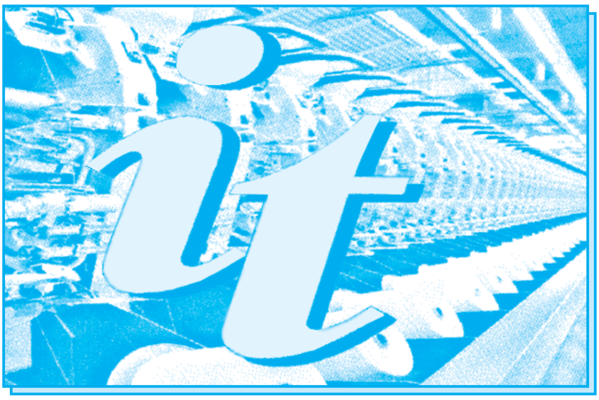

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A theoretical approach for predicting the tensile behavior of needle punched-heat set heavy geotextiles

ÜMIT HALIS ERDOGAN NILUFER ERDEM

REZUMAT – ABSTRACT – INHALTSANGABE

O abordare teoretică a prestabilirii comportamentului la tracţiune a geotextilelor grele interţesute termofixate

Geotextilele sunt supuse, în general, deformării la tracţiune, în etapa utilizării finale. Prin urmare, caracteristicile mecanice ale geotextilelor interţesute sunt foarte importante în proiectarea sistemului geotextile-sol. În acest studiu, s-a realizat o abordare teoretică în prestabilirea comportamentului mecanic al geotextilelor grele interţesute termofixate la testele de tracţiune. Modelul a fost construit folosind metoda elementului finit şi teoria materialelor compozite. Ca date iniţiale, în calculele teoretice, au fost utilizate proprietăţile unui material geotextil interţesut de referinţă. Pentru analiza tensiunii s-a folosit un program cu elemente finite, disponibil pe piaţă. Mecanismul de deformare a geotextilelor interţesute, în cadrul testelor de tracţiune, a fost evaluat prin compararea datelor rezultate din calculele teoretice cu cele experimentale. Rezultatele indică faptul că modelul poate prevedea cu destulă acurateţe modul de distribuire a tensiunii în geotextilele-eşantion şi, totodată, arată o deplină concordanţă cu datele experimentale. Cu toate acestea, în cazul alungirilor, modelul nu poate prevedea cu destulă precizie deformarea sub sarcină a geotextilelor grele.

Cuvinte-cheie: geotextile, neţesute, termofixare, teoria compozitelor, metoda elementului finit

A theoretical approach for predicting the tensile behavior of needle punched-heat set heavy geotextiles

Geotextiles are generally subject to tensile deformation during their end-use. Therefore, mechanical characterization of these fabrics is very important in designing a geotextile-soil system. In this study, a theoretical approach was proposed to predict the mechanical behavior of needle punched-heat set heavy geotextiles in tensile tests. The model was constructed using finite element method and the theory of composite materials. The properties of a reference fabric were used as initial data in theoretical calculations and a commercially available finite element program was chosen to carry out stress analysis. Deformation mechanism of geotextile fabrics in tensile tests was evaluated by comparing theoretical calculations and experimental data. The results indicate that the model can predict the stress distribution in sample fabrics reasonably well and show good agreement with experiments. However, in the case of elongations, the model could not predict the strains of heavy geotextiles accurately.

Key-words: geotextiles, nonwoven, heat-setting, composite theory, finite element method

Eine theoretische Ansatzmethode für die Voraussage des Zugverhaltens bei schweren vernadelt-thermofixierten Geotextilien

Geotextilien sind generell in der Implementationsstufe einer Zugdeformation ausgesetzt. Als Folge sind die mechanischen Eigenschaften der Geotextilmaterialien besonders wichtig im Systementwurf Geotextil -Boden. Bei dieser Untersuchung wurde eine theoretische Ansatzmethode erarbeitet, für die Voraussage des mechanisches Verhaltens bei Zugversuchen der schweren vernadelt-thermofixierten Geotextilien. Das Modell wurde anhand der Methode des Finiten Elementes und der Theorie der Verbundwerkstoffe verfasst. Als Eingangsdaten für die theoretischen Berechnungen wurden die Eigenschaften eines gewebten Geotextilmustermaterials angewendet. Für die Analyse der Spannung wurde ein kommerzielles Programm für Finite Elemente angewendet. Das Umformungsmechanismus der gewebten Geotextilien wurde im Rahmen der Zugteste anhand dem Datenvergleich bewertet, welche aus den theoretischen und experimentellen Berechnungen hervorgehen. Die Ergebnisse beweisen die Tatsache, dass das Modell mit zufriedenstellende Genauigkeit die Distributionsweise der Spannung im Geotextil-Muster und gleichfalls eine völlige Übereinstimmung mit den experimentellen Daten aufweist. Trotzdem, im Falle der Dehnungen, kann das Modell nicht mit genügender Genauigkeit die Lastdeformation der schweren Geotextilien voraussagen.

Stichwörter: Geotextilien, Vliesstoffe, Thermofixierung, Verbundwerkstofftheorie, Methode des finiten Elementes

The application areas of textile structures have expanded especially in technical fields such as military, construction, medical etc. since late 1970s. Among these technical applications, nonwoven geotextiles are the important part of the complex construction projects in civil engineering by virtue of their many advantages. Nonwoven geotextiles can be defined as complex sheets or web structures formed by arrangement of fibers or filaments by mechanical, thermal or solvent methods. The three bonding methods can also be combined. Needle punched nonwovens, which are produced by the penetrating action of barbed needles, are amongst the most widely used geotextile materials. These types of geotextiles are felt like in appearance and are relatively thick [1, 2]. The properties of needle punched geotextiles such as mechanical performance and dimensional stability can be improved by calendaring the fabric with heated rollers prior to installation. This post treatment imparts additional stiffness to the fabric which is particularly beneficial to ground reinforcement and separation applications. In fact the common aim of post heat treatment is to produce a uniform and dimensionally stable geotextile which is essentially isotropic in its properties [3].

Various mechanical functions such as reinforcement, separation and protection are provided by fabrics in a geotextile-soil system. Therefore, mechanical characterization of the fabric is very important in designing with geotextiles. However, numerous fiber and fabric parameters such as fiber type, orientation of fibers, fabric weight, fabric thickness and also method of bonding have influence on the mechanical behavior of nonwoven fabrics. Moreover, complexity of mechanical characterization of nonwoven fabric increases, because of the interaction of mechanisms like breakage, elongation, shear, bending and buckling during deformation. Nevertheless, several attempts have been made to predict the mechanical behavior of nonwovens under various kinds of loads. As a result of these studies a number of theoretical models were developed. In 1960s Backer and Peterson, reported a fiber network theory for nonwoven fabrics based on fiber tensile properties and orientation of fibers [4]. The elastic theory of orthotropic materials was used in prediction of material constants of a nonwoven. Hearle et al. expanded the fiber network theory and reported a series of papers about nonwoven fabrics considering energy method, effects of fiber curl etc. [5, 6]. Later, image analysis techniques have been

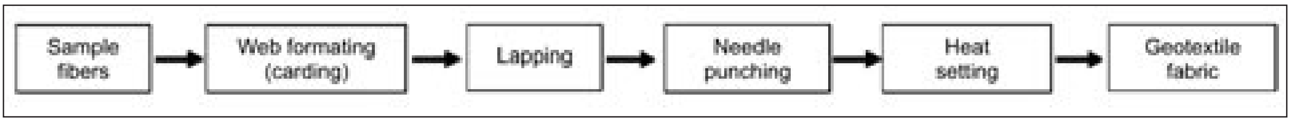


Fig. 1. Flow chart for the production of geotextile fabrics

employed to identify fiber orientation and to obtain a mechanism of macroscopic deformation. Pourdeyhimi et al. presented various methods for fiber orientation measurements and compared these methods [7, 8]. Moreover, several simulation techniques and computer models have been developed to predict the behavior of nonwovens based on previous general methods. Brinton et al. demonstrated the feasibility of computer simulation for predicting the mechanical properties of nonwoven fabrics using a fundamental microscopic description of the system [9, 10]. Bais-Singh et al. reported analytical and experimental studies to simulate the nonuniform development of stress and strains in the nonwoven fabrics [11, 12]. Liao et al. constructed a finite element model to determine the mechanical response of nonwoven fabrics from the measurements of fiber properties by using layer theory [13, 14]. More recently, Kim applied orthotropic symmetry theory to predict the behavior of thermally point-bonded nonwoven fabrics at different angles [15]. In the aforementioned studies, the properties of constituent fibers and structural arrangement of fibers in the web were commonly used to predict the mechanical properties of nonwoven fabrics. In needle punched-heat set heavy nonwovens, the behavior of constituent fibers are dissimilar in the surface and in the inner parts of the fabric during tensile deformation. The change in the orientation of fibers during tension was restricted by heat treatment on the surface of fabric. Therefore, it can be tedious to apply single fiber based theoretical models to needle punched-heat set heavy nonwovens. In this study, we aimed to construct a theoretical approach to predict the mechanical behavior of needle punched-heat set heavy nonwoven geotextiles in tensile test. To achieve this goal, structural and mechanical properties of a "reference fabric" were used as initial data in the theoretical analysis instead of constituent fiber properties. The model was constructed using theory of layered composite materials and finite element method considering the previous studies [12, 13, 16]. The constructed constitutive model and experimental data were incorporated into a commercially available finite element program ANSYS to carry out stress analysis. The adequacy of the model was discussed by comparing the theoretical and experimental results of geotextile samples in this study.

MATERIALS AND METHODS

Materials used

The five needle punched-heat set geotextile fabrics, made from polypropylene staple fibers, were supplied by a commercial geotextile producer.

The production process of sample fabrics is described in figure 1. The weights of reference and sample fabrics are 200 g/m^2, 300 g/m^2, 400 g/m^2, 600 g/m^2 and, respectively, 800 g/m^2.

EXPERIMENTAL PART

At first, the thickness of sample geotextile fabrics was measured using a digital thickness gauge with a certain pressure (2.00 ± 0.2 kPa) according to TS EN ISO 9863-1 [17]. An average of 5 thickness readings for each geotextile sample was recorded. Then, tensile behavior of geotextile samples was examined both in the machine direction (MD) and in the cross machine direction (CD) on a computer controlled Shimadzu Autograph AG-IS Series universal testing machine.

The wide-width tensile test was performed according to TS EN ISO 10319 to minimize the errors which can be caused by edge curling of specimens and to avoid the extreme strains in strip test [18]. The test length was kept as 100 mm and width as 200 mm and the fabrics were strained at a rate of 20 mm/min. An average of ten stresses-strains readings for all sample fabrics in the MD and in the CD was obtained. The tensile properties of reference fabric were used as initial data in theoretical analysis to predict the mechanical properties of other samples. Therefore, material constants of reference fabric such as Poisson's ratio, shear modulus and elastic moduli were also obtained.

In the nonwoven production line, all fibers in the card web are parallel to each other, but after lapping and punching, fibers in the layers of fabric are oriented at various directions following random or some known statistical distribution. Therefore, the orientation of fibers in a nonwoven fabric is another parameter that needs to be defined as initial data in the theoretical analysis. However it is very difficult to obtain fiber orientation distribution in heavy nonwovens such as needle punched geotextiles with experimental methods, because they consist of a large number of fiber layers [19]. Moreover, after heat setting process, measurement of fiber orientations gets more difficult with both experimental and computational methods. In our approach, orientation angles of layers in heavy nonwovens were simply derived considering the orientation angles of fibers in reference fabric. For this purpose, at first fiber orientation distribution of reference fabric was measured under a projection microscope before heat setting process. Finally the orientation angle of layers in heavy samples was assigned to program considering both the number of web layers in fabrics and the fiber orientation distribution of reference fabric.

Model and theoretical formulations

The basic principles of our approach for nonwovens are similar to theoretical models proposed in earlier publications [11–13]. We assume that nonwoven fabrics are made up of fiber layers similar to composite materials. Thus a layered nonwoven can be regarded as a laminate and each layer of fabric can be considered equivalent to a lamina. We also assume that the nonwoven fabrics are formed by layered finite elements, and fibers

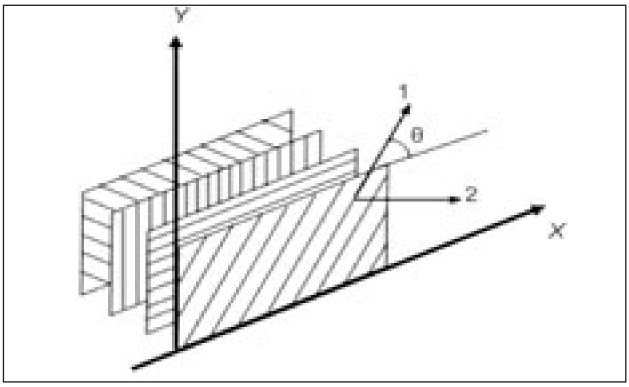


Fig. 2. Layered structure of nonwoven fabric

(layers) that make up the fabric are bound together at nodal points of the mesh of the finite element. Nonwovens especially heavy ones consist of a number of fiber layers (placed at an angle) as shown in figure 2. The axes in the *X-Y* coordinate system represent the global axes, such that the uniaxial loading direction and transverse directions of fabrics coincide with the *Y* and *X* axes, respectively. The local axes for an individual layer (lamina) are given by the 1-2 coordinate system, such that all fibers in the layer are oriented along the direction *1* and the direction *2* is perpendicular to the fibers.

A unidirectional layer of nonwoven fabric falls under orthotropic material category. If the layer is thin and does not carry any out of plane loads, plane stress conditions can be assumed for the layer. The relationship of stress and strain for an orthotropic plane stress problem can be written as [20];

$$\begin{bmatrix}\sigma_1\\ \sigma_2\\ \tau_{12}\end{bmatrix} = \begin{bmatrix}Q_{11} & Q_{12} & 0\\ Q_{12} & Q_{22} & 0\\ 0 & 0 & Q_{66}\end{bmatrix}\begin{bmatrix}\varepsilon_1\\ \varepsilon_2\\ \gamma_{12}\end{bmatrix} \tag{1}$$

where:

$$Q_{11} = \frac{E_1}{1-\upsilon_{12}\upsilon_{21}};$$

$$Q_{12} = \frac{\upsilon_{21}E_1}{1-\upsilon_{12}\upsilon_{21}};$$

$$Q_{22} = \frac{E_2}{1-\upsilon_{12}\upsilon_{21}};$$

$$Q_{66} = G_{12};$$

σ_1, σ_2, τ_{12} are the layer stresses in the 1-2 coordinate;

ε_1, ε_2, ε_{12} – the layer strains in the 1-2 coordinate;

ν_{12}, ν_{21} – the major and the minor Poisson's ratios;

E_1 is the longitudinal Young's modulus;

E_2 – the transverse Young's modulus;

G_{12} – the in-plane shear modulus.

The global and local stresses in a layer are related to each other through the orientation angle of the layer. Then, the relationship of stress and strain between the local and global system can be defined as [20]:

$$\begin{bmatrix}\sigma_x\\ \sigma_y\\ \tau_{xy}\end{bmatrix} = \begin{bmatrix}\cos^2\theta & \sin^2\theta & -2\sin\theta\,\cos\theta\\ \sin^2\theta & \cos^2\theta & 2\sin\theta\,\cos\theta\\ \sin\theta\,\cos\theta & -\sin\theta\,\cos\theta & \cos^2\theta-\sin^2\theta\end{bmatrix}\begin{bmatrix}\sigma_1\\ \sigma_2\\ \tau_{12}\end{bmatrix} \tag{2}$$

and

$$\begin{bmatrix}\varepsilon_x\\ \varepsilon_y\\ \gamma_{xy}\end{bmatrix} = \begin{bmatrix}\cos^2\theta & \sin^2\theta & \sin\theta\,\cos\theta\\ \sin^2\theta & \cos^2\theta & -\sin\theta\,\cos\theta\\ \sin\theta\,\cos\theta & -\sin\theta\,\cos\theta & \cos^2\theta-\sin^2\theta\end{bmatrix}\begin{bmatrix}\varepsilon_1\\ \varepsilon_2\\ \gamma_{12}\end{bmatrix} \tag{3}$$

where:

σ_x, σ_y, τ_{xy} are the layer stresses in the *X-Y* coordinate;

ε_x, ε_y, γ_{xy} – the ayer strains in the *X-Y* coordinate;

θ is the orientation angle of the layer.

By substituting equations (2) and (3) into equation (1) the stress- strain relationship of each layer in the global coordinate system can be expressed as:

$$\begin{bmatrix}\sigma_x\\ \sigma_y\\ \tau_{xy}\end{bmatrix} = \begin{bmatrix}\bar{Q}_{11} & \bar{Q}_{12} & \bar{Q}_{16}\\ \bar{Q}_{12} & \bar{Q}_{22} & \bar{Q}_{26}\\ \bar{Q}_{16} & \bar{Q}_{26} & \bar{Q}_{66}\end{bmatrix}\begin{bmatrix}\varepsilon_x\\ \varepsilon_y\\ \gamma_{xy}\end{bmatrix} \tag{4}$$

where:

$\bar{Q}_{11} = Q_{11}\cos^4\theta + 2(Q_{12} + 2Q_{66})\sin^2\theta\cos^2\theta + Q_{22}\sin^2\theta;$

$\bar{Q}_{12} = (Q_{11} + Q_{22} - 4Q_{66})\sin^2\theta\cos^2\theta + Q_{12}(\cos^4\theta + \sin^4\theta);$

$\bar{Q}_{22} = Q_{11}\sin^2\theta + Q_{22}\cos^4\theta + 2(Q_{12} + 2Q_{66})\sin^2\theta\cos^2\theta;$

$\bar{Q}_{16} = (Q_{11} - Q_{12} - 2Q_{66})\cos^3\theta\sin\theta - (Q_{22} - Q_{12} - 2Q_{66})\sin^3\theta\cos\theta;$

$\bar{Q}_{26} = (Q_{11} - Q_{12} - 2Q_{66})\cos\theta\sin^3\theta - (Q_{22} - Q_{12} - 2Q_{66})\sin\theta\cos^3\theta;$

$\bar{Q}_{66} = (Q_{11} + Q_{22} - 2Q_{66})\sin^2\theta\cos^2\theta + Q_{66}(\cos^4\theta + \sin^4\theta).$

If the strains are known at any point along the thickness of the laminate (fabric) the global stresses can be calculated for each layer. Then stresses in all layers can be integrated using theory of composite materials to give the overall mechanical behavior of the layered nonwoven. Thus, fabric stresses in the *X-Y* direction for each finite element in the symbolic matrix form can be given by:

$$[\sigma]^e = [D]^e[\varepsilon]^e \tag{5}$$

where:

$[D]^e$ is the material constitutive matrix of the element.

$[\sigma]^e = [\sigma_x\,\sigma_y\,\tau_{xy}]^T$ and $[\varepsilon]^e = [\varepsilon_x\,\varepsilon_y\,\gamma_{xy}]^T$.

In some nonwovens namely needle punched ones; deformation is nonuniform in uniaxial test [1, 5]. The state of stresses and strains are not the same in different regions of stress-strain curves due to various effects such as nonlinear stress-strain behavior of fibers, shear effects and reorientation of staple fibers in the beginning of the tensile test. However, heat setting process generally restrict some of these mechanisms especially the reorientation of fibers in the beginning of the tensile test. Figure 3 illustrates the stress-strain curves of our reference fabric. As seen in this figure the stress uniformly varies with strain both in MD and CD. For this reason, linear stress-strain behavior is assumed for each layer and material constants, which are

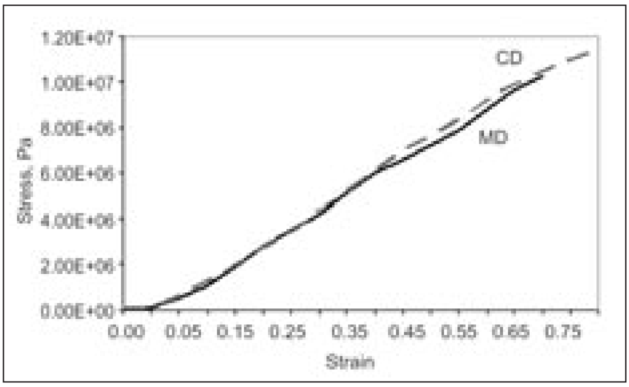


Fig. 3. Stress-strain curves of reference fabric in the *MD* and *CD*

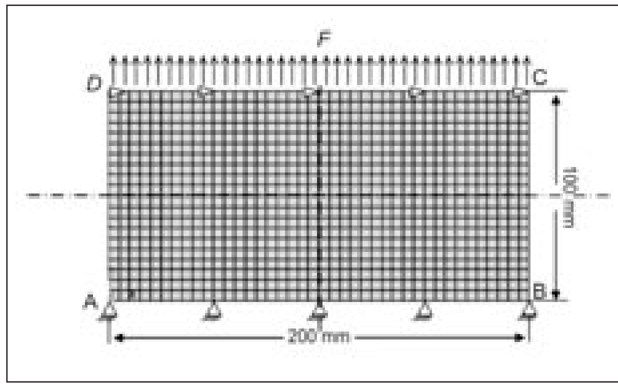


Fig. 4. Initial geometry of fabric model

Table 1

MATERIAL CONSTANTS OF A LAYER			
Property	**Symbol**	**Value**	
		MD	***CD***
Longitudinal modulus	E_1	18.48 MPa	16.82 MPa
Traverse modulus	E_2	16.82 MPa	18.48 MPa
In-plane shear modulus	G_{12}	6.43 MPa	6.28 MPa
Poison's ratio	υ_{12}	0.24	0.21

Table 2

REAL CONSTANTS FOR ELEMENTS AND LAYERS				
Fabrics	**Fabric weight,** g/m^2	**Total number of layers**	**Layer thickness,** mm	**Element total thickness,** mm
Reference	200	4	0.37	1.48
Heavier samples	300	8	0.31	2.48
	400	12	0.25	2.96
	600	16	0.29	4.46
	800	20	0.30	6.09

denoted in equation (1), are used as components of stiffness matrix.

We incorporated the above element constitution relations into a commercial finite element program ANSYS to carry out stress analysis. Experimental data on the reference fabric tensile properties and web structure parameters are also supplied to program as input data. We have considered elastic theory of orthotropic materials and the material constants of reference fabric, which are given in table 1, were used as initial data in the analysis.

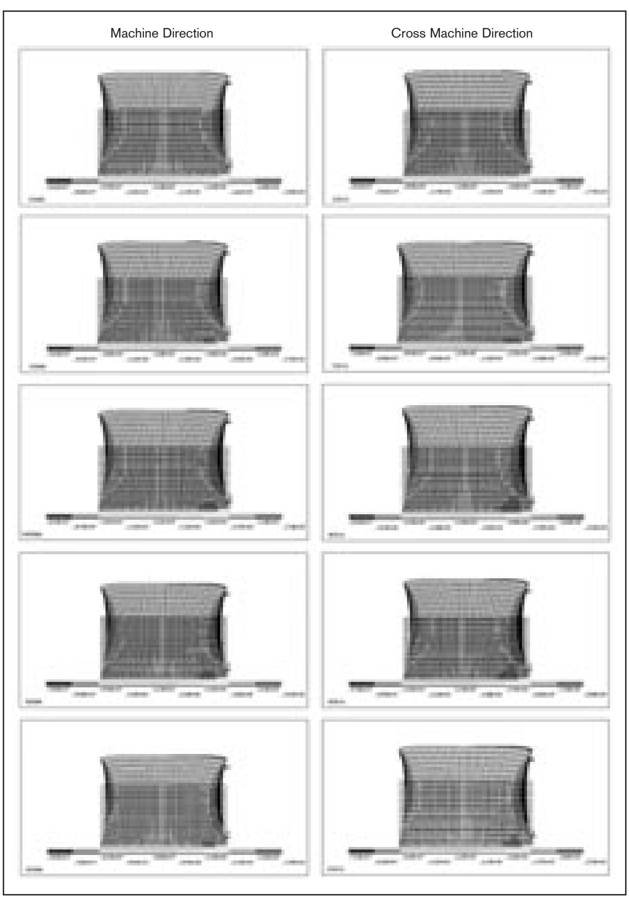


Fig. 5. Distributions of computed stresses in simulated sample fabrics

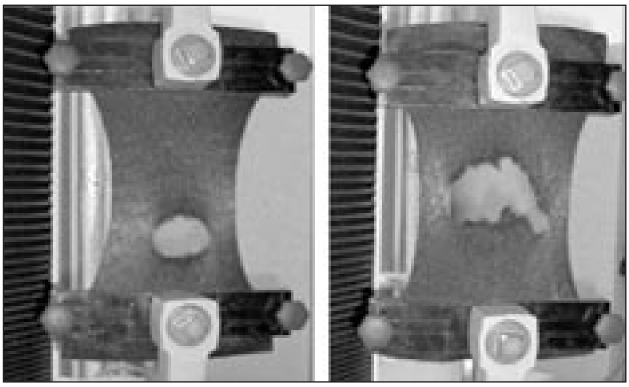
Geometry of the finite element mesh

The initial geometry of fabric and the boundary conditions applied to the model are shown in figure 4. Side *AB* and *CD* are constrained within the jaws. All translations and rotations are constrained on side *AB*. However, side *CD* is allowed to move only vertically. Both sides *AD* and *BC* are allowed to move freely in the transverse direction.

"Structural layered composite" element is chosen to mesh the initial fabric model. Uniformly distributed tensile load (negative pressure) is applied to side *CD*. The magnitudes of applied loads are different for different fabric samples and are slightly less than their failure initiation loads. The real constants for layers and elements are given in table 2. Fabric thickness measurement values are used to assign thickness value for each element.

RESULTS AND DISCUSSIONS

The constructed theoretical model was used for stress analysis of needle punched-heat set heavy geotextiles. The distribution of computed stresses of sample fabrics in *MD* and *CD* can be seen in figure 5. As seen in the plotted contours, the state of stresses is not the same throughout the models because of constraints, imperfectly symmetric distribution of fibers within the fabrics and transverse contraction during tensile deformation. Particularly, stresses are much higher in the four corners than the other parts. Maximum stresses are calculated near the jaws as a result of constraints. Minimum stresses are obtained near the free edges. Besides, critical stress distributions and concentrations are calculated around the center of the models.



a *b*

Fig. 6. Deformation of fabric (800 g/m^2) in uniaxial tensile tests: *a – MD;* **b** – *CD*

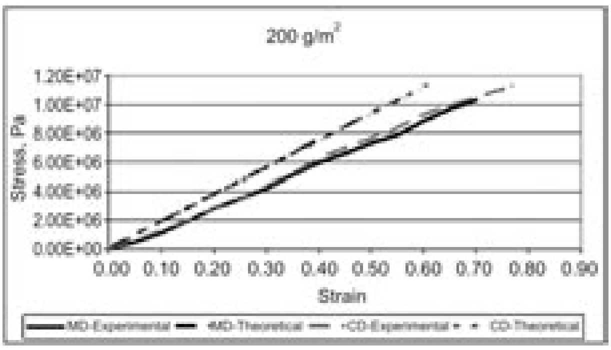


Fig. 7. Comparison between theoretical and experimental results of reference fabric

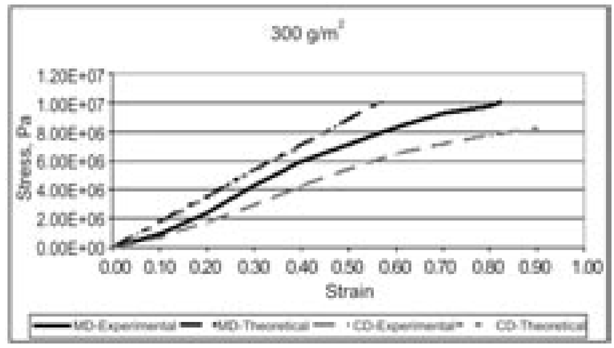


Fig. 8. Comparison between theoretical and experimental results of 300 g/m^2

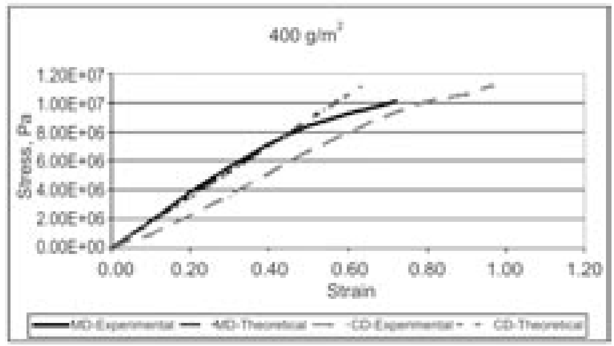


Fig. 9. Comparison between theoretical and experimental results of 400 g/m^2

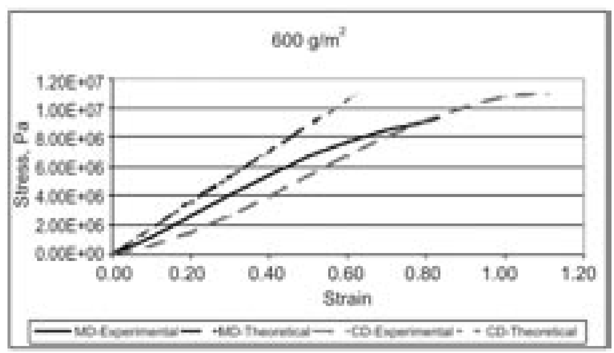


Fig. 10. Comparison between theoretical and experimental results of 600 g/m^2

Consequently meaningful stress data can be obtained from the stress distribution of computed models of needle punched heat set nonwoven geotextile samples. The typical shape of the deformed fabric samples in the tensile tests can be seen in figure 6 *a*, *b* (in *MD*, respectively, in *CD*). The comparisons of figure 5 and figure 6 show that experimentally obtained and theoretically computed configurations of geotextile samples are similar in uniaxial tensile tests.

There is not any lateral contraction at the jaws of computed figures; however contraction gradually increases to its maximum value at the center of the models.

As given in figure 6, very similar behaviors are observed during experiments due to the geometry of test. The inconstant lateral contraction of nonwoven fabrics in uniaxial tests is successfully simulated in the models. In the computed figures, critical stress concentrations were calculated around the center of models. Similarly, as seen in figure 6, the experimental breaks usually occur around the center of specimens in uniaxial tensile tests. Therefore, at first the element stresses in the center of theoretical solutions were considered for comparison. Theoretically and experimentally calculated stresses of reference and other fabric samples in the *MD* and *CD* are given in table 3. As seen in the table 3 predicted stresses in the center of plotted models are compatible with experimental ones and close to measured maximum stresses. Experimentally measured maximum stresses are predicted with almost 8–9% average margin of error in the center of the models. In conclusion the agreement between the theoretical and experimental values is not poor in both *MD* and *CD*.

Table 3

EXPERIMENTAL AND CALCULATED STRESSES

Fabric weight, g/m^2	**Stresses,** Pa			
	Experimental		*Theoretical*	
	MD	*CD*	*MD*	*CD*
200*	1.033 10^7	1.135 10^7	1.075 10^7	1.184 10^7
300	1.006 10^7	8.964 10^6	1.107 10^7	9.860 10^6
400	1.013 10^7	1.115 10^7	1.109 10^7	1.224 10^7
600	9.357 10^6	1.094 10^7	1.027 10^7	1.200 10^7
800	8.135 10^6	9.160 10^6	9.143 10^6	1.012 10^7

* Reference fabric

Finally, stress-strain curves of geotextile fabrics are achieved by using the constructed theoretical model. A comparison is made between the theoretical and experimental curves as shown in figures 7–11. In general a reasonable agreement is obtained between the theoretical an experimental stresses. However, in the case of elongations, the model could not predict the strains of heavy geotextiles in uniaxial tensile test accurately. As the fabric weights increase and fabrics become

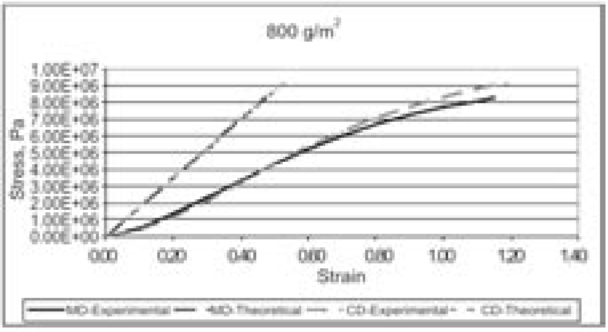


Fig. 11. Comparison between theoretical and experimental results of 800 g/m^2

thicker, higher displacements were predicted with respect to experimental measurements. As shown in figures 8–11, the initial part of the stress strain curves in heavy nonwovens are partly different from the reference fabric's curves due to the number of staple fibers which reorient in the beginning of the tensile test. From the other point of view, in the model, the fibers that make up the fabric are assumed to be bonded together only at nodal points of the mesh of finite elements, however in real fabrics bonded areas are not as homogeneous as in constructed model. Moreover, the nonuniformity in the thickness of fabrics can affect the tensile behavior of geotextiles. As a nature of bonding process the weak bonded zones can also occur in real fabrics.

CONCLUSIONS

In this study, a theoretical approach is proposed to predict the mechanical properties of heavy nonwoven geotextiles using composite layer theory and finite element method. The comparisons of theoretical and experimental values indicate that meaningful stress data can be obtained from the stress distribution of computed models. The calculated stresses in the center of the model, where the experimental breaks are usually observed, are close to measured maximum stress. Moreover, similar fabric configurations are observed in the experimental and computed results. In the case of elongations, predicted values are not very close to the experimental ones. The reason for this may be reorientation of staple fibers during deformation is high in heavy fabrics with respect to reference fabric and also bonded areas in the real fabrics are not as homogeneous as constructed models. Consequently, the constructed model makes it possible to predict the stress distribution in heavy needle punched geotextiles form the properties of a light nonwoven. However, the elongation of heavy fabrics can not be predicted with adequate accuracy. Therefore further work is needed, which may consider the reorientation of fibers during deformation of heavy nonwovens exactly.

ACKNOWLEDGMENTS

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Application of Taguchi and full factorial experimental design to model the color yield of cotton fabric dyed with 6 selected direct dyes

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REZUMAT – ABSTRACT – INHALTSANGABE

Aplicarea metodei Taguchi şi proiectarea factorială experimentală, în vederea modelarii randamentului tinctorial al ţesăturilor din bumbac, vopsite cu şase tipuri de coloranţi direcţi

Această lucrare descrie modelarea randamentului tinctorial al ţesăturilor din bumbac 100%, vopsite cu şase tipuri de coloranţi direcţi, folosind metoda Taguchi şi proiectarea experimentală factorială, precum şi o metodă de regresie a suprafeţei de răspuns. Factorii aleşi au fost: concentraţia vopselei, concentraţia electroliţilor (clorurii de sodiu), temperatura şi timpul de vopsire. Pentru efectuarea testelor conform metodei Taguchi, au fost alese câte două niveluri pentru fiecare factor. După obţinerea datelor, au fost determinaţi factorii semnificativi prin analiza de varianţă (ANOVA). Apoi, nivelul factorilor semnificativi a fost crescut de la 2 la 3, iar testele suplimentare au fost efectuate cu ajutorul proiectării factoriale complete. ANOVA a fost aplicată din nou şi, în final, a fost realizat modelul iniţial de regresie a suprafeţei de răspuns, luând în considerare factorii semnificativi. După verificarea termenului de valabilitate a modelelor iniţiale, s-au aplicat transformările BOX-COX, până când modelele au devenit valide.

Cuvinte-cheie: ţesătură din bumbac, coloranţi direcţi, randament tinctorial, proiectare experimentală Taguchi, proiectare factorială completă, transformare Box-Cox, regresia suprafeţei de răspuns

Application of Taguchi and full factorial experimental design to model the color yield of cotton fabrics dyed with six selected direct dyes

This paper describes the modeling of the color yield of 100% cotton fabric dyed with six selected direct dyes, using Taguchi and factorial experimental designs as well as response surface regression method. The factors chosen were dye concentration, electrolyte (sodium chloride) concentration, temperature and time of dyeing. To conduct the tests using Taguchi approach, two levels were chosen for each factor. After obtaining the data, significant factors were determined by analysis of variance (ANOVA). Then, the level of significant factors was increased from 2 to 3 and the supplementary tests were carried out using full factorial design. ANOVA was applied again and finally, initial response surface regression model was produced considering the significant factors. After verifying the validity of the initial models, BOX-COX transformation was implemented until the models enjoyed validity.

Key-words: cotton fabric, direct dyes, color yield, Taguchi experimental design, full factorial design, Box-Cox transformation, response surface regression

Anwendung der Taguchi-Methode und des vollfaktoriellen Experimentellentwurfs für die Modellierung der Farbausbeute bei Baumwollgewebe gefärbt mit 6 direkten Farbmittel

Diese Arbeit beschreibt die Modellierung der Farbleistung (Fk) der 100% Baumwollgewebe, gefärbt mit 6 auserwählten direkten Farbmittel (2 aus jedwelcher Gruppe A, B und C), anhand der Taguchi-Methode und des faktoriellen Experimentellentwurfs, sowie der Regressionsmethode der Kontaktoberfläche. Auserwählte Faktoren waren Farbmittelkonzentration, Elektrolytenkonzentration (Natriumchlorid), Temperatur und Färbedauer. Für die Testdurchführung anhand der Taguchi-Angehmethode wurden 2 Stufen für jeden Faktor auserwählt. Nach der Datenlese (Fk), wurden die signifikanten Faktoren durch die Varianzanalyse bestimmt (ANOVA). Dann wurde das Niveau der signifikanten Faktoren von 2 zu 3 erhöht und die zusätzlichen Teste wurden anhand des vollfaktoriellen Entwurfs durchgeführt. ANOVA wurde erneut angewendet und am Ende wurde das Regressionsmodell für die ursrüngliche Kontaktoberfläche durchgeführt, aufgrund des ermittelten signifikanten Faktor. Nach der Verifizierung der Gültigkeit des ursprünglichen Modells, wurde die BOX-COX Umwandlung durchgeführt bis die Modelle die benötigte Gültigkeit erlangten.

Stichwörter: Baumwollgewebe, direkte Farbstoffe, Farbleistung, Taguchi Experimentellentwurf, Vollfaktorentwurf, Box-Cox Umwandlung, Kontaktoberflächenregression

Cotton, the most important natural fiber, is the purest form of cellulose found in nature. The content of cellulose in cotton is about 91% and increases to 95% after removing natural impurities. The remaining 5% consists of other materials such as protein, pectin, ash and minerals [1]. The microstructure of crystalline cotton is defined as cellulose I, consisting of about 70% crystalline and 30% amorphous regions. The hydrophilic nature of cotton makes its dyeing with different classes of dyes possible [2].

Direct dyes, also called substantive dyes, can be applied to cotton fibers easily. These dyes are less expensive than others which are suitable for cellulosic fibers. However, their low washing fastness is a major drawback. Direct dyes are of anionic type and dissolve in water. These dyes have an aromatic structure and contain chromophore and groups rendering them soluble. The chropmophore of direct dyes can be divided into monoazo, diazo, triazo, polyazo, stilbene derivative, thiazole derivative and phethalocyanin derivative groups [3–5]. Society of dyers and colorists *(SDC)* has also classified direct dyes according to their leveling and migration behavior into classes *A, B* and *C* [6].

The main parameters affecting the color yield in exhaust dyeing of cotton with direct dyes are dye and electrolyte concentration, dyeing time and temperature as well as the liquor ratio (L:R).

In many branches of industry including textile, process optimization which has a considerable impact on cost minimization has gained importance. To fulfill this task for dyeing operation, employing more efficient machineries, new dyeing techniques as well as new products play an important role. However, another technique that can help optimization is to find the optimum conditions of the dyeing bath which lead to a certain color yield. This requires a model representing the way that each factor as well as the interaction between them plays part in determining the color yield (response). Sound

and reliable modeling should be based on an appropriate experimental design.
Literature review reveals a number of efforts concerning modeling in dyeing. A summary of these works follows next. A mathematical model was proposed by Rys and Sperb describing the behavior of the fixation efficiency of mono-functional reactive dyes for various dyeing conditions [7].
Cegarra and Puente produced isoreactivity equations to determine the conditions of temperature to achieve constant sorption at different sorption times [8]. Huang and Yu used fuzzy models to provide a systematic approach to controlling dye bath concentration, *p*H, and temperature in dyeing cotton cloth with direct dyes [9]. In another work, in order to improve the control of the process cycle for the application of reactive dyes in package dyeing, Shamey and Nobbs employed mathematical modeling [10]. In four papers, Tavanai et al. reported modeling of color yield in two-phase wet fixation-reactive dyeing of cotton fabric (random experimental design) [11], modeling of color yield in polyethylene terephthalate dyeing through fuzzy regression [12], modeling of color yield in two-phase pad steam-reactive dyeing of cotton cloth (binomial experimental design) [13] and finally modeling of color yield of six direct diazo dyes on cotton fabric through central composite design [14].

THEORETICAL BACKGROUND

In almost all fields of inquiry, experiments are carried out in order to discover some findings about processes or systems. An experiment can be defined as a test or series of tests in which purposeful changes are made to the input factors of a process or system so that the reasons for changes are observed and identified. The concepts of design of experiments have been in use since Fisher's work in agricultural experimentation. Fisher successfully designed experiments to determine optimum treatments for land to achieve maximum yield [15].
The first step in designing any experiment is recognizing the statement of problem. This is followed by the determination of effective factors with their levels and specifying response variable. Then, based on the objectives, one must select a suitable experimental design and carry out the experiments accordingly. The obtained data is analyzed by analysis of variance (ANOVA) method, leading to the determination of factors with significant effect on response variable. Finally a model can be worked out which represents the response variable as a function of the already determined significant factors. The choice of experimental design depends on the kind of problem, the number of factors as well as their levels [16].
The Taguchi approach [17] is one of the experimental design which has ascertained a great deal of success until now. The overall aim of Taguchi design is to find factor levels that maximize *S/N* ratio. In statistical terms *"S"* is called "signal" and *"N"* is called "noise". The higher the *S/N* ratio, the better the quality; in general, the *S/N* ratio could be considered in three modes of smaller is better, nominal is better and larger is better. The "larger is better" mode is found to be appropriate for experimental design. *S/N* is shown in equation (1).

$$S/N = -10 \log \left(\frac{\sum_{i=1}^{n} 1/y_i^2}{n} \right) \quad (1)$$

In equation (1), n is the number of repetitions for an experimental combination, i is a numerator, and y_i is the performance value of the 1th experiment [17]. Generally speaking, application of Taguchi method leads to economizing in cost and time by decreasing the number of experiments.
Contrary to Taguchi, full factorial design considers all possible combinations of a given set of factors. Since most of the industrial experiments usually involve a significant number of factors, a full factorial design results in a large number of experiments [18]. Response surface methodology which is a collection of mathematical and statistical techniques is useful for the modeling and analysis of problems in which a response of interest is influenced by several factors. If the response is modeled by a linear function of the independent factors, then the approximating function is the first-order model (2).

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k + \varepsilon \quad (2)$$

where:
ε represents the noise or error observed in the response y.
In this model the regression coefficient β_i is a measure of the change in the response y due to a change in the input variable x_i. If there is curvature in the system, then a polynomial of higher degree such as a second-order model (3) must be used [18]:

$$y = \beta_0 + \sum_{i=1}^{k} \beta_i x_i + \sum_{i=1}^{k} \beta_{ii} x_i^2 + \sum \beta_{ij} x_i x_j + \varepsilon \quad (3)$$

Transformations are often applied to data to achieve certain objectives such as normalizing the data, stabilizing the variance, or eliminating interaction effects.

Table 1

TAGUCHI EXPERIMENTAL DESIGN TABLE

Run no.	Coded factor values			
	X_1	X_2	X_3	X_4
1	1	1	1	1
2	1	2	2	1
3	1	1	1	1
4	1	1	2	2
5	1	2	2	2
6	1	2	1	2
7	2	1	2	1
8	2	2	1	1
9	2	2	2	1
10	2	1	2	2
11	2	2	1	2
12	2	1	1	2

Note: X_1 is direct dye concentration (% on weight of fiber);
X_2 – lectrolyte (sodium chloride) concentration (% on weight of fiber);
X_3 – dye bath temperature (°C);
X_4 – dyeing time (min.)

Table 2

THE AMOUNT OF CODED FACTOR VALUES IN TAGUCHI EXPERIMENTAL DESIGN STATED IN TABLE 1								
Factors	X_1		X_2		X_3		X_4	
Direct dyes / Levels	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
C.I. Direct Blue 67	0.5%	2%	15%	35%	60	70	30	60
C.I. Direct Red 31	0.5%	2.5%	15%	35%	40	60	30	50
C.I. Direct Blue I	0.5%	2.5%	15%	35%	50	60	50	70
C.I. Direct Red 224	0.5%	2.5%	15%	35%	70	80	30	50
C.I. Direct Blue 2	0.5%	2.5%	15%	35%	50	60	30	50
C.I. Direct Red 23	0.5%	2.5%	15%	35%	70	80	50	70

Table 3

FULL FACTORIAL EXPERIMENTAL DESIGN TABLE FOR C.I. DIRECT RED 23			
Run no.	Coded factor values		
	X_1	X_2	X_3
1	–1	–1	0
2	1	3	1
3	0	1	0
4	1	1	0
5	0	–1	1
6	0	0	-1
7	1	0	–1
8	1	–1	–1
9	–1	0	–1
10	–1	1	–1
11	0	0	0
12	0	1	1
13	1	1	–1
14	1	–1	0
15	–1	0	0
16	–1	1	1
17	0	–1	–1
18	–1	–1	–1
19	0	1	–1
20	1	–1	1
21	1	1	1
22	–1	1	0
23	–1	0	1
24	0	–1	0
25	–1	–1	1
26	0	0	1
27	1	0	0

The most commonly used transformer is the power family given by Box-Cox as shown in equation (4):

$$y^{(\lambda)} = \begin{cases} \dfrac{y^{\lambda}-1}{\lambda} \lambda \neq 0 \\ \log(y)\lambda = 0 \end{cases} \quad (4)$$

Box-Cox proposes a maximum likelihood procedure to estimate the power, λ. This is equivalent to minimizing $\sqrt{MSE}$ over the choices of λ. 10–12 points are usually chosen for λ. These points are in the range of –2 to +2. Then for each λ, a model is fitted to the data. The λ related to the model with lowest MSE is chosen as the power used to modify the original model [18].

As literature review showed scarce information on modeling of the color yield of dyed cotton fabric through Taguchi design, this research aimed at modeling the color yield (F_k) of 100% cotton fabric dyed with 6 selected direct dyes as a function of dye concentration, electrolyte concentration, time and temperature of dyeing.

EXPERIMENTAL PART

Materials, dyeing of the samples and color yield measurement

Samples of 100% bleached (no optical brightener) cotton fabric (128 g/m^2), weighing 2 g each were dyed according to Taguchi experimental design with two levels, namely level *1* (minimum value) and level *2* (maximum value) for each control factors. Control factors are the factors which affect the response. As already mentioned, in direct dyeing process, dye and electrolyte concentration, time and temperature of dyeing constitute the main factors affecting the color yield. It is worth mentioning that water hardness in two levels of 1 for hard water (hardness = 195 ppm) and 2 for soft water (hardness 40 ppm) was chosen as uncontrollable factor. An L_{12} scheme with two levels for each factor (11 degrees of freedom) was chosen for the design as shown in table 1. Table 1 shows 12 runs for each dye with conditions of the variables stated as coded factor value whose real amount is shown in table 2.

The six diazo direct dyes chosen for this work were as follows:

- C. I. Direct Blue 67 and C. I. Direct Red 31 (Class A);
- C. I. Direct Blue 1 and C. I. Direct Red 224 (Class B);
- C. I. Direct Blue 2 and C. I. Direct Red 23 (Class C).

Samples were dyed in Polymat (AHIBA 1000) laboratory dyeing machine. Each dyeing (run) was carried out with hard water (block *1*) as well as soft water (block *2*). So a total of 24 dyed samples were prepared for each dye. Dyeing was started at room temperature with the dye bath containing the required amount of dye. The dye bath temperature was raised to the final value in 20 minutes and then electrolyte was added to the dye bath. Dyeing was continued at final temperature

Table 4

FULL FACTORIAL EXPERIMENTAL DESIGN TABLE FOR C.I. DIRECT RED 224		
Run no.	Coded factor values	
	X_1	X_2
1	1	–1
2	–1	–1
3	1	0
4	–1	0
5	0	–1
6	1	1
7	0	0
8	0	1
9	–1	1

Table 5

THE AMOUNT OF CODED FACTOR VALUES IN FACTORIAL EXPERIMENTAL DESIGN STATED IN TABLE 3 AND TABLE 4										
Factors	X_1			X_2			X_3			X_4
Direct dyes / Levels	Level –1	Level 0	Level 1	Level –1	Level 0	Level 1	Level –1	Level 0	Level 1	
C.I. Direct Blue 67	0.5%	1.25%	2%	15%	25%	35%	60	60	60	30
C.I. Direct Red 31	0.5%	1.5%	2.5%	15%	15%	15%	40	50	60	30
C.I. Direct Blue 1	0.5%	1.5%	2.5%	15%	25%	35%	50	50	50	50
C.I. Direct Red 224	0.5%	1.5%	2.5%	15%	25%	35%	70	70	70	30
C.I. Direct Blue 2	0.5%	1.5%	2.5%	15%	25%	35%	50	50	50	30
C.I. Direct Red 23	0.5%	1.5%	2.5%	15%	25%	35%	70	80	90	50

Table 6

ANOVA FOR C.I. DIRECT RED 23 WHILE USING TAGUCHI DESIGN FOR *S/N*					
Source	Degree of freedom	Sum of squares	Mean squares	*F*	*P* value
X_1	1	252.035	192.501	4204.980	0.000
X_2	1	0.890	0.913	19.940	0.037
X_3	1	0.848	0.662	14.470	0.049
X_4	1	0.910	0.349	7.620	0.110
X_1X_4	1	0.060	0.040	0.870	0.449
X_1X_2	1	0.065	0.053	1.160	0.394
X_2X_4	1	0.084	0.094	2.050	0.289
X_3X_4	1	0.020	0.020	0.440	0.574
Error	2	0.092	0.046		
Total	10	255.004			

Note: Signal to noise (*S/N*): larger is better

Table 7

ANOVA FOR C.I. DIRECT RED 23 WHILE USING FULL FACTORIAL DESIGN					
Source	Degree of freedom	Sum of squares	Mean squares	*F*	*P* value
Block	1	2.000	2.000	0.070	0.792
X_1	2	87887.800	43943.900	1583.690	0.000
X_2	2	1784.300	892.200	32.150	0.000
X_3	2	236.500	118.200	4.260	0.025
X_1X_2	4	255.200	63.8	2.30	0.086
X_1X_3	4	67.200	16.8	0.610	0.662
X_2X_3	4	268.300	67.1	2.420	0.074
$X_1X_2X_3$	8	196.600	24.6	0.890	0.542
Error	26	721.400	27.7		
Total	53	91419.300			

for the required amount of time (table 1 and 2). At the end of dyeing, the samples were thoroughly rinsed in water (40°C) and finally dried.
The color yield of the samples (F_k) was measured by the Tex flash spectrophotometer (Datacolor), from which K/S (Kubelka-Munk theory) was calculated as shown in equation (5):

$$\left(K/S\right)_\lambda = \frac{\left(1-R_\lambda\right)^2}{2R_\lambda} \quad (5)$$

where:
R_λ is the minimum reflectance of light with a given wavelength (predominant wavelength) from a sample of infinite thickness, expressed in fractional form.
Fk function considers *K/S* in different wavelengths of the visible light as well as color matching functions (6).

$$F_k = \sum_{400}^{700} \left(K/S\right)_\lambda \left(\bar{x}_{10,\lambda} + \bar{y}_{10,\lambda} + \bar{z}_{10,\lambda}\right) \quad (6)$$

where:
$\bar{x}_{10,\lambda} + \bar{y}_{10,\lambda} + \bar{z}_{10,\lambda}$ are the color matching functions for the 10° standard observer at each wavelength measured (ISO 7724/1-1984) [19].
After identifying the significant factors in Taguchi approach the level of significant factors was increased from 2 to 3 and the supplementary experiments were carried out using full factorial design. Table 3 and table 4 show full factorial experimental design for C.I. Direct Red 23 and, respectively, C.I. Direct Red 224. Factors and their levels in full factorial design are shown in table 5. It is worth mentioning that the

Table 8

DESCRIPTIVE INDICES OF THE FINAL MODEL FOR C. I. DIRECT RED 23	
R^2	98.30%
R^2_{adj}	98.10%
MSE	32.1

Table 9

ANOVA FOR C.I. DIRECT RED 224 WHILE USING TAGUCHI DESIGN FOR *S/N*					
Source	Degree of freedom	Sum of squares	Mean squares	*F*	*P* value
X_1	1	120.620	85.190	59.160	0.016
X_2	1	27.739	27.965	19.420	0.048
X_3	1	5.441	0.591	0.410	0.587
X_4	1	12.010	10.118	7.080	0.117
X_1X_4	1	5.115	1.199	0.830	0.458
X_1X_2	1	8.557	8.129	5.650	0.141
X_2X_4	1	6.350	6.732	4.680	0.163
X_3X_4	1	0.530	0.530	0.370	0.606
Error	2	2.880	1.440		
Total	10	189.248			

Note: Signal to noise (*S/N*): larger is better

Table 10

ANOVA FOR C.I. DIRECT RED 224 WHILE USING FULL FACTORIAL DESIGN					
Source	Degree of freedom	Sum of squares	Mean squares	*F*	*P* value
Block	1	3588.500	3588.500	23.850	0.001
X_1	2	6255.800	3127.900	20.790	0.001
X_2	2	983.000	461.500	3.270	0.092
X_1X_2	4	863.100	215.800	1.430	0.307
Error	8	1203.800	150.500		
Total	17	12894.100			

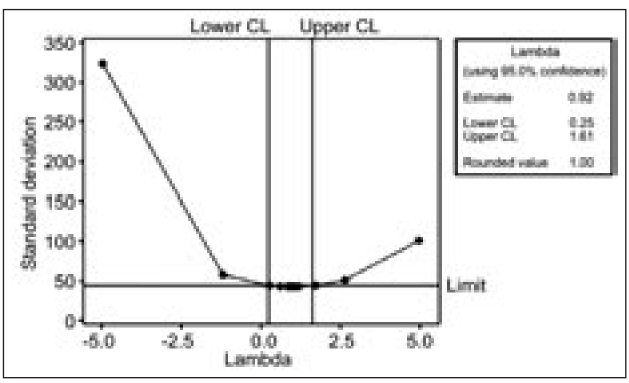

Fig. 1. Box-Cox transformation for C.I. Direct Red 23

non-significant factors in Taguchi method were kept constant in their lowest level in full factorial design.

RESULTS AND DISCUSSIONS

Due to lack of space, the complete methodology to obtain the final model for C. I. Direct Red 23 and C. I. Direct Red 224 are reported here. For the rest of dyes, only the final models will be presented.

C.I. Direct Red 23

The data (F_k) obtained from Taguchi design was analyzed by ANOVA and the factors significant at 5% level (table 6) namely, X_1 (dye concentration), X_2 (electrolyte concentration) and X_3 (dye bath temperature) are determined. In the next stage, the level of the three significant factors was increased to 3 and the supplementary tests were carried out using full factorial design. Again the obtained data was analyzed by ANOVA and the factors significant at 5% level (table 7) i. e. X_1, X_2 and X_3 were determined.

To produce a model, response surface regression method was applied employing significant factors in full factorial design with the help of statistical software package (MINITAB 14). Equation (7) shows the initial model:

$$F_k = 108.773 + 48.965(X_1) + 7.039(X_2) - \\ -1.995(X_3) - 11.453(X_1X_1) \quad (7)$$

To verify the validity of the initial model, Box-Cox transformation was implemented. Figure 1 shows the

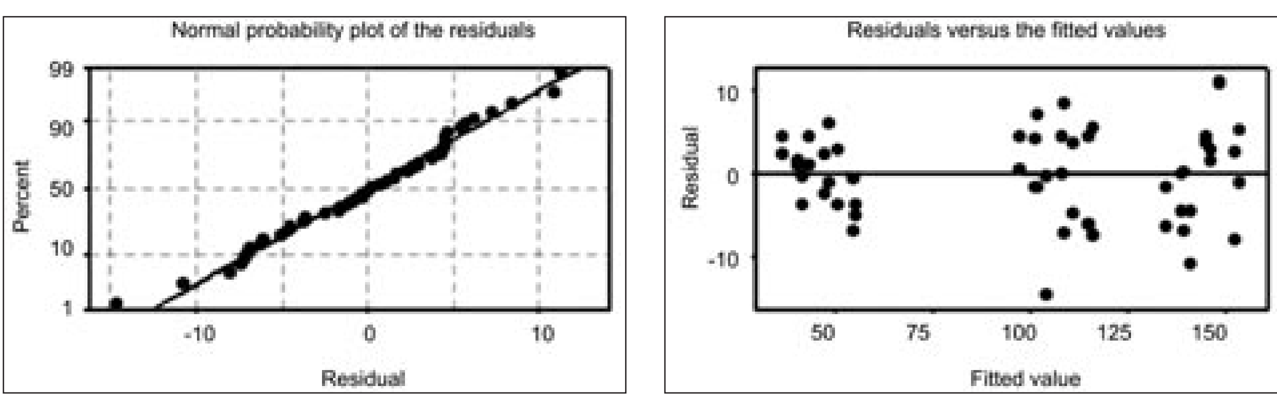

Fig. 2. Normal plot of residual and residual versus fits for C.I. Direct Red 23

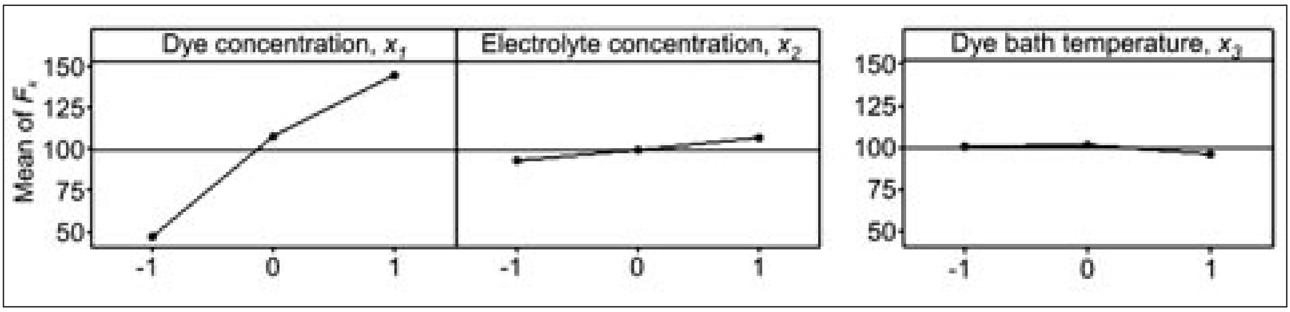

Fig. 3. Main effects plot for C.I. Direct Red 23

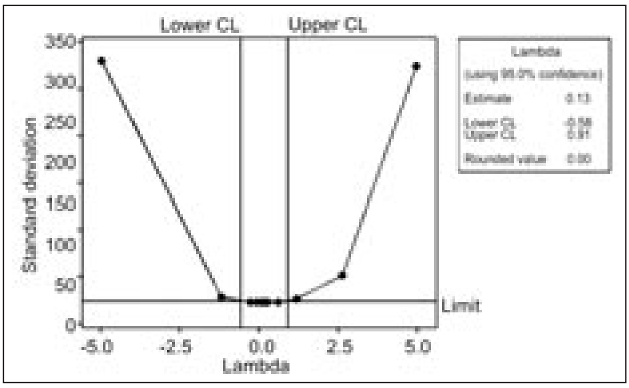

Fig. 4. Box-Cox transformation for C.I. Direct Red 224

Box-Cox transformation for the initial model. As seen in figure 1, the suggested value for λ is equal to 1. In other words, the Box-Cox does not propose a modification and the initial model is accepted as it stands. The validity of the initial model was evaluated also using residual graphs. Figure 2 shows the normal plot of residual and residual versus fits for C. I. Direct Red 23. These were obtained with the help of MINITAB software. As it can be seen, the initial model enjoys a good fit. Table 8 shows the R^2, R^2_{adj} and RMSE of the model.

The main effects plots for C. I. Direct Red 23 (for *S/R* with “larger is better” mode) are shown in figure 3. The main effects plots for C. I. Direct Red 23 (for *S/N* with “larger is better” mode) are shown in figure 3.

C. I. Direct Red 224

Similar to C. I. Direct Red 23, the data (F_k) obtained from Taguchi design was analyzed by ANOVA and factors significant at 5% level were determined (table 9). Table 9 shows that X_1 (dye concentration) and X_2 (electrolyte concentration) are significant at 5% level. The level of these significant factors was raised to 3 and a series of test were carried out using full factorial experimental design.

Table 10 shows the result of ANOVA for the obtained results. As it can be seen, in this case only X_1 is significant at 5% level.

The initial model obtained for C. I. Direct Red 224 using response surface regression method is shown in equation (8).

$$F_k = 58.420 - 14.119(B) + 22.325(X_1) \qquad (8)$$

Figure 4 shows the Box-Cox transformation for the model (8) suggesting the value zero for λ. After applying the modification, the ANOVA shows that X_1, X_2 and X_1X_1 are significant at 5% level. The final model is presented as in equation (9):

$$ln(F_k) = 3.949 - 0.275(B) + 0.476(X_1) + 0.121(X_2) - -0.238(X_1X_1) \qquad (9)$$

It's reminded that B in equation (9) shows the effect of block (using soft or hard water) in the model. Figure 5 shows the normal plot of residual and residual versus fits for C. I. Direct Red 224. As it can be seen, the modified model enjoys a good fit. Table 11 shows the R^2, R^2_{adj} and MSE of the initial and modified model. Table 11 shows that the descriptive indicators have improved

Table 11

DESCRIPTIVE INDICATORS OF THE FINAL MODEL FOR C. I. DIRECT RED 224

Descriptive indices	Initial model	Modified model
R^2	76.3%	94.00%
R^2_{adj}	71.3%	91.50%
MSE	217.85	0.024

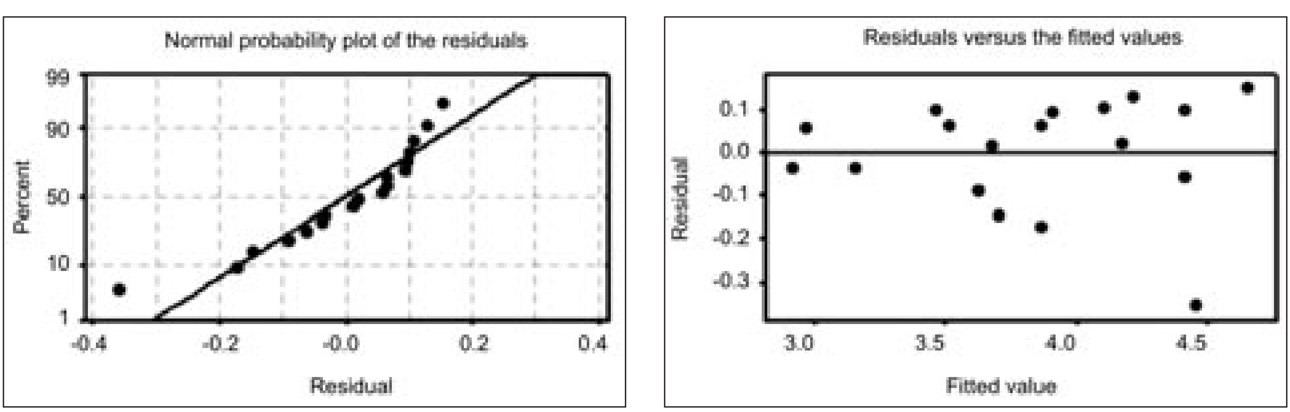

Fig. 5. Normal plot of residual and residual versus fits for C.I. Direct Red 224

Table 12

ANOVA FOR C.I. DIRECT RED 224 WHILE USING TAGUCHI DESIGN FOR *S/N*

	Dye	R^2	R^2_{adj}	*MSE*	Final model
Class A	**C.I. Direct Blue 67**	98.2%	97.4%	34.70	$F_k = 117.441 + 3.192\ (B) + 41.251\ (X_1) + 9.014\ (X_2) -$ $- 11.701\ (X_1X_1)$
	C.I. Direct Red 31	98.0%	97.2%	0.05	$ln\ (F_k) = 4.741 + 0.424\ (X_1) + 0.226\ (X_1) - 0.228\ (X_1X_1) -$ $- 0.103\ (X_3X_3) + 0.133\ (X_1X_3)$
Class B	**C.I. Direct Blue 1**	99.1%	98.9%	0.035	$(F_k)^{0.5} = 6.843 + 0.145\ (B) + 2.040\ (X_1) - 0.474\ (X_1X_1)$
	C.I. Direct Red 224	94.0%	91.5%	0.024	$ln\ (F_k) = 3.949 - 0.275\ (B) + 0.476\ (X_1) + 0.121\ (X_2) -$ $- 0.238\ (X_1X_1)$
Class C	**C.I. Direct Blue 2**	98.2%	97.7%	16.20	$(F_k) = 60.683 + 30.690\ (X_1) + 5.630\ (X_2) - 5.312\ (X_1X_1)$
	C.I. Direct Red 23	98.3%	98.1%	32.10	$F_k = 108.773 + 48.965\ (X_1) + 7.039\ (X_2) - 1.995\ (X_3) -$ $- 11.453\ (X_1X_1)$

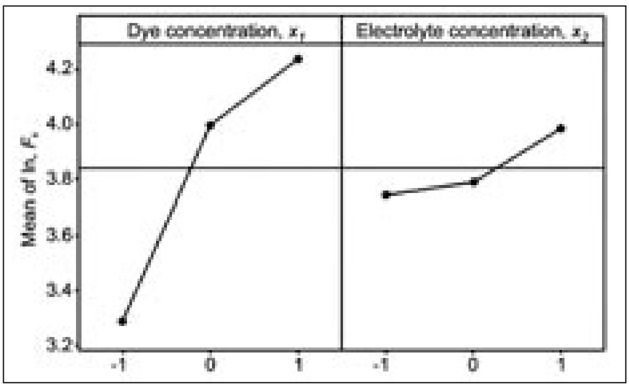

Fig. 6. Main effects plot for C.I. Direct Red 224

after modification. The main effect plots for C. I. Direct Red 224 (for *S/R* with "larger is better" mode) is shown in figure 6. Table 12 shows the final models obtained for all the six diazo dyes employed in this research. Finally the models obtained in this research were compared with those obtained by Zavare [14] who employed Central Composite Design for the same direct dyes. Comparison of the descriptive indicators (R^2 and R^2_{adj}) show that the models obtained through Taguchi and Factorial designs, have improved relative to the central composite design.

CONCLUSIONS

The color yield of 100% cotton fabrics dyed with the six selected direct dyes can be modeled using Taguchi and full factorial design as well as response surface regression method. The value of R^2 and R^2_{adj} of the obtained models show that the models possess appropriate fitness in all cases.

However, neither the models of the dyes of classes *A*, *B* and *C* show any similarity nor the models of the dyes belonging to each of the classes of *A*, *B* and *C*. For the six direct dyed selected in this research, electrolyte concentration and dyeing temperature are the most important factors on color yield. Time of dyeing, in the range selected in this research, does not affect color yield.

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Cotton/polyester Solo-Sirofil composite yarn

RUI-HUA YANG
WEI-MIAN WU
YU-QIN WAN
HONG-BO WANG
CHUN-PING XIE
WEI-DONG GAO

REZUMAT – ABSTRACT – INHALTSANGABE

Fire compozite din bumbac/poliester Solo-Sirofil

În scopul îmbunătățirii proprietăților firelor compozite din bumbac/poliester, în special a pilozității acestora, s-au studiat implicațiile introducerii unui cilindru Solospun în sistemul de filare Sirofil. În acest scop, în cadrul experimentului au fost produse nouă fire compozite diferite, din bumbac/poliester, cu finețea (densitatea de lungime) de 35 tex/75D, 39 tex/75D și 48 tex/75D și coeficienții de torsiune de 390, 425, 460, folosind sistemul de filare Sirofil, cu sau fără cilindru Solospun. Ulterior, au fost măsurate și comparate proprietățile fizice ale firelor, respectiv pilozitatea, rezistența la rupere, alungirea la rupere și neuniformitatea acestora. Rezultatele obținute arată că pilozitatea firelor filate prin sistemul Solo-Sirofil a scăzut cu 90%, în timp ce alungirea la rupere, rezistența la rupere și uniformitatea s-au deteriorat ușor.

Cuvinte-cheie: Solospun, Sirofil, Solo-Sirofil, fire compozite, fire din bumbac/poliester, proprietăți, coeficient de torsiune, pilozitate

Cotton/polyester Solo-Sirofil composite yarn

The effect of introducing a Solospun roller in the Sirofil spinning system in order to improve the properties of cotton/polyester composite yarns, especially the yarn hairiness was studied. For this purpose, as part of the experiment, 9 different cotton/polyester composite yarns, with yarn count (linear density) of 35 tex/75D, 39 tex/75D and 48 tex/75D, and twist factors of 390, 425, 460 were produced, by using the Sirofil spinning system, with and without a Solospun roller. Afterwards, the yarn physical properties including hairiness, breaking intensity, breaking elongation and irregularities were measured and compared. The results obtained indicate that the hairiness of Solo-Sirofil spun yarn was decreased by 90%, while yarn breaking elongation, breaking intensity and evenness were slightly deteriorated.

Key-words: Solospun, Sirofil, Solo-Sirofil, composite yarns, cotton/polyester yarns, properties, twist factors, hairiness

Solo-Sirofil Verbundgarne aus Baumwolle/Polyester

Es wurde die Anwendung eines Solospun-Zylinders im Sirofil-Spinnsystem untersucht im Sinne der Verbesserung der Eigenschaften der Verbundgarne Baumwolle/Polyester, insbesondere die Haarigkeit der Garne. In dieser Arbeit wurde ein Solospun-Zylinder verwendet und es wurden 9 unterschiedliche Verbundgarne aus Baumwolle/Polyester mit der Feinheit von 35 tex/75D, 39 tex/75D und 48 tex/75D und Zwirnkoeffizienten (alfa (T_t)) von 390, 425, 460 anhand des Sirofil-Spinnsystem produziert, mit oder ohne Solospun-Zylinder. Nachträglich wurden die physischen Garneigenschaften, einschliesslich Haarigkeit, Reisswiderstand, Reissdehnung und Unregelmässigkeiten gemessen und verglichen. Die Ergebnisse zeigen die Tatsache dass die Haarigkeit der Solo-Sirofil gesponnenen Garne mit 90% gesunken ist, während die Reissdehnung, der Reisswiderstand und die Gleichmässigkeit sich leicht verringerten.

Stichwörter: Solospun, Sirofil, Solo-Sirofil, Baumwolle/Polyester Verbundgarne, Zwirnkoeffizienten, Haarigkeit, Garneigenschaften

Sirofil is the technology which combines filaments and staple fibers together to form composite yarn, possesing the properties of both filament and staple fiber yarns [1–3]. The advantages not only enhance yarn quality, but they also shorten the process. More and more composite yarns are used to develop new kinds of fabrics. However, hairiness of Sirofil yarns is still a matter to be concerned. Solospun™ can spin weave able single yarns with less hairiness without the need for plying and sizing [4–5]. It is a new modified ring spinning developed by CSIRO, WRONZ and the Woolmark Company. Several studies investigated the hairiness and breaking intensity of Solospun yarns [6–8], which indicated that the hairiness of Solospun wool yarns was much reduced. Till now, there is no published paper which outlines how to use a Solospun roller in the Sirofil spinning system to improve the properties of cotton/polyester composite yarn, especially the hairiness. The aim of this paper is to study if utilising a Solospun roller in the Sirofil spinning system will further improve the resultant cotton/polyester composite yarn properties. In this work, 9 different cotton/polyester composite yarns with yarn linear density (count) of 35 tex, 39 tex and 45 tex, and twist factors – alpha, *Tt* – of 390, 425, 460 were produced in Sirofil and new hybrid Solo-Sirofil spinning systems, and the physical characteristics of the produced yarns were then investigated.

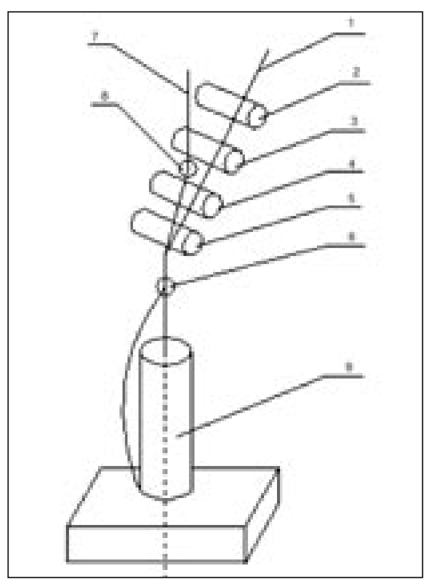

Fig. 1. Schematic of Solo-Sirofil spinning process:
1 – roving; 2 – back roller; 3 – middle roller; 4 – front roller; 5 – Solospun roller; 6 – yarn guide; 7 – filament; 8 – filament guide roller; 9 – composite yarn

MATERIALS AND METHODS

Materials used

Pair of Solospun rollers and filament guide were fitted onto an EJM-128K ring spinning frame for Solo-Sirofil spinning process [9], as shown in figure 1, while a pair

Table 1

SPINNING PARAMETERS									
Tex	35 tex/ 75 D	35 tex/ 75 D	35 tex/ 75 D	39 tex/ 75 D	39 tex/ 75 D	39 tex/ 75 D	45 tex/ 75 D	45 tex/ 75 D	45 tex/ 75 D
Twist factor	390	425	460	390	425	460	390	425	460

Table 2

BREAKING TENACITY OF SOLO-SIROFIL AND SIROFIL										
Item	Type	35 tex			39 tex			45 tex		
		Twist factor								
		390	425	460	390	425	460	390	425	460
Breaking tenacity, cN/tex	Solo-Sirofil	16.3	16.0	15.3	17.0	18.0	17.7	15.2	18.1	17.2
	Sirofil	17.2	18.6	17.0	20.6	18.7	17.9	19.6	19.2	18.2
Breaking elongation, %	Solo-Sirofil	9.5	9.8	10.1	8.1	8.3	11.4	8.6	11.1	11.4
	Sirofil	10.9	11.8	13.1	9.5	8.7	13.1	10.4	12.3	13.6

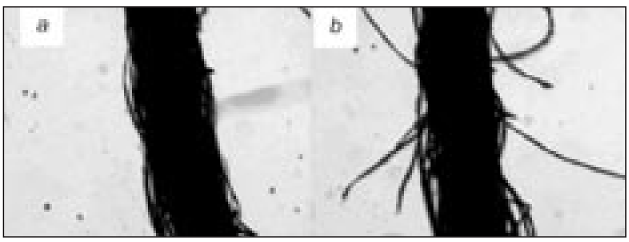

Fig. 2. Longitudinal views of yarns:
a – Solo-Sirofil; *b* – Sirofil

of filament guide was fitted on the same machine for Sirofil spinning process. Solo-Sirofil and Sirofil was spun at the same time using the same machine settings. Both spinning process uses a filament yarn with a staple fibre roving which are fed separately and kept at a fixed distance to the nip of the front drafting roller, they make up a triangular zone which is twisted together to form the composite yarn. We used a cotton sliver (mean fibre length – 25.4 mm, linear density of the fibre – 1.5 dtex, micronaire value of the fibre – 3.43 and roving size – 5.0 g/10m) and a polyester filament (75D) as the filament yarn both for Solo-Sirofil and Sirofil spinning system. Some of the spinning parameters were listed in table 1.

Testing methods

The longitudinal view of the yarn was observed with a Questar Hi-scope video microscope system. Hairiness

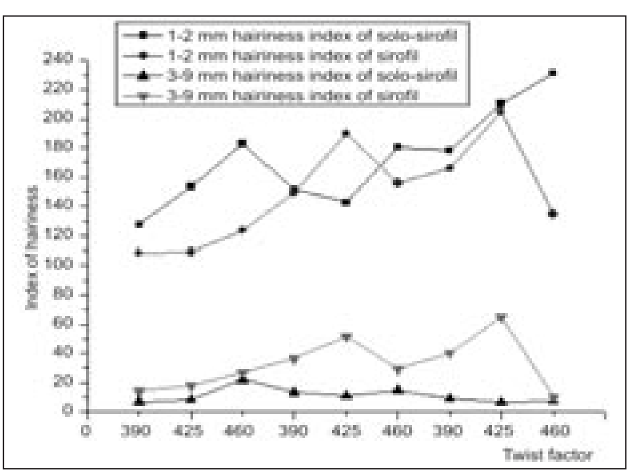

Fig. 3. Hairiness of Solo-Sirofil and Sirofil
(35 tex, 39 tex and 45 tex)

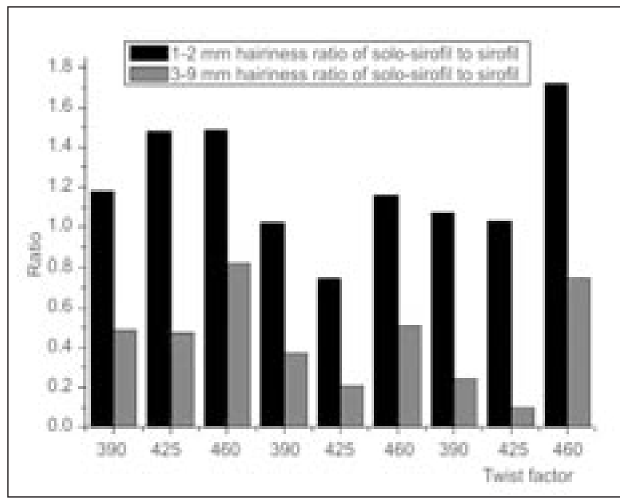

Fig. 4. Hairiness ratio of Solo-Sirofil and Sirofil
(35 tex, 39 tex and 45 tex)

was tested at a testing speed of 30 m/minutes and test length of 10 m on an YG172 hair tester. The hairline was measured for 1–9 mm per meter. The breaking intensity and elongation were determined at a test length of 500 mm, extension rate of 250 mm/minutes and pretension of 0.5 cN/tex on a YG061 tensile tester. Irregularity was tested by YG135G with the yarn speed of 400 m/minutes and the testing time of 1 minute. All the tests were performed in a standard atmosphere of 20 ± 2°C and 65 ± 2% RH.

RESULTS AND DISCUSSIONS

Figure 2 reveals that Solo-Sirofil have a much smoother surface than that of Sirofil. It also shows that Solo-Sirofil have a light-twist-ply structure as the function of the small grooves of Solospun roller. Figure 3 and figure 4 indicates that the indexes of hairs equal to or longer than 3 mm which are bad for fabric processing of nine kinds of Solo-Sirofil are decreased much as that of Sirofil, the least hair ratio of Solo-Sirofil to Sirofil is only 0.1, which means that the hair of Solo-Sirofil is reduced by 90%. And the indexes of hairs shorter than 3 mm, which are good for handle, of Solo-Sirofil most are increased as that of Sirofil. It was shown that due to the small grooves of a Solospun roller, as a drafted strand enters into the nip of this roller, multi-strands are twisted and hence several smaller twist triangles are

Table 3

YARN IRREGULARITIES OF SOLO-SIROFIL AND SIROFIL							
Tex	Twist factors	Type	Yarn irregularities				
			CV, %	U, %	Thin, –50%	Thick, +50%	Neps, +200%
35	390	Solo-Sirofil	9.95	7.76	0	0	5
		Sirofil	8.79	6.99	0	1	1
	425	Solo-Sirofil	9.37	7.41	0	0	0
		Sirofil	8.54	6.80	0	1	1
	460	Solo-Sirofil	9.15	7.25	1	0	1
		Sirofil	8.27	6.56	0	0	0
39	390	Solo-Sirofil	9.40	7.23	0	3	3
		Sirofil	8.41	6.61	0	2	2
	425	Solo-Sirofil	10.08	7.50	0	6	2
		Sirofil	8.79	6.70	0	4	3
	460	Solo-Sirofil	9.11	7.3	2	2	5
		Sirofil	8.33	6.5	0	1	1
45	390	Solo-Sirofil	9.94	7.01	0	2	6
		Sirofil	9.03	7.00	0	2	2
	425	Solo-Sirofil	11.95	9.20	0	0	0
		Sirofil					
	460	Solo-Sirofil	12.04	7.90	1	6	7
		Sirofil	8.37	6.54	1	2	2

produced as a result of final twist transition. The transfer degree of fibers of Solo-Sirofil was increased and transfer amplitude was reduced as fibers of each ply was already added some friction and cohesion due to each ply was twisted lightly first and then joint together to form a Solo-Sirofil [10], which at some extent optimized the hair index of Solo-Sirofil. Also as each ply was twist first and then jointed together to twist as composite yarn, the tension of the yarn was increased, so the long hair was reduced.

Table 2 demostrates that the breaking intensity and breaking elongation of Solo-Sirofil and Sirofil. Strenth of Solo-Sirofil was deduced by 5%–12%, and breaking elongation by 15%–33%. As the special light-twist-ply mechanism of Solo-Sirofil, the friction and cohesion of fibers of Solo-Sirofil composite yarn was reduced as some of their twist was added to each ply, which at some degree made a drop of the intensity and breaking elongation of the composite yarn.

Table 3 shows that evenness of Solo-Sirofil is worse than that of Sirofil. The increased irregularities for Solo-Sirofil spun yarns could be related to the large reduction of long hairiness.

When coarse and long hair fibres are incorporated into the yarn body, localized unevenness may increase as a result of an increased concentration of fibre mass and the associated change in yarn thickness in the region [10–11].

CONCLUSIONS

Solo-Sirofil and Sirofil were produced on a modified ring spun machine. The longitudinal views of yarns show that the appearance of Solo-Sirofil is clearer and tighter than that of Sirofil. Hair index of 3–9 mm of 9 different types of Solo-Sirofil is reduced much than that of Sirofil, while 1–2 mm was more than that of Sirofil. Compared with Sirofil, Solo-Sirofil has a smoother surface, less hairiness, less intensity and breaking elongation with worse evenness.

ACKNOWLEDGMENTS

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STANDARDIZARE

CEN ŞI CENELEC AU RĂSPUNS AFIRMATIV APELULUI PRIVIND PARTENERIATELE DIN CERCETARE ŞI INOVARE

CEN și CENELEC – organisme europene de standardizare, au salutat inițiativa privind „Parteneriatul în Cercetare și Inovare“ și invitația actorilor publici și privați de a-și uni forțele, la nivel european, pentru găsirea unor soluții privind provocările majore actuale. Comunicarea recunoaște importanța standardizării în consolidarea coerenței peisajului european din cercetare-inovare. CEN și CENELEC sprijină Uniunea Inovării în viitoarele parteneriate, care vor aduce împreună toate părțile interesate, pentru a găsi soluții comune la problemele majore cu care se confruntă omenirea, cum ar fi schimbările climatice, deficitul de energie și de resurse, sănătatea și îmbătrânirea populației. Aceste soluții vor fi vitale pentru Europa de mâine, de aceea ele trebuie să fie sigure, interoperabile, și diseminate în întreaga Europă.

Standardizarea oferă o punte de legătură între cercetare și inovație, fiind cheia lansării pe piață a rezultatelor cercetării. Standardele europene pot ajuta la scurtarea timpului de introducere pe piață a produselor și serviciilor noi. Prin intermediul unor instrumente specifice, incluzând paginile web și un birou de informare, CEN și CENELEC stau la dispoziția cercetătorilor și a companiilor care doresc sprijin în acest domeniu.

Multe proiecte de cercetare din U.E. au profitat deja de aceste oportunități și au integrat standardizarea în activitățile proprii. De exemplu, pentru a atenua schimbările climatice, trebuie să cunoaștem mai bine pământul pe care trăim. Proiectul I-SOIL, finanțat de U.E., cercetează interacțiunile dintre sol și științele conexe și are ca scop dezvoltarea, validarea și evaluarea conceptelor și strategiilor necesare transferului distribuției parametrilor fizici măsurați pe hărți. Printre activitățile proiectului I-SOIL se numără dezvoltarea unui standard european privind abordarea celor mai bune practici pentru măsurătorile inducției electromagnetice la suprafață.

Comitetul European pentru Standardizare (CEN) este un catalizator al afacerilor din Europa, eliminând barierele comerciale pentru părțile europene interesate, cum ar fi: industria, administrația publică, furnizorii de servicii, consumatorii etc. Misiunea sa este aceea de a stimula economia europeană în comerțul global, de a spori bunăstarea cetățenilor europeni și de a proteja mediul. Prin serviciile sale, CEN oferă o platformă pentru dezvoltarea standardelor europene și a altor specificații. Cei 31 de membri naționali lucrează împreună pentru a construi o piață europeană internă de bunuri și servicii și pentru a poziționa Europa în economia globală. Prin sprijinirea cercetării și diseminarea inovației, standardele sunt instrumente puternice de creștere economică.

Comitetul european pentru standardizare electrotehnică (CENELEC) este responsabil, în mod oficial, de standardizarea în domeniul electrotehnic. Într-o economie din ce în ce mai globală, CENELEC stimulează inovarea și competitivitatea, făcând ca tehnologia să fie disponibilă nu numai pentru întreprinderile mari, ci și pentru IMM-uri, prin elaborarea de standarde voluntare. CENELEC facilitează accesul atât pe piața europeană, cât și pe piața internațională, prin acordul de cooperare cu Comisia Electrotehnică Internațională (IEC). Standardele electrotehnice europene sunt create pentru a ajuta la modelarea pieței interne europene, pentru încurajarea dezvoltării tehnologice și asigurarea interoperabilității, dar și pentru garantarea siguranței și sănătății consumatorilor și protecției mediului.

Sursa: www.cwn.eu; www.cenelec.eu

Natural antibacterial finishing of wool fiber using plasma technology

AMINODDIN HAJI
AHMAD MOUSAVI SHOUSHTARI

REZUMAT – ABSTRACT – INHALTSANGABE

Tratament de finisare naturală antibacteriană a fibrei de lână, folosind tehnologia cu plasmă

În acest studiu, pentru vopsirea fibrelor de lână a fost folosit un colorant cationic natural, Berberina, extras din arbuștii și rădăcinile de Berberis Vulgaris. În scopul îmbunătățirii capacității tinctoriale a fibrelor și a reducerii temperaturii de vopsire, acestea au fost supuse unui tratament preliminar ecologic cu plasmă, la temperatură scăzută. Gazul folosit la tratare a fost aerul atmosferic. Au fost studiate efectele tratamentului cu plasmă și ale mordantului asupra vopsirii și rezistenței fibrelor de lână. S-a constatat că, prin aplicarea tratamentului cu plasmă, absorbția colorantului cationic de către fibră a fost îmbunătățită. Comparativ cu mostrele netratate, lâna tratată cu plasmă a demonstrat o capacitate de vopsire mai bună, precum și bune proprietăți de rezistență la spălare, frecare și lumină. De asemenea, prin tratarea preliminară cu mordant Alum au fost optimizate proprietățile de rezistență ale mostrelor vopsite. Acestea au fost testate privitor la activitatea antibacteriană împotriva a două bacterii gram pozitive și a două bacterii gram negative, folosind testul AATCC, metoda 100-2004. Lâna vopsită a demonstrat un nivel înalt al activității antibacteriene.

Cuvinte-cheie: lână, mordant, plasmă, vopsire, colorant natural, antibacterian

Natural antibacterial finishing of wool fiber using plasma technology

In this study, Berberine, a natural cationic dye extracted from the roots and woods of Berberis vulgaris, was used to dye wool fibers. To improve the dyeability of the fibers and reduce the dyeing temperature, an environmental friendly pretreatment, low temperature plasma treatment, was performed. Atmospheric air was used as plasma treatment gas. The effect of plasma treatment and mordanting on dyeing and fastness properties of wool fiber was studied. Plasma treatment improved the absorption of the cationic dye to wool fiber. Compared to untreated samples, plasma treated wool showed better dyeability with good fastness properties against washing, rubbing and light. Also, pre-mordanting with Alum improved the fastness properties of dyed samples. The dyed samples were tested for antibacterial activity against two gram negative and gram positive bacteria, using AATCC test method 100-2004. The dyed wool presented a high level of antibacterial activity.

Key-words: wool, mordant, plasma, dyeing, natural dye, antibacterial

Natürliche antibakterielle Wollfaser-Behandlung mit Plasma-Technologie

In dieser Untersuchung wurde ein kationisches Farbstoff-Berberine, gewonnen aus den Wurzeln und Stengel der Berberis Vulgaris, für die Färbung der Wollfaser angewendet. Um die Färbbarkeit der Faser und die Farbtemperatur zu verringern, wurde eine umweltschonende Vorbehandlung und eine Plasmabehandlung bei niedriger Temperatur durchgeführt. Es wurde der Effekt der Plasmabehandlung und der Beize auf die Färbung und die Echtheitseigenschaften der Wollfaser untersucht. Die Plasmabehandlung verbesserte die Absorption des kationisches Farbstoffes auf der Wollfaser. Im Vergleich mit den unbehandelten Mustern, zeigte die plasmabehandelte Wolle eine bessere Färbung mit guten Echtheitseigenschaften gegenüber Waschen, Reibung und Licht. Gleichsfalls, Vorbeize mit mit Alum verbesserte die Echtheitseigenschaften der Farbmuster. Die Farbmuster wurden gegenüber antibakterieller Einwirkung getestet, mit zwei Gramm negativen und ein Gramm positiven Bakterien, anhand der AATCC 100-2004 Testmethode. Die gefärbte Wolle zeigte einen hohen Grad antibakterieller Einwirkung

Stichwörter: Wolle, Beize, Plasma, Färben, natürliches Farbstoff, antibakteriell

In the field of textiles and the cosmetics industry natural dyes have been gaining interest particularly with respect to growing awareness of environmental and health-related problems [1]. Compared with synthetic dyes, they have several advantages such as biodegradability, non toxic functions, specific medical actions and environmentally friendly finishes [2]. Natural dyes can be derived from almost anything-plants, minerals, and even some insects. Most natural dye colors are found in the roots, bark, leaves, flowers, skins, and shells of plants [3]. Some natural dyes, when applied on textiles, show antibacterial effects, so can be considered as functional dyes with health care properties. Natural dyes extracted from Henna [4], Amur cork tree [5, 6], Rhizoma coptidis [7], Citrus grandis Osbeck [8] and Berberis vulgaris [2] have shown considerable antibacterial effect when applied on textile fibers.

The surface of a wool fiber plays a critical role in wool processing, particularly with respect to dye uptake. Wool fiber surface is a protein matrix heavily acylated with lipid, predominantly 18-methyleicosanoic acid. Removal of the lipid layer results in improvement of polymer adhesion and dye uptake [9].

Ecologic and economic restrictions which are increasingly imposed on the textiles industry require the development of environment friendly and economic processes. Plasma treatment is a promising approach for surface modification of textiles without affecting the bulk properties. The effect of plasma treatments in wool dyeing has been studied [10]. Corona treatment uses ionized air to modify the surface of the wool fibers. The presence of high amounts of oxygen and nitrogen species in the plasma gas induces chemical and physical changes on the surface through oxidation, grafting and adhesion, by the formation of carbonyl, carboxylic, hydroxyl, amino, nitro etc. groups [11].

Plasma treated wool fabrics have shown better dyeability with acid [11], reactive and metal complex [12] dyes. In this study, we have studied the effect of atmospheric pressure plasma treatment on dyeability of wool fiber with a cationic natural dye. The antibacterial activity of dyed fabric has been evaluated too.

MATERIALS AND METHODS

Materials used

In this work, plain woven wool fabric (250 g/m^2) was supplied from Iran Merinos Textile Company, Iran. Before being used, the fabric was scoured with a solution containing 1 g/L non-ionic detergent at 45^{o}C

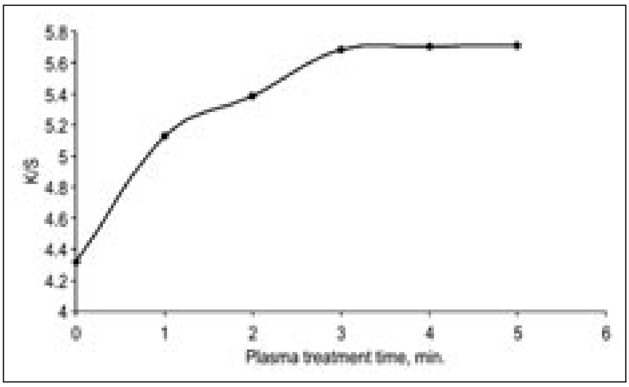

Fig. 1. Effect of plasma treatment time on color strength of samples dyed for 45 minutes at 60°C

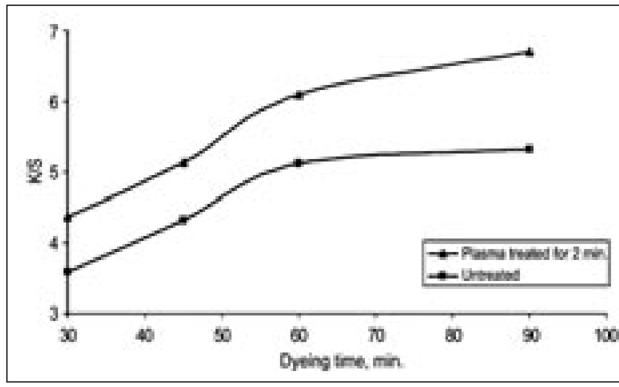

Fig. 2. Effect of dyeing time on color strength of samples dyed at 60°C

for 20 minutes. Then the fabric was thoroughly washed with water and air dried at room temperature.

Berberis vulgaris roots were first washed and dried and then powdered. To prepare the original solution of the dye, each 100 gram of powder was added to 1 liter of distilled water and boiled for 2 hours and then filtered. The concentration of the resultant solution is 10% W/V. All chemicals used were analytical grade reagents from Merck.

Methods used

Plasma treatment. The samples were treated in an atmospheric pressure plasma chamber composed of two parallel electrodes with 3 mm space. The samples were placed between the electrodes. In all treatments, air was used as the processing gas with the power of 50 watts, voltage of 20 kV and frequency of 10 kHz at different time intervals.

Mordanting. The scoured wool fabrics were mordanted using 2% owf of alum (aluminium potassium sulfate) at 80°C and $L : G = 40 : 1$, for 45 minutes.

Dyeing. 100 cc of original dye solution was mixed with 100 cc of distilled water for each 5 gram of wool ($L : G = 40 : 1$). To maximize the absorption of berberin cationic dye to wool fiber, *p*H of the dye bath was adjusted on 8 (according the author's previous study [2]), using sodium carbonate. The dyeing was started at 40°C and the temperature was raised to final temperature (60, 70, 80, 90 and 100°C) at the rate of 2°C per minute. Then the samples remained in that condition for appropriate time (30, 45, 60, 90 minutes), and then rinsed and air dried. All mordanting and dyeing processes were carried out using a laboratory dyeing machine made by Rissanj Co. – Iran.

Color measurements. The reflectance of dyed samples and color coordinates CIE L^*, a^*, b^* values were measured on a Color-eye 7 000 A spectrophotometer using illuminant D 65 and 10° standard observer. Color strength, *K/S*, of dyed samples were calculated using Kubelka-Munk equation:

$$K/S = (1 - R)^2/2R \qquad (1)$$

where:

R is the observed reflectance;

K – the absorption coefficient;

S – the light scattering coefficient.

Color fastness tests. Color fastness to washing, light and rubbing was measured according to: ISO 105-C01:1989(E), ISO 105-B02:1994(E), ISO 105-X12:1993(E), respectively.

Antibacterial test. The antibacterial property of dyed samples was quantitatively evaluated according to AATCC 100-2004. The bacterial species used were Klebsiella pneumoniae (gram negative) and Staphylococcus aureus (gram positive). The colonies of both bacteria before and after incubation on the agar plate were counted by microscope. The reduction in the number of bacteria which was calculated using equation 2 which shows the efficacy of the antibacterial treatment.

$$E\% = [(N_1 - N_2)/N_1] \cdot 100 \qquad (2)$$

where:

N_1 is the number of bacteria colonies at the beginning of the test (0 hour);

N_2 – the number of bacteria colonies after 24 hours contact of dyed samples.

SEM images were taken using an AIS2100 scanning electron microscope (Seron Technology, South Korea) to study the effect of plasma treatment on the surface structure of wool fibers.

RESULTS AND DISCUSSIONS

Effect of plasma treatment on color strength of dyed wool

Figure 1 shows the effect of plasma treatment time on the color strength of wool sample dyed for 45 minutes at 60°C. It is evident that plasma treatment increased the absorption of the cationic dye to wool fiber and the color strength increases with increase in plasma treatment time up to 3 minutes.

It can be seen from figure 2 that the plasma treated samples show higher color strengths than untreated wool, when dyed at 60°C for the same time. The color strength of untreated sample dyed for 60 minutes is equivalent to the plasma treated one dyed for 45 minutes.

Figure 3 shows the effect of dyeing temperature on color strength of untreated and plasma treated wool. The color strength increases with the increase in temperature for both samples, but it is greater for plasma treated sample when dyed at the same temperature. The color strength of plasma treated sample dyed at 70°C is equivalent to that of untreated one dyed at 100°C. It can be deduced from figures 2

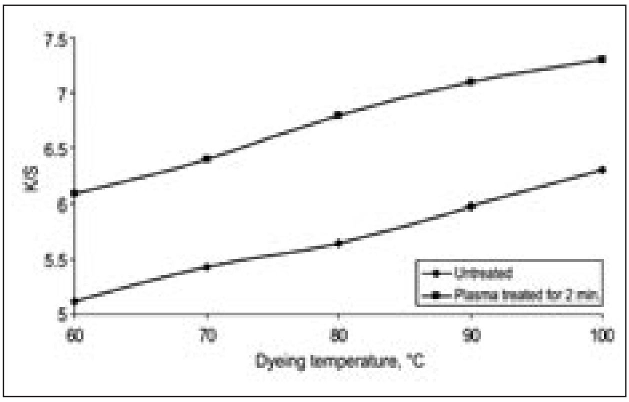

Fig. 3. The effect of dyeing temperature on color strength of untreated and plasma treated wool dyed for 45 minutes

Table 1

EFFECT OF MORDANTING WITH 2% OWF ALUM ON DYEABILITY OF UNTREATED AND PLASMA TREATED WOOL (45 minutes at 60°C)

	K/S	*L**
Untreated – unmordanted	5.12	70.35
Untreated – mordanted	5.35	69.12
Plasma treated – unmordanted	6.08	68.43
Plasma treated – mordanted	6.42	67.05

and 3 that compared to untreated wool, plasma treatment can lower the dyeing time and temperature when the same color strength is desired. This is important from both economical and ecological point of view.

Effect of mordant on dye absorption

According to table 1, pre-mordanting with 2% owf alum increased the color strength of both untreated and plasma treated samples when dyed. Also the L^* of untreated sample is higher than plasma treated one, which confirms the higher dye absorption on plasma treated wool when pre-mordanting is performed. Aluminum mordant absorbed onto the wool fiber increased its dyeability with Berberine dye.

Fastness properties

Table 2 shows the fastness properties of untreated and plasma treated (mordanted and unmordanted) dyed wool. There is no difference between fastness properties of untreated and plasma treated wool. All fastness properties of dyed samples when mordanted are higher than when unmordanted. This increase is due to

Table 2

FASTNESS PROPERTIES OF UNTREATED AND PLASMA TREATED (2% OWF ALUM MORDANTED AND UNMORDANTED) DYED WOOL

	Wash fastness	Rub fastness (dry)	Rub fastness (wet)	Light fastness
Untreated – unmordanted	3–4	4	2–3	5–6
Untreated – mordanted	5	4–5	3–4	5–6
Plasma treated – unmordanted	3	4	2–3	6
Plasma treated – mordanted	3–4	4–5	3–4	6

Table 3

ANTIBACTERIAL ACTIVITY OF DIFFERENT SAMPLES (% reduction of bacteria after 24 hours incubation)

Sample \ Bacteria	Staphylococcus aureus	Klebsiella pneumoniae
Control (not dyed)	0%	0%
Plasma treated – alum mordanted – dyed	99.5%	99.6%

increase in size of dye molecules when connected to metal atoms into the fiber. Wet rub fastness was less than dry rub fastness because the water molecules can dissolve some of water-soluble dye molecules and make them easier to be removed from the fiber by rubbing. All fastness properties of plasma treated, mordanted and then dyed wool fibers are generally acceptable.

Surface analysis

According to figure 4, plasma treatment for 2 minutes destroyed the surface layer (scales) of wool fiber. This can lead to increase in dye penetration into the fiber and lower the dyeing time and temperature compared to untreated samples.

Antibacterial activity

Table 3 shows the percent reduction in number of two bacteria after 24 hours incubation on the surface of undyed and dyed (after 2 minutes plasma treatment) wool. It is obvious that the dyed wool has excellent antibacterial activity against both bacteria used in this study. Berberine colorant is a quaternary ammonium compound, containing a positive charge on *N* atom that could destroy the negatively charged cell membrane of the bacteria by disturbing charge balances of cell membrane. Other detrimental effects of quaternary ammonium compounds on microbes are denaturizing of proteins and disruption of the cell structure [2].

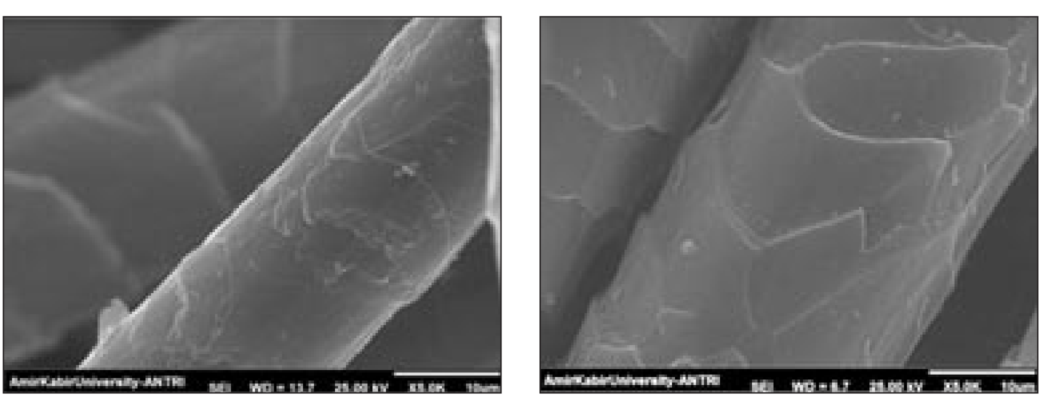

Fig. 4. SEM images of untreated and plasma treated wool (2 minutes)

CONCLUSIONS

Berberine, which is a cationic colorant present in the extract of Berberis vulgaris root, can be used as a natural dye for wool.

Mordanting with aluminum before dyeing increased the dye uptake and fastness properties of the samples. Wool fiber dyed with this dye has great antibacterial activity against both gram positive and gram negative bacteria.

Atmospheric air plasma treatment can enhance absorption of this dye into wool fiber.

This environmentally friendly pretreatment can lower the time and temperature needed for wool dyeing. Furthermore, this process is environmentally friendly and has the minimum pollution.

This natural dye can be used for dyeing wool with good fastness and excellent antibacterial properties.

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STANDARDIZARE

STANDARD PRIVIND MĂSURĂTORILE DIMENSIONALE ALE CORPULUI FEMEILOR DE STATURĂ MICĂ

ASTM International, Dayton, Ohio/S.U.A., este una dintre cele mai mari organizații active în dezvoltarea standardelor internaționale și a sistemelor de livrare din lume. Ea elaborează standarde internaționale pentru materiale, produse, sisteme și servicii utilizate în construcții, producție și transport.

Comitetul Internațional ASTM D13 pentru domeniul textilelor lucrează în prezent la o nouă propunere de ghid privind dimensiunile corporale ale femeilor de staturi mici și înalte, în vederea elaborării unui nou standard de măsurători dimensionale pentru femei, deoarece actualul standard este bazat pe o singură înălțime – cea medie.

Noul standard propus, *ASTM WK33671* „Ghid de măsurare a dimensiunilor corpului femeilor de statură mică/*Adult misses petite figure type*" se află sub jurisdicția subcomitetului D13.55 pentru măsurarea dimensiunilor corpului, în vederea dimensionării articolelor de îmbrăcăminte.

Melliand International, septembrie 2011, nr. 4, p. 184

Assessment of the size charts of apparel business in online clothing sale for children between the ages of 3 and 6

NURGÜL KILINÇ

REZUMAT – ABSTRACT – INHALTSANGABE

Evaluarea tabelelor de mărimi folosite de magazinele cu vânzări online, pentru îmbrăcămintea copiilor cu vârste cuprinse între 3 și 6 ani

Scopul acestei studiu îl constituie studierea tabelelor de mărimi folosite de magazinele de îmbrăcăminte cu vânzări online, specializate în confecțiile pentru copii cu vârste cuprinse între 3 și 6 ani, și stabilirea criteriilor de determinare a dimensiunilor corecte și a gamei de dimensiuni disponibile. Metoda de lucru pe care se axează acest studiu este chestionarul online. Subiecții studiului au fost reprezentați de 173 de magazine online, care au afișat pe site propriile tabele de mărimi folosite. La sfârșitul studiului, s-a constatat că, pentru a identifica mărimea potrivită din tabelele afișate pe site-urile acestor magazine, cel mai des sunt oferite date privind greutatea și înălțimea. După analiza întregii game de mărimi prezentate în tabele, s-a observat că nu există un standard antropometric folosit de producătorii de îmbrăcăminte pentru copii cu vârsta cuprinsă între 3 și 6 ani.

Cuvinte-cheie: tabele de mărimi, tabele de mărimi pentru copii, îmbrăcăminte pentru copii, dimensiuni ale îmbrăcămintei, vânzări online ale îmbrăcămintei

Assessment of the size charts of apparel business in online clothing sale for children between the ages of 3 and 6

The aim of this study is to investigate the size charts used by the apparel firms selling clothes online for 3–6 year old children, and present the criteria they use in determining the correct size as well as the range of these sizes according to age variable. Internet survey research was the chosen methodology for this study. The sample of the study is 173 firms which have size charts on their websites. Is revealed at the end of this research that in the size charts presented on their websites, in order for their customers to identify the correct sizes, mostly weight and height measurements are given place. When the range of measurements according to age groups is looked through, it was observed that there is not an exact standard in anthropometric measurements used in clothes manufacture of children for 3–6 ages and size description.

Key-words: size chart, children size chart, children clothing, clothing sizes, online clothing sales

Bewertung der Ausmasstabellen im online Bekleidungsverkauf für Kinder im Alter von 3 bis 6 Jahren

Zweck dieser Untersuchung ist die Datenerfassung für Ausmasssysteme im online Bekleidungsverkauf für Kinder im Alter von 3 bis 6 Jahren und deren anthropometrischen Messungen für die Identifizierung des richtigen Bekleidungsausmasses sowohl für Hersteller als auch für Verbraucher. Als Basis der Untersuchung gelten die Ausmasstabellen der Websites von 173 online Geschäften. Als Schlussfolgerung der Untersuchung wurde festgestellt, dass in den Ausmasstabellen der Websites meist Höhe und Gewicht als Ausmasse enthalten waren. Als der Ausmassbereich in Beziehung der Altersgruppen in Betracht gezogen wurde, hat man beobachtet, dass es kein genaues Standard in den anthropometrischen Messungen für die Bekleidungsherstellung bei Kindern des Alters zwischen 3 und 6 Jahren und deren Ausmass-beschreibung vorhanden ist.

Stichwörter: Ausmasstabelle, Kinderausmasstabelle, Kinderbekleidung, Bekleidungsmasse, Bekleidung, online Verkaufsgeschäft

The apparel industry has started using the internet in an attempt to improve the efficiency and effectiveness of marketing, to provide customers access to information about products and their availability, to build brand value, and to offer customers a convenient medium to make purchases online. The most valuable aspects of internet shopping, as compared to store-based and catalogue shopping are typically perceived to be competitive pricing, one-source shopping, convenience and time-savings [1]. In spite of all these advances and the advantages provided by the apparel trade through the internet, consumers' concerns, originated by the facts that they can not touch the products they would like to buy, they can not see them directly and they can not try them on, cause the fact that clothing sales through the internet is low especially for some products. Comfort and fit are among the highest determinants for apparel purchase in today's market. A clothing that does not fit well, will not sell [2]. The clothing industry is concerned with mass producing well-fitting clothes for various ages and the size groups within a given population and this can only be done effectively if the sizes produced are based on an authoritative data. This data is obtained through anthropometric surveys which measure a representative sample of the population group being examined, and then submitting the collected measurements to a statistical analysis. Result of these processes provides the information for developing more accurate sizing system [3]. A classifying process, accepted by both the manufacturers and the consumers emerged as a consequent of the process of classification of the bodies into certain size groups by accepting some certain sizes of all people as fixed. This classification is called "clothing size". A clothing sizing system is essential for effective clothing design and production. A sizing system classifies a specific population into homogeneous subgroups based on some key body dimensions. Persons of the same subgroup have the same body shape characteristics, and share the same clothing size [4].

When a consumer purchases clothes by a mail order or in a store a size label provides information about the size before the consumer actually tries on the garment. If the consumer is to select the correct clothing size efficiently, the size needs to be adequately described. Since the beginning of the ready-to-wear clothing industry in the late nineteenth century, size categories of garments have been coded by numbers or letters, with numerical codes indicating the age, bust and height measurement of the consumer. Numerical size codes, which are unrelated to body dimensions, are confusing

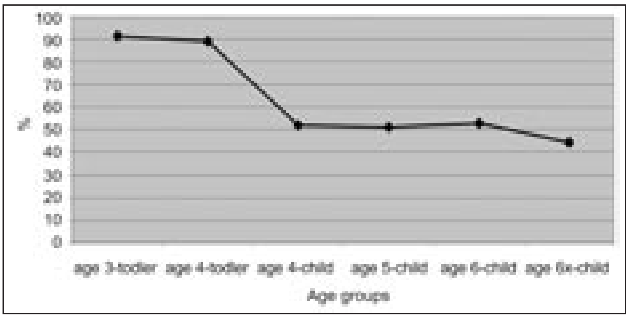

Fig. 1. The range of age groups in size chart of clothing business

the consumer when choosing garments to try on for proper fit [5].

There are two main approaches to identify body size in the age groups of babies and children. These are using the age variable as body size and using the height variable as body size. It provides convenience to the adults who don't know the anthropometric measurements of children growing constantly to identify the correct clothing size. However, it is also known that there is no linear correlation between the ages of children and their physical development [6]. Range of height measurements of children in any age group is quite wide. For this reason, age of a child reflects the height of the child and his\her physical characteristics only roughly. It is necessary to consider not only the age but also the other body measurements when buying clothes in order to provide the accordance of clothing to the body [7].

The businesses in online sales have been presenting size charts including different sizes to identify accurate body size to their customers in their websites. Although size charts continue to be used by companies, procedures for their creation have often been blurred, giving the impression either such procedures are non-existent or that they are unscientific. Indeed, some size charts have been developed through trial and error, but it is notable that many companies have conducted their own surveys and hold vast amounts of anthropometric data [8]. Three main objectives of this research are as follows:

- To compose data consisting of anthropometric measurements for child clothing manufacturers and consumers;
- To bring out anthropometric measurements used in description of clothe sizes in child clothing sector and the range of these measurements based on age variable;
- To determine the level of measurement standardization in child clothing sector taking advantage of measurement tables of businesses;
- Research questions comprised in evaluation of measurement tables of clothing businesses selling online clothes for children aged 3–6 years are as below;
- What are the age groups taking part in measurement tables of clothing businesses selling online clothes for children aged 3–6 years and that they use for description of clothe size?
- What are the other anthropometric measurements that clothing businesses selling online clothes for children aged 3–6 years consider according to age variable in description of correct clothe size for consumers? From which of these measurements do they take advantage of mostly?
- What is the range according to age groups of the measurements in measurement tables of clothing businesses selling online clothes for children aged 3–6 years?

EXPERIMENTAL PART

Internet survey research was the chosen methodology for this study. The universe of the research has been composed by the business in online sales of clothing for children aged between 3 and 6 and the anthropometric body size charts presented as reference by them to their customers in order to identify the accurate clothing size. The business in online clothing sales for the children aged between 3 and 6 are identified through the search engines on the internet. When the business' size charts prepared for the children aged between 3 and 6 are considered it is usually confirmed that anthropometric measurements are presented by being grouped accordingly with the ages. It is also found in some businesses that grouping is presented accordingly with height. This research is restricted with the businesses who classify body sizes accordingly with the age variable and the classifications done accordingly with height or other variables are excluded. The sample of this research is composed by the 173 businesses selected via random method among those who classify their size charts accordingly with the age variable and who have their size charts available in their websites and their size charts.

It is studied in details what the anthropometric measurements presented by the business to their customers to identify the accurate clothing size are and the differences between the anthropometric sizes placed in the same age group by analysing the size charts placed in the websites of the business composing the sample of this research accordingly with the age variable.

RESULTS AND DISCUSSIONS

When the size classifications done accordingly with the age variable of the business in online clothing sales for the children aged between 3 and 6 are considered it is seen that there are 6 sub-groups as age 3 toddler, age 4 toddler, age 4 child, age 5 child, age 6 child and 6x child (Research question 1). It is also seen that there is no sex differentiation in the size charts prepared for the children aged between 0 and 6 but sizes of boys and girls become different in the size charts prepared for the children over 7 years.

It is seen in figure 1, that the age 4 measurements are subjected to be classified into two different categories as age 4 – toddler and age 4 – child. The same applies for the age 6 measurements as child aged 6 and 6x. This is not the case for the age 3 and 5 groups. The most common age group to come across in clothing business' measurement charts are the age 3 – toddler and age 4 groups, the age 4 child, age 5 child, age 6 child, and age 6x child groups are found in nearly half of the businesses, which compose the sample of this research (Research question 1).

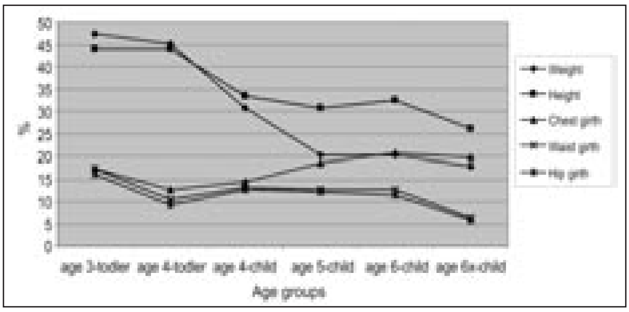

Fig. 2. The range of the body size, used to define clothing size

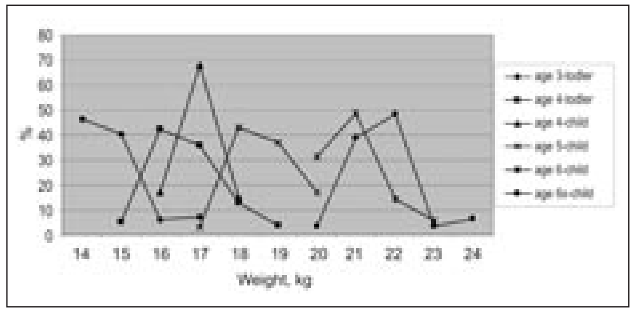

Fig. 3. The range of weight measurements according to age

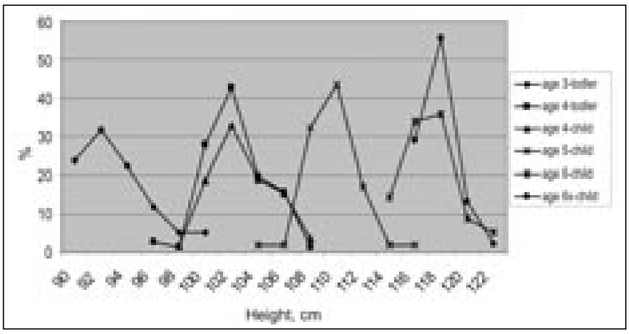

Fig. 4. The range of height measurements according to age

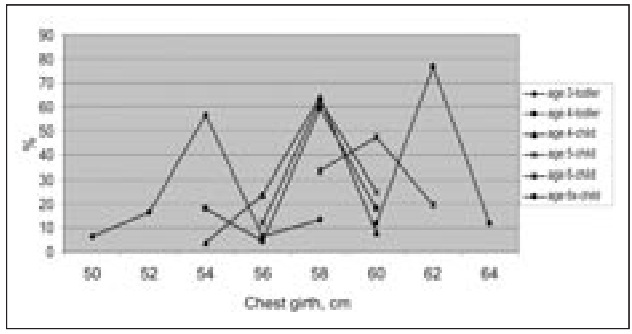

Fig. 5. The range of the chest girth measurements according to age

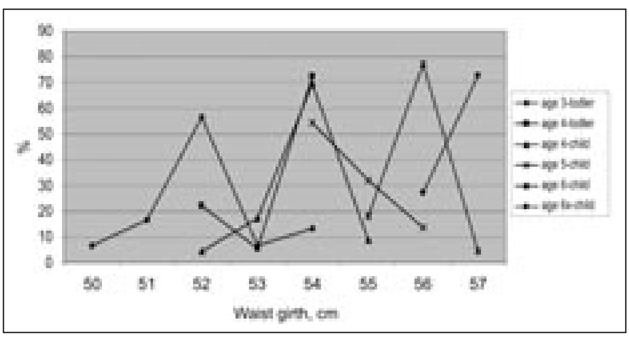

Fig. 6. The range of waist girth measurements according to age

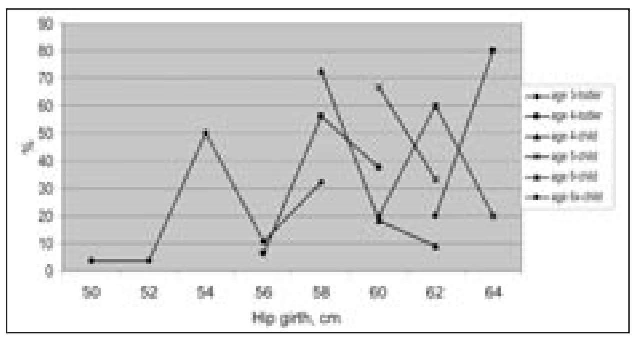

Fig. 7. The range of the hip girth measurements according to age

For business to prevent goods from being returned due to size mismatches, the most important role is played by size charts that guide consumers to purchase products of the right size. Various clothing types are sold more online. The clothing types are baby clothing, socks, sports clothing and so on [9]. Especially as seen in figure 1, measurements for younger ages are more common. This can be thought to be because of the fact that this group is seen as more appropriate for consumption of goods from the internet, and because baby clothing sales are often made online.

In the analyses made for the 2nd research question, it was confirmed that a great majority of the businesses selling online clothes for children aged 3–6 years use mostly height and weight measurements in their size charts in order to help customers specify the right clothes size (fig. 2). It is also concluded that for the age groups of age 3 – toddler and age 4 – toddler, weight measurements are used more than height measurements to define clothing sizes (fig. 2). As the age group gets older it can be said that height measurements are used more than weight measurements to define clothing sizes. It can be seen in figure 2 that other than weight and height measurements, waist and hip measurements are not used commonly to define sizes for children aged 3–6.

For the 3rd research question, the range of measurements of weight (fig. 3), height (fig. 4), chest (fig. 5), waist (fig. 6), hip (fig. 7) that are in measurement tables of businesses comprising the sample of the study is analysed. After analysing figure 3, it can be seen from the business included in the research that the range of weight measurements in the size charts of establishments which sell online for children aged 3–6 are between 14 kg and 25 kg. In figure 3, it is seen that the age 4 – child groups' weight measurements are higher than that of the age 4 – toddler group for most establishments. It is also clear that for most business the weight measurements for children age 6x – child are higher than those for the child age 6 – child group.

According to the data from figures 3 and 4, whilst the differences of height between the age groups of age 4 – toddler and age 4 – child are not much different, the weight measurements for the age 4 – child group is higher than those of the age 4 – toddler group. Because of this we can say that the factor of difference

between the two groups is the difference of weight. The same goes for the age 6 – child and age 6x – child groups.
Range of chest girth measurement are between 50–64 cm (fig. 5), waist girth measurement as 50–57 cm (fig. 6) and hip girth measurement as 50–64 cm (fig. 7) in size charts of business which sell clothes online for children aged 3–6. Range of chest girth measurement in figure 6 shows to have become intense as the same measurements between 50 and 60 cm in size group of age 4 – toddler, age 4 – child and age 5 – child. This shows that clothes put on the market for consumers in three different size groups are in a similar situation on size. Range of waist girth measurement in a similar situation is observed. The most commonly met measurement is 54 cm on age 4 – toddler, age 4 – child and age 5 – child size groups (fig. 6). Size groups showed different range in hip girth measurement. Although the most commonly met measurement is 58 cm age 4 – toddler and age 4 – child in hip girth measurement, each size group shows different range (fig. 7) (Research question 3).
The International Organization for Standardizations existing standards are: ISO/TR 7250 (Basic human body measurements for technological design), ISO 3635 (Size designation of clothes – Definitions and body measurement procedure), ISO 3638 (Size designation of clothes-infants' garments), (Size designation of clothes – Men's' and boys' underwear, nightwear and shirts), ISO 4416 (Size designation of clothes – Women's and girls' underwear, nightwear, foundation garments and shirts), (Size designation of clothes – Men's' and boys' outwear garments), (Size designation of clothes – Women's and girls' outwear garments), ISO 8559 (Garment construction and anthropometric surveys – Body dimensions). These standards contain limited anthropometric measurements. These are height, chest girth and hip girth measurements attached to the measurement variable. There is no range of measurements according to the age variable. However business which sell garments online for children aged 3 to 6 use a measurement system based on the age variable for parents who don't know the other anthropometric measurements so that they can decide on the clothing size. There is a lot of international research that can be found 10–12 which includes anthropometric measurements for children aged 3–6. But anthropometric measurements which can be referred to especially for clothing production aren't generally classed according to the age variable, but to the height variable. The World Health Organisation's (WHO) statistics are also important as an international anthropometric data. These statistics are used to follow the development of children. Additionally, most clothing companies which sell online give their customers weight measurements as reference to help them decide on the right sizes. It is uncommon to come across weight measurements in anthropometric measurements and researches prepared for clothing production. Statistics published by the WHO (2006) calculated different weight averages for boys and girls. As shown in figure 3, when analysing the range of statistics on weight measurements given by the WHO (2006) it is understood that they are used as reference by most business to help their customers decide on the right sizes. When analysing the range of height measurements used as reference by business to help customers decide on the right size given in figure 4, it is seen that most business' size charts for children aged 3–4 are below the measurements given by the WHO (2006). But generally use the same measurements as given by the WHO (2006) for children aged 5.
Measurements of 1 783 boys and girls were taken by Aldrich (1991), in a way which reflects the general population range of children, for the research which states that factors such as geographical areas, social and ethnic groups were taken into account. After analysing the measurements taken, standards for 22 measurements which take the age variable into account were determined. It is possible to come across the measurement range given by Aldrich (1991), in Taylor and Shoben (2004) which show the English standards as reference. When comparing these results with those given in figure 4, it is seen that because in the measurements below 98 cm and 104 cm given for children aged 3–4 the range intensifies, the measurements for children aged 3–4 are below of those given by Aldrich (1991) and Taylor and Shoben (2004). The range of measurements given for children aged 5 (1991) in figure 4 and by Aldrich, Taylor and Shoben (2004) of 110 cm is pretty similar to the measurements of online clothing businesses. But only 33% of businesses use the 116 cm measurement given by Aldrich (1991), Taylor and Shoben (2004) for children aged 6. Other businesses use the age 6 height measurements to define measurements bigger than 116 cm.
It can also be seen that Aldrich's research (1991) on chest girth measurements largely coincide with the range given in figure 5. Taylor and Shoben (2004) give the same measurements as Aldrich (1991). When comparing Aldrich's research (1991) with the results from figure 6 on waist girth measurements, only 13% of the business included in the research give the 54 cm measurement for children aged 3, with the rest of the business giving smaller measurements.
Only 8.70% of businesses give the 55 cm waist measurement for children aged 4, with the rest using smaller measurements. Aldrich's (1991) 56 cm waist standard measurement for children aged 5 is similar to the measurements used by 13.64% of the businesses included in the research, whilst the other business haven't included this measurement in their charts. The 58 cm measurement for children aged 6 is also not included in the business' charts; instead they have used smaller measurements. Taylor and Shoben's (2004) waist measurements for children aged 3–6 are smaller compared to Aldrich's (1991) and is also more similar to the results and range of this research. Taylor and Shoben (2004) have given bigger measurements for hip girth than Aldrich (1991). It can be said that when the measurements are compared to the range in figure 7 we see that the measurements given to their customers for children aged 3–6 by clothing business which sell online are very similar.
The growth and development of a human body is influenced by food, genetics, lifestyle and environmental

Table 1

	Research	Age 3	Age 4	Age 5	Age 6
Weight, kg	This research	14.000–15.999	16.000–17.999	18.000–19.999	21.000–22.999
	WHO (2006) [13]	15.3–15.00**	17.3*–17.2**	18.3*–18.2**	21.7*–21.2**
	Aldrich (1991) [7]	–	–	–	–
	Taylor & Shoben (2004) [14]	16	17	19	21
	Ariadurai & Nilusha (2009) [16]	–	–	–	–
	Otieno & Fairhurst (2000) [16]	15	17	18	19
Height, cm	This research	90.00–95.99	100.00–103.99	108.00–111.99	116.00–119.99
	WHO (2006)	99.9*–99.0**	106.7*–106.2**	110.0*–109.4**	118.9*–118.0**
	Aldrich (1991)	98	104	110	116
	Taylor & Shoben (2004)	98	104	110	116
	Ariadurai & Nilusha (2009)	–	–	116.3*–117.9**	121.3*–120.9**
	Otieno & Fairhurst (2000)	98	104	110	116
Chest girth, cm	This research	52.00–55.99	56.00–59.99	58.00–61.99	58.00–63.99
	WHO (2006)	–	–	–	–
	Aldrich (1991)	55	57	59	61
	Taylor & Shoben (2004)	55	57	59	61
	Ariadurai & Nilusha (2009)	–	–	47*–47**	52*–52**
	Otieno & Fairhurst (2000)	53	55	57	59
Waist girth, cm	This research	51.00–52.99	54.00–54.99	54.00–55.99	56.00–57.99
	WHO (2006)	–	–	–	–
	Aldrich (1991)	54	55	56	58
	Taylor & Shoben (2004)	52.6	53.8	55	56.2
	Ariadurai & Nilusha (2009)	–	–	45*–44**	50*–48**
	Otieno & Fairhurst (2000)	–	–	–	–
Hip girth, cm	This research	54.00–57.99	58.00–61.99	60.00–63.99	62.00–65.99
	WHO (2006)	–	–	–	–
	Aldrich (1991)	58	60	62	65
	Taylor & Shoben (2004)	58.6	61	63.4	65.8
	Ariadurai & Nilusha (2009)	–	–	55*–52**	60*–58**
	Otieno & Fairhurst (2000)	56	57	58	59

THE COMPARISON OF MEASUREMENTS FOUND IN THE ANTHROPOMETRIC SIZE CHARTS ACCORDING TO THE AGE VARIABLE OF CHILDREN AGED 3–6 (*BOYS, **GIRLS)

factors. These influential factors shape the body to different body strata [17]. Besides international standards, various countries have their own anthropometric measurement research.

Ariadurai, Nilusha and Alwis (2009) who classify clothing measurements according to the age variable, took measurements of 160 Sri Lankan children aged 5–12 for height, waist girth, body size and hip girth. They classified the measurements of their research according to gender and put forward statistical results. It is seen that the large majority of business which sell garments online have not divided genders in their measurement charts.

The results of the research done by Ariadurai, Nilusha and Alwis (2009) have bigger measurements for height than that of this research. The average measurements put forward by Ariadurai, Nilusha and Alwis (2009) for chest girth, waist girth and hip girth are significantly smaller than those in table 1 in this research.

The research done by Otieno and Fairhurst (2000) on 618 Kenyan children classified weight, height, chest girth and hip girth measurements according to the age variable. The weight and height measurements taken by Otieno and Fairhurst (2000) take place in between the measurement gaps in the dense range of this research. Chest and hip girth measurements are below the dense range of measurements for their age groups in this research.

CONCLUSIONS

Anthropometric data and sizing systems are important components of apparel quality. Apparel can not be top quality unless it fits satisfactorily the potential wearers [18]. One major source of apparel fit problems can be traced to the pattern grading and sizing system, which assumes that proportionally graded sizes, can fit most of the population. However, anthropometric data shows that little correlation exists among body measures. There is much proportional variation in the population that is not well addressed with current sizing systems [19]. The sizing systems of clothes and the anthropometric measurements which represent them are even more important for online sales as there isn't a chance of trying the garments on.

It has been put forward at the end of the research that the businesses which sell garments online for children aged 3–6 have anthropometric measurements for 6 subgroups connected to the age variable. Age 3 – toddler and age 4 – toddler age groups are the most common size charts to come across within the businesses included in the research. It has been confirmed that height and weight anthropometric measurements are referred to the most by business which sell online, to help consumers of garments for children aged 3–6. Besides height and weight measurements, some business also offer chest, waist and hip girth measurements in their size charts to help consumers pick the right size.

The difficulty of preparing standard measurements for children aged 3–6 all over the world is obvious as this age group is most affected by geographical features, genetic factors, nutrition and so on, also being the period where growth and development in children is the fastest. But despite this difficulty, taking advantage of the benefits of selling clothes online, and global competition are important for clothing business. Despite technological advances and more research into the subject, anthropometric measurements still carry an importance for clothing production today.

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The competitiveness of the textile industry and textile products in Romania – an analysis according to Mereuță model

DANIELA LIVIA TRAȘCĂ MONICA DUDIAN

REZUMAT – ABSTRACT – INHALTSANGABE

Competitivitatea industriei textile și a produselor textile din România - o analiză efectuată conform modelului Mereuță

Obiectivul acestei lucrări îl constituie evaluarea stării de competitivitate a companiilor care își desfășoară activitatea în cadrul industriei textile din România, în perioada 2001–2007, prin utilizarea modelului de evaluare Mereuță (2006). În acest scop, au fost întocmite fișe individuale pentru fiecare subramură a industriei. Aceste fișe cuprind valorile indicatorilor economici, punctele tari, slabe și de indiferență și diagrama dinamică de stare. Fișele individuale stau la baza construirii unei matrice de evaluare, care pune în evidență competitivitatea companiilor din ramura studiată.

Cuvinte-cheie: industria textilă, produse textile, eficiență internă, eficiență externă, sistem de companii, creștere economică, competitivitate, model Mereuță

The competitiveness of the textile industry and textile products in Romania – an analysis according to Mereuță model

The objective of this work is the evaluation of the competitiveness of companies operating in the textile industry and textile products from Romania, 2001–2007, using the Mereuță's valuation model (2006). For this purpose we made one individual form for each sub-branch of the industry that consists of three parts: the values of economic indicators, strengths, weaknesses and indifference, and dynamic state diagram. The individual records are the basis for building an assessment matrix that highlights the competitiveness of companies in the industry studied.

Key-words: internal efficiency, external efficiency, system of companies, economic growth, competitiveness, Mereuță model

Die Konkurrenzfähigkeit der Textil- und Textilienindustrie in Rumänien: eine Analyse gemäß dem Modell Mereuță

Ziel des vorliegenden Beitrages ist die Bewertung für die Zeitspanne 2001–2007 des Standes der Konkurrenzfähigkeit der Gesellschaften, die Aktivitäten im Rahmen der Textilindustrie und der Textilerzeugnisse durchzuführen, aufgrund der Anwendung des Bewertungsmodells Mereuță (2006). Zu diesem Zweck haben wir je eine Einzelkarte für jeden Gewerbezweig erstellt, die jeweils drei Teile beinhaltet: Werte der Wirtschaftsindikatoren, Stärke, Schwachstellen und Indifferenz; sowie das dynamische Diagramm des Zustandes. Die Einzelkarten sind Basis des Aufstellens einer Bewertungsmatrix, die die Konkurrenzfähigkeit der im Rahmen des Gebietes untersuchten Gesellschaften hervorhebt.

Schlüsselwörter: Textilindustrie, Textilerzeugnisse, interne Leistungsfähigkeit, externe Leistungsfähigkeit, Typ (System) der Gesellschaft, Wirtschaftswachstum, Konkurrenzfähigkeit, Modell Mereuță

After 1990, Romania has begun a long process of non-industrialization, which resulted in a significant reduction of the population occupancy in the industry, a reduction of the industrial production and hence exports. It is therefore necessary to make such studies to identify industries with growth potential, studies which are taking into account economic cycles. Mereuță model (2006) was constructed to assess the state of competitiveness of manufacturing industry in terms of economic growth in Romania. The model has been applied by its author across entire manufacturing industry between 1998–2004 (Nicolescu and Mereuță, 2007), being examined all 23 of its branches. The conclusions reveal that most of the industries had, in the period mentioned above, a neutral static and dynamic economic development.

This article brings a new element by applying the model in a new area, namely the seven sub-branches of the textile industry. The analysis was thorough and was conducted at the sub-branch not at the main branch of the manufacturing industry. By applying this model, this article outlines "the systemic personality" of the textile industry and textile products in a national context.

By implementing NACE revised 2 in Romania since 2008, it is allowing the full comparability of the data proposed by the national statistical system and by the international statistical system. Therefore, the extension of the methodology to other countries from European Union could lead to a definition of a model system for companies which are operating in textile industry.

METHODOLOGY AND DATA

Mereuță's considers the following diagnostic variables of the companies' situation: the gross value at factor cost of an industry branch in value added at factor cost in the industry (*VAi/VA*), labor productivity (*VAi/NSi*), gross operating surplus ratio (*EBE/CA*), general profitability rate (*Rb/CA*), the share of export industry in the export of the industries (*Exi/Ex*) and the degree of coverage of imports by exports (*Ga*). The indicators mentioned above act according to the contribution of branches to the value added at the factor cost and exports, the efficiency of the intern economy and effectiveness of external economy. The model assumes the drawing of each individual record for each sub-branch, which consists of three parts: the values of economic indicators, strengths, weaknesses and indifference and dynamic state diagram.

Regarding the values of the economic indicators, the statistical data were taken from reports published by the National Institute of Statistics on the results and performance of businesses and Romanian foreign trade. Although the 2010 edition appeared on the results and performance of the enterprises in industry and construction, which includes statistical data for the year 2008, in the present study, the last year of analysis is 2007, because since 2008, statistical data are drawn differently from the previous years and do not ensure comparability.

Table 1

EVALUATION SCALE			
No.	Class	Significance	Total points
1	*A+*	Significantly favorable condition	4÷6
2	*A*	Favorable condition	1÷3
3	*B*	Neutral state	0
4	*C*	Unfavorable condition	–1÷–3
5	*C–*	Significantly unfavorable condition	–4÷–6

Source: Mereuţă, 2007, p. 668

Table 2

SIGNIFICANCE OF THE DYNAMIC EVALUATION SCALE		
Class	*Ed* value	Significance for period 2001–2007
A_d^+	4.5 < *Ed* < 5.0	Significantly favorable condition
A_d	3.5 < *Ed* < 4.5	Favorable conditions
B_d	2.5 < *Ed* < 3.5	Neutral state
C_d	1.5 < *Ed* < 2.5	Unfavorable conditions
C_d^-	1.0 < *Ed* < 1.5	Significantly unfavorable condition

Source: Mereuţă, 2007, p. 668

Table 3

FIBERS PREPARATION AND SPINNING: STRENGTH, WEAKNESSES AND INDIFFERENCE

Indicator	*VA*	*P*	*Pg*	*EBE*	*Ex*	*Ga*	Total	Class
2001	0	+1	+1	–1	+1	–1	1	*A*
2002	+1	+1	–1	–1	+1	–1	0	*B*
2003	–1	+1	–1	–1	=1	–1	–2	*C*
2004	0	+1	+1	–1	+1	–1	1	*A*
2005	–1	+1	–1	–1	+1	–1	–2	*C*
2006	0	+1	–1	–1	+1	–1	–1	*C*
2007	–1	+1	+1	–1	+1	–1	0	*B*

Table 4

THE PRODUCTION OF FABRICS: STRENGTHS, WEAKNESSES AND INDIFFERENCE

Indicator	*VA*	*P*	*Pg*	*EBE*	*Ex*	*Ga*	Total	Class
2001	+1	–1	–1	–1	+1	–1	–2	*C*
2002	+1	–1	–1	–1	+1	–1	–2	*C*
2003	+1	–1	–1	–1	+1	–1	–2	*C*
2004	+1	–1	–1	–1	+1	–1	–2	*C*
2005	+1	–1	–1	–1	+1	–1	–2	*C*
2006	0	0	–1	–1	+1	–1	–2	*C*
2007	0	+1	–1	–1	+1	–1	–1	*C*

Table 5

FINISHING OF TEXTILES: STRENGTHS, WEAKNESSES AND INDIFFERENCE

Indicator	*VA*	*P*	*Pg*	*EBE*	*Ex*	*Ga*	Total	Class
2001	–1	+1	+1	+1	–1	–1	0	*B*
2002	–1	+1	+1	+1	–1	–1	0	*B*
2003	–1	+1	+1	+1	–1	–1	0	*B*
2004	–1	+1	+1	+1	–1	–1	0	*B*
2005	–1	+1	+1	+1	–1	–1	0	*B*
2006	–1	+1	0	+1	–1	–1	–1	*C*
2007	–1	–1	–1	–1	–1	–1	–6	*C–*

Table 6

THE MANUFACTURE OF TEXTILE ARTICLES (EXCEPT CLOTHING AND UNDERWEAR): STRENGTHS, WEAKNESSES AND INDIFFERENCE

Indicator	*VA*	*P*	*Pg*	*EBE*	*Ex*	*Ga*	Total	Class
2001	–1	0	–1	–1	–1	–1	–5	*C–*
2002	–1	–1	+1	+1	–1	–1	–2	*C*
2003	–1	–1	+1	+1	–1	–1	–2	*C*
2004	+1	0	+1	+1	–1	–1	1	*A*
2005	+1	–1	+1	+1	–1	–1	0	*B*
2006	+1	–1	+1	+1	–1	–1	0	*B*
2007	+1	0	+1	+1	–1	–1	1	*A*

Strengths, weaknesses and indifference are determined in relation to the indicators' values of the six variables such as follows: relatively strong points will be represented by indicators with positive values in relation to the reference system and we will note them with +1, relatively weak points will be represented by indicators with unfavorable values in relation to the reference system and we will note them with –1, and the points of indifference will be represented by indicators with values within the limits ±5% compared with the reference system and we will note them with 0. This used scale allows the ranking of each subsystem by companies of the textile industry and textile products into 5 classes, according to the table 1.

Regarding the dynamic state diagram, the average of the dynamic evaluation is calculated using a scale from 1 (class *C–*) to 5 (class *A+*), according to the relation (1):

$$E_d = \frac{\sum_1^7 N_i}{7} \quad (1)$$

(because the analyzed period consists of seven years), defining five classes for each sub-branch as follows table 2.

The statistic assessment *Es* takes into consideration the state class of 2007 of the analyzed sub-branch, and the global assessment *Eg* is defined by the classification in 5 classes, dynamic and static.

All the results thus obtained will be summarized in an assessment matrix divided into five areas: area *I* – unfavorable static and dynamic economic status; zone *II* – static economic status significantly favorable to dynamic economic status; area *III* – favorable static and dynamic economic status; area *IV* – dynamic economic status significantly favorable to static economic status; area *V* – static economic status or/and dynamic neutral.

EMPIRICAL ANALYSIS

Currently, the textiles and textile products industry has seven sub-branches, namely: fibers preparation and spinning (sub-branch *1*); the production of fabrics (sub-branch *2*); finishing of textiles (sub-branch *3*); the manufacture of textile articles (except clothing and underwear, sub-branch *4*); the manufacture of other textiles (sub-branch *5*); the manufacture by knitting or crocheting (sub-branch *6*); the manufacture of knitted or crocheted clothes (sub-branch *7*). The table 3 are captured and its sub-branches during 2001–2007. Table 4

Table 7

THE MANUFACTURE OF OTHER TEXTILES: STRENGTHS, WEAKNESSES AND INDIFFERENCE								
Indica-tor	*VA*	*P*	*Pg*	*EBE*	*Ex*	*Ga*	Total	Class
2001	–1	0	–1	+1	–1	+1	–1	*C*
2002	–1	0	–1	0	–1	+1	–2	*C*
2003	–1	0	–1	+1	–1	+1	–1	*C*
2004	–1	–1	+1	–1	–1	+1	–2	*C*
2005	–1	0	–1	0	–1	+1	–2	*C*
2006	–1	0	+1	+1	–1	+1	1	*A*
2007	–1	+1	+1	+1	–1	+1	2	*A*

Table 8

THE MANUFACTURE BY KNITTING OR CROCHETING: STRENGTHS, WEAKNESSES AND INDIFFERENCE								
Indica-tor	*VA*	*P*	*Pg*	*EBE*	*Ex*	*Ga*	Total	Class
2001	–1	+1	–1	+1	–1	–1	–2	*C*
2002	–1	+1	–1	+1	–1	–1	–2	*C*
2003	–1	+1	+1	+1	–1	–1	0	*B*
2004	–1	+1	+1	+1	–1	–1	0	*B*
2005	–1	0	–1	+1	–1	–1	–3	*C*
2006	–1	0	–1	+1	–1	–1	–3	*C*
2007	–1	–1	+1	–1	–1	–1	–4	*C–*

Table 9

THE MANUFACTURE OF KNITTED OR CROCHETED CLOTHES: STRENGTHS, WEAKNESSES AND INDIFFERENCE								
Indica-tor	*VA*	*P*	*Pg*	*EBE*	*Ex*	*Ga*	Total	Class
2001	–1	+1	–1	+1	–1	–1	–2	*C*
2002	–1	+1	–1	+1	–1	–1	–2	*C*
2003	–1	+1	+1	+1	–1	–1	0	*B*
2004	–1	+1	+1	+1	–1	–1	0	*B*
2005	–1	0	–1	+1	–1	–1	–3	*C*
2006	–1	0	–1	+1	–1	–1	–3	*C*
2007	–1	–1	+1	–1	–1	–1	–4	*C–*

Table 10

STATIC AND DYNAMIC EVALUATION		
Sub-branches	Dynamic evaluation	Static evaluation
1	E_d = 2.86 → Bd	*Bs* → neutral state
2	E_d = 2 → Cd	*Cs* → unfavorable state
3	E_d = 2.57 → Bd	*C–s* → significant unfavorable state
4	E_d = 2.71 → Bd	*As* → favorable state
5	E_d = 2.57 → Bd	*As* → favorable state
6	E_d = 2.14 → Cd	*C–s* → significant unfavorable state
7	E_d = 4.29 → Ad	*As* → favorable state

presented abbreviation list for the values of economic indicators on textiles and textile products. The reference values were calculated as follows: the average share of the added value at factor cost has been determined for all seven sub-branches of the textile industry and textile products (1/7), productivity, general profitability and overall gross operating surplus are consolidated values, throughout the seven sub-branches of the industry, the average share of the export of textile products and textile industry has been determined for all seven sub-branches (1/7), and the degree of coverage of imports by exports of textile industry and textile products refers to FOB exports and CIF imports.
Based on table 5–12 we obtained the strengths, weaknesses and indifference for each sub-branch of the textile industry and textile products.
Based on these results we have obtained the following dynamic state chart cast for each sub-branch of the textile industry and textile products (fig. 1).
Dynamic state diagrams allow us to deduce the following conclusions on the seven sub-branches of industry analysis (table 13).
The analysis of the seven sub-branches of the textile industry and textile products following matrix results of evaluation (fig. 2).
The evaluation matrix presented above allows drawing conclusions about the state of competitiveness of companies operating in the seven sub-branches of the textile industry and textile products.

DISCUSSIONS AND CONCLUSIONS

As it is obvious from the evaluation matrix, in 2001–2007, most sub-branches of the textile industry and textile products were located in the *V* area, being characterized as a neutral static and dynamic economic development. This result is similar with the result obtained by Nicolescu and Mereuță (2007) for the entire manufacturing industry during 1998–2004. The four sub-branches located in this area are: fibers preparation and spinning, finishing of textiles, manufacture of textile articles (except clothing and underwear) and the manufacture of other textiles. These sub-branches summed up at level of 2007, 51.7% from the added value at factor cost and 58.98% from the exports of textile industry and textile products. Of these sub-branches, two registered in 2007 a superior average to the national productivity: the preparation of fibers and spinning and other textile manufacturing. However, the only sub-branch that has registered a degree of coverage of imports by exports in excess was the other textile manufacturing sub-branch.
Special comments involve the production of fabrics and manufacture of knitted or crocheted clothes, both lying in the zone *I* of the matrix, which means that they are characterized by a relative lack of competitiveness. The two branches cumulated in 2007, 14.39% from the added value at the factor cost, 15.92% from exports of textile industry and textile products and 8.92% from the average number of employees. These sub-branches are characterized by a very low level of profitability and by limited auto financing.
The only sub-branch which lies in zone *III* of the evaluation matrix is the manufacture of knitted or crocheted clothes. This sub-branch is characterized as follows, in the whole range of analysis, by a favorable static and dynamic economic status, being the two sub-branches which recorded a level of import coverage by export surplus.
We conclude that, in the analyzed period, there were no significant changes in the economic condition of the

Table 11

THE VALUE OF ECONOMIC INDICATORS FOR TEXTILE AND TEXTILE PRODUCTS AND ITS SUB-BRANCHES, 2001–2007							
Economic indicator/year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
VAi/VA							
Reference	0.143	0.143	0.143	0.143	0.143	0.143	0.143
Fibers preparation and spinning	0.144	0.16	0.119	0.138	0.12	0.139	0.132
The production of fabrics	0.268	0.237	0.206	0.177	0.158	0.143	0.14
Finishing of textiles	0.023	0.064	0.094	0.101	0.111	0.094	0.066
The manufacture of textile articles (except clothing and underwear)	0.07	0.055	0.13	0.162	0.166	0.198	0.206
The manufacture of other textiles	0.091	0.088	0.102	0.079	0.095	0.095	0.114
The manufacture by knitting or crocheting	0.002	0.004	0.01	0.008	0.01	0.009	0.004
The manufacture of knitted or crocheted clothes	0.402	0.393	0.34	0.334	0.319	0.321	0.339
VAi/Nsi (thousands lei/employee)							
Reference	7.07	9.56	11.35	13.33	13.71	16.26	17.66
Fibers preparation and spinning	8.85	12.25	13.03	18.11	16.27	20.31	21.28
The production of fabrics	6.02	7.97	10.04	11.03	12.44	16.9	20.05
Finishing of textiles	14	20.2	28.68	24.97	21.85	23.15	15.1
The manufacture of textile articles (except clothing and underwear)	6.59	7.09	9.36	13.81	12.87	15.03	16.86
The manufacture of other textiles	6.85	9.2	11.92	12.08	14.11	16.6	20.98
The manufacture by knitting or crocheting	7.77	13.94	15.35	17.49	14.22	16.44	15.2
The manufacture of knitted or crocheted clothes	7.33	9.55	10.58	11.71	12.3	14.18	16
Rb/CA, %							
Reference	0.81	2.96	3.97	2.01	3.93	5.7	2.37
Fibers preparation and spinning	2.98	2.02	–0.7	3.51	1.8	1.58	3.39
The production of fabrics	–8.05	–5.09	–3.2	–13.6	1.94	5.22	–2.07
Finishing of textiles	21.15	29.02	24.1	18.65	14.66	5.65	–9.16
The manufacture of textile articles (except clothing and underwear)	–1.11	4.15	10.92	7.96	4.67	13.54	6.51
The manufacture of other textiles	3.5	1.71	3.66	9.2	2.26	6.08	12.25
The manufacture by knitting or crocheting	–8	–7.6	8.56	6.51	3.23	4.1	6
The manufacture of knitted or crocheted clothes	5.48	6.6	4.9	3.66	3.76	3.73	–0.68
EBE/CA, %							
Reference	12.79	14.69	13.54	11.15	9.48	9.78	6.97
Fibers preparation and spinning	10.51	12.76	10.38	9.91	6.2	7.1	4.94
The production of fabrics	8.46	8.55	7.29	3.72	6.32	6.63	5.45
Finishing of textiles	28.53	36.07	33.19	24.78	23.48	15.63	4.43
The manufacture of textile articles (except clothing and underwear)	11.31	16.03	14.85	19	12.86	13.16	10.57
The manufacture of other textiles	14.36	14.42	15.22	9.62	9.85	11.68	8.56
The manufacture by knitting or crocheting	28	21.52	22.52	18.39	12.77	13.59	2.53
The manufacture of knitted or crocheted clothes	17.2	17.69	14.63	10.97	7.56	8.93	7.05
Exi/Ex							
Reference	0.143	0.143	0.143	0.143	0.143	0.143	0.143
Fibers preparation and spinning	0.203	0.194	0.233	0.241	0.262	0.306	0.337
The production of fabrics	0.254	0.237	0.195	0.185	0.153	0.196	0.155
Finishing of textiles	0.004	0.033	0.022	0.083	0.099	0.096	0.046
The manufacture of textile articles (except clothing and underwear)	0.06	0.049	0.088	0.116	0.109	0.131	0.103
The manufacture of other textiles	0.057	0.051	0.059	0.042	0.045	0.037	0.104
The manufacture by knitting or crocheting	0.001	0.001	0.006	0.005	0.011	0.009	0.004
The manufacture of knitted or crocheted clothes	0.421	0.436	0.396	0.329	0.321	0.272	0.251
Ga							
Reference	1.189	1.198	1.257	1.273	1.266	1.231	1.083
Fibers preparation and spinning	0.05	0.055	0.091	0.094	0.104	0.133	0.164
The production of fabrics	0.083	0.071	0.08	0.109	0.153	0.161	0.16
Finishing of textiles	0.123	0.136	0.15	0.169	0.227	0.319	0.393
The manufacture of textile articles (except clothing and underwear)	0.302	0.343	0.364	0.412	0.468	0.508	0.438
The manufacture of other textiles	9.37	9.02	9.078	9.41	8.225	7.349	5.379
The manufacture by knitting or crocheting	0.04	0.07	0.08	0.04	0.03	0.04	0.09
The manufacture of knitted or crocheted clothes	4.28	4.38	4.42	4.55	3.97	3.67	2.69

* The reference values were calculated as follows: the average share of the added value at factor cost has been determined for all seven sub-branches of the textile industry and textile products (1/7), productivity, general profitability and overall gross operating surplus are consolidated values, throughout the seven sub-branches of the industry, the average share of the export of textile products and textile industry has been deteermined for all seven sub branches (1/7), and the degree of coverage of imports by exports of textile industry and textile products refers to FOB exports and CIF imports.

Source: Results and performances of businesses in industry and commerce 2003–2009, Romania's foreign trade Yearbook 2003–2009, authors' calculations

Table 12

ABBREVIATION LIST	
CA	turnover
EBE	gross operating surplus
Exi	exports of industrial branches
Ex	total exports of the industry
Ed	dynamic evaluation
Es	static evaluation
Eg	global evaluation
Ga	the degree of coverage of imports by exports
P	labor productivity
Pg	overall profitability
Rb	gross profit for the current year
NSi	number of employees in the branch *i*
VAi	gross value added at factor cost of a branch
VA	gross value added at factor cost of the industry

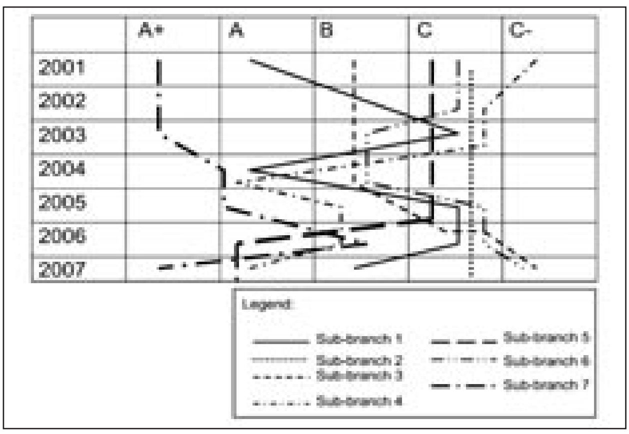

Fig. 1. Dynamic state diagrams

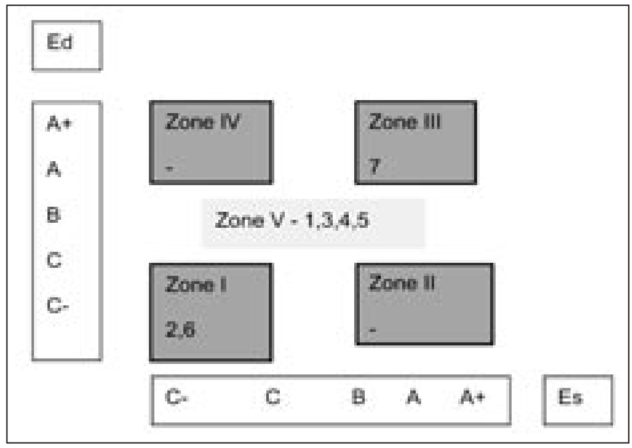

Fig. 2. The evaluation matrix

sub-branches of the textile industry and textile products. In 2007, this industrial sub-branch summed up only 1.72% of the added value at factor cost of the whole industry, 2.77% from the entire export industries and 3.67% from the average number of employees. Although the contribution to the economic activity is not very significant, the analysis of the competitivity supports the idea that at least some sub-branches of industry can be components of the Romanian economy generating foreign exchange and jobs.

For the future, we intend to apply Mereuță model to other countries of European Union, so that we can build a reference matrix, which allow international comparisons.

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A new testing instrument with artificial arm to simulate fabric bagging by human elbow

VILDAN SÜLAR

REZUMAT – ABSTRACT – INHALTSANGABE

Un nou instrument de testare, cu braţ artificial, pentru simularea deformării ţesăturilor în zona cotului

Modificarea formei ţesăturilor, care presupune deformarea tridimensională apărută în timpul purtării zilnice a articolelor de îmbrăcăminte, este o proprietate importantă, care ar trebui să fie luată în considerare. În acest studiu, a fost proiectat şi realizat un nou instrument de testare, compus dintr-un braţ artificial cu articulaţia cotului, pentru a simula deformarea ţesăturilor în condiţii dinamice. Acest nou instrument de testare a fost utilizat alături de un dispozitiv de testare a înălţimii deformării, care, de asemenea, a fost realizat în cadrul acestui studiu. Prin folosirea braţului artificial, valorile sarcinii de deformare au fost obţinute pentru diferite cicluri de deformare, iar valorile înălţimii deformării au fost măsurate după deformare. Deformarea ţesăturilor în condiţii dinamice a fost investigată pe diferite tipuri de ţesături, cu structuri variate, pentru a determina fiabilitatea instrumentului, iar rezultate obţinute au fost satisfăcătoare.

Cuvinte-cheie: instrument de testare, braţ artificial, deformarea ţesăturii, sarcină de deformare, înălţimea deformării

A new testing instrument with artificial arm to simulate fabric bagging by human elbow

Fabric bagging which is defined as three-dimensional shape deformation arising during daily usage of garments is an important property that should be considered. In the context of this study, a new testing instrument composed of an artificial arm with elbow joint was designed and produced to simulate fabric bagging under dynamic conditions. This new test instrument was used in conjunction with a bagging height testing device which was also produced in the study. By using the artificial arm produced, bagging load values were obtained for different deformation cycles and bagging height values were measured after deformation. The bagging deformation occurred in dynamic conditions were investigated by using different kinds of woven fabrics with different structures to examine the reliability of the instrument and satisfactory results were obtained.

Key-words: test instrument, artificial arm, fabric bagging, bagging load, bagging height

Neues Testinstrument mit künstlichem Arm für die Simulierung der Gewebeumformung beim Ellbogen

Die tridimensionelle Gewebeumformung beim täglichen Tragen der Bekleidungsartikel ist eine wichtige Eigenschaft. In dieser Untersuchung wurde ein neues Testinstrument entworfen und gefertigt, welches aus einem künstlichem Arm mit Ellbogenartikulation gebildet ist, für die Simulierung der Gewebumformung in dynamischen Bedingungen. Dieses neues Testinstrument wurde zusammen mit einer Testvorrichtung für die Messung der Umformungshöhe verwendet, welches gleichfalls im Rahmen dieser Untersuchung gefertigt wurde. Es wurden durch Anwendung des künstliches Armes die Werte der Umformungslast für unterschiedliche Umformungszyklen und die Werte der Umformungshöhe nach der Umformung gemessen. Für die Bestimmung der Instrumentzuverlässigkeit wurde die Gewebeumformung in dynamischen Bedingungen für unterschiedliche Gewebetypen mit unterschiedlichen Strukturen untersucht und es resultierten zufriedenstellende Ergebnisse.

Stichwörter: Testinstrument, künstliches Arm, Gewebeumformung, Umformungshöhelast, Umformungshöhe

Garments are affected by multi-directional forces as a result of the long period and repetitive flexing during people's daily movements. This situation causes sometimes permanent, sometimes temporary shape and appearance deterioration. Fabric bagging is a type of three dimensional residual deformation that generally occurs in knees, elbows, hips and heels because of cyclic motions on different parts of a garment. This type of deformation causes a dome shaped undesirable appearance deterioration and may be the reason for a garment to be accepted as worn although the greater part of a garment may have a serviceable life. For this reason, it is an important property and many researchers have studied to evaluate fabric bagging behaviour theoretically and experimentally. There are several methods developed based on two main approaches to investigate the bagging behaviour of fabrics experimentally. Some of the researchers such as Zhang (1999), Zhang et al. (1999a, 1999b, 2000), Kisilak (1999), Uçar et al. (2002), Sengöz (2004), Abooei and Shaikhzadeh Najar (2006), Doustar (2009) used an apparatus adaptable to a tensile tester to simulate fabric bagging. On the other hand, the researchers such as Grunewald and Zoll (Sengöz 2004), Özdil (2008) used a device similar to an arm as described in DIN 53860 and they examined fabric bagging behaviour occurring on the elbow of an arm in static conditions. Different from those studies, Abghari et al. (2004) investigated the relation of in-plane fabric tensile properties with woven fabrics' bagging behaviour. They developed a new test method and measured woven fabric tensile deformations along warp and weft directions.

However, there is no published work which investigates experimentally the bagging behaviour of fabrics occurring during the cyclic motions of an arm. Therefore, the aim of this work was to develop an instrument to investigate the bagging behaviour of woven fabrics in dynamic conditions. For this purpose, a new test instrument similar to an arm and having an elbow joint was developed and test fabrics were deformed to simulate fabric bagging under dynamic conditions. The bagging load values were obtained from this instrument during bagging cycles. An optical system of measurement, constructed for the study according to DIN 53860, was used to determine the bagging height values.

EXPERIMENTAL PART

Development of the new testing instrument

A sketch of the parts and a photograph of the new bagging tester are shown in figure 1 and figure 2. It can be seen in figure 1 and 2 that the fabric-bagging tester has a pneumatic artificial arm with an elbow joint and this artificial arm is capable of making cycles in the directions "up and down" like the arm of a real human

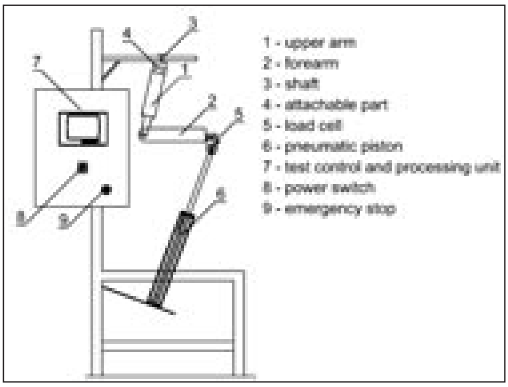


Fig. 1. A sketch of the parts of the newly designed artificial arm with elbow joint to simulate fabric bagging

Fig. 2. A photograph of the newly designed artificial arm with elbow joint

being. Thus, this test instrument tries to imitate the bagging deformation occurring on elbow part of an arm. It is to be noted here that bagging height which is a measure of bagging deformation, is determined in static conditions in the standard test method described in DIN 53860. The important difference from previous studies is that the artificial arm used in this study simulates the bagging behaviour of a fabric in dynamic conditions. Another important difference is that the loading values are continuously measured and recorded during cyclic motions of the artificial arm up to any desired number of cycles. In preceding studies, some researchers examined fabric bagging by using a spherical steel ball adaptable to the upper jaw of a tensile tester and generally the effect of five deformation cycles were tested by the help of the samples cut in a square shape. In these bagging tests, fabrics are generally deformed for a predetermined bagging height and then load values are measured during five cycles. The newly designed bagging instrument provides to deform sleeve shaped fabrics in dynamic conditions and to measure and process bagging load values at the same time. After bagging deformation, it is possible to measure bagging height and there is no predetermined bagging height in the new and dynamic bagging test.

The new testing instrument consists of four main parts: artificial arm, pneumatic piston, load cell, test control and processing unit. The artificial arm is constructed by upper arm *1* and forearm *2* with an elbow pin joint and is made from carbon steel with chrome nickel plating to obtain a smooth surface. The dimensions of the artificial arm are 300 mm length of forearm, 300 mm length of upper arm with 60 mm diameter. The upper arm is linked to a horizontal shaft *3* by an attachment 4 which is rotatable around the horizontal shaft and can be separated from the upper arm by means of a screw arrangement to mount or dismount the test specimen easily. A tension-compression load cell *5* (Tedea-Huntleigh, Model 614) is mounted at the lower end of forearm to detect the load values during cyclic motions. A pneumatic piston *6* is used to supply the reciprocal movement of the artificial arm. Air pressure of the pneumatic piston is set to six bars by a pressure regulator. A position sensor is located on this pneumatic piston to be able to determine deformation angle between upper arm and forearm in order to simulate the actual conditions of bagging deformation in different positions of the arm. Test control and processing unit *7* consist of a PLC and a touch panel and it is used for two purposes: to define test parameters and to record load values. Prior to the bagging tests, three test parameters are defined: deformation angle, number of cycles (number of times the fabric would be deformed), and time delay (the time duration at which the arm remains at maximum deformation position for the chosen deformation angle). During the test, the PLC records two loading values for every second. After bagging test is completed, the output data recorded by the PLC is transferred to a PC and the recorded load data which is necessary to calculate bagging load is obtained and it is referred to as the first test parameter.

In addition to the artificial arm, a bagging height measuring device similar to that described in DIN 53860, was produced and the bagging height values of deformed fabrics were measured. Thus, a second test parameter was obtained.

Procedure test

Procedure test consists of three main parts: *1* – preparing tubular samples by sewing; *2* – bagging deformation of samples by using artificial arm and recording bagging load values; *3* – measurement of bagging height. To apply this procedure, three fabric samples of every fabric type were prepared by cutting in dimensions 230 mm x 550 mm along the long side parallel to warp direction. These samples were then sewn with one cm seam allowance with a 3.5 stitch per cm frequency using lockstitch as sewing type and thus test samples similar to the sleeve of a jacket were prepared. For all tests, the sewn part of these test sleeves was placed with the stitch line in inner position of the artificial arm. After placing the test sample on artificial arm, it was fixed at the top of upper arm and then the test started to end up at the chosen number of bagging cycles (fig. 3). The fabric sample, being free on the lower end, was allowed to slip on the surface of artificial arm during the cyclic motions. After bagging test was completed, the test parameters namely, bagging load and bagging height were obtained, respectively.

Determination of bagging load and bagging height of test samples

All loading values recorded during the bagging test were transferred to a PC at the end of each test. The bagging load values were calculated from the recorded

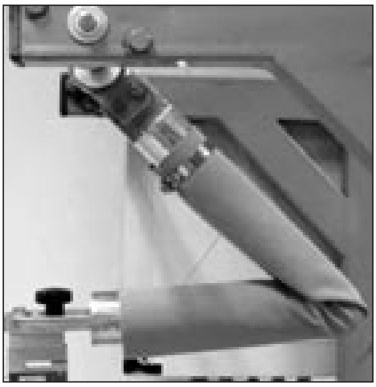


Fig. 3. A fabric sample during the bagging test

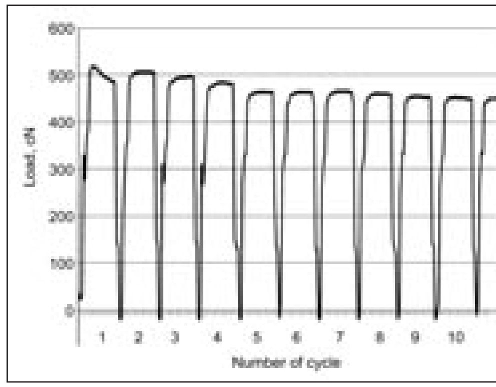


Fig. 4. A typical part of the loading curve recorded during bagging cycles (time delay: 10 seconds)

data and also typical loading curves were obtained (fig. 4). In this study, bagging load is defined as the average of the load values recorded during chosen cycles at a chosen deformation angle. The average of load values was calculated as bagging load as given in equation (1):

Bagging load = Sum of load values/Number of load values

$$\text{Bagging load} = \frac{\sum_{t=0}^{2t} L}{2t} \qquad (1)$$

where:

t is test duration, second;

$2t$ – total number of load values;

L – load, cN.

To determine the second test parameter, the bagging height was measured according to DIN 53860 from the height of fabric shadow projected on a screen by using an optical system (fig. 5). For this aim, the test sample was placed on a cylindrical measuring tube of 60 mm diameter before bagging test and the shadow of the sample (h_1) is drawn on a graph paper placed on the screen. After bagging test, the test sample was taken off carefully from the artificial arm and was carried to the bagging height measuring device with high attention not to affect the bagging deformation. Test sample was placed again on measuring tube and shadow of the deformed fabric (h_2) was drawn on the same graph paper (fig. 6). The maximum value of difference between distances measured by the shadow before and after the bagging test was called as bagging height (H, mm), in equation (2):

$$H = h_2 - h_1 \qquad (2)$$

Materials used

In the context of the study, twenty-two woven fabrics of commercial types in market were used. All of the fabrics tested in the study are suitable for suiting's which are most frequently used in everyday business life. Some structural parameters of fabrics were determined by standard methods and then bagging tests were performed. All tests were conducted under standard atmospheric conditions (20 ± 1°C temperature, 65 ± 1% relative humidity). The structural parameters of the test fabrics are given in table 1.

In this study, all fabric samples were deformed at 45° deformation angle which is the angle at maximum deformation position and the bagging load and bagging height values were determined for two different bagging cycles as 100 and 200. The bagging load and bagging height values of deformed fabrics were measured according to the instructions given in the previous parts.

The SPSS 16.0 statistics software was used for statistical analysis of the test results. Reliability analysis was conducted to test the repeatability of the bagging load measurements carried out by the designed bagging tester. Cronbach's alpha was used to measure the internal consistency of the test replications. Analysis of variance (ANOVA) was also conducted and Duncan's multiple range test was carried out to examine the significance of differences between the fabric types at 95% confidence level.

RESULTS AND DISCUSSIONS

The test parameters namely bagging load and bagging height were obtained for different types of fabrics at different bagging cycles. Therefore bagging load was the test parameter obtained from the newly designed bagging tester; reliability analysis was only conducted for bagging load results. The intraclass correlation coefficients obtained by reliability analysis showing the internal consistency of the test replications, and also the repeatability of the instrument, are given in table 2.

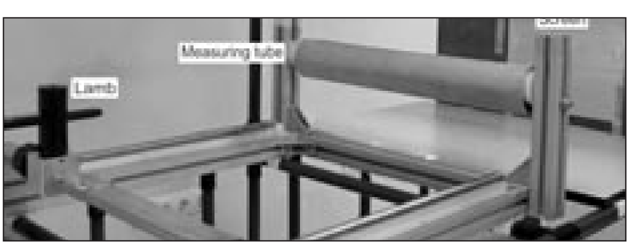


Fig. 5. Bagging height measuring device

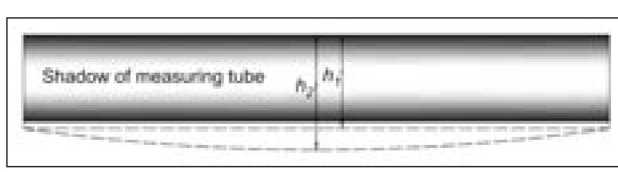


Fig. 6. Schematic diagram of bagging height measurement from the shadow of fabric sample:
h_1 – height of fabric sample measured from its own shadow before bagging test; h_2 – height of fabric sample measured from its own shadow after bagging test

Table 1

SOME STRUCTURAL PROPERTIES OF FABRICS USED IN EXPERIMENTAL STUDY								
Fabric	Raw material[a]	Weave	Yarn setting, thread/cm		Warp crimp factor, %	Weft crimp factor, %	Fabric unit weight, g/m^2	Fabric thickness[b], mm
			Warp	Weft				
1	100% W	Plain	27	25	7.1	17.2	157.7	0.33
2	100% W	Plain	26	23	8.9	8.5	132.8	0.30
3	98% W, 2% E	Plain	24	24	9.0	23.7	169.6	0.41
4	98% W, 2% E	Plain	30	26	7.4	29.0	260.0	0.30
5	100% W	2/1 twill	34	32	5.2	16.4	147.0	0.29
6	100% W	2/1 twill	33	30	6.4	12.4	149.2	0.32
7	100% W	2/1 twill	21	29	16.7	21.9	189.7	0.51
8	100% W	Herringbone twill	45	44	6.8	13.5	131.5	0.32
9	55% W, 45% C	Plain	46	29	12.9	5.1	124.1	0.27
10	50% W, 50% P	Herringbone twill	32	29	6.9	5.8	270.0	0.31
11	70% W, 30% P	2/1 twill	34	28	7.9	8.9	260.0	0.28
12	80% W, 20% P	Herringbone twill	39	34	5.7	10.0	250.0	0.26
13	44% W, 54% P. 2% E	2/1 twill	37	29	9.1	18.8	295.0	0.35
14	49% C, 49% P. 2% E	3/2 twill	47	32	14.6	22.1	286.2	0.66
15	97% C, 3% E	2/1 twill	60	31	14.2	25.3	192.8	0.44
16	88% W, 9% PA, 3% E	Plain	33	25	13.5	21.3	270.0	0.28
17	75% C, 25%S	Basket	38	38	7.7	3.4	270.0	0.35
18	75% W, 25% S	2/2 twill	32	29	5.4	8.7	245.0	0.28
19	100% Linen	Plain	22	17	3.0	8.7	260.0	0.33
20	100% P	Fancy twill	114	48	18.5	3.2	169.5	0.45
21	100% C	Plain velvet	26	38	1.7	5.5	177.7	0.91
22	90% C, 8% Ws, 2% E	Corduroy	39	24	5.7	31.8	263.3	1.18

[a] W – wool, C – cotton, P – polyester, E – elastane, Ws – cashmere, S – silk
[b] under 5 gf/cm^2 pressure

Table 2

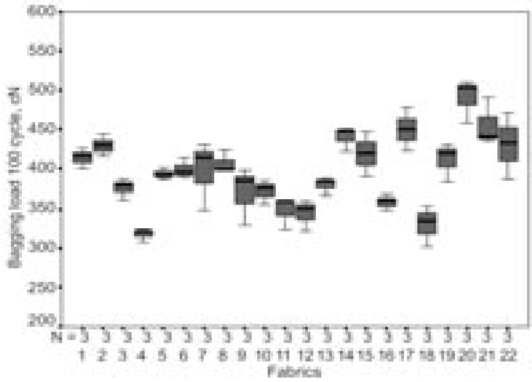
INTRACLASS CORRELATION COEFFICIENTS OF THE MEASURED PARAMETERS		
Intraclass correlation	Bagging load 100 cycle	Bagging load 200 cycle
Ingle measure intraclass correlation	0.755	0.752
Average measure intraclass correlation	0.902	0.901

As it can be seen from table 2, the reliability of the measurements is acceptable for the parameters "bagging load at different cycles" according to the intraclass correlation coefficients. This result shows that the testing instrument gives similar results for test replications of the same fabric sample. After checking consistency of the instrument and repeatability of the test results, test fabrics were evaluated according to their bagging performances.
To examine the differences amongst fabric types, variance analyses were performed for bagging load and bagging height values. The results given in table 3 also show that the differences between fabric types are statistically significant meaning that the test system distinguishes the differences in fabric behaviour in relation to different fabric types ($p < 0.05$).
The differences or the similarities for bagging load and bagging height values obtained for different bagging cycles can be observed in figure 7 and figure 8.
Figure 7 *a, b* show two box-plot diagrams of the bagging load values at 100 and 200 bagging cycles and it can be observed that the average of bagging load values are generally higher for the fabrics deformed at 100 cycles in comparison to the ones deformed at 200 cycles. This result can be explained as such that during 100 cycles the first and the important initial deformation occurs and after this initial deformation, lower loads are recorded for other deformation cycles when the test is continued.
This result is in accordance with Zhang's [8] and Doustar's findings [3] explaining the importance of the initial

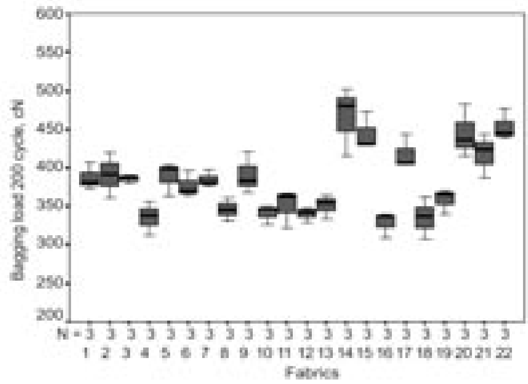
Table 3

VARIANCE ANALYSIS RESULTS OF THE TEST PARAMETERS FOR FABRIC TYPE						
Source	Dependent variable	Type III Sum of squares	*df*	Mean square	*F*	Sig.
Fabric type	Bagging load 100 cycle	118858.608	21	5659.934	10.229	0.000[a]
Fabric type	Bagging load 200 cycle	111448.815	21	5307.086	10.115	0.000[a]
Fabric type	Bagging height 100 cycle	25.259	21	1.203	15.120	0.000[a]
Fabric type	Bagging height 200 cycle	40.246	21	1.916	28.108	0.000[a]

[a] significant at 95% confidence level ($p < 0.05$)



a



b

Fig. 7. Box-plot diagrams of bagging load values obtained by:
a – artificial human elbow tester after 100 bagging cycles; ***b*** – artificial human elbow tester after 200 bagging cycles

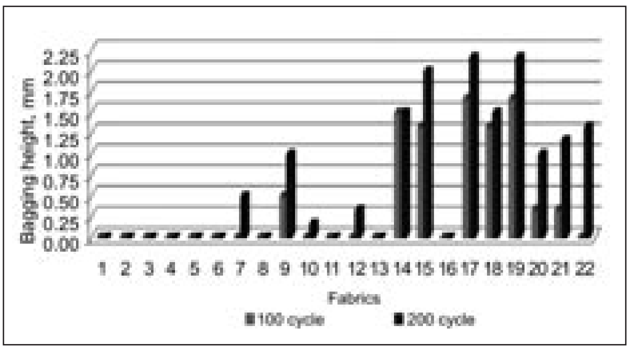


Fig. 8. Bagging height values of test fabrics obtained by artificial human elbow tester after different bagging cycles

cycles on bagging deformation. The multiple range test carried out along with variance analysis also confirms these results separating the deformed fabrics into 11 groups for the test at 100 cycles and 7 groups for the test at 200 cycles.

There is a little exception for some of the test fabrics having elastane yarn. For these fabrics (fabric 3, 4, 14, 15, 22), slightly higher load values are observed for 200 deformation cycles. The higher extensibility character of the fabrics having elastane yarn may be the reason for this result because when a fabric is forced to stretch during cyclic motions of the artificial arm, it can be stretched easier by the help of elastane yarn in comparison to a fabric having no elastane. When the test has been continued for a number of cycles, elastane yarn may have lost extensibility character to some extent so that consequently a higher bagging load for 200 cycles is obtained.

Figure 8 shows the bagging height values obtained by artificial human elbow tester after different bagging cycles. When figure 8 is examined, it is seen that there is no bagging height in some test fabrics which have wool fibre with a high content. The bagging height results are in a concordance with the fabric properties, especially with the raw material. Because of good recovery properties of wool fabrics, no bagging height was obtained for these fabrics. Although higher bagging height values were obtained for 200 deformation cycles, for the first eight fabrics having wool fibre there is only one fabric having bagging height lower than 0.50 mm after only 200 deformation cycles. And also it is seen that fabrics 10, 11 12, 13, 16 had bagging height values lower than 0.50 mm after 200 bagging cycles. All of these fabrics were made of wool and polyester fibres. Polyester is an important chemical fibre that complements the characteristics of wool fibres and this result is in accordance with Kisilak' research (Kisilak, 1999) on fabric bagging.

According to the multiple range test results, the bagging height values of fabrics deformed at 100 cycles were separated into two groups such as the fabrics having bagging height equal or lower than 0.50 mm and higher than 0.50 mm.

At 200 bagging cycles, the test fabrics were seperated into four different groups such as 0–0.50 mm, 1.00–1.33 mm, 1.16–1.50 mm and 2.00–2.16 mm. This result confirms that 200 bagging cycles test is to be preferred for the evaluation of bagging height since fabric properties become more effective when the number of bagging cycles is increased.

CONCLUSIONS

Many studies have been carried out for years to examine the bagging behaviour of fabrics. In this study, a new testing instrument was designed to simulate fabric bagging by an artificial human elbow. The main difference from previous studies is that this artificial arm with an elbow tries to simulate the bagging behaviour of a fabric in dynamic conditions as it is in real conditions of use. A wide range of woven fabrics which are commonly used for suiting's were used to examine the bagging behaviour.

After determining basic structural properties of test fabrics, two main bagging parameters were obtained such as the bagging load which was the test parameter directly obtained from the bagging instrument and bagging height which was measured by an optical system produced also in the context of this study. The artificial human elbow bagging tester has been shown to have repeatability and reliability. When results of variance analyses results are examined, it is seen that the bagging tester has the ability to distinguish different fabric types for different deformation cycles and also bagging height values become evident at 200 cycles test fabrics than at 100 cycles test.

Consequently, it is possible to say that this newly designed bagging tester can be used to examine fabric bagging occurring in cyclic motions. Although the newly bagging tester was used to test a wide range of woven suiting fabrics at 100 and 200 bagging cycles at

45^{o} deformation angle, it will be useful to examine the effects of different bagging cycles not used in this study, and to test also the bagging behaviour of different knitted structures as further studies.

ACKNOWLEDGEMENTS

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DOCUMENTARE

Tehnologie chimică

SISTEM DE VOPSIRE CU AZOT A ARTICOLELOR DE ÎMBRĂCĂMINTE

Compania producătoare de echipamente de vopsire ***Tonello S.R.L.***, din Sarcedo/Italia, a elaborat un nou sistem de vopsire pe bază de azot, care permite economisirea energiei, a apei și a substanțelor chimice utilizate în procesul de vopsire.

Sistemul automat de vopsire G1 N2, care permite derularea unor procese de vopsire în atmosferă de azot, a fost conceput pentru a limita considerabil utilizarea agenților reducători, asigurând un mediu de lucru mai curat și mai sigur. În plus, acest sistem este proiectat pentru a oferi o mai bună stabilitate, pe parcursul întregului proces de vopsire.

Echipamentul G1 N2 este dotat cu un kit 101^{o}, care asigură o etanșeizare perfectă a sistemului.

Dozarea azotului, a vopselurilor și a produselor chimice se face controlat, iar la cerere echipamentul poate fi dotat cu sisteme Tonello Jet, care favorzează vopsirea articolelor de îmbrăcăminte umede, cu un raport de flotă 1:2.

Melliand International, septembrie 2011, nr. 4, p. 187

Thermal properties of conductive fabrics made from coating with carbon black particle

DANIELA NEGRU

COZMIN-TOMA BUDA
DORIN AVRAM

REZUMAT – ABSTRACT – INHALTSANGABE

Proprietățile termice ale materialelor textile conductive obținute prin peliculizări cu particule de negru de fum

O soluție pentru obținerea materialelor textile conductive o constituie peliculizarea țesăturilor și fibrelor cu soluții conductive. În acest studiu, s-a folosit negrul de fum în calitate de componentă principală a soluției conductive, ce urmează a fi aplicată manual pe un material textil. Țesătura a fost realizată din fire filate din bumbac, iar în structura acesteia au fost inserate fire de oțel inoxidabil. Pentru caracterizarea țesăturilor conductive au fost efectuate măsurători de temperatură și putere disipată la diferite tensiuni, cuprinse între 3 și 12 V, în condiții normale de mediu (temperatura camerei 22°C și umiditatea relativă 65%). Temperatura maximă atinsă a fost de 71°C, iar puterea disipată pe unitatea de suprafață a atins 0,528 W/cm². De asemenea, au fost efectuate testări într-o cameră de climatizare, la temperaturi de –10°C, 0°C și +10°C și o umiditate relativă de 10%, temperatura probelor fiind măsurată prin aplicarea unei tensiuni de valoare fixă în curent continuu.

Cuvinte-cheie: țesături conductive, negru de fum, proprietăți termice, generarea căldurii

Thermal properties of conductive fabrics made from coatings with carbon black particles

A solution for obtaining conductive textiles is to coat fabrics and yarns with conductive solutions. The conductive element that was used in this research is carbon black (CB), which is the main component of a conductive solution that is applied on a textile fabric by manual coating technique. The fabric was woven from cotton spun yarns and its structure has stainless steel yarns (SS) inserted. Conductive fabrics were characterized by temperature and power dissipation measurements, at various voltages, ranging from 3 to 12 V, under normal environmental conditions (room temperature 22°C, 65% HR). The maximum temperature reached 71°C and the power density per unit area reached 0.528 W/cm². The tests were performed in a climatic chamber, with the temperature set to –10°C, 0°C and +10°C and 10% HR, measuring the samples temperature when a fixed DC voltage was applied.

Key-words: conductive fabric, carbon black, thermal properties, heat generation

Thermische Eigenschaften der leitfähigen Textilmaterialien, gefertigt durch Beschichtung mit Russschwarz

Eine Lösung für die Fertigung von leitfähigen Textilmaterialien wird von der Beschichtung der Gewebe und Faser mit spezifischen Lösungen für die Verleihung des leitfähigen Charakters gebildet. In dieser Untersuchung wurde Russschwarz als Hauptkomponente der spezifischen Lösung angewendet, welche durch Handarbeit auf ein Textilmaterial aufgetragen wird. Das Gewebe wurde aus Baumwollfaser gefertigt und es wurden in dessen Struktur Garne aus rostfreiem Stahl eingetragen. Für die Charakterisierung der leitfähigen Gewebe wurden Temperatur-und Leistungsmessungen bei unterschiedlichen Spannungen zwischen 3 und 12 V durchgeführt, bei normalen Umweltbedingungen (Raumtemperatur 22°C und relative Feuchtigkeit 65%). Die erreichte Maximaltemperatur betrug 71°C, und die Leistung auf die Flächeneinheit betrug 0,528 W/cm². Es wurden auch Untersuchungen in einem Klimaraum durchgeführt, bei Temperaturen von –10°C, 0°C und +10°C und eine relative Feuchtigkeit von 10%, indem die Temperatur der Proben durch Anwendung eines konstanten Gleichstroms gemessen wurden.

Stichwörter: Leitfähige Gewebe, Russschwarz, thermische Eigenschaften, Wärmegenerierung

The importance of conductive textiles is increasing because their various applications in many fields of activity, like possible applications in the areas of electromagnetic shielding [1, 2], chemical sensors [3, 4], and heating fabrics [5, 6]. The conductive textiles are textile materials combined with other materials trough different methods such are polymerization, metal wire inserting and coating technologies. The conductive textiles represent a new class of textiles, the novelty being the fact that among the intrinsic properties of these, like elasticity and flexibility, they are enriched with new properties, like electrical and thermal properties.

Woven and knitted metal wires have been used in a textile-monitoring suit, but have the distinctive disadvantage of increasing stiffness and reducing elasticity. Conductive polymers (polyaniline, polypyrolle) and conductive materials (carbon nanotubes and particles) have important electrical properties. Conducting polymers are being considered as they can be integrated into a fabric structure. Conductive polymer composites (CPC) based on insulating polymer matrix and electrically conductive fillers such as carbon black (CB), carbon nanotubes, graphite, metal powders, etc. exhibit many interesting features due to their resistivity which is changing with mechanical, thermal, electrical or chemical solicitations. This versatility of CPC is the foundation for their applications such as self-regulated heating, positive temperature coefficient materials, electromagnetic shielding, and chemical vapour detection, etc [7, 8].

Coating techniques were becoming attractive in the field of conductive textile, because the process of coatings relatively simple, cheap and materials obtained maintain their mechanical properties, along with electrical properties.

The US Company Thermion Systems International has developed a carbon fibre heating non-woven fabric, Thermion. Resistive heating is due to the metal coating of non-woven carbon fabric with nickel, used currently in the aerospace industry [9].

Akif Kaynak et al. reported realization of a Lycra® fabric coated with conductive polymer polypyrrole trough chemical synthesys by oxidation the monomer of pyrol in the presence of the textile substrate, the conductive fabric obtained having a high level of electric conductivity and being stable [10].

Fugetsu et al. have obtained electrically conductive multifilament yarns using the method of dye-printing

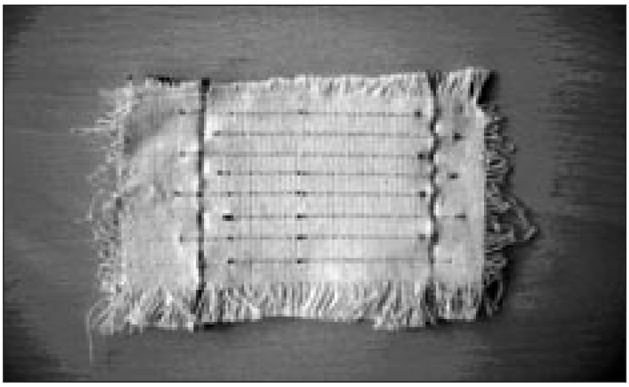


Fig. 1. Woven sample with stainless steel yarns

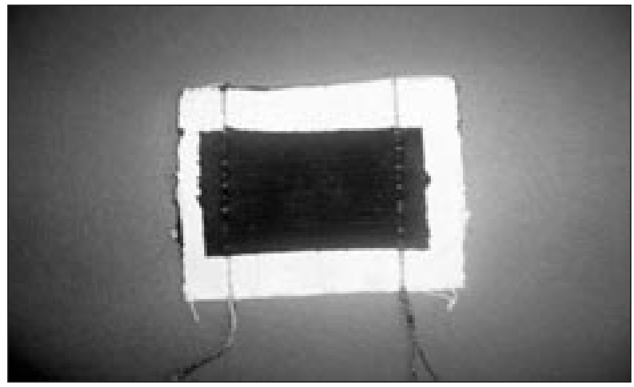


Fig. 2. Woven sample with stainless steel yarns coated with carbon black mixture

them with carbon nanotubes; using a die-printing approach, the carbon nanotubes were directly applied to polyester multifilament yarns to form an electrically conductive layer over each filament of the multifilament yarn. The yarns obtained have electrical rezistivity ranging from 10^3–10^9 Ω/cm. Yarns with resistivity of 10^3 Ω/cm could be used to form flat, soft and portable electrical heaters [11].

Electrically conductive textile material was obtained by Yoshiyuki et al. using carbon nanotubes (CNT) – filled Polytetrafluoroethilene (PTFE); a film was formed by using dispersion fluids of CNT and PTFE [12].

Heating devices (such as seats, mattress pads, blankets and clothing) are defined in terms of power demands per surface unit. Heaters that have contact with the human body (e.g. heated seat) typically require less than 15.5 mW/cm^2 [13].

A plain woven fabric from spun cotton yarns with SS yarns in the structure coated with CB conductive particles was studied in this paper. The thermal properties of these conductive fabrics were invesigated in order to use them in heating applications. A possibile application consist in using a textile flexible heating element, which can be integrated into a piece of protective clothes like jackets, pants, gloves, helmets, thus providing worm in those areas of the body where is needed, e.g. in the case of a jacket the heating element can be placed around the waist, chest; for pants the heating element can be placed also in the area of the waist. Those protective clothes can be used for outdoor purposes, like protection equipment for people who work in rough condition of temperature and relative humidity of air.

EXPERIMENTAL PART

The main materials and the technique used in this work for manufacturing the conductive fabrics were presented in [15]. The fabrics samples were produced using a compact weaving machine, at the ENSAIT Institute, Roubaix, France using spun cotton yarns having a fineness of 32 tex and stainless steel yarns with fineness of 91 x 2 tex, possessing 275 filaments per SS and 12 μm the diameter of the filament. The weft yarns, both cotton and SS were inserted manually, while the SS on warp direction were integrated into the warp. The distance between two SS (on the warp direction) is approximately 70 mm and the distance between two SS on the weft direction is 7 mm, SS yarns being parallel and equidistant; the length of SS representing weft was 60 mm. For decrease the electrical resistance, but also to acquire a power supply element, SS were added to the samples as it can be seen in figure 1. The pattern designed for SS is intended to decrease the electrical resistance by creating a parallel electrical resistance.

After weaving the fabric, the next step was preparing the coating mixture. The coating mixture consists of a dispersant soluble in water, Disperbyk, which is an additive from BYK Additive, an elastomer, Kraton IR0401 BU Latex from Kraton Polymers Group of Companies, black carbon powder, Printex L6, supplied by Degussa Corp and distilated water. The maximum percentage of CB used for coating mixtures was 46% and the minimum was 21.6%. The components of the coating solution have been chosen in order to obtain a homogenous coating. The samples were placed on a magnetic table with a pattern above and the coating solution was applied at one side of the fabric; a metallic cylinder was positioned for spreading the coating solution onto the entire fabric surface. When the device is on, the cylinder advances with a certain pressure and covers the fabric with a thin layer. The samples obtained, illustrated in figure 2, were left to dry for 24 hours at room temperature.

The obtained samples coated with the CB solution were rigid and it seems obvious that another type of structure must be used, for example a knitted structure, which is more flexible. Some knitted fabrics were produced on a flat machine, but this particular stainless steel yarn was difficult to knit, mostly due to the SS yarn length density. The best way of introducing such yarns in a knitted structure is their in-lay, without knitting them as weft yarns. A knitted structure is very elastic comparatively with the woven structure, but the conductive mixture gives rigidity to the sample. The advantage is that the stainless steel yarn is not on the surface of the fabric, so the fabric roughness is smaller. Choosing a woven structure seems to be the most appropriate, since SS cannot be knitted.

The electrical resistance measurements of the textile materials coated with CB conductive solutions shows that these materials present a good conductivity. The electrical resistance of the textile samples without SS in the structure is between 1.2–12 kΩ and with SS in the structure is between 14–290 Ω. The CB percentages for this research were chosen with regard to electric resistance. The smaller, the resistance, the higher is the power dissipated and implicitly the temperature achieved on the surface of the sample.

MEASUREMENTS USED

Testing the thermal properties of the heating fabrics samples in normal environmental conditions (22 ± 2°C, 65 ± 2% HR)

As described earlier, the samples coated with CB should be integrated into protective garments like heating fabrics. These samples must be supplied with power which is converted to heat. The thermal properties of the conductive fabrics are (*i*) the current (*I*) and the electrical resistance (Ω) and *(ii)* the electrical resistivity (*Rs)* and the power dissipated (*P*). The tests were performed at Laboratoire de Génie et Matériaux Textiles (GEMTEX), Roubaix, France, within Erasmus student mobility framework according with the international normatives.

For testing the thermal properties of the heating fabrics samples in normal environmental conditions, a DC power supply was used to generate constant voltages (3, 6, 9 and 12 V) and a TTI 1906 Computing multimeter was used for recording the electrical parameters: the current and the electrical resistance.

The measurements were performed according to the AATCC Test Method 76-1995. To calculate the power achieved per surface unit, it is necessary measuring the surface resistivity, which is the resistance between two measuring points on a piece of fabric. According to the AATCC Test Method 76-1995, the surface resistivity of coated conductive fabric samples was measured by placing two rectangular copper electrodes on the surface of the sample, the electrical resistance *R* was measured when a *DC* voltage was applied and the current *I* was recorded. The power density per unit area is:

$$P = \frac{V^2}{R} \tag{1}$$

Since $R = Rs$ (l/w), at a given voltage V the current drawn is:

$$I = \frac{Vw}{R_s l} \tag{2}$$

where:

R_s is the surface resistance;

w – the width;

l – the size of the sample, hence the power density per unit area is:

$$P = \frac{V^2}{R_s l^2} = \frac{IV}{lw}\left[\frac{W}{m^2}\right] \tag{3}$$

where:

P is the power achieved per unit area of surface;

I – the current flowing;

V – the voltage;

l – the length of the fabric between the contacts;

w – the width of the sample [6].

The distance between the electrodes was 5 cm, and the width of the sample also 5 cm. The power dissipated is calculated with the formula (3). The temperature measurements have been made with the thermocouple, 8 measurements on each sample and averaged. The measurements were made on the four corners of the samples, twice.

Testing the thermal properties in specific conditions of temperature and relative humidity (–10°C, 0°C, +10°C and 10% HR)

In order to observe the behaviour of the samples when these are included in a protection equipment, for example destined for workers who perform labours at low temperatures (high altitudes with low relative humidity), the measuring of the power achieved and the temperature were at –10°C, 0°C, +10°C and 10% HR. For testing the thermal properties in specific conditions of temperature and relative humidity a climatic chamber Climats Excall 400 with extreme temperature range from –85°C to +180°C, climatic test RH from 10% to 98% and control of temperature variation rate from 1°C/minute to 20°C/minute, a TTI 1906 computing multimeter and a temperature thermocouple Testo 925 type K were used. The samples were placed one by one in the climatic chamber, the SS yarns being clamped with metallic clips providing the electrical connections with the power supply, which was placed in exterior of the climatic chamber, given the possibility to vary the voltage. The samples were conditioned for 30 minutes in the climatic chamber before the measurements. Temperature was measured with the thermocouple, which was placed also in the climatic chamber and having the possibility to handle it from the exterior; 8 measurements for each sample were performed and averaged. The results obtained were processed using the following formula (4):

$$\Delta T = Ts - T_{cc}\left[^{\circ}C\right] \tag{4}$$

where:

P is the

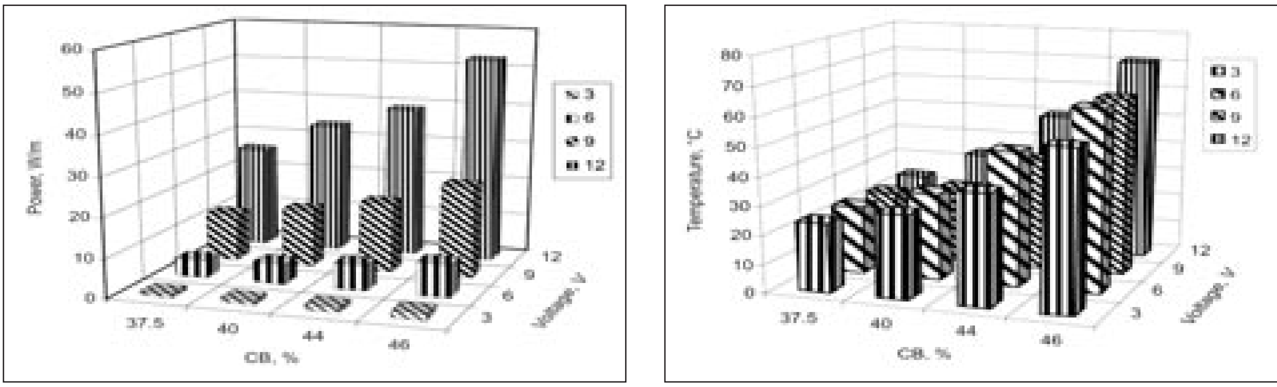
ΔT is the difference of the temperature in the climatic chamber, °C;

T_s – the temperature measured on the sample surface, °C;

T_{cc} – the temperature in the climatic camber, °C.

RESULTS AND DISCUSSIONS

A coated textile fabric for heat generation must have a certain temperature when a voltage is applied, depending by the end-use application of the sample. A heated fabric used for keeping worm in certain parts of the body must have a comfortable temperature, the heat generation must be homogeneous and relatively constant. A fabric coated with CB particles solution can provide that, but cannot be placed directly onto the skin due their roughness and to the fact that affect the comfort at the skin level, and a solution is to integrate it into a piece of clothing, along with the power supply, which can be a battery from 9 to 12 V. The clothing can be protection equipment, outwear, for healhtcare etc. It is the reason for testing the samples in normal conditions of temperature and humidity, but also in special conditions of temperature and relative humidity. As it can be seen in figure 3*a*, the tests were performed for 37.5%, 40%, 44% and 46% CB percentage, the power dissipation values ranging from 0.72 to



a *b*

Fig. 3. The power dissipation depending on the CB conductive particles concentration when:
a – fixed voltage is applied; ***b*** – the rinsing of temperature depending on voltage and CB concentration

Table 1

THE TEMPERATURE RESULTS FOR SAMPLES COATED WITH CB SOLUTIONS AT VOLTAGES FROM 3 TO 12 V

% CB	3V	6V	9V	12V
37.5	24.1	23.7	23.2	24
40	29	30.5	27	34
44	38.5	47	39	50
46	55	63	62	71

52.8 W/m^2, fact that lead to the conclusion that a bigger concentration of CB conductive particles and a higher voltage applied increase the power achieved and implicitly the warmth when the heating element is positioned near the human body. Power per unit area values show that achieving minimum value 1.56 W/m^2 requires low values of the voltage applied. Higher values obtained are attributed to the increases of the voltage and the concentration of CB particles. The heating performances of the conductive fabrics realized are satisfactory, taking into account the fact that less than 15.5 mW/cm^2 are needed to keep worm near the human body.

The electrical resistance and implicitly the resistivity vary with the temperature, decreasing with the increase of the temperature. Table 1 presents the values of the temperature obtained for samples coated with CB solutions when different values of the voltage were applied. The influence of the CB percentage is greater then the infuence of the voltage applied as regard on temperature achieved.

There were some hot spots, especially in the centre of the samples, one explanation being the fact that the coating thickness was not the same in every point of the heating fabric. The increase of the temperature of the conductive fabric was significant for at least 37.5% CB concentration, at 22^{o}C room temperature and 65% HR.

The minimum of temperature achieved was for 37.5% CB at 3 V and maximum for 46% CB at 12 V, fact that lead to conclusion that the rising of the CB concentration and the voltage will determine an increase of the temperature; however, as it can be observed in figure 3*b*, the influence of the CB percentage is greater then the infuence of the voltage applied as regard on temperature achieved.

The results indicate that the power dissipated and temperatures are increasing with the increase of CB conductive particles concentration and the voltage applied. Figure 4 shows the difference in temperature of the CB coated samples as a function of the CB concentration at various values of voltage applied.

Figure 4*a* present this variation for 37.5% CB concentration, figure 4*b* for 40% CB concentration, figure 4*c* for 44% CB concentration and figure 4*d* for 46% CB concentration. The temperature difference was measured when temperature in the climatic chamber was –10^{o}C, 0^{o}C, +10^{o}C and relative humidity was 10%.

From the testes performed with different concentrations of CB conductive particles, it was found that the maximum difference of temperature achieved was for 46% CB, at 12 V. As it can be observed in figure 4, the difference in temperature range from 4^{o}C for 37.5 CB percentage to 6^{o}C for 46% percentage of CB, when *Tcc* is –10^{o}C; 4.1^{o}C for 37.5 CB percentage to 6^{o}C for 46% percentage of CB, when *Tcc* is 0^{o}C and 4.2^{o}C for 37.5 CB percentage to 8.5^{o}C for 46% percentage of CB, when Tcc is +10^{o}C at 12 V. The samples exhibit a maximum surface temperature value 8.5^{o}C when a 12 V is applied, for a concentration of CB particles by 46%.

Smaller voltages applied did not determine significant changes in the temperature. The power dissipated was not investigated in the second part of the experiment due the fact that the increase of the temperature for -10^{o}C to +10^{o}C was quite suggestive, indicates the fact that for low temperatures clothes with heating elements embedded may provide the warmth needed.

CONCLUSIONS

Conductive fabrics obtained by coating with carbon black conductive particles were tested in order to establish if they can be used for heating applications.

The investigation of thermal properties in normal environmental condition, but also in special environmental conditions of temperature and relative humidity, shows that these materials are conductive fabrics able to heat. To obtain higher values for the power achieved is indicate to reduce the surface resistivity, meaning a higher concentration of carbon black conductive particles. The heating fabric obtained can be used to generate heat in different environmental conditions. If the heating elements it supposed to be integrated into the clothing, for example underwear, the temperature next to the body

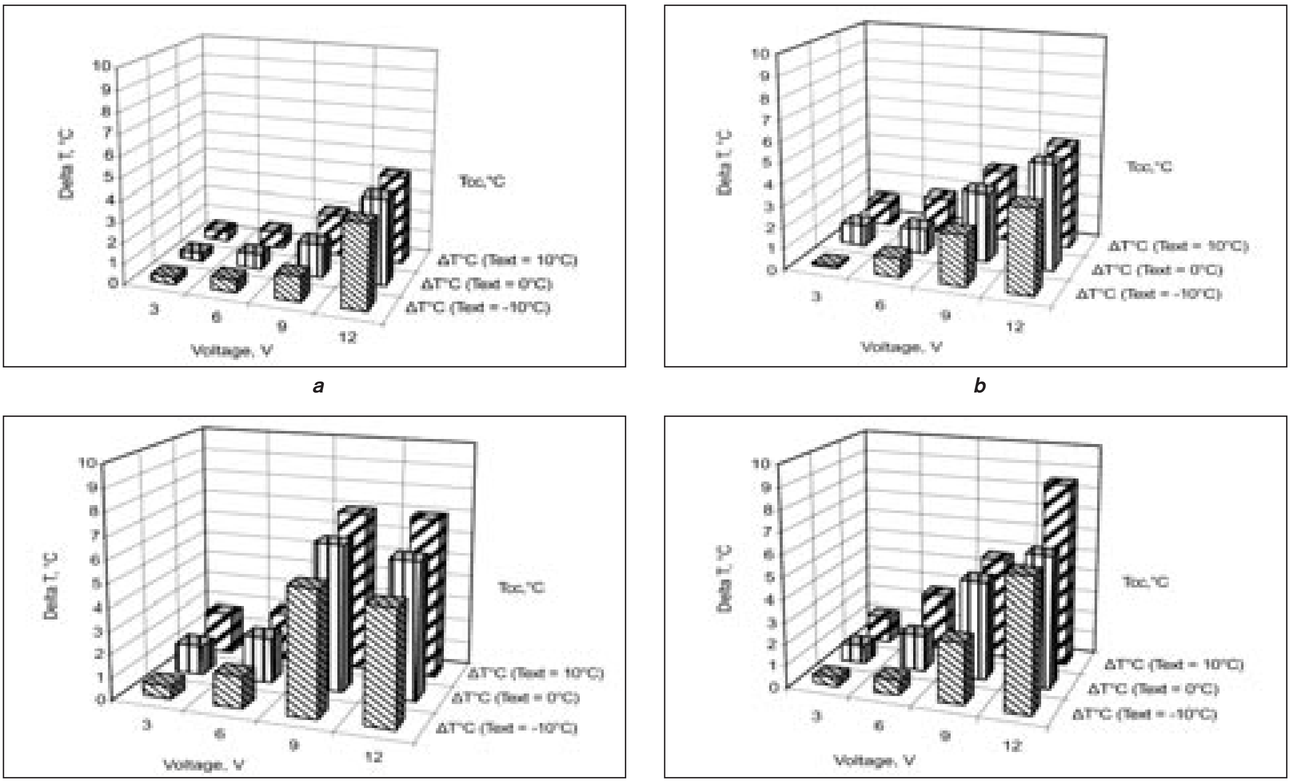


Fig. 4. Variation of temperature as a function of the voltage for different values of temperature in climatic chamber for samples coated with: ***a*** – 37.5% CB concentration; ***b*** – 40% CB concentration; ***c*** – 44% CB concentration; ***d*** – 46% CB concentration

must be near the body temperature, so a bigger voltage must be supplied in order to achieve a comfortable sensation of warmth.

Further researches are necessary regarding the type of the woven fabrics, like twill, and also the type of the yarns used, which can be factors that influence the coating procedure and implicit the perfor mances of the conductive fabrics.

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Motivation and consumer behavior: a view in apparel industry

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REZUMAT – ABSTRACT – INHALTSANGABE

Motivaţia şi comportamentul consumatorului: o privire de ansamblu asupra industriei de îmbrăcăminte

Nevoile umane reprezintă baza unui marketing modern. Durabilitatea, profitabilitatea şi dezvoltarea unei firme, într-un astfel de mediu competitiv, depind de o înţelegere mai bună şi mai rapidă a nevoilor nesatisfăcute ale consumatorilor, în comparaţie cu alţi competitori, în vederea satisfacerii acestora. Prin urmare, prima misiune a unui comerciant este aceea de a aborda consumatorul şi de a descoperi structura şi priorităţile dorinţelor şi necesităţilor sale. Scopul studiilor comportamentale ale consumatorului este acela de a încerca să înţeleagă consumatorii, să descopere când, de ce şi cum reacţionează aceştia. Totuşi, aceste reacţii sunt destul de complicate şi depind de fiecare individ în parte. Motivaţia este unul dintre procesele de analiză şi de anticipare a dorinţelor consumatorilor. Dacă un comerciant reuşeşte să afle motivele consumatorului, acesta ştie ce va cumpăra consumatorul şi va realiza produse în consecinţă, fără a mai aştepta ca ele să fie alese dintre alte produse pe care consumatorul decide să le cumpere. Acest studiu oferă informaţii cu privire la conceptul de motivaţie, istoria acesteia şi anumite teorii şi încearcă să descopere forţele care motivează comportamentul de cumpărare în industria de îmbrăcăminte.

Cuvinte-cheie: motivaţie, comportamentul consumatorului, industria de îmbrăcăminte

Motivation and consumer behavior: a view in apparel industry

Human needs are the basis of modern marketing. Sustainability, profitability and growth of a firm in such a competitive environment depend on understanding the unsatisfied needs of the consumer better and sooner than its rivals and satisfy them. Therefore, the first mission of a marketer is to approach the consumer and uncover the structure and priorities of his wants and needs. The aim of consumer behavior studies is to try to understand the consumers, to reveal when, why and how they react. However, these reactions are quite complicated and depend on the individual. Motivation is one of the processes to analyze the consumer and have foresight. If a marketer succeeds in finding out the motives of the consumer, he knows what the consumer will buy and manufactures accordingly without waiting for to be picked among the other products that consumer decides to buy. This study is intended to give information about the process of motivation, its history and certain theories and to try to reveal the underlying forces that lead to buying behavior in apparel industry.

Key-words: motivation, consumer behavior, apparel industry

Motivation und Kundenverhalten: eine Perspektive für die Bekleidungsindustrie

Die menschlichen Bedürfnisse stellen die Grundlage für einen modernen Marketing. Die Nachhaltigkeit, die Leistungsfähigkeit und die Unternehmensentwicklung in einer wettweberbsfähiger Umwelt, hängt von einem besseren Verstehen der Kundenbedürfnisse und deren besseren und schnelleren Befriedigung im Vergleich zum Wettbewerb. Deshalb ist die erste Aufgabe eines Vermarkters die Kundenansprechung und die Identifizierung seiner Wünsche und Bedürfnisse. Zweck der Kundenwerhaltensuntersuchung ist der Versuch die Kunden zu verstehen, herauszufinden wann, warum und wie sie reagieren. Auf jeden Fall sind diese Reaktionen ziemlich kompliziert wenn es auf Individuen zukommt. Motivation ist eines der Prozesse für die Kundedanalyse und- voraussage. Wenn es einem Vermarkter gelingt die Anregungen des Kunden herauszufinden, wird er wissen was der Kunde kaufen wird und entsprechend produzieren, ohne darauf zu warten aus anderen Produkten vom Kunden ausgewählt zu werden. Diese Untersuchung verfolgt die Erörtung der Motivation, seine Geschichte und einige Theorien für die Begründungen des Kundenverhaltens in der Bekleidungsindustrie.

Stichvörter: Motivation, Kundenverhalten, Bekleidungsindustrie

Human needs are the basis of modern marketing. Sustainability, profitability and growth of a firm in such a competitive environment depend on understanding the unsatisfied needs of the consumer better and sooner than its rivals and satisfy them [1]. Therefore, the pursuit of the marketer is to fully understand and anticipate the customers' needs [2].

The term consumer behavior is defined as the behavior that consumers display in searching for, purchasing, using, evaluating and disposing of products and services that they expect will satisfy their needs. Consumer behavior focuses on how individuals make decisions to spend their available sources (time, money, effort) on consumption-related items. That includes what they buy, why, when and where they buy it, how often they buy and use it, how they evaluate it after the purchase and the impact of such evaluations on future purchases, and how they dispose of it [1].

Motivation is one of the processes to analyze the consumer and have foresight. If a marketer succeeds in finding out the motives of the consumer, he/she knows what the consumer will buy and manufactures accordingly without waiting for to be picked among the other products that consumer decides to buy [1].

Motivation refers to the drive, urge, wish, or desire that leads to a goal-oriented behavior [3]. In other words motivation is the driving force within individuals that impels them to action. This driving force is produced by a state of tension, which exists as a result of an unfulfilled need. Individuals strive to reduce this tension through behavior that they anticipate will fulfill their needs and relieve them. Therefore, marketers must view motivation as the force that induces consumption [1].

Most of an individual's specific needs are dormant much of the time. The arousal of needs at a specific time may be caused by individual's physiological condition, emotional or cognitive processes or stimuli in the outside environment. When people live in a complex and highly varied environment, they experience many opportunities for need arousal. Conversely, when their environment is poor or deprived, fewer needs are activated [1].

The Austrian-born Ernest Dichter shaped American marketing and consumer research in the postwar era and is known as the father of motivation research. Dichter based his entire market and consumer research methodology on the basis of Freudian psychoanalysis.

He stated that consumers were driven by largely unexpressed desires, fears and complexes. Ernest Dichter became a brand in 1950s America, where he advised corporations on how to use psychoanalysis in order to research the hidden motivations of their consumers [4].
One of the first researchers to investigate shopping motivations was Tauber [3]. Tauber's (1972) article is still cited in contemporary texts as a seminal piece which offers insight into shopping motives [5]. Using depth interviews, Tauber divided shopping motivations into two categories: personal and social. In the category of personal shopping motivations he identified the need for role playing, diversion, self-gratification, learning about new trends, physical activity, and sensory stimulation. The need for social experiences outside the home, communication with others having the same interest, peer group attraction, status & authority, and pleasure of bargaining were included in the category of social shopping motivations [3].

CLASSIFICATION OF MOTIVES

In the literature motives can be classified as primary and secondary motives. Primary motives are physiological and include the needs for food, water, air, clothing, shelter etc. They are needed to sustain biological life. Secondary motives are acquired and generally psychological. These are learnt in response to our culture or environment and may include needs for self-esteem, prestige, affection and power. Acquired motives results from the individual's subjective psychological state and from relationships with others [1].
Within a consumer behavior context, motivation refers to an activated state within a person that leads to goal-directed behavior. Motivation can also be classified as utilitarian (functional) and hedonic (symbolic or expressive). In the context of shopping, utilitarian motivation involves satisfying functional needs such as searching for products, services, or information that solve consumption-related problems; convenient shopping; and reduction of costs (i. e., money, time and effort) that may have to be expended in transportation, finding specific products or services, and waiting in check-out lines. Hedonic shopping motivation involves satisfying emotional or expressive needs such as fun, sensory stimulation, novelty, relaxation and gratification [6].

MOTIVATION THEORIES

Human behavior is a complex phenomenon, therefore there are numerous motivation theories that aim to explain the consumer behavior such as Maslow's Hierachy of Needs, Herzberg's Two-Factor Theory and Alderfer's ERG Theory. However, one of the widely applied theories is mentioned in this study.

Hierarchy of needs

Dr. Abraham Maslow, a clinical psychologist, formulated a widely accepted theory of human motivation based on the notion of a universal hierarchy of human needs. The theory identifies five basic levels of human needs, which rank in order of importance from lower-level (biogenic) needs to higher-level (psychogenic) needs. The theory postulates that individuals seek to satisfy lower-level needs before higher-level needs emerge. The lowest level of chronically unsatisfied need that an individual experiences serves to motivate his/her behavior. When the need is fairly well satisfied, a new (and higher) need emerges [1].
There are five levels of needs; physiological needs (lowest level), safety needs, social needs, esteem (ego) needs and self-actualization needs (highest level).
Generally, a consumer behavior fulfills more than only one need. For instance, people buy clothes for social and personal needs like protection, acceptation among people and ego needs [1].

MEANS-END CHAIN THEORY

MEC analysis is a qualitative research approach that investigates the cognitive structures of individuals. MECs explain how the activity of shopping enables an individual to achieve a desired end state. Reynolds and Gutman point out that an understanding of the structure of attributes, consequences, and values depicted in MECs facilitates a motivational perspective because it uncovers the underlying reasons why certain attributes or expected consequences are desired [7].
A means-end chain is a series of linked beliefs. These chains determine a person's perceptions of objects and behaviors. According to the theory, the means-end chain proceeds from desired end (personal values) to means (benefits and attributes) and then to behavior. The earlier (or higher) stages of a means-end hierarchy contain abstract self-knowledge (such as knowledge about the person's life goals and values), whereas the later (or lower) stages carry relatively concrete knowledge (such as knowledge about product/service attributes and their functional, psychological, and social benefits) [8].

LITERATURE REVIEW ON MOTIVATION FACTORS ON APPAREL INDUSTRY

Motivations influence the initiation, intensity, and persistence of behavior. The result of motivations is desire or need for the product. Motivations provide the consumer with the reason to buy. Many researchers have identified reasons that motivate consumers to purchase a clothing product. Protection against the physical, social, and psychological environment was mentioned as one of the motivations to purchase clothing by early researchers. Clothes are an individual's most immediate environment, acting as a buffer between the biological self and the wider physical and social environment. The important role of clothing in presenting a desired image and lifestyle is identified. Clothing allows consumers to express an identity to others in terms of their symbolic or expressive meanings [9]. Due to the reasons mentioned above purchasing clothes is a compulsory and particular act. Thus, many researchers have been conducted on this subject.
It is indicated in a study that consumers' needs vary considerably with cultural differences and that different needs may lead to different motives. For example, Japan, South Korea, Taiwan, and Hong Kong have a high degree of collectivism whereas countries such as the USA, Australia, and Canada display strong individualism. In collectivist cultures, attitudes towards events,

Fig. 1. Maslow's hierarchy of needs
Sursa: Maslow's Hierarchy of Needs, http: www.abraham-maslow.com/m_motivation/Hierarchy_of_needs.asp (retrieved on 28 March 2011)

actions, and objects rely on how they relate to the individual's needs to belong, fit-in, and maintain social harmony whereas attitudes in an individualistic culture rely more on the individual's needs concerning uniqueness, self-expression, and defining and validating internal attributes. Such cultural differences may lead to different motives for purchasing a product [10].

A survey was conducted on adolescents' motivations for clothing and found that the needs of recognition and conformity were the two most important motivations. Almost 50% of the adolescent responses expressed that the most important motivation for clothing was the desire for recognition, and 38% indicated the desire to conform. It was found that peer group pressure played an important role for adolescent girls as they determined where to shop. They paid particular attention to peer group approval of brands when purchasing coats, blouses, dresses, and scarves for school. In addition to fulfilling the need for a particular product, self-esteem, or social needs, shopping for clothing also satisfies hedonic motivations such as the need for fun, novelty, and variety [9].

A research was carried out to understand high school adolescents' clothes-buying behavior and to examine the similarities and differences between male and female shoppers. When male and female participants' purchase motivations were compared, the results showed that males and females had similar degrees of conformity, sexual attraction, and recognition motivations. Males in the study indicated that their two most important clothing purchase motivations were sexual attraction and recognition. However, the most important purchase motivation for female participants was recreation, followed by sexual attraction [10].

The results of the studies show that gender differences exist in shopping motivations and patterns. For instance, it was found that more teen females tend to shop for clothes, than do teen males. It was suggested that the teen consumer group, compared to the other age groups (20–49 and 50+), had stronger shopping motivations for diversion, browsing, and social experience. Researchers also reported that teens are more likely to shop for fulfilling hedonic needs for enjoying crowds and entertaining than are adult consumers. Other anecdotal evidence exists that teens' motivations for shopping cover a wide spectrum, from utilitarian shopping for purchasing products to hedonic shopping including social or entertaining aspects such as looking for members of the opposite sex, having fun, seeing friends, and people watching [11].

A study conducted in Australia revealed that products that are used in public (apparel) or whose consumption outcome is manifest in public (shampoos and cosmetics), have purchase motivations that are susceptible to hedonic appeals [12].

In another study, the relationships between fashion innovativeness/opinion leadership and utilitarian/hedonic shopping motivations were investigated. The results indicated that fashion innovativeness was significantly related to various hedonic shopping motivations; fashion innovativeness was positively associated with adventure and idea shopping motivations, whereas it was negatively associated with value shopping motivation. It was also found that fashion opinion leadership was positively associated with utilitarian shopping motivation [13].

Hedonic shopping motivations were investigated in a study. The results show that role motivation and adventure motivation appear as the most significant motivation in the perception of merchandise quality. These results indicate that the respondent's view of merchandise is dependent upon their reason for shopping. Those shoppers who view shopping as part of their daily activities or who have a specific motivation for shopping (part of adventure), are more likely to focus on product quality. This could be because these people view shopping as a necessity and are not looking for social interactions. On the other hand, for those shoppers who view shopping as a social activity and are trying to fulfill their need for stimulation, personal service is more relevant [14].

Gender is a significant factor in understanding consumer behavior because males and females are subjected to different social roles and pressures. Additionally, it was reported on male and female attitudes toward shopping as: *a* – women are more positive about shopping than men; *b* – many men perceive shopping as effeminate; *c* – men shop to fulfill an instrumental need, rather than shopping for shopping's sake. However, several studies reveal somewhat conflicting results in gender differences. For instance, it was revealed in a study that boys were more associated with utilitarian aspects such as perfectionist, quality-conscious, and habitual consumer decision making styles; girls were associated with utilitarian (e.g., price-conscious and value-for-money) as well as hedonic (e.g., recreational and hedonistic, and novelty and fashion-consciousness) decision-making styles. Right choice in shopping for their clothing but also to receive hedonic benefits such as excitement in their shopping venue [15].

CONCLUSIONS

Consumer behavior studies are beneficial to have foresight about what, when and why the consumer will buy, as unfulfilled needs of the consumer must be satisfied to be/stay competitive in nowadays' harsh rivalry.

Marketing process starts before manufacturing. Thus, target audience must be set and factors motivating the target audience must be uncovered before proceeding to manufacturing.

Additionally, motivating factors should be emphasized during advertising and promotion activities.

In conclusion, motivation is an important process according to the viewpoint of both psychology and marketing, which effect the purchasing of apparels. Therefore it is crucial for the apparel industry to reveal and understand the underlying motivations of consumers that leads to buying behavior and act accordingly.

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Materii prime

NOI APLICAȚII ALE FIBRELOR TENCEL

La târgul internațional *Techtextil*, desfășurat la Frankfurt, în perioada 24–26 mai 2011, compania producătoare de fibre celulozice ***Lenzing AG*** a prezentat noile aplicații ale fibrei Tencel în sectorul auto.
Pentru a satisface cererile tot mai exigente ale constructorilor de automobile, au fost create tipuri speciale de fibre pentru acest sector. Fibrele Tencel – denumirea comercială înregistrată pentru Lyocell, pot fi folosite în amestec cu toate fibrele convenționale, avantajul acestor amestecuri fiind îmbunătățirea proprietăților materialelor textile destinate domeniului auto, prin crearea unui management al umidității similar cu al altor aplicații din domeniul textil. Folosirea unui amestec cu 30% Lyocell duce la crearea unui climat mai uscat al articolelor realizate. În plus, fibra poate fi folosită în diverse aplicații electronice, de la instalațiile de aer condiționat la echipamentele audio. Separatoarele din hârtie cu Tencel-Lyocell pot avea grosimi foarte mici, ceea ce contribuie la o mai bună performanță. De asemenea, aceste fibre pot fi încorporate în filtrele de ulei și de combustibil.

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Filatură

MAȘINĂ AUTOMATĂ DE FILAT CU ROTOR

Mașina de filat cu rotor R60 (fig. 1), produsă de firma ***Rieter Machine Works Ltd.,*** din Winterhur/Elveția, este o realizare recentă, cu accent pe productivitate și flexibilitate. Avantajele acesteia sunt rezultatul implementării unei noi unități de filare S60, cu geometrie de filare inovatoare, și a robotului cu ciclu accelerat, ambele contribuind la creșterea nivelului de eficiență pentru o gamă largă de aplicații. Noua mașină de filat cu rotor R60 a fost prezentată la târgul internațional *ITMA*, desfășurat la Barcelona. Noul aranjament al duzelor și funcția inovatoare twist-stop a unității de filare S60 duc la creșterea stabilității procesului de filare și la reducerea numărului de ruperi ale firelor, ceea ce permite o creștere a productivității cu până la 5%. Construcția modulară a robotului duce la o creștere suplimentară a vitezei cu 10%. O levată completă și un ciclu de legare sunt acum finalizate în doar 22 de secunde. Folosind noua unitate „twist“, timpul de setare a fost redus la minimum. Dispozitivele individuale de acționare a cilindrului de alimentare îmbunătățesc tehnologia AEROpiecing® de legare a firelor, prin controlul direct și rapid al depunerii benzii. Mașina R60 poate fi dotată cu până la 540 de rotoare. Acest lucru duce la o creștere a productivității cu 8%, comparativ cu modelul anterior R40. De asemenea, consumul de energie al acestei mașini de ultimă generație a fost redus, în funcție de aplicație, cu 5%, în comparație cu R40.

Fig. 1

Interfața operatorului cu ecran tactil color mare oferă informații clare cu privire la starea mașinii și permite setarea cu ușurință. Întregul concept vizează scurtarea timpului inactiv și, astfel, o fiabilitate ridicată a mașinii. O nouă opțiune integrată a R60 face posibilă filarea individuală a mai multor loturi pe fiecare parte a mașinii. În plus, R60 poate fi echipată cu opțiunea VARIOspin, pentru producția de fire de efect. Această opțiune utilizează capacitatea excepțională a dispozitivelor individuale de acționare a cilindrului de alimentare. Metoda filării cu rotor este adecvată pentru firele standard. Un alt punct forte îl constituie ușurința manipulării firelor cu lungimi mici, cu finețea de până la 50 *Nm*. Tehnologia AEROpiecing® – un concept unic al Rieter pentru firele filate cu rotor, împreună cu consumul redus de energie și facilitatea operării sunt factori decisivi pentru eficiența economică ridicată a filării cu rotor.

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NOI INOVAȚII ALE FIRMEI OERLIKON SAURER

Compania elvețiană ***Oerlikon Saurer*** a implementat o serie de inovații în domeniul răsucirii firelor pentru covoare și a firelor cablate pentru anvelope în liniile de produse *Allma* (Kempten/Germania), *Volkmann* (Krefeld/Germania) și *Saurer.*

Volkmann CT – o nouă mașină pentru răsucirea fibrelor scurte

Având o construcție modulară, mașina ***Volkmann CT***, destinată răsucirii fibrelor scurte, poate fi folosită pentru toate tipurile de materii prime și pentru toate domeniile de finețe a firului. Noile concepte „eco-drive“ și „eco-spindle“ completează perfect gama existentă de fuse, fiind posibilă reducerea cu până la 40% a cheltuielilor pentru energie, chiar și în cazul firelor foarte fine.
Datorită noii geometrii de înfășurare și triunghiului de înfășurare alungit, se realizează o foarte bună uniformitate a înfășurării firului. Derularea procesului are o nouă dimensiune a eficienței și include, opțional, posibilități de setare centrală, administrare a rețelelor, monitorizare a calității, măsurare a lungimii și a altor parametri. Avantajelor menționate li se adaugă ușurința în operare și siguranța absolută în funcționarea mașinii.

Volkmann Heat – SET scurtează durata prelucrării firelor pentru covoare

După cablare, firele pentru covoare BCF sunt tratate termic, în vederea conferirii unei stabilități a formei acestora. Procesul de termofixare a fost integrat de Volkmann într-un concept combinat, astfel încât un ciclu al procesului de prelucrare a firelor reunește cablarea, termofixarea și înfășurarea (fig. 1).

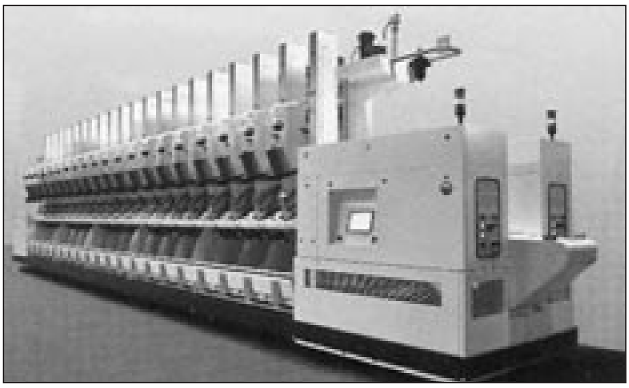

Fig. 1

Allma TC2 – mașină de răsucit pentru fire tehnice

Noua mașină de răsucit Allma TC2 se caracterizează printr-o flexibilitate și productivitate sporită. Ea permite prelucrarea tuturor tipurilor de materiale din domeniul de finețe 235–60 000 dtex, cu viteze de producție de până la 450 de metri pe minut. Tehnologiile inovatoare de prelucrare ajută la îmbunătățirea calității firelor obținute.

Allma CC4 – mașină de cablare a firelor de cord pentru anvelope

Allma CC4 a fost introdusă deja în producția de fire de cord cablate pentru anvelope. În funcție de finețea firului și de tipul fusului, se pot realiza economii de energie de până la 50%.

Epoca 6 pro – o nouă mașină de brodat

Viteza medie de producție a noii mașini de brodat Epoca 6 pro este cu până la 30% mai mare, în condițiile în care se păstrează fiabilitatea și calitatea broderiei. Acest lucru este posibil datorită:

- unui sistem inovator de acționare, care poate fi configurat în funcție de cerințe; noile acționări individuale ale acelor, a suveicii și conducătorului de fir, precum și acționarea directă a dispozitivului de presare a materialului sunt adaptate în mod ideal la mișcările suportului;
- posibilităților unice de setare – setarea electronică a conducătorului de fir și a dispozitivului de presare a materialului, setarea manuală a lățimii căruciorului și tăierea perfectă a firelor, datorită noului sistem de reglare individuală și sistemului de oprire a firului.

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O NOUĂ CARDĂ DE ÎNALTĂ PERFORMANȚĂ

Compania ***Rieter Machine Works Ltd.***, din Winterthur/ Elveția, a realizat o nouă cardă C70 (fig. 1), de înaltă performanță, ale cărei îmbunătățiri se referă la extinderea zonei active de cardare și la creșterea preciziei de setare a distanței dintre garnitura de cardă și capace.

Fig. 1

Elementele optimizate de extracție din zonele de precardare și postcardare permit o mai bună economisire a materiilor prime. Consumul redus de materii prime și de energie per kilogram de bandă cardată contribuie la obținerea unei producții eficiente de fire de calitate superioară. Performanța de producție a cardei C70, în comparație cu C60, poate crește cu până la 40%, la o calitate a benzii similară sau chiar îmbunătățită. Această optimizare este realizată prin redistribuirea zonelor de cardare din sfera capacelor și prin ghidarea mai precisă a capacelor reproiectate. Folosind carda C70, cele 32 de capace de cardă sunt operative. Zona activă a capacelor crește cu 45%, comparativ cu carda C60, și cu 60%, în comparație cu cardele tradiționale. Ghidarea precisă a capacelor și reproiectarea acestora a permis o setare foarte exactă și reproductibilă a distanței dintre garnitură și capace, astfel încât să fie posibil un minimum de 0,1 mm. Această precizie conduce la rezultate îmbunătățite ale procesului de cardare. În plus, a fost optimizat și procesul de curățare a capacelor de cardă. Datorită cuțitului detașor din zona de precardare și postcardare, se obține o utilizare optimă a fibrei. Cuțitul detașor cu distanță variabilă a ejectorului poate fi schimbat cu ușurință, în cel mai scurt timp posibil. Viteza capacelor este reglată prin intermediul convertorului de frecvență, independent de viteza cilindrului. Acest lucru înseamnă că se poate realiza o reglare individuală a cardei, în funcție de tipul de materie primă utilizată.

Sistemul integrat, complet automat, de ascuțire IGS – un produs exclusiv Rieter – este disponibil opțional și oferă clientului valori constante ale calității, pe întreaga durată de viață a garniturii de cardă.

Performanța ridicată de producție a cardei C70 duce la optimizarea consumului de energie, acesta fiind cu 15% mai mic decât la carda C60. Având în vedere prețurile în creștere ale energiei electrice la nivel mondial, acest lucru reprezintă un factor esențial în îmbunătățirea producției de fire.

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MAȘINI DE ȚESUT DE LA *ITEMA WEAVING*

ITEMA Weaving, cu mărcile sale *Sultex, Vamatex* și *Somet*, a prezentat la ITMA 2011, care a avut loc la Barcelona/Spania, în perioada 22–29 septembrie, ultimele sale inovații tehnologice, respectiv mașina de țesut cu jet de aer Sultex A9500 și mașina de țesut cu graifăr Vamatex Silver 501. Ambele mașini dispun de o platformă nouă, complet automatizată. ITEMA Weaving a lansat un pachet software “loom browser”, care permite utilizatorului un acces rapid şi uşor la informaţii, în scopul monitorizării eficienţei, nivelurilor de oprire, diverselor setări şi/sau în vederea creării şi a descărcării modelelor de bătătură şi de ratieră. În plus, această platformă asigură un suport tehnic profesional la distanţă, printr-o simplă conectare la internet, accesând reţeaua de asigurare a service-ului global ITEMA.

Maşina de ţesut cu jet de aer Sultex A9500

Cu performanţele sale ridicate şi designul simplificat, maşina de ţesut cu jet de aer Sultex A9500 stabileşte noi standarde în privinţa productivităţii şi simplităţii operaţionale. Nu a fost făcut niciun compomis în timpul proiectării. Folosind maşina A9500 se realizează o calitate excelentă a ţesăturii. Maşina este echipată cu o geometrie unică a rostului, special concepută pentru a promova o staţionare de lungă durată şi o reducere drastică a consumului de aer. Timpul mare de inserţie a bătăturii şi duzele de mare eficienţă asigură o curbă optimă de acceleraţie, pentru orice tip de fire. Noua platformă electronică, concretizată într-un ecran tactil mare, cu multe culori, oferă noi funcţionalităţi şi oportunitatea unui dialog eficient cu reţeaua de service ITEMA. Maşina de ţesut cu jet de aer Sultex A9500 (fig. 1) este adecvată pentru denimul cu greutate medie şi mare, ţesăturile colorate şi aplicaţiile în domeniul lenjeriei.

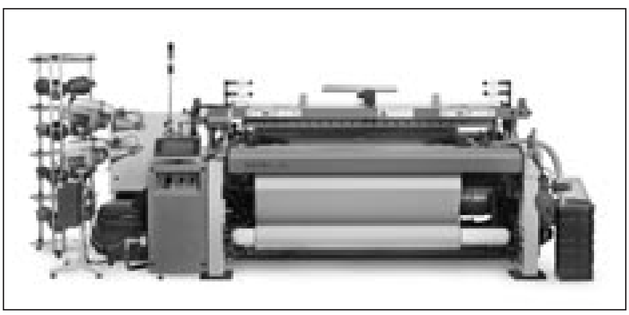

Fig. 1

La ITMA, ITEMA Weaving a expus maşina A9500 B 190 F4 T S10 pentru denim de efect şi maşina A9500 B 340 C2 T S10 pentru lenjerie de pat fină.

Maşina de ţesut cu jet de aer Sultex A9000

Asamblată în China, maşina de ţesut Sultex A9000 are aceeaşi inginerie şi design ca şi Sultex A9500. Maşina este echipată strategic şi este oferită clienţilor din întreaga lume pentru aplicaţii competitive de ţesere, la viteză maximă şi cu costuri reduse.

Vamatex Silver 501

Această versiune de înaltă performanţă a binecunoscutei maşini Silver HS a câştigat deja aprobarea entuziastă a principalilor ţesători europeni, depăşind aşteptările în ceea ce priveşte performanţa, uşurinţa în utilizare şi, mai presus de toate, calitatea superioară a ţesăturilor din bumbac, la o viteză de producţie maximă. Silver 501 (fig. 2) este echipată cu o nouă platformă electronică şi se bazează pe un design mecanic complet revizuit, pentru a asigura performanţe superioare ale ţeserii şi stabilitate absolută a operaţiilor de realizare a denimului sau a ţesăturilor grele.

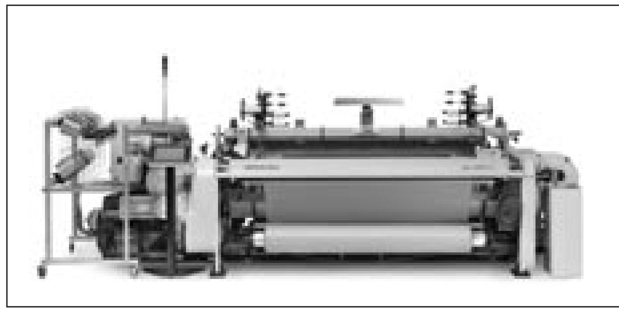

Fig. 2

Fără precedent în ţeserea cu graifăr, noul tip de inserţie a bătăturii este special proiectat pentru a asigura clienţilor furnizarea rapidă a unor opţiuni adecvate diverselor aplicaţii competitive.
Acest sistem de transfer revoluţionar SK, cu graifăre noi şi conducători de bandă acoperiţi cu diamant, asigură o gamă largă de aplicaţii: de la ţesăturile pentru cămăşi de mare fineţe şi calitate superioară până la ţesăturile tehnice grele. De asemenea, pentru aplicaţii speciale, maşina Silver 501 poate fi echipată cu graifăre cu trecere liberă. Prin terminalul cu ecran tactil mare, cu multe culori şi software intuitiv – care facilitează dialogul cu ţesătorul şi tehnicianul, noua platformă electronică asigură un maximum de simplitate şi uşurinţă în utilizare. Conectarea la ethernet permite diagnosticarea la distanţă şi suport tehnic specializat.
La ITMA, ITEMA Weaving a expus maşina de ţesut Silver 501 190, destinată realizării ţesăturilor fine pentru cămăşi şi Silver 501 360, destinată realizării ţesăturilor peliculizate.

Maşina de ţesut cu graifăr Somet Alpha PGA

Datorită graifărului universal PGA, flexibilitatea maşinii de ţesut Somet Alpha PGA este încă în topul listei de dorinţe ale ţesătorilor. Fără a face compromisuri în privinţa vitezei, maşina Alpha PGA rămâne cea mai flexibilă maşină, atunci când este necesară inserţia a mai multor tipuri de fire de bătătură, cu desimi diferite, de exemplu, cele pentru tapiţerie. Schimbarea modelelor este rapidă şi uşoară şi nu necesită reglaje meticuloase ale maşinii. Alpha PGA este alegerea perfectă pentru ţesătorii care caută un partener de încredere pentru ţeserea în variante de modele complicate.
La ITMA, ITEMA Weaving a expus maşina de ţesut Alpha PGA 190, pentru ţesături Leno în 12 culori şi Alpha PGA 340 pentru ţesături din fire de efect destinate tapiţeriei.

Maşina de ţesut cu graifăr Vamatex R880

Vamatex R880 este rezultatul soluţiilor avansate, a experienţei acumulate privind maşinile de înaltă performanţă, precum şi a sinergiilor create în cadrul organizaţiilor euro-chineze ale companiei ITEMA. R880 are caracteristici demonstrate de înaltă performanţă, versatilitate şi fiabilitate.

Maşina de ţesut cu graifăr Vamatex Silver DynaTerry

Vamatex este marca recunoscută pentru maşinile de ţesut cu graifăr, destinate producerii prosoapelor pluşate. Tehnologia dovedită a Vamatex Silver DT asigură o productivitate mare, uşurinţă în operare, flexibilitate maximă şi calitate superioară. ITEMA Weaving a expus, la ITMA, mașina Silver DT 260, destinată realizării prosoapelor de plajă.

Mașina de țesut cu proiectil Sultex P7300HP

Datorită consumului redus de energie, versatilității și capacității de adaptare și dezvoltare de neegalat, Sultex P7300HP este alegerea perfectă pentru acei clienți care doresc să pătrundă rapid pe piețe noi. Cu o lățime maximă a țesăturii de 655 cm, mașina de țesut cu proiectil este cea mai potrivită pentru realizarea țesăturilor tehnice cu cea mai mare lățime de țesere, de exemplu a țesăturilor Leno, a benzilor de polipropilenă și a noilor tipuri de denim.
La ITMA, compania ITEMA Weaving a expus mașina P7300HP V8 S540 N2 EP D2, destinată producerii geotextilelor.

Sultex CWT

Tehnologia de țesere personalizată va furniza clienților o mașină de țesut care satisface cerințele unice și complexe ale acestora, pentru a intra pe noi piețe producătoare de agrotextile, geotextile, benzi transportoare, pânză groasă, ecrane de cinema și proiectoare, țesături filtrante, prelate și țesături metalice. Poate fi atinsă o tensiune a urzelii de până la 15 000 N/m.
ITEMA Weaving asigură clientului servicii postvânzare, rapide și de calitate, oferind piese de schimb de calitate OEM și suport tehnic la domiciliul clientului, prin telefon sau accesând rețeaua globală de suport ITEMA, prin internet. În plus, programul de consultanță tehnică al firmei în domeniul textilelor oferă un audit cuprinzător și un raport cu recomandări clare privind costurile, întreținerea, îmbunătățirea calității, a productivității etc.

Informații de presă. ITEMA, iunie 2011

Tricotaje

O NOUĂ MAȘINĂ RECTILINIE DE TRICOTAT COMPUTERIZATĂ

Producătorul japonez de mașini rectilinii de tricotat ***Shima Seiki Mfg. Ltd.***, din Wakayama, a dezvoltat o nouă mașină rectilinie de tricotat computerizată SSR 112, care este foarte productivă, eficientă din punct de vedere energetic și compactă (fig. 1).
Încetinirea dezvoltării economiei globale a orientat producția spre acele centre de producție care oferă o cantitate cât mai mare de bunuri de bază, la un preț cât mai mic. Cererea pentru mașinile de tricotat computerizate a crescut în special pe piețele emergente. Mașinile rectilinii manuale și cele mecanice au fost eliminate în favoarea mașinilor computerizate, cu productivitate mai mare. Asigurând o producție a tricotajelor de bază mult mai rapidă, SSR112 a fost concepută tocmai pentru a satisface aceste necesități. SSR112 are o lățime de tricotare de 45 inch și este dotată cu un sistem dublu de transport ultracompact.

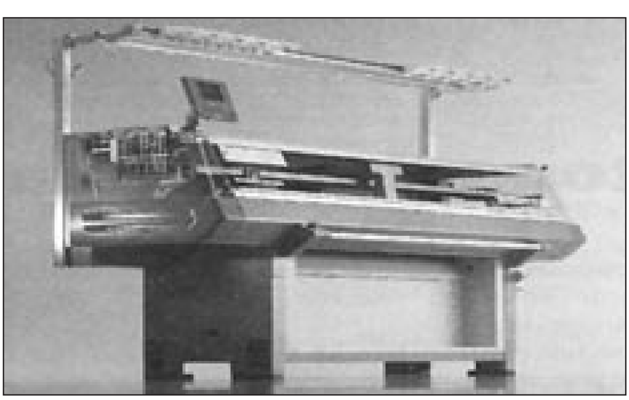

Fig. 1

Tricotarea de mare viteză este posibilă prin dotarea cu un sistem de transport cu răspuns rapid R2Carriage. În scopul asigurării calității și fiabilității, solicitate mai mult ca oricând de către unitățile de producție moderne, SSR112 beneficiază de un sistem digital de control al ochiurilor DSCS, care are un consum de energie mai mic cu 25%, comparativ cu mașinile din generația anterioară. Compania subliniază că SSR112 este considerată o mașină standard, care excelează în producția de tricotaje, fiind adecvată nevoilor specifice ale pieței.
Compania Shima Seiki poate satisface și alte cerințe suplimentare, datorită gamei variate de mașini rectilinii de tricotat computerizate de care dispune.

Melliand International, 2011, nr. 3, p. 142

Textile nețesute

INOVAȚII ÎN PRELUCRAREA MATERIALELOR NEȚESUTE

Ultimele inovații ale firmei ***Tatham Ltd.,*** din Bradford/Marea Britanie, în domeniul tehnologiilor de prelucrare a materialelor nețesute, printre care sistemul TS Drive pentru carde și noul sistem de control TSX crosslapper, au fost prezentate la târgul internațional *ITMA*, de la Barcelona/Spania. Pe lângă acestea, a fost prezentată gama de sisteme de cântărire TS și de sisteme de acționare a războaielor de țesut cu ace. Compania a prezentat, de asemenea, informații cu privire la liniile de prelucrare a textilelor medicale, liniile pilot și la modernizările cardei pentru lână.
Cu sistemul TS Drive se obține un nivel excelent de performanță și de fiabilitate, de inegalat până în prezent. Combinația dintre tehnologia high-tech și siguranța operațională oferă cea mai sigură metodă de prelucrare a materialelor, în condiții superioare de performanță, cu posibilitatea reglării vitezei.
Prin instalarea sistemului de control TSX și a sistemului de control al greutății pe orice mașină de cardat, este posibilă reducerea consumului total de fibre, produsele fiind fabricate conform specificației solicitate, ceea ce conduce la economii semnificative de materie primă.

Melliand International, august 2011, p. 171

Noi tehnologii

O NOUĂ TEHNOLOGIE 3D

În curând, „3D“ – termenul-cheie utilizat în prezent pentru a descrie ultimele tehnologii inovative, va fi tot mai des întâlnit în sectorul articolelor de îmbrăcăminte pentru sport. Compania ***Toray***, lider în inovație, a reușit să încorporeze toate avantajele tridimensionalității în materiale de înaltă performanță, destinate jachetelor de vânt, ori jachetelor impermeabile și respirabile. Folosind tehnologia 3D (fig. 1), Toray a introdus un nou material tridimensional impermeabil, cu respirabilitate ridicată. Secretul succesului este suprafața tridimensională a membranei sau a peliculei, care face ca căptușeala interioară a materialului să fie uscată și moale, în orice condiții climaterice. Realizate pe baza tehnologiei 3D, jachetele pot fi purtate confortabil în contact direct cu pielea, deoarece, pe lângă faptul că oferă un plus de confort, materialul este extrem de respirabil. Acest efect este obținut datorită structurii tridimensionale, care mărește de câteva ori suprafața de evaporare a transpirației. Umiditatea este imediat transportată spre exterior și, astfel, împiedică producerea condensului sub căptușeala interioară a materialului.

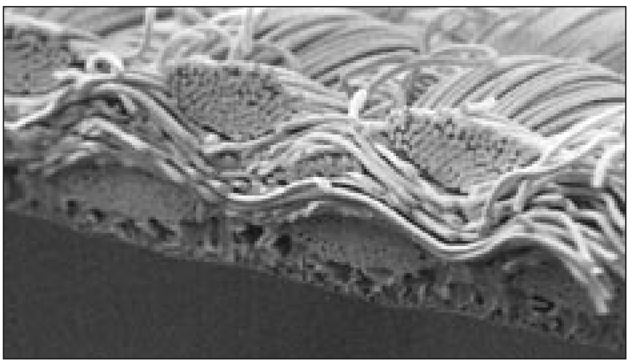

Fig. 1

Caracteristicile funcționale ale acestei noi tehnologii 3D sunt susținute de pelicula Entrant și membrana Dermizax, fabricate de Toray. Robustețea și, totodată, greutatea redusă, elasticitatea și confortul deosebit conferit pielii sunt caracteristicile speciale ale acestui nou concept extraordinar, care ridică din nou standardul pentru funcționalitatea de top.
În plus, Toray lansează o nouă peliculă cu respirabilitate ridicată, destinată realizării îmbrăcămintei sportivilor ce practică diverse sporturi active, care poate fi combinată cu tehnologia 3D.

Sursa: www.toray.de

NOI DISPERSII POLIURETANICE

Compania ***Bayer MaterialScience AG/*** Leverkusen a elaborat două noi dispersii poliuretanice (PU), din linia Impranil, pe care le-a prezentat la târgul internațional Techtextil 2011, desfășurat la Frankfurt/Germania.
Noile dispersii permit obținerea unei producții de piele sintetică durabilă, cu peliculă de înaltă calitate, fără utilizarea de solvenți sau substanțe toxice. Folosind formule cu conținut ridicat de substanțe solide (60%), pelicula de spumă, de o anumită grosime, poate fi aplicată chiar într-o singură etapă, sporind astfel productivitatea mașinii.
Dispersiile PU cu conținut mare de substanță solidă, cum ar fi Impranil DLU, fac posibilă aplicarea unor peliculizări cu spumă flexibile și stabile hidrolitic, pentru huse, tapițerie, dosul mochetei și îmbrăcăminte softshell.
Peliculizările realizate cu Impranil LP DSP 1069 conferă îmbrăcămintei exterioare și altor produse textile o mare rezistență la șoc, fără a le compromite tușeul moale. Mai mult, peliculizările sunt foarte rezistente la lumină, iar atunci când sunt combinate cu izocianat reticulat, de exemplu cu Desmodur N 3900, sunt și rezistente la spălare.

Melliand International, august 2011, p. 125

Aparate de măsură și control

NOI APARATE DE MĂSURĂ ȘI CONTROL

Firma ***Mesdan S.p.A.***, cu sediul în Italia, produce o largă gamă de dispozitive de testare, cum ar fi: echipament Martindale pentru determinarea efectului piling și a rezistenței la abraziune, aparat pentru determinarea rezistenței la rupere a materialelor textile cu conținut de elastomer, aparat pentru determinarea adeziunii și aparat pentru determinarea permeabilității la apă a materialelor textile.
Compania produce, de asemenea, un dispozitiv automat de îmbinare a firelor numit Jointair, destinat semitorturilor din fibră de sticlă, carbon și fibre aramidice, firelor cablate pentru anvelope și firelor industriale.
Beta LaserMike a elaborat un nou sistem de măsurare fără contact, denumit LaserSpeed (fig. 1).

Fig. 1

Acesta monitorizează, în timpul procesului de producție, atât lungimea, cât și viteza materialelor textile țesute și nețesute.
Lungimea și viteza sunt măsurate cu o precizie mai mare cu ± 0,05%, iar reprezentanții Beta LaserMike afirmă că gama lor completă de instrumente pot măsura diferite viteze – de la 0 m/min. până la 12 000 m/min., de la distanțe de până la 1 000 mm, cu o lungime a câmpului de până la 100 mm.

Sursa: www.mesden.it

APARAT PENTRU MĂSURAREA CONTRACȚIEI FIRELOR

Compania ***Testrite***, cu sediul în Halifax/Marea Britanie, comercializează majoritatea aparatelor de testare a contracției firelor către producătorii mondiali de anvelope. Modelul MK5 măsoară contracția firelor din componența anvelopelor, la temperaturi bine controlate, situate între 20 și 250^{o}C.
La acest model, cuptorul și unitatea hardware sunt separate de modulul de control, care are un display cu 16 caractere alfanumerice și 20 de taste tactile, pentru a programa cerințele testărilor.

Testerul *SmartForce* este un instrument ce măsoară contracția și forța diferitelor tipuri de material textile, inclusiv fire industriale și tehnice, materiale din plastic, benzi, filamente, fire monofilamentare, hibride și filate la temperaturi înalte.
Cu ajutorul acestui aparat este determinată contracția termică liberă sau forța de contracție, atunci când materialul este supus unei temperaturi prestabilite de până la 250°C.
Pot fi testate simultan două mostre, având posibilitatea de a măsura contacția liberă și forța de contracție ale ambelor mostre sau contacția liberă a uneia dintre mostre și forța de contracție a celeilalte.
Având în dotare un pachet de programe software pentru PC, testerul SmartForce poate memora rezultatele testărilor, pentru referințe viitoare.
Cuptorul pentru contracția termică Mk 3, proiectat în cooperare cu divizia tehnică pentru anvelope a companiei Dunlop Rubber Co. Ltd., permite testarea unor fâșii de material cu lățimea de 2,5 cm, precum și a firelor mono și multifilamentare.
Mostrele de testare, așezate între două plăci încălzite, sunt supuse unei temperaturi controlate a aerului. Contracția reziduală este măsurată prin îndepărtarea mostrei din zona încălzită și lăsarea acesteia să se răcească.

Melliand International, septembrie 2011, nr. 4, p. 227

Modă

TENDINȚE ALE MODEI PENTRU IARNA 2012/2013

Sezonul de iarnă 2012/2013 nu presupune doar a „ieși în evidență cu orice preț“, ci înseamnă și atingerea unui rafinament sofisticat.
O abundență de fire vopsite, de efect, buclate, bicolore, fire de bumbac acoperite cu lână, crep din viscoză și fire fine cu nopeuri creează texturi vii, un tușeu voluminos și un aspect cald.
În afară de amestecurile din lână cu o tentă de Brit Chic, lâna pură rămâne o tendință importantă în confecționarea îmbrăcămintei.
Țesăturile placate cu aur și catifeaua strălucitoare din aur sugerează faptul că firele pufoase și luxul ocupă un loc aparte în moda acestui sezon.
Catifeaua cu structuri patent este întâlnită nu doar la modelele ultrasubțiri, ci și la cele foarte largi, în stilul anilor ’70.
În afară de țesăturile din lână și catifea, materialele moderne asemănătoare neoprenului, țesăturile ușoare și cele tehno, precum și finisajele elegante mate sunt o provocare pentru moda actuală.
Acestea includ țesăturile fine creponate, din viscoză și poliamidă amestecate cu lână, țesăturile tricotate din urzeală, din poliamidă și fire micromodale, și cele cu față dublă, din crep și satin.
Culoarea continuă să rămână un element central în această iarnă, roșul, albastrul, griul, nuanțele de petrol și de maro fiind preponderente.

Sursa: www.munichfabricstart.de

Diverse

ASPECTUL ECOLOGIC – O PRIORITATE PENTRU *MADEIRA*

Încă de la începutul anului 2011, o mare parte din fibrele de poliester reciclat a fost inclusă în producția de Polyneon 40. Compania ***Madeira*** a depășit astfel, încă o dată, cerințele industriei și, în prezent, adoptă soluții raționale pentru a se asigura că valoarea broderiilor fine este menținută, pe măsură ce deciziile privind protecția mediului au devenit tot mai importante. Producția durabilă de Polyneon 40, obținută de compania Madeira, beneficiază deja de un avantaj suplimentar, datorită caracteristilor ecologice, fiind apreciată de mulți clienți din întreaga lume. Nu există nicio restricție, atunci când este vorba de selectarea culorii și nu se fac compromisuri în privința calității. Datorită experienței sale îndelungate, compania Madeira poate decide cu ușurință care dintre culori sunt adecvate materiilor prime folosite.
Compania a menținut aceleași prețuri și în acest an, chiar dacă costurile de producție sunt cu cca 10% mai mari, din cauza scumpirii țesăturilor crude.
Chiar dacă producția de poliester reciclat necesită mai multă energie, avantajele constau în faptul că nu se utilizează țiței, iar deșeurile rezultate sunt mai reduse. Acești factori au jucat un rol important în alegerea amestecului pentru țesăturile crude.

Sursa: www.madeira.de

ETICHETE PENTRU ARTICOLE DE ÎMBRĂCĂMINTE PRIETENOASE PIELII

Dirk Höfer și Gregor Hohn, de la Centrul de cercetare și service pentru igienă și biotehnologie al Institutului Hohenstein, au prezentat domnului Jörg Weber – director general al Rabe Moden GmbH, eticheta de calitate *„Prietenos cu pielea“* și componenta sa *„Confortabil pentru piele alergică“.*
De câțiva ani, Rabe Moden supune produsele sale unor teste pentru detectarea substanțelor dăunătoare, în conformitate cu cerințele Oeko-tex® Standard 100.
Tendința actuală a consumatorilor este să caute produse durabile, de bună calitate. În acest sens, Jörg Weber afirmă: *„în prezent clienții sunt foarte atenți la ceea ce cumpără și pun, din nou, mare preț pe produsele regionale“.*
Testele de calitate se bazează pe evaluarea efectului total al produselor utilizate de consumator asupra pielii. În acest scop, pentru testare, sunt folosite celule vii, astfel încât rezultatele să fie cât mai aproape de cele reale.
Pentru a li se acorda eticheta de calitate, produsele testate nu trebuie să aibă niciun efect dăunător asupra celulelor umane.
Rabe Moden a adăugat etichetei „*Prietenos cu pielea*“ și componenta „*Confortabil pentru piele alergică*“. Cu ajutorul celulelor imune este evaluat potențialul de a produce alergii al substanțelor care pot fi degajate de proba de material testată.

Sursa: www.hohenstein.de/SITES/presse.asp

CREŞTEREA PRODUCŢIEI DE TEXTILE TEHNICE ÎN JAPONIA

Pentru prima oară, după câțiva ani de stagnare, în 2010 producția de fibre artificiale și de textile tehnice din Japonia a crescut.

Această creștere va continua și în anii următori, datorită faptului că cererea de materiale pentru reconstrucție a crescut brusc, după ce, în martie 2011, nord-estul țării a fost lovit de cutremur și tsunami.

Producția de fibre sintetice a crescut cu 21% în 2010, aceasta fiind prima creștere într-un interval de 10 ani. De asemenea, capacitatea de producție a crescut vertiginos. Producția de nețesute a crescut cu 11%, cea de bunuri textile cu 5%, iar producția de textile consolidate a înregistrat o creștere de 13%. În cazul fibrelor celulozice, producția a crescut cu 11%, atingând cel mai înalt nivel din ultimii ani, similar celui înregistrat în anul 2002.

Melliand International, august 2011, p. 120

ITMF – PRODUCŢIA GLOBALĂ DE FIRE ŞI ŢESĂTURI STAGNEAZĂ

Revenirea puternică la nivel global a producției textile, după nivelurile minime înregistrate în primul trimestru al anului 2009, nu a fost de lungă durată. În trimestrul al patrulea al anului 2010, creșterea producției de fire a stagnat, iar cea a producției de țesături a încetinit. Comparativ cu trimestrul anterior, în trimestrul patru al anului 2010, producția globală de fire a scăzut cu 0,9%. Acest lucru se datorează producției scăzute înregistrate în America de Sud, America de Nord și Asia (–8,5%, –4,1% și, respectiv, –1,1%). În aceeași perioadă, în Europa producția de fire a crescut cu 12,7%. La nivel mondial, producția de textile a continuat să crească ușor, cu 0,3%, în trimestrul al patrulea din 2010. Nivelurile scăzute ale producției din America de Nord (–8,5%) și America de Sud (–7,5%) au fost compensate de creșterile înregistrate în Europa (+7,7%) și Asia (+0,5%).

Melliand International, august 2011, p. 120

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