modifiers, finishing, nanoadditives, nanosofteners

INTRODUCTION

Institute of Natural Fibres & Medicinal Plants department in Zyrardow has conducted examination on the refining aperture which gives linen products anti-crease and softener features. Compositions of finish baths with the use of conventional agents (reactive formaldehyde-free resin) and nano-modifiers were developed. Comparative laboratorial tests were carried out. During each test the concentration of conventional aperture agents, polyurethane nano-additives, silicone nanosofteners and auxiliaries for examined fabrics were changed. The value of the examined parameters of linen fabrics were the basis to choose optimal options of classical and modified finish [1].

The aim of the study was improvement of mechanical properties by using nano-modifiers in finishes. Endowing the products with desired properties by using suitable modifiers leads to improved functionalization of these products.

One of the most important factors that influence the quality of fabric is ability of fabrics to recover from inducted wrinkles. Some kinds of fibers as wool or silk have a good resistance to creasing [2]. Flax fiber contains high amounts of pectins that act as substances sticking the elementary fibers and causing stiffness of the fiber. Complete removal of pectins in the finishing process threatens with breakdown to elementary fibers and thus leads to substantial decrease of breaking tenacity/ High stiffness on the other hand affects negatively the resistance to creasing and the hand of the fabric.

Another very important treatment for textile is softening finish. With softeners textile can achieve an agreeable, soft hand (supple, plain, sleek) some smoothness, more flexibility and better drape and pliability [3].

Different nano-modifiers were used in the study, which improve the above mentioned parameters. The tests were conducted to determine the crease resistance and the effect of the silicon nano-modifiers on the hand of the products.

EXPERIMENTAL PART/ RESULTS

The first stage of the research.

The material for the tests was linen fabric labeled as 30033, made of yarn of linear mass at 74 tex bleached to 75% whiteness.

The compositions of the finishing baths with standard additives were developed i.e. with reactive formaldehyde free resins and nano-modifiers [4, 5].

The comparative studies were run with variants of conventionally used concentrations of finishing agents, polyurethane nano-additives and additional agents for the tested fabrics.

Conventional finish:
- reactive formaldehyde-free resin – 100 g/dm3
- softening agent on the basis of fatty acids - 25 g/dm3
- softening agent on the basis of silicone - 25 g/dm3
- catalytic agent - 15 g/dm3

Modified finish:
- reactive formaldehyde-free resin - 60g/dm3
- polyurethane nanoadditive – 25 g/dm3
- softening agent on the basis of fatty acids - 25 g/dm3
- softening agent on the basis of silicone - 25 g/dm3
- catalytic agent - 9 g/dm3

Technical parameters of finishing:
- Degree of liquor pick-up - 65%
- Drying - 100 ÷ 110˚C
- Curing - 150˚C, 4 min

The crease resistance was determined according to the standard: PN-P-04737:1973 Textiles. Determination of drapeability.

Table 1. Crease resistance of linen fabric 30033 with conventional and modified finish.

Sample		Resistance to crease
		%
Linen fabric 30033 with conventional finish	warp	43.5
	Weft	48.0
Linen fabric 30033 with modified finish	Warp	60.8
	weft	59.2

The crease resistance of the fabric with modified finish is higher what implies that the relaxation of the fabric is higher than this observed for the fabric with conventional finish.

The finishing processes often cause negative changes in the fabric structure; therefore the mechanical properties were tested in the study [6]. The results of these tests are presented in Table 2.

Table 2. Strength parameters of the linen fabric 30033 before and after the modification.

Sample		Tensile strength	Breaking strength
		daN	daN
Linen fabric 30033 without finish	Warp	80.81	9.2
	Weft	87.97	9.8
Linen fabric 30033 with conventional finish	Warp	63.51	4.0
	Weft	61.24	4.4
Linen fabric 30033 with modified finish	Warp	75.10	5.0
	Weft	76.78	7.4

We can observe decrease in strength parameters of the fabrics with finish; still the results obtained for the modified finish are better than for the conventional finish.

Applied finish sometimes can be disadvantage because it may cause changes in hue and yellowing of white goods [3]. In order to evaluate the degree of yellowing or change of hue during the finishing process a colorimetric analysis was done for the samples. The test of color parameters were carried out with White-Color 01 device that compares the change in color between the non-finished fabric and the fabrics after conventional and modified finishing processes. The results (Figures 1 and 2) are graphically presented in the form of computer printouts in CIELAB colorimetric system.

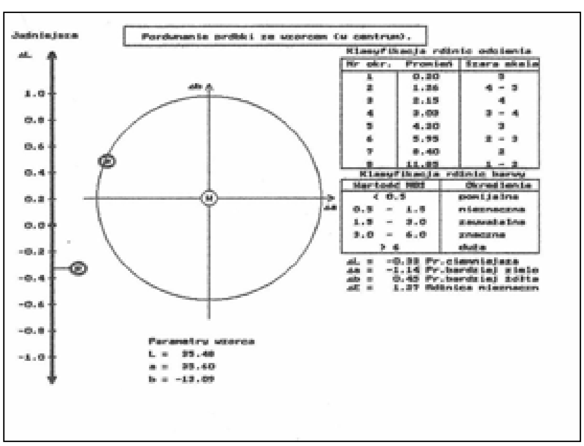

Figure 1. Comparison of non-finished fabric with the fabric with conventional finishing.

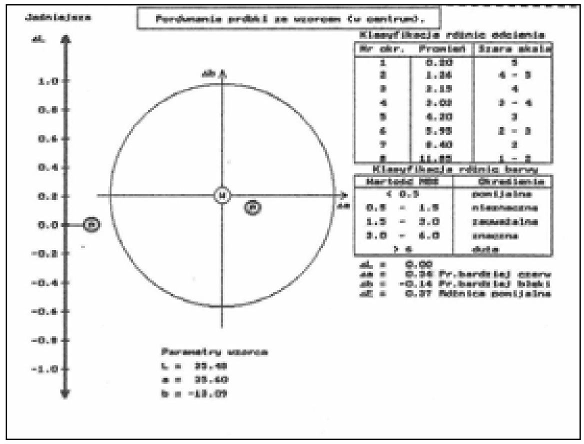

Figure 2. Comparison of non-finished fabric with the fabric with modified finishing.

The colorimetric analysis resulted in the following measurements:

- Non-finished fabric – 64,26%
- Fabric with conventional finish – 62,64%
- Fabric with modified finish – 62,86%

Based on the results of the colorimetric analysis it can be concluded that the process did not have significant effect on the hue of the fabrics.

The second stage of research.

The second part of the study comprised endowing the products with soft and smooth handle. This is linked with improvement of resilience and drapability. The softening effect is achieved by lowering the friction coefficient between fibers and increasing of the smoothness [7].

In order to improve the handle of the fabric two methods can be applied i.e. chemical and mechanical. For example to the mechanical softening is used machine a spiral scroll roller breaking machine – fabric having too stiff a handle is LED over and under the rapidly rotating scroll rollers and is thereby greatly softened. The alternate rollers rotate in opposite directions [8, 9].

The current study involved using the chemical method. Obtaining sufficient softness degree of linen fabrics required using high amounts of suitable softeners. Therefore the tested products were bathed in softening finish containing silicon nano-softener.

The most commonly used softeners are combinations of these products based on silicones and fatty acids. They ensure good feel and smoothness of the surface, yet have certain drawbacks. If the softening finish is applied to fabrics already dyed change in hue and reduction of the color resistance to wet rubbing and ironing can be observed.

Linen fabric labeled as 23080 was studied, made from yarn of linear mass at 44 tex bleached at 75% and fabrics dyed for salmon and black colors for determination of the effect of the finish on the change of color.

In the first stage of the study the finishing baths were prepared with addition of only silicon products for testing the softness degree of the fabrics. This parameter was determined by testing bending stiffness according to the standard: PN-P-04631:1973 Determination of stiffness of textiles. Then, colorimetric analysis was performed.

The fabrics were padded on a laboratory double shaft foulard machine with homogeneous padding degree of the bath i.e.

at 71% and were dried at 110°C in a drying chamber with air blow.

Table 3 presents the parameters of the fabrics softened with specific silicon products and the parameters of the non-finished reference fabric sample.

Table 3. Fabric parameters before and after application of softeners.

Composition of finishing baths with silicon products	Stiffness of fabrics	Whiteness degree
	μNm	%
Non-finished fabric	0.856	69.9
Persoftal nano-silk 10g/dm^3	0.417	69.2
Persoftal nano-silk 20g/dm^3	0.370	69.2
Persoftal nano-silk 30g/dm^3	0.359	69.2
Persoftal SIS 30g/dm^3	0.393	68.9
Sebosan SXB 30g/dm^3	0.368	68.2
Persoftal Plus 30g/dm^3	0.369	67.8

The compositions of finishing baths with maximum addition of softening agents (recommended by producers) and different amounts of softeners based on carboxylic acids combined with nano-silicon. The selection of the bath composition was done so that the optimum degree of fabric softness, improvement of the feel and drapability of the fabrics could be achieved.

The technical parameters of the padding process were as follows:

- padding degree - 68 %
- drying temperature - 120˚C

Table 4 presents the results of the measurements of bending stiffness and whiteness degree for linen fabric 23080 before and after finishing baths with the use of various amounts of softeners.

Table 4. The results of the measurements of the linen fabric 23080 after using various amounts of finishing products.

Composition of finishing baths with softening products		Stiffness of fabrics	Whiteness degree
		μNm	%
Non-finished fabric (reference)		0.856	69.9
Sebosan SN Sebosan SXB	30g/dm^3 30g/dm^3	0.360	68.1
Persoftal Pen Persoftal Plus	25g/dm^3 25g/dm^3	0.360	67.8
Persoftal Pen Persoftal nano-silk	10g/dm^3 30g/dm^3	0.350	69.2
Persoftal Pen Persoftal nano-silk	15g/dm^3 30g/dm^3	0.349	69.2

Apart from instrumental analysis, organoleptic examination of the fabric softness was also carried out. Although the method is regarded as controversial because of its subjective character, it is still used when evaluating the drapability of fabrics [10].

The handle of the fabrics and their drapability was evaluated as similar with indicating the fabrics softened with Persoftal nanosilk baths as the best among the tested samples.

It is known that padding with softeners can lead to changes in the fabric color, therefore the effect of silicon and nano-softeners on the color change was tested for the fabric in salmon color and for resistance to wet rubbing for the black fabric. The results of the tests are shown in Table 5.

Table 5. The evaluation of color change and resistance to wet rubbing for the fabrics finished with silicon and nano-softening finishes.

Composition of the finishing bath		Salmon fabric	Black fabric
		Color change	Color fastness to wet rubbing – Degree of whiteness soil
Non-finished fabric		reference	3 - 4
silicon containing finish			
Persoftal nano-silk	10g/dm^3	difference negligible	3 - 4
Persoftal nano-silk	20g/dm^3	difference negligible	3 - 4
Persoftal nano-silk	30g/dm^3	difference negligible	3 - 4
Persoftal SIS	30g/dm^3	Slight difference	2 - 3
Sebosan SXB	30g/dm^3	Noticeable difference	3
Persoftal Plus	30g/dm^3	Noticeable difference	2 - 3
finishes containing nano-softeners			
Sebosan SN Sebosan SXB	30g/dm^3 30g/dm^3	Noticeable difference	3
Persoftal Pen Persoftal Plus	25g/dm^3 25g/dm^3	Noticeable difference	2 - 3
Persoftal Pen Persoftal nano	10g/dm^3 30g/dm^3	Noticeable difference	3 - 4
Persoftal Pen Persoftal nano-silk	15g/dm^3 30g/dm^3	Negligible difference	3 - 4

The analysis of the results leads to the conclusion that the finishing baths did not affect significantly the change of color and its resistance to rubbing.

DISCUSSION:

The comparative analysis of linen fabric finished with conventional anti-crease finishing and the modified one, the following observations were made. By replacement of reactive resin with 40% polyurethane nano-additive the following effects were found:

- better crease angle, what is represented in relaxation test by 17% for warp and by 11% for weft,
- lower loss of strength parameters from 12 to 15 daN for stretching and from 1 to 3 daN for tearing strength,
- better touch,
- improved ecological conditions by reduced methanol emission.

The use of silicon nano-softener in refining finishing for linen fabrics results in numerous improved parameters without any undesired effects:

- the softness of the fabrics expressed as the total bending stiffness is more than 40 % higher than this of the non-finished fabric,
- the product does not have negative effect on the whiteness of fabrics,
- the product does not have negative effect on the change of fabric color and the resistance of the dyeing to wet rubbing,
- the use of silicon nano-softener allows for 40% reduction in use of preparations that improve the hand of fabric, what is beneficial for the environment.

CONCLUSION:

After the bath of modified finish with polyurethane nanoadditive and after modified finish with nanosilicon we can observe:

- improvement of crease resistance:
- improvement in the resistance parameters (tensile strength and tearing strength),
- increased fabric softness,
- absence of effect of the softening nanoproducts on the color and its resistance to wet rubbing,
- better fabric feel,
- improvement of ecological conditions.

REFERENCES

1. Kut D., Gutnsesoglu C., Orhan M., 2010, Crease-resistance finish of linen/viscose blend fabrics, Fibres&Textiles in Eastern Europe 2010, Vol. 18, No. 6(83), 91-93. | 2. Can Y., Akaydin M., Turhan Y., Ay E., June 2009. Effect of winkle resistance finish on cotton fabrick properties. Indian Journal of Fibre & Textile Reserch. Vol. 34, 183-186. | 3. Schindler W. D., Hauser P. J., 2004, Chemical finishing of textiles, 29-41, Woodhead Publishing Limited. | 4. Bielecki J., Jędraszczyk H. 1973. „Technologia chemicznej obróbki włókien". Wrocław: PWSZ. | 5. Brzeziński S. 1999. „Wybrane zagadnienia z chemicznej obróbki włókna". Bielsko-Biała: Politechnika Łódzka. | 6. Mazzuchetti G., Demichelis R., Songia M.B., Rombaldoni F., 2008, Objective measurement of tactile sensitivity related to feeling of softness and warmth. Fibres & Textiles in Estern Europe 2008, Vol 16, No 4(69), 67-71. | 7. Poradnik inżyniera: Włókiennictwo1978, Warszawa: WNT. | 8. Behery H. 2005. Effect of mechanical and physical properties on fabric hand. Tomasino C., Effect of mechanical finishing on fabric hand, 342-383. Woodhead Publishing Limited. | 9. Hall A.J., 1966, „Textile Finishing". 86-134, London: Heywood Books | 10. Meissner J. 1979. „Apretura wyrobów włókienniczych". Warszawa: WNT | 11. Blackburn R. S., 2009, Sustainable textiles – Life cycle and environmental impact. 302-338. Woodhead Publishing Limited. | 12. PN-P-04737:1973 Textiles. Determintion of drapeability. | 13. PN-P-04631:1973 Determination of stiffness of textiles. | 14. PN-EN ISO 13934-1:2002 Textile. Tensile properties of fabrics – Part 1: Determination of maximum force and elongation at maximum force using the strip method. | 15. PN-EN ISO 13937-2:2002 Textiles. Tear properties of fabrics – Part 2: Determination of tear force of trousers-shaped test specimens (Single tear method). |