INFLUENCE OF TEXTILE CARE PROCESSES ON THE MECHANICAL PROPERTIES OF THE WOVEN FABRIC

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ABSTRACT
This research was carried out within the project Hospital Protective Textiles – HPROTEX with the goal of systematic research aimed at addressing the problem of textile dust, potential transmission of infectious agents and causers of sophisticated medical device malfunctions in the hospital environment.
In this paper the influence of the wash cycles on the mechanical characteristics of woven fabric for multiple use, of different construction and structural characteristics has been investigated. Fabric samples in different weaves and different density of warp and weft were subjected to a number of washing cycles after which their tensile properties were tested.
The results of the study have shown that the tensile modules of woven fabrics change with increasing number of washing cycles. The influence of weave and woven fabric density, ie weave and firmness factor, on tensile stiffness of the fabric subjected to the number of washing cycles is also evident.
Key Words: Textile dust, woven fabrics, textile care, mechanical properties

1. INTRODUCTION
Textile materials are widely used in healthcare facilities, such as hospitals, emergency rooms and trauma centers. To meet high hygiene standards in hospitals, the frequent textile care is required, resulting in a decrease of mechanical properties due to fiber damage in yarn, ie degradation of yarn structure. Degraded yarn structure subjected to the mechanical loads that occurs during usage of woven fabric is prone to increased release of textile dust particles. This can not only adversely affect the sterility of the hospital rooms but also can cause medical devices failure by depositing on their sensitive parts. Since most hospital textiles are made entirely or partly from cotton fibers, and cellulose supports growth of microorganisms, textile dust can be a carrier for microorganisms and be responsible for spread of infection in the hospital environment.
The geometric structure of the fabric is very complex [1]. The system is made up of several subsystems, each of which can be viewed as a separate complex entity and each, in part, affects the physical and mechanical properties of the fabric.
Under the influence of external loads, the fabric is strained and deformed at all levels: at fiber level, yarn as system of mutually twisted fibers, weave points and their close surroundings, which is dependent on repeat unit. Even at low loads, deformations occur in the structure of the fabric and are manifested as thread displacements. Because of this, friction (thread on thread) is present at the weave points. Warp and weft displacement in the weave point can weaken the yarn structure in such a way that the fibers tear due to friction and leave the structure in the form of textile dust. Amount of internal friction in the fabric depends on the characteristics of yarn and fiber and additionally on its structural and mechanical characteristics such as weave, fabric density, crimp and tensile properties [2]. The angle of yarns at the point of contact (weave point) and positioning of weave points in repeat unit will impact friction resistance, which is encompassed by two parameters - weave factor and fabric firmness factor.
Weave factor expresses way in which warp and weft interlace inside default repeat unit. Various ways of calculating weave factor are suggested by different authors. Weave factor according to Milašius calculation is presented in references [3-4].

Fabric firmness factor is measure for fabric compactness due to its constructional characteristics. Milašius modified Brierley's relation in which he embedded previously mentioned weave factor P_1 [5].

2. EXPERIMENTAL

Woven fabric samples from 50/50 cotton/polyester blend were tested. Samples are woven in plain, twill 3/1 and satin 4/1 weave. Declared warp thread number is 35.8 cm^{-1}. Unwashed samples and also samples after 1, 3, 10 and 25 washing cycles were tested.

3. RESULTS AND DISCUSSION

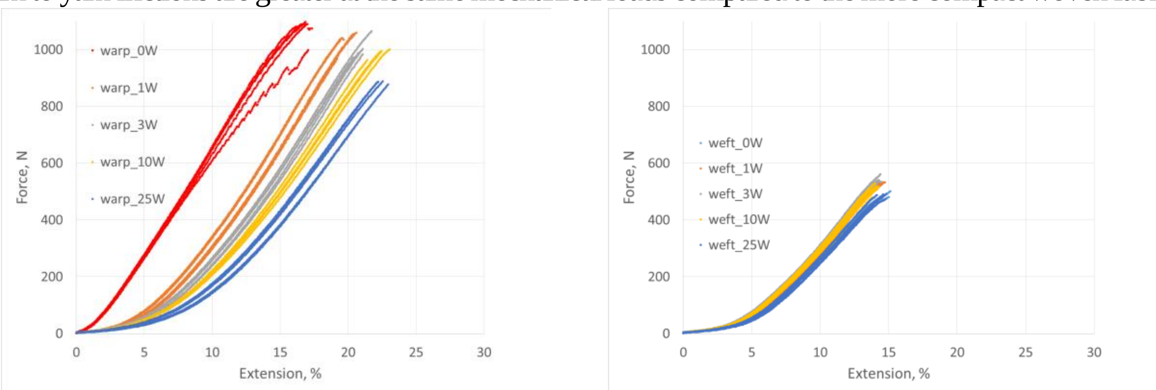
The fabric thickness and fabric density was determined for stated samples. Test results are shown in Tab. 1.

Table 1. Constructional characteristics of fabric samples

Number of wash cycles	Thickness [mm]			Fabric density [threads/cm]						Weave factor			Firmness factor		
				warp			weft								
	P	T	S	P	T	S	P	T	S	P	T	S	P	T	S
0	0,37	0,45	0,47	37	36	34	19	20	21	1	1,3	1,4	47,9	36,7	34,8
1	0,42	0,46	0,57	38	36	36	20	20	22	1	1,3	1,4	49,9	36,7	36,6
3	0,44	0,50	0,58	38	37	36	20	21	22	1	1,3	1,4	49,9	38,2	36,6
10	0,46	0,58	0,63	38	38	37	20	23	23	1	1,3	1,4	49,9	40,7	38,0
25	0,47	0,57	0,61	38	36	38	21	22	24	1	1,3	1,4	51,4	38,8	39,4

Where P is plain weave, T is twill weave, S is satin weave fabric

From the table it is apparent that as the washing cycles increase, due to the fabric shrinkage, there is a gradual increase of the warp and weft density, fabric thickness and consequently increase of firmness factor. For less compact woven fabrics in the twill and satin weave, this effect is weaker after a large number of washing cycles (25 cycles). The assumption is that the cause of this is the greater degradation of the yarn that is more mobile in these weaves, and the yarn to yarn frictions are greater at the same mechanical loads compared to the more compact woven fabric.

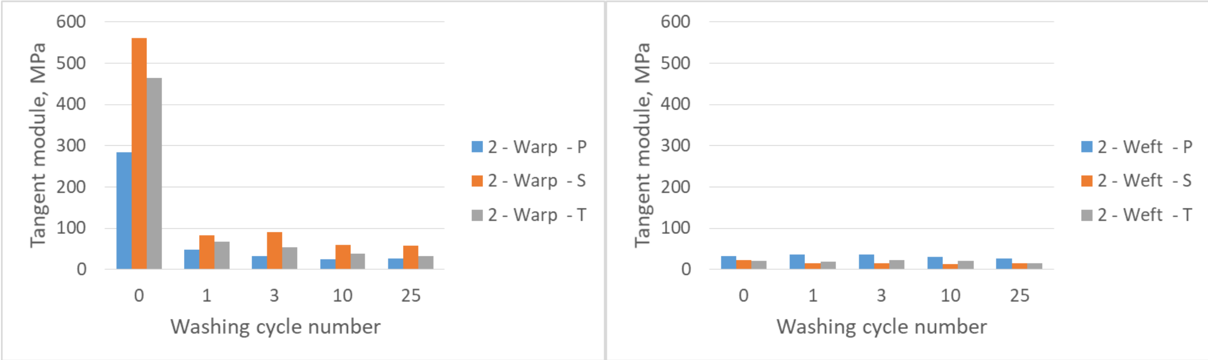


a. b.

Figure 1. Tensile properties of the woven fabric sample, plain weave, after 0, 1, 3, 10 and 25 washing cycles: a. warp direction, b. weft direction

Tensile properties of the fabric were also tested on *MesdanLab Strenght Tester* and the results are graphically shown in Fig. 1.

From the graph in Figure 1a, woven samples stress strain curves in the warp direction after 0, 1, 3, 10, and 25 washing cycles can be seen. From the curves slope it is apparent that the tensile stiffness of the sample falls most at the beginning, ie after the first washing cycle, while the modules lowering in the further cycles is visible but less pronounced. Because of the greater compliance of woven fabric after washing, it is expected that such fabrics in use will generate more dust. Compared to the tensile stiffness in the warp direction, the woven sample is initially more compliant in the weft direction, and the changes in the tensile modules are not pronounced. Fabric samples in other weaves behave the same way.



a. b.

Figure 2. Tangent tensile module at 2% extension of the woven fabric samples, after 0, 1, 3, 10 and 25 washing cycles: a. warp direction, b. weft direction

Figure 2 shows the tensile module of the woven samples in the warp direction (Fig.2a) and in the weft direction (Fig.2.b.) at a extension of 2% which is estimated as the extension of the fabric subjected to mechanical loads in normal use. From the figure it is apparent that the tensile stiffness of the fabric samples in all weaves in the warp direction is remarkably high and suddenly decrease right after the first washing cycle. At the same time, low tensile stiffness in the weft direction is extremely low due to higher fabric crimp.

4. CONCLUSION

The firmness factor of the fabric increases with the increase of the washing cycle number which results from the fact that the fabric shrinks in the washing process, and becomes more compact. Stagnation in firmness factor growth occurs at the critical point when yarns in the fabric start to lose their mechanical properties due to structure degradation. The tensile stiffness of the woven samples is highest in the warp direction, and already after the first washing cycle suddenly decreases, for increased relaxation of the woven fabric in the warp direction which is very tensed in the weaving process. The tensile stiffness differs depending on the weave, and at lower extensions, the woven fabric in weaves with a smaller number of yarn interlacements in weave unit, will have higher values of tensile modules thanks to a lower crimp.

Acknowledgments

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5. REFERENCES

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